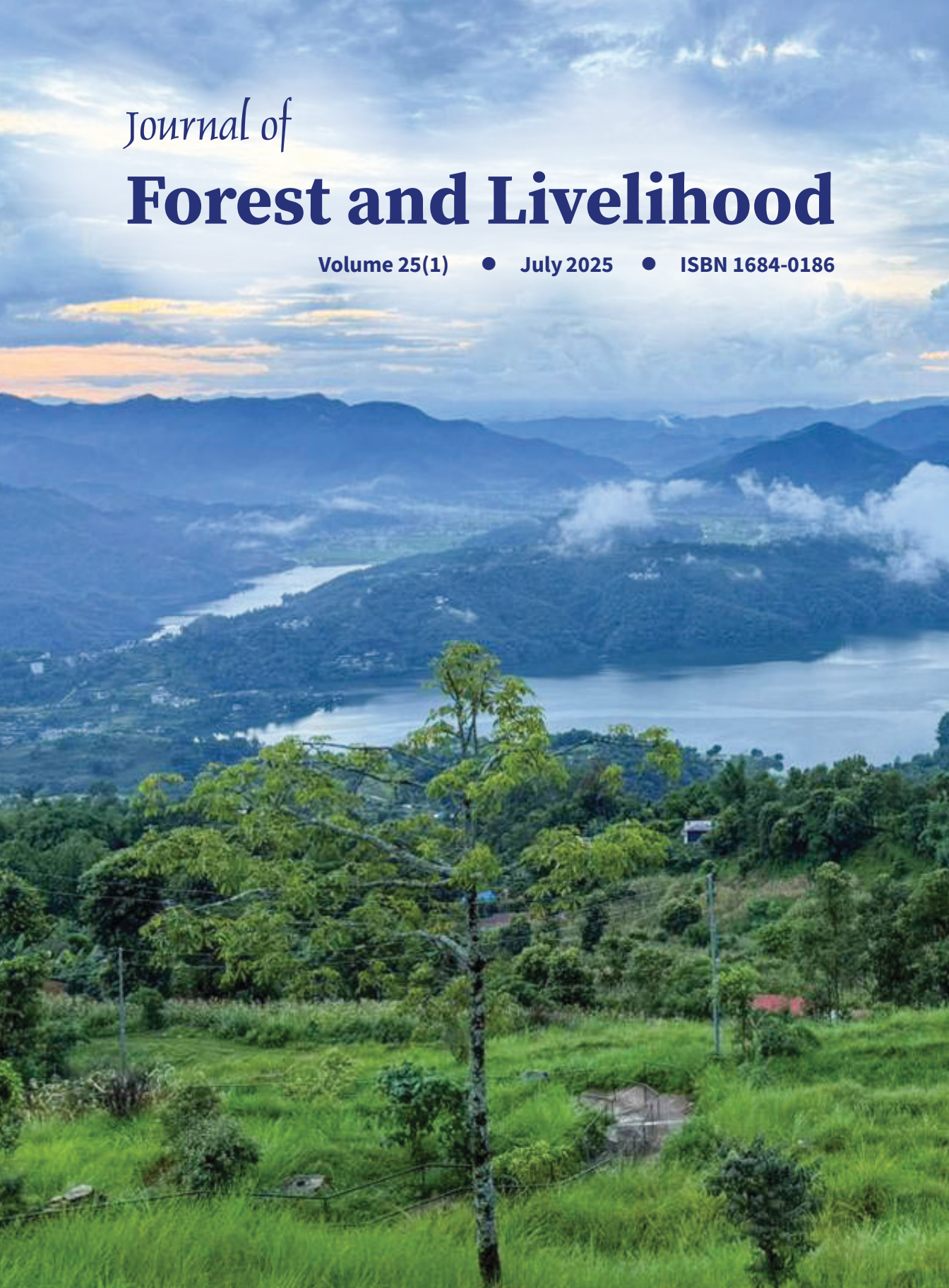

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Guidelines for Contributors

Established in 2001, *Journal of Forest and Livelihood* or *JFL* is a peer-reviewed journal that documents and disseminates the insights, lessons and innovations taking place in sociocultural, political and economic aspects of environmental governance and rural livelihoods in Nepal.

JFL aims to inform environmental policy processes by facilitating dialogue among politicians, professionals, activists, researchers and policymakers. The journal publishes original scientific papers, short communications and review articles. We welcome articles analysing contemporary issues on nature–society interactions that have direct implications on both local livelihoods and resource sustainability. We particularly encourage papers that are guided by critical social sciences perspectives and enriched by insights from deliberative governance, political economy, political ecology, social learning and institutional theories. The authors are fully responsible for the originality of their contributions and formal correctness and for ensuring that their contributions have not been published previously.

Types of contribution: Contributors may consider two options: a) long articles of up to 5,000 words or not exceeding 15 pages, including tables, figures, references, and abstract and b) short technical communications of around 1,500 words or four printed pages. They are required to specify the type of contribution while submitting the article.

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The text in the article should be divided into the following sections: Introduction, Materials and methods, Results, Discussion, Acknowledgement, References, Tables and figures, Legends.

Introduction should outline the main reasons why the research was conducted; describe a brief review of literature consisting of refereed periodicals, journals and books, and the goal of the author/s.

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Formatting: Papers should be submitted in the A4 standard page size, with a 2.5 cm margin on each side, and the font and font size should be Times New Roman 12 pt. The heading levels should be properly identified.

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References: All publications cited in the text should be included in the list of references .

Authors are strongly advised to follow the standard scientific conventions of referencing and format.

Some of the articles in this issue have been drawn from the presentations during the International Conference, Revitalising Community Forestry in the Era of Socio-environmental Crisis, held on March 4–5, 2024 in Kathmandu. The conference was jointly organised by the Government of Nepal and Australian Centre for International Agricultural Research-funded project, Enhancing Livelihoods from Improved Forest Management in Nepal (EnLiFT2). The editors would like to express their sincere gratitude to ACIAR for providing financial support for organising this conference. A sincere thanks to Dr Naya Sharma Paudel, Dr Prakash Bhattarai, Ms Manita Khanal, Mr Yogendra Bikram Poudel and Ms Srijana Sigdel for taking their time out to review this issue. We would also like to acknowledge the managerial support of Mr Amrit Adhikari and anonymous reviewers for their valuable inputs.

Editorial

In this issue of the *Journal of Forest and Livelihood*, we introduce research articles around community forestry that focus on landscape restoration, ecological resilience and livelihood improvement and shed light on how they may lead to sustainable resource management.

The article by Staddon starts off on a broader conceptual approach. Taking macropolitical considerations when discussing resilience, she challenges the dominant narratives with thoughtful commentary on the role of care ethics in moving the conversation away from narrow technocratic understanding towards more politically engaged approaches.

Similarly, Feiersinger *et al.* critically review the effectiveness of community forest operational plans in influencing forest cover dynamics in two community forest user groups (CFUGs) of Nepal. They found that the outcome of CFUGs depends more on how communities engage with management rather than what is written in the operational plan. This suggests that written plans alone are not sufficient, as actual implementation, local engagement and socioecological factors significantly influence outcomes.

Exploring institutional and governance dimensions and reflecting on the importance of local-level institutions in restoration, Dahal *et al.* discuss the significance of community-based forest management in forest landscape restoration. They analyse the overall situation of forest landscape restoration, taking the context of the Asia region as a reference case, with quantitative data. The findings indicate a strong relationship between successful restoration of degraded and deforested land areas and adoption of community-based forestry models.

Villages in Nepal's hills and mountains face significant challenges in water availability for drinking and irrigation. To address the challenges, the Government of Nepal has been implementing ecosystem-based adaptation (EbA) projects to reduce climate vulnerability. Khanal *et al.* present how EbA strategies have enhanced water availability and maintained soil moisture in the hill districts of Nepal. Their findings on the participatory approach and gender sensitivity show the possibility of EbA for local resilience.

Rajbhandari *et al.* study the impact of non-timber forest products (NTFPs) on rural livelihoods, with a specific focus on a *Sishnoo* powder-producing enterprise, and investigate the roles NTFP-based micro-enterprises can play in a economically and socially advancing rural communities.

Invasive alien plant species (IAPS) pose significant threats to biodiversity and ecosystem services, particularly in ecologically sensitive regions like Nepal. Shrestha *et al.* investigate the distribution and ecological impacts of IAPS across altitudinal gradients in Jajarkot district. The article underlines the impacts of IAPS on indigenous biodiversity and advocates specific interventions and effective management.

NTFPs are a vital part of Nepal's economy, providing for people's needs without causing degradation. However, their availability is increasingly threatened by climate change and other human-induced pressures. Noting this issue, Adhikari *et al.* study the status of availability of NTFPs and local perceptions of climate-related changes in forest-dependent communities in a village in Dolakha district. Their findings indicate the need for stronger regulatory mechanisms, sustainable harvesting guidelines and community-led restoration efforts to safeguard NTFPs and strengthen resilience in rural Himalayan landscapes.

Some of the articles in this issue have been drawn from the presentations during the International Conference, Revitalising Community Forestry in the Era of Socio-environmental Crisis, held on March 4–5, 2024 in Kathmandu. This issue offers a broad and integrated perspective of the approaches, obstacles and opportunities for reaching ecological sustainability and improved livelihoods through community forestry in Nepal.

Content

The Politics of Care in Coping Well with Change: Conceptualising and Questioning Care to Move beyond 'Resilience' in Rural Nepal

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Abstract

Care has been described as 'everything we do to maintain, continue, and repair our 'world' so that we can live in it as well as possible' (Fisher and Tronto 1990). This paper centres the role and politics of care in understanding efforts to promote 'resilient' forests and meaningful livelihoods in Nepal. It considers some of the major socio-ecological changes occurring in Nepal, and how the promotion of 'resilience' approaches in the face of these changes has been critiqued as overly techno-managerial and apolitical. As an alternative, the paper draws on Tronto's (2013) care framework to offer a series of questions that help us understand not only how villagers cope with but cope well with change, and to question where responsibilities for caring and resisting certain changes might lie. It is the hope that this paper will enable researchers and practitioners to critically reflect on the role of care in their own efforts to promote 'resilient' forests and meaningful livelihoods in Nepal, and beyond.

Keywords: Feminist political ecology, care ethics, reciprocity, climate change, environmental risk

INTRODUCTION

> *"On the most general level, we suggest that caring be viewed as a species activity that includes everything we do to maintain, continue, and repair our 'world' so that we can live in it as well as possible. That world includes our bodies, ourselves, and our environment, all of which we seek to interweave in a complex, life-sustaining web" (Fisher and Tronto 1990 p.40)*

I have no doubt that most readers of this paper, and of this journal, will care deeply about forests and people in Nepal, and beyond. We are united by our shared sense of care, whether as researchers or as practitioners. It is what drives us to do our work, despite the myriad challenges we face in our workplaces on a daily basis. And this makes sense, given that the quote above highlights that care is at the centre of human activity, which promotes sustainable environments and societies. This realisation is also true of those forests and people that we care about - care is at the centre of rural communities and landscapes across Nepal, ensuring meaningful lives and healthy ecosystems. And yet, care is not something that is typically considered or questioned in projects and policies related to Nepal's community forestry (CF) or the promotion of 'resilience' in forest landscapes and livelihoods. This paper seeks to rectify the lack of attention to care and its relationship to rural 'resilience' in the face of climate change, environmental risks and socio-political changes.

The paper first considers some of the major socio-ecological changes occurring in Nepal, and how the promotion of 'resilience' in the

face of these changes has been critiqued as an overly techno-managerial and apolitical approach to understanding how livelihoods and landscapes cope with change. As an alternative, the paper draws on Tronto's (2013) care framework to offer a series of questions that help us understand not only how villagers cope with but cope well with change, and to question where responsibilities for caring and resisting certain changes might lie. It is the hope that this paper will enable researchers and practitioners to critically reflect on the role of care in their own efforts to promote 'resilient' forests and meaningful livelihoods in Nepal, and beyond.

CHANGE IN RURAL NEPAL

It has been said that 'change is the constant' in Nepal (Nightingale in press) and that crises are endemic (Pain *et al.* 2024). Whilst change is often considered in relation to the climate crisis, environmental risks and natural hazards, these clearly intersect with social, cultural and political-economic change across multiple geographical scales - from the household to the global. Change is not something that happens only in the present moment either; whilst our attention is often focused on sudden shocks and one-off incidents (such as an earthquake or flood event), changes over longer timeframes and that occur more slowly (such as climate change or out-migration), are equally significant in the current conditions of landscapes and lives of communities. The intention of this section is not to document all of the potentially relevant changes occurring in Nepal; however, I review here those that are typically discussed in relation to CF and rural communities.

Nepal is experiencing multiple environmental changes. It is ranked the 4th most vulnerable country in the world to climate change, and suffers from water-induced disasters and hydro-meteorological extreme events including droughts, storms, floods, inundation, debris flow, soil erosion and avalanches (GoN 2016). Temperatures are rising, glaciers are retreating and rainfall is decreasing; on top of which, Nepal is ranked the eleventh most earthquake-prone country in the world (GoN 2016). These climate and environmental hazards lead to the loss of life and livelihoods, and to projected economic costs of 2-3 per cent of GDP per year by 2050 (World Bank no date). Rural communities are considered particularly vulnerable to climate change, as the agriculture they rely on is predominantly rain fed, meaning droughts and floods pose a serious threat to food security, as well as physical safety (CKND 2022). Nepal's 2023 National Adaptation Plan unsurprisingly identifies the three most urgent priority sectors in tackling climate change as: i) agriculture and food security; ii) forests, biodiversity and watershed conservation; and iii) disaster risk reduction and management (UNEP 2023). Initiatives to promote 'resilience' to climate and other hazards in these rural environments, have thus often focused on farm and livelihood-based initiatives like growing apples and other commercial crops, in order to reduce poverty, tackle food security and cushion communities against extreme weather (WFP 2023).

Nepal was, until the 1950s, a deeply feudal and rural agrarian society, but since then it has been experiencing a series of profound political, economic and infrastructural changes, 'compressed' into a relatively short time frame (Sharma 2021). Road construction has been the focus of much development spending, leading to widespread connectivity between urban centres and once remote parts of the country, enabling increasing mobility of both market goods and people (Sharma 2021).

Although the majority of Nepali population is still living in rural areas, the country is one of the ten fastest urbanising countries in the world. Migration from rural areas predominantly involves men and youth, who leave in search of employment, education and other opportunities in urban centres across the country and beyond. Remittances from migration make a significant contribution to Nepal's economy, standing at around 25 per cent of GDP, but it has huge impacts in rural areas, where populations are aging, 'the feminisation of agriculture' is taking place, and farm-forest relations are changing (Poudel *et al.* 2024; Leder 2022; Tamang *et al.* 2014; Paudel *et al.* 2014). Rural subsistence farming and livelihoods are tied closely to local forests, however, interrelated changes are leading to reducing farm sizes, labour shortages, forest expansion and wildlife encroachment (Poudel *et al.* 2024; Khatri *et al.* 2024). Whilst local ecologies and social structures determine pressures on land and economic consequences in specific rural areas (Sugden *et al.* 2022), access to land and labour at the household level is considered key to coping (Poudel *et al.* 2024).

What is understood and experienced by 'the household' is however also changing, with kinship relations and relationships with physical 'homes' shifting (Shneiderman *et al.* 2023), along with intergenerational caring arrangements (Sharma 2021). Changes within 'traditional' family roles are perceived by some older people as 'unjust', as they have state protection and provisions for them (Speck and Muller-Boker 2020), with some older people saying that they 'are not cared for by [our] own children' (Speck 2017 p.434). For over two decades, aged people (i.e., those 60 years of age and over) have been considered marginalised physically, socially and economically in Nepal, with aged women being further marginalised due to patriarchy and gender norms (Subedi 2005). Despite an increasingly aging population, it is argued however that not enough is known about older people and how government and other programmes meaningfully address their needs in Nepal (Tausig and Subedi 2022). Others questions what this means for young people born in rural areas in search of 'freedom' (Sharma 2016), and the 'viability' of their lives during times of multiple social and environmental crises (Jeffrey and Dyson 2022).

Emerging from the decade-long civil war, in 2015 Nepal became a secular democratic federal republic state, with a Constitution that promotes equality for all. Historical inequalities and marginalisation are on-going however, with discrimination based on caste, gender, (dis)ability, age, class and geography is a daily experience in both personal lives and professional settings. Hutt (2020, p.145) highlights that there is a 'huge disparity between the well-resourced, cosmopolitan capital, Kathmandu, and the still very basic living standards in other parts of the country'. Whilst current development trajectories have created new forms of risk and precarity across Nepal (Sharma 2021), inequalities have remained particularly relevant within 'peripheral' rural and agrarian environments (Blaikie *et al.* 2005; Blaikie *et al.* 2000), where the ways in which people experience and are affected by political-economic changes and environmental hazards depends upon their intersectional identities. It is well known for example that women bear the brunt of climate change, given that they are the primary contributors to agricultural work, are responsible for household water needs, are the ones to collect fuelwood for cooking, are the primary care-givers within households, and are most vulnerable to disaster risks given social norms and physical capabilities (ICIMOD 2021).

It is clear that change is 'the constant' in Nepal (Nightingale in press), taking place across multiple spatial scales (from within households to the national level) and with differing temporal dimensions (on a daily basis to generational changes), and all in relation to combinations of impacts from the climate crisis, environmental risks and socio-political shifts, i.e. through 'multiple crises [which] are causally entangled generating collectively higher-level uncertainties' (Pain *et al.* 2024, p.5). Reflecting on the pace of change for a moment; some are sudden one-off events, e.g., a flooding event with significant short-term impacts on individual lives and land, and which typically feature in the media and garner immediate responses from the state and other actors. In contrast to these 'sensational' and 'spectacle-driven' changes, other changes can be slower and take place gradually, and as such may go unnoticed e.g., the 'slow violence' of climate change, with its 'attritional lethality' (Nixon 2013). Slow and sudden changes exist along a continuum of course, and inter-relate in complex ways, e.g., sudden flooding events can cause immediate loss of life or land, but can also cause longer-term mental health issues and anxieties that surface with any new flooding events. The physical and emotional impacts of these changes can thus be negative, but may also be experienced positively, e.g., collective responses and actions to support those impacted by a flood can build a sense of community and of being cared for, and can build practical skills and knowledges necessary to respond to future floods. As such, the ways in which socio-ecological changes and challenges are experienced reflect individual intersectional identities collective responses at household and community levels, and also support offered by the state and non-state actors. We next turn to consider state and other external actor's efforts to help villagers and landscapes to cope with these changes by building their 'resilience', after which we turn to ideas of care in order to understand not only how villagers might cope with these changes, but how they might cope well and lead meaningful lives.

'RESILIENCE' IN RURAL NEPAL

'Resilient' landscapes and livelihoods are the ultimate goal of many climate change adaptation and disaster risk reduction policies and interventions in Nepal. 'Resilience' is derived from the Latin "resilio", meaning "to jump back" or "bounce" (Shwaikh 2023) and in ecological sciences is a useful measure of a system's ability "to absorb disturbance and reorganise while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks" (Walker *et al.* 2004 p.2). Resilience thinking has been extended to social arenas through the concept of 'social resilience', defined as 'the ability of groups or communities to cope with external stresses and disturbances as a result of social, political, and environmental change' (Adger 2000 p.347). These ideas emerged out of foundational work in 'social-ecological systems' (SES), which contributed much by bringing together ecological and social domains and drawing attention to the dynamic relationships between them, highlighting 'uncertainty and surprise, how periods of gradual change interplay with periods of rapid change and how such dynamics interact across temporal and spatial scales' (Folke 2006 p.253). Folke *et al.* (2010) linked resilience with 'adaptability' and 'transformability' to conceptualise how changes may occur over such temporal and spatial scales, with subsequent work exploring the ways in which community resilience can emerge and promote adaptability (Ross and Berkes 2013). Whilst

this work on resilience in social-ecological systems has contributed much, it has been critiqued for its under theorisation of the role of political and economic factors in responding to change, and of its apolitical view of how social change takes place (Cote and Nightingale 2011), as explored further below. Resilience thinking within sustainable development often sees communities as simply 'bouncing back' from moments of shock, as demonstrated for example in the Government of Nepal's National Planning Commission, which writes that 'Resilient communities are capable of bouncing back from adverse situations which confront them suddenly and periodically' (NPC 2011). This paper aligns with the work of Pain *et al.* (2024) in Nepal who argues that 'resilience without transformation…is survival only' (p.5), and thus push to move beyond discourses and programmes of 'resilience' towards thinking and initiatives that promote not just coping with but coping well with change, to ensure not just survival, but meaningful lives and livelihoods.

Whilst resilience has become a global buzzword, it is argued that it has a long history in Nepal (Nightingale in press). Nightingale (in press) suggests that the Theory of Himalayan Degradation (THED) (i.e. that Himalayan hillsides were being degraded from an assumed stable climax habitat due to a combination of over-population, poverty and ignorance) (Eckholm 1975), marked the start of international interest in the 'resilience' of Nepal's hills and mountains. During the 1970s and 1980s, responses to THED and initiatives to involve communities in the management of local forests shifted understandings to appreciate the dynamic nature and inherent instability of the Himalaya, and to recognise the importance of villagers' relationships with forests and active use of forest resources. Subsequently, through Nepal's globally-renowned community forestry programme, rural villagers have generated livelihood benefits and extensive forest restoration, and have been supported in adapting to a changing climate and responding to other environmental risks. Assumptions remain however that villagers need their 'capacities built' and that they require external knowledge and technical assistance in the form of livelihood diversification to do so. Nightingale (in press) highlights, though that whilst a prior focus on:

> *'Adaptation implies a need for change and helps to emphasise the problems local people face are not of their own making... [that, the current focus on] Resilience, in contrast, firmly places the burden on local people. If they do not have the right knowledge and skills, they will fall victim to climate related disasters. This logic neglects that for many people, they will not be able to avoid harm or bounce back. Losing all of one's agricultural land to a GLOF [Glacial Lake Out Flow] is not a case of lacking knowledge or skills. It is a simple loss of livelihood resources. Furthermore, the shift to resilience has made climate change interventions more technical, rather than less'.*

Technical and technocratic approaches to climate change adaptation and 'resilience' building have been discussed and critiqued worldwide. Eriksen *et al.* (2021) for example reviewed 34 internationally-funded climate change interventions aimed at community adaptation, finding that many inadvertently reinforce, redistribute or create new sources of vulnerability, in part due to inadequate understandings of historical and on-going socio-political processes meaning that the resilience of some is related to and gained at

the expense of others. In other work, Eriksen *et al.* (2015) highlight the political nature of such climate change interventions, arguing the need to engage with multiple knowledges of what being able to cope with climate change requires, and shifting discourses and assumptions about who is 'vulnerable' and why (Arora-Jonsson 2011) and what is required in order to transform presumed vulnerabilities. In Nepal, Nightingale (in press) argues that rural villagers are necessarily 'resourceful, observant, creative, and able to embrace change. In other words, they are already resilient to climate change, they are already experiencing climate change; this is not something in the future for them' (p.X). Supporting such academic findings, 'The State of Gender Equality and Climate Change in Nepal' (ICIMOD 2021) report finds that whilst the Government of Nepal is committed to gender equality and social inclusion, its efforts to integrate this with regards to climate change have been dominated by technical and technocratic activities. The report argues that whilst;

> *'Policies do focus on addressing the vulnerabilities of women and marginalised groups, they...continue to regard these groups as vulnerable and lacking the knowledge and experience to address the impacts of climate change. This view of women and marginalised groups as beneficiaries or passive recipients of policy formulation and projects, rather than as influencers and agents of change, ignores the critical role that women play in addressing everyday impacts of climate change, denies them agency, and leads to low investments in budgetary allocations for human resources and capacity building [of government staff]'.*

In order to refocus and reframe climate change adaptation and resilience efforts, to make them inclusive of lived experiences, multiple knowledge and on-going daily decision-making and rural practices – as well as the limits of these - Ensor *et al.* (2019) call on researchers and practitioners to 'ask the right questions'. Rather than asking about climate change (only), they call on us to ask questions about change in relation to both wider socio-ecological shifts and climate change interventions and policies themselves, and to do so through epistemological frameworks better able to explore how change and coping with change actually occurs. Cote and Nightingale (2012) too, argue that the extension of ideas of resilience to social settings 'has important limits, particularly its conceptualisation of social change' (p.475). One approach that is well placed to reveal how people cope with change, is to focus on the role of emotions in nature-society relations (Gonzalez-Hidalgo and Zografos 2020; Sultana 2015). Reflecting on the emotional geographies of climate change, Sultana (2022) e.g., asks: 'Do we always have to pretend to be resilient, show how we've overcome difficulties, display the positive sides to our humanity, showcase our vitality, make nice – when do our complex realities and emotions matter beyond positive spins of strength and resilience?' (Sultana 2022 p.11). Whilst to be resilient - as an individual, a community, or an ecosystem - is typically to be seen as embodying and exemplifying positive attributes of strength and an ability to thrive in the face of adversity, Shwaikh (2023) highlights its use as a political tool that 'pass[es] the burden of coping…to individuals instead of tackling the root causes' (p.3). She draws attention to resistance to resilience narratives from around the world, connecting responses to disasters such as Hurricane Katrina in the US to responses to political conflicts in Northern Ireland and Palestine, sharing the words of US writer Zandashé l'orelia brown;

> *'I dream of never being called resilient again in my life. I am exhausted by strength. I want support. I want softness. I want ease. I want to be among kin. Not patted on the back for how well I take a hit. Or how many? Instead of hearing "You are one of the most resilient people I know," I want to hear "You are so loved," "You are so cared for," "You are genuinely covered."'*

In seeking to move beyond techno-managerial and apolitical approaches that promote 'resilience' in rural Nepal (and beyond), the paper centres and explores an ethics of care as one lens through which we might understand how villagers not only cope with, or survive, on-going socio-ecological changes, but how they might cope well with them, in order to live meaningful lives and in turn, support healthy landscapes. Further, centring the politics of care offers opportunities to move beyond the limits of resilience approaches in how they ignore the root causes of changes (such as climate change causing GLOFs which take away villagers' agricultural land, from which they simply cannot 'bounce back'), as it draws attention to questions of responsibility and accountability in acting to resist and respond to certain forms of change.

CENTRING 'CARE' AND A 'POLITICS OF CARE'

As shared in the opening quote of this paper, care is 'everything we do to maintain, continue, and repair our 'world' so that we can live in it as well as possible' (Fisher and Tronto 1990). The importance of care work for society; that is tending to others, cooking, cleaning, fetching firewood and water is increasingly recognised as essential for families, communities and the wider economy, particularly so because of aging populations around the world, due to cuts to public services and social protections, and as the climate crisis impacts livelihoods and means increasingly living with environmental risks (Oxfam 2020). Care work is also important with regards to nature, for example the stewardship of specific ecosystems and habitats by those who live there, as well as care (or lack thereof) shown towards global environmental 'resources' or commons including the atmosphere, biosphere and hydrosphere. Caring for society and caring for nature is of course related and is often reciprocal, and care is an essential element in the (re)making of social-ecological relationships over space and time (Kimmerer 2024; Kimmerer 2013). There is a politics to care work in nature-society relations; however, given how care/lack of care is connected to processes of marginalisation and inequality, as well as to possibilities for transformation and justice. This demands the centring not only of care but also of the politics of care, when considering rural livelihoods and landscapes in Nepal, and beyond. I now explore these things more fully.

Care work is essential for all life on earth, yet is often performed by and at the expense of marginalised people and environments around the world. Globally, domestic care work – whether unpaid or (under)paid – is typically done by women and girls, and by those who experience discrimination based on race, ethnicity, caste, nationality and sexuality (Oxfam 2020). When it comes to conserving biodiversity, it is well known that Indigenous Peoples and Local Communities (IP and LCs) can be highly successful in stewarding and protecting ancestral and other territories based on 'traditional ecological knowledge' and customary practices (Fa *et al.* 2020; Sze *et al.* 2021; Dawson *et al.* 2021; Pascual *et al.* 2023). A recent statistical analysis of 170 peer-reviewed empirical studies for example,

reveals that significantly more positive ecological outcomes are associated with the most equitable forms of governance i.e. those involving equal partnerships with and control by IP and LCs (Dawson *et al.* 2024). Directly connecting conservation and care, Esbach *et al.* (2024) discuss the indigenous praxis of the Cofàn community of Zàbalo in the Ecuadorian Amazon, *tsampima coiraye* or 'care for the forest', and their concept of *purifama atesuye* which represents a 'critical politics of abundance', which they argue stands in direct contrast to Western conservation approaches and their 'colonial assumptions of damage, noble savagery, and the scarcity of natural resources as the driving motivator for environmental stewardship' (p.838). Notions of 'abundance' help us to see care not as a 'burden' but rather as linked to flourishing, and thus the promotion of healthy ecosystems and meaningful lives. In Nepal, where 36 per cent of the population comprise IPs, and where LCs are involved in managing 40 per cent of Nepal's forests, there is clear evidence that IP and LCs promote the care and conservation of not only forests but also biodiversity, water and a range of other 'natural resources' (Oldekop *et al.* 2019; Koirala 2021; World Bank 2024).

Despite the important care work performed by IP and LCs in conserving environments worldwide, they are typically marginalised in conservation decision-making across multiple scales, and are increasingly threatened by the '30 x 30' agenda and other protectionist conservation approaches that can lead to IP and LCs displacement, livelihood restrictions and human rights abuses (Brockington and Igoe 2006; Adams and Hutton 2007; Dowie 2009; Survival International no date). In Nepal, the negative impacts of mainstream conservation on IP and LCs has been recognised for some time (Paudel 2005) and it has been argued that whilst it 'is often held up as an exemplary conservation success story [that] unfortunately, that success has come at a high price for the country's Indigenous peoples, who had lived in and depended on these protected areas for generations' and yet suffer forced evictions, restricted access to food and resources, and arbitrary arrests and other ill-treatment and excessive use of force (Amnesty International 2021).

Whilst care work for society and the environment is often unpaid or underpaid, goes unrecognised and undervalued, and is performed by those who are marginalised within society and suffer on-going inequalities, care also holds positive political and ecological potential and possibilities. Working in situations of armed conflict, Krystalli and Schulz (2022) counter a typical focus on violence and suffering and instead recommend that scholars centre love and care in their research 'as practices and potential sites of politics that shape how people survive and make sense of violence as well as imagine and enact lives in its wake' (p.1). Feminist writer Bell Hooks' (1993) writes on 'love', arguing that love is not only something experienced between individuals or for personal satisfaction, but rather has political significance at the societal level, as it stands directly against patriarchy, racism and all other forms of domination and discrimination. Feminist political ecologists have highlighted the political role of care in nature-society relations (Sultana 2015; Nightingale 2011; Gururani 2002), arguing for example that in order to advance climate justice;

> *'we need to re-imagine 'caring for climate' through a 'caring economy' (or what some refer to as the 'solidarity economy'...), and re-embed the economy (and 'sustainability') in social and ecological*

> *relationships guided by the principles of cooperation, sharing, reciprocity, and intersectional environmental justice...This means care work must be fundamentally construed as environmental change work and vice versa' (Di Chiro 2019 p.306-7).*

Di Chiro (2019) argues that to decolonise environmental and climate policy there must be learning from cultures with highly refined knowledge systems and practices of care and reciprocity, and cites the work of feminist scholar-activist Zoe Todd (2016) that;

> *'...reciprocity, love, accountability, and care are tools we will require to face uncertain futures and the end of worlds as we know them. Indeed, this ability to face the past, present, and future with care – tending to relationships between people, place, and stories – will be crucial as we face the challenges of these times' (p.308).*

Working with care and through an ethics of care are seen to hold potential to shift dominant knowledge systems in sustainable development (Harcourt *et al.* 2023), and to deliver socio-ecological justice (Narayanaswamy *et al.* 2023). This, however, implicates and includes us as researchers and practitioners, in line with calls in Nepal to reflect on our own roles in transforming environmental governance (Ojha *et al.* 2022). We must critically reflect on our own positionalities, engage our emotions, and embody an ethics of care in order to cultivate awareness of the power dynamics embedded in our work, and to shift those to promote greater social and environmental justice (Ravera *et al.* 2023; Staddon 2022; Staddon *et al.* 2023). Seeing our own vulnerabilities in the face of change and crises as related to (and not necessarily different from) those with whom we work, and linking lived experiences, can help to avoid colonial practices of othering in our research and practice (Eriksen 2022). The centring of care and care work is clearly of relevance to those of us interested in understanding social and environmental sustainability; not least because of the political nature of care giving and its relationship to both deepening but also potentially transforming inequalities and injustices. In order to explore and understand the material outcomes and political potential of care and care work in Nepal's rural landscapes and communities, I next present a conceptual framework and series of questions through which we might do so.

CONCEPTUALISING AND QUESTIONING CARE IN COPING WELL WITH CHANGE

Drawing together the various strands of this paper – the socio-environmental changes occurring in rural Nepal, the need to move beyond techno-managerial 'resilience' approaches in responding to these changes, and the material importance and political potential of care and care work – I now present a framework for centring questions of care in our understandings of how Nepal's rural villagers and landscapes are coping with change, and where responsibilities for caring might lie so that they can cope well and live meaningful lives and support healthy ecosystems.

Tronto - the eminent scholar of care and care ethics – argues that 'care can serve both as a moral value and a foundation for the political success of a good society. It offers a way to change paradigms, move beyond moral boundaries, and advance towards more just and caring societies. Realising this, however, requires that we analyse how today's society views care and what power dynamics are involved' (Jounou and Tronto 2024 p.269). Tronto's work validates the discussion above of care as a value of many

IP and LCs, and as a practice with material outcomes; it also reaffirms the political dimensions of care and care work, as often performed by marginalised communities and simultaneously disregarded and undervalued in economic terms. In response to, and in order to resist, increasing neoliberalism (with its focus on the individual and personal self-interests), Tronto (2013) offers a set of principles or phases necessary for taking responsibility for and promoting care; caring ABOUT, caring FOR, care GIVING, care RECEIVING, and caring WITH.

This framework has been adopted and adapted by others in various ways (Lemon and Boman 2022; Groot *et al.* 2018; Brannelly 2018), including in relation to understanding 'green care' practices and practitioners in Finland (Moriggi *et al.* 2020). Moriggi *et al.* (2020) argue that green care is 'a relational achievement attained through iterative processes of learning' between people and nature (p.1). The relational nature and transformative potential of care-centred environmental governance has also been highlighted in the UK, as a way to resist neoliberal and hyper-bureaucratic structures (Giambartolomei *et al.* 2023). Here I use Tronto's five stage framework to unpack and question the role and politics of care in how villagers and forests respond to and cope with change, and how they are supported in that by state and other external actors. I consider each of the five principles in turn next, offering some initial thoughts on what this might mean for rural Nepal based on the literature reviewed above; I hope that future research may provide detailed empirical insights on these. I end with a series of questions that future research might ask in relation to each principle, firstly of rural communities, and secondly of policies and programmes aimed at supporting them.

Whilst the five principles are presented in Tronto's framework as distinct phases, they of course inter-relate in ways that make their neat separation impossible in practice.

Caring ABOUT (attentiveness)

The first principle of care in Tronto's (2013) framework is caring about i.e. recognising a need for care (Tronto 2010). This phase involves the moral quality of attentiveness. Conceptualising caring about urges us to ask questions of who or what is – or is not – cared about and paid attention to, both by policy-makers and practitioners and within rural communities.

As established at the start of this paper, we, as researchers and practitioners, arguably all care about Nepal's forests and people, it is what unites us. Caring about i.e. attentiveness to, Nepal's forests and people is also arguably at the heart of government policies and the initiatives of a wide range of state and non-state actors. As reviewed above however, those policies and programmes can be overly techno-managerial and apolitical, and can thus miss the differentiated needs of members of diverse communities, and can even contribute to on-going marginalisation within those, based for example on gender. Recognising the need for care in general does not necessarily mean attention is given to those who have the greatest need of care, which can be construed as a lack of care about certain people or environments, such as for example aged people within rural areas of Nepal.

Within rural communities and landscapes, people may care about and are attentive to a whole range of things; from families and friends living near and far, to the provision of education and health facilities, from access to land and labour for subsistence farming, to

the use and management of local forests, from the impact of sudden flood events, to the 'slow violence' of climate change, and from the vital financial flows from remittances, to the ability to acquire the latest technology and engage in 'modern' lifestyles. As reviewed above, the composition of rural communities and experiences of the household are shifting in response to out-migration and the global capitalist economy (among other factors), with age an increasingly significant factor in what individual villagers may care about with regards the sorts of things listed above.

Caring FOR (responsibility)

The second principle of care in Tronto's (2013) framework is care for i.e. taking responsibility to meet that need for care (Tronto 2010). This phase involves the moral quality of responsibility. Conceptualising caring for urges us to ask questions of who does – or does not – take responsibility in caring and care giving, for a range of people and environments.

Whilst caring about something or someone is arguably easy, as it simply involves attention but no actual care giving, caring for that thing or person involves stepping up to deliver on our attention to their need of care. Caring for in terms of policies and programmes aimed at supporting the care needs of rural communities and landscapes as they face on-going socio-ecological changes, means more than drawing attention to those needs, but rather for example providing sufficient financial and human resources in order that the work of caring for them can actually be delivered, both in the short-term but also long-term. A lack of care for rural villagers may be experienced for example when government acts, such as the Constitution and processes of federalisation, are not delivered upon in practice, meaning (as discussed above) that whilst urban centres enjoy 'modern' amenities and access to health care and education for example, these remain lacking in rural areas, and thus for the majority of Nepali citizens.

As reviewed above, responsibilities and opportunities for providing care for family members are shifting, with those 'left behind' in rural villages responsible for the everyday caring for family – and friends and farms and forests, whether in fact they care about them or not. With rural populations aging, caring for human and non-human others, is increasingly the responsibility of those who are older, whether they have the capacity to deliver that care or not. Of course, caring for others can take many forms, both physical, financial, emotional and spiritual (as explored next), meaning that family members who have migrated can care for those in their household through the sending of remittances and through trips back to villages at particular times of increased care needs. Importantly, it may be argued that migrants are caring for their families by sacrificing their own needs and desires, to move for work (often for extended periods of many years), that will allow them to send much needed financial capital that is unobtainable in rural settings.

Care GIVING (competence)

The third principle of care in Tronto's (2013) framework is care giving i.e. the actual physical work of providing care (Tronto 2010). This phase involves the moral quality of competence. Conceptualising care giving urges us to ask questions of what form care giving takes, how it is manifested and how well it is practiced by a range of different actors.

The physical work of care giving by the state and non-state actors can be seen in the form

and content of policies and programmes developed, and in the practices adopted by policy-makers and practitioners. Current approaches that promote 'resilience' in rural areas, as discussed above, often focus on specific market-based livelihood diversification initiatives, such as growing apples, or involve the building of villager 'capacities' and technical knowledge. Such techno-managerial and apolitical approaches have been critiqued due to the lack of awareness of and attention to the already existing abilities and knowledges of those already living with a range of environmental risks, including climate change. The ways in which on-going relationships of care giving existing in rural communities and landscapes are thus invisibilised by the focus on technical capacities in such initiatives. At the same time, the giving of care through for example healthcare provision or pensions from the state, are often seen as insufficient in supporting rural household needs, particularly at times of sudden crisis such as following an earthquake or landslide.

As mentioned above, the physical work of care giving within rural communities and households can take many forms, from the daily provision of cooking and cleaning by those close by, to the sending of remittances by those who have moved far away. The physical work of providing care to forests, farmlands and animals is very much the responsibility of those who remain in rural areas however. It is widely recognised that with shifting rural demographics, the work done by Community Forest User Groups (CFUGs) is changing, with reduced capacity and interest in many areas for active forest governance. The reduced use of forest resources and provision of care to forests, for example through the lack of maintenance of fire breaks, results not only in changes in forest structure and composition, but also in the reduction of local embodied knowledge of the sustainable use and harvesting of forest products, and of the forest territory itself. Practices of care giving, and changes of these, have consequences not only for those human or non-human others who receive that care, but also impact the care givers, and their epistemic, material and emotional relationships with local environments.

Care RECEIVING (responsiveness)

The fourth principle of care in Tronto's (2013) framework is care receiving i.e. the evaluation of how well the care provided had met the caring need (Tronto 2010). This phase involves the moral quality of responsiveness. Conceptualising care receiving urges us to ask questions of how is the reception of care experienced, and how well or not it is felt to respond to the need for care in the first place.

It is perhaps a little hard to judge how well policies and programmes aimed at supporting rural communities and landscapes through on-going socio-ecological changes are received and experienced, as seldom are project 'beneficiaries' asked about their perceptions of participating, or about how well project procedures and outcomes align with their own needs. When communities' experiences and opinions are sought, it tends to be by those initiating or associated with the project itself, and through a fairly constrained range of tools and methods which struggle to capture an honest reflection or meaningful evaluation of how the project had met their needs, both materially and symbolically. Such community consultations are all too often at the end of projects too, rather than at the start, which is when people would be better able to reflect on past experiences, assess current needs, and then feed into the design of future projects. Potential opportunities to hear people's evaluations of care or support they have been given, would be when they

have the chance to vote for elected members of local or national government, when they vote for and reward those from whom they have received positive experiences of care, and conversely when they may show their displeasure by not voting for those whom they perceive not to have cared for them or their needs. Other opportunities to understand experiences of care receiving come in the form of public protest, when people are driven to demonstrate against experiences of injustice and marginalisation, which we may see here as essentially about the reception of a lack of care.

Within rural communities, the experiences of and responses to receiving care are perhaps more obvious. Care can be experienced in the receiving of food given to a hungry neighbour, or the reception of remittances sent by faraway relatives for example, both of which may engender a positive material response (i.e. the satiating of hunger, or funds necessary for accessing local health facilities), but also an emotional one, where by the recipients may feel cared for, attended to, remembered and loved. Experiencing a perceived lack of care can generate a very different range of feelings and responses however, including in relation to the environment. With changing farm-forest relations and forest expansion in rural areas across Nepal, comes increasing human-wildlife conflicts in the form of crop predation by monkey, porcupine and deer. Due to a perceived lack of care on the part of the state to do anything meaningful to tackle these conflicts, some villagers have been known to set retaliatory fires in local forests; this response demonstrating clearly the anger they feel at being uncared for. Giving and receiving care are clearly relational experiences, connecting people and the environment, with consequences for both.

Caring WITH (reciprocity)

The fifth and final principle of care in Tronto's (2013) framework is caring with i.e. where caring needs to be consistent with democratic commitments to justice, equality and freedom for all (Groot *et al.* 2018). This phase involves the moral quality of reciprocity or trust and solidarity. Conceptualising caring with urges us to ask questions about the politics of care including: who performs care work, what forms of care work are made in/visible, who does not do the care work for which they are responsible, how can those not providing care be held accountable, and what forms of resistance to injustices are possible through practices of reciprocity and solidarity.

The example mentioned above, of the giving of food to a hungry neighbour, who receives it as a material and emotional gain, can also evolve over time, and be responded to and replicated when the giver of food themselves experiences hunger and the neighbour who received their gift of food now becomes the giver. This reciprocal caring with is the basis of the moral economy, evident in many subsistence communities around the world, at least until their disruption by the capitalist economy. This reciprocity is the basis also of 'resilience', whereby villagers are better able to cope with situations of food insecurity through the receiving of care given by their fellow villagers. Whilst not a perfect system (and one which can for example recreate caste-based injustices by excluding particular castes from these reciprocal relationships), this form of caring with is not typically visibilised in efforts to promote 'resilience', nor is it the focus of policies or programmes. All too often, community-based 'participatory' initiatives are in fact top-down efforts to impose pre-determined targets and obligations onto community 'beneficiaries', in relationships that demand compliance rather than seeking to build trust or solidarity with

communities and their own knowledges and ways of working.

As rural communities are aging, caring with necessarily entails reciprocity amongst older villagers, with age rather than necessarily caste or gender, being increasingly significant in relationships of care. As reviewed above, whilst older people can feel 'left behind' in rural areas and a burden to their younger relatives, this simultaneous sense of a lack of care but yet a need for care, provides a common lived experience from which to build strong relationships of reciprocity. Whilst migrant family members may do all they can to send financial resources to elderly rural relatives, they still expect the state and other non-state actors to support them through the provision of healthcare and pensions that allow them a healthy and meaningful life. Holding these actors to account for a perceived lack of care to aged rural populations, however, is hard, as the elderly are already marginalised within society and face age-based injustices. It may also be hard for them to hold other community members accountable when they see them not taking responsibility for necessary care work, for example, when younger people are not interested in the 'drudgery' of farming or work in the forest. Working together however, through mutual support and solidarity, may be the best option for rural communities in coping with change.

The questions and issues raised above by conceptualising care according to Tronto's five stage framework, are by no means exhaustive, they are just the start of thinking through what the centring of care might mean in attempts to understand how rural communities and landscapes are coping in the face of constant change, and what might be done to respond to the needs identified in this way. In order that researchers and practitioners can put these concepts of care to use in their work, a series of questions are offered in Table 1. These are intended as a way to help draw attention to care i.e. to recognise the need to care about care, as well as a way to care with through our work that centres justice and equity.

Table 1: Questions of care that may be asked to better understand how Nepal's rural communities and landscapes are coping with change, and where responsibilities for caring might lie (following Tronto's (2013) five stage ethics of care framework)

Principle of care (and: moral quality)	Questions to be asked of: Rural communities and landscapes	Questions to be asked of: Policies and programmes
1. Caring ABOUT (attentiveness)	• What and who is cared about within rural settings? • What and who is not cared about within rural settings? • How is care and attentiveness different for individuals within diverse communities?	• What and who is cared about within policies and programmes? • What and who is not cared about within policies and programmes? • How is care and attentiveness to differential needs and to lived experiences demonstrated in these?
2. Caring FOR (responsibility)	• Who takes responsibility for care work in rural settings? • Who does not take responsibility for care work in rural settings? • How do responsibilities differ between those living in or away from rural areas?	• How do policies and programmes demonstrate their responsibility for care work in rural settings? • Which policies and programmes demonstrate a lack of responsibility for care work in rural settings?

3. Care GIVING competence)	• How is care giving manifested within rural settings – through what forms of physical work, financial resources and emotional support? • How well is care giving learnt about and practiced by different members of diverse communities?	• How is care manifested within policies and programmes – through what forms of physical, financial and other provision and support? • How well is care giving learnt about by practitioners, by drawing on lived experiences and needs of villagers?
4. Care RECEIVING (responsiveness)	• How is the reception of care experienced by rural communities – materially and emotionally? • How is the reception of care experienced differently by individuals in diverse communities? • How is a lack of care received and responded to within rural settings?	• How do policy-makers and practitioners seek to understand rural communities' experiences of receiving policy/project-based care? • How do policy-makers and practitioners respond to communities' actions expressing frustrations at a perceived lack of care by the state and others?
5. Caring WITH (reciprocity)	• What practices and relationships promote reciprocity and sharing? • Who is and who is not involved in reciprocal relationships in rural settings? • How individuals within diverse communities are held accountable when they do not care about or give care when needed?	• How might policies and programmes seek to understand reciprocal caring relationships in rural settings? • How might policies and programmes seek to promote reciprocal caring relationships with and within rural settings? • How might policies and programmes be held accountable for a lack of trust in and care for diverse rural communities?

Highlighting the inherently and intimately political nature of care, Tronto asserts that 'care does not belong in the private sphere, is not natural, and cannot become a commodity. Rather, care is something for which we are collectively responsible' (Jounou and Tronto 2024 p.270). To conclude this paper, I summarise what centring and questioning care, as something public, as something that can be cultivated through embodied actions and emotions, and as something relational, reciprocal and for which we are jointly responsible, means for understanding and supporting rural villagers and landscapes in Nepal, and how we as researchers and practitioners can lean into the responsibility for care that we collectively hold.

CONCLUSIONS: CONSEQUENCES OF CARE AND CARING FOR NEPAL'S RURAL FORESTS AND VILLAGERS

It is the hope that this paper will generate an interest in and enable researchers and practitioners to critically reflect on the role of care in their own efforts to support healthy forests and meaningful livelihoods in Nepal, and beyond. In order to do so, I have highlighted some of the major socio-environmental changes occurring in rural Nepal, I have reviewed literature that suggests a need to move beyond techno-managerial 'resilience' approaches in

responding to these changes, and as one way to do that, I have engaged with scholarship which draws attention to the material importance and political potential of care and care work. I then presented Tronto's (2013) five stage framework for understanding the ethics of care, and offered a series of questions that can help us centre care in our understanding of how Nepal's rural communities and landscapes are coping with change, and where responsibilities for caring might lie.

Drawing on ideas of care and Tronto's (2013) framework enables us to recognise, better understand, and potentially to visibilise the role of care in how rural communities are coping with change, and what coping well entails. This is important, given that change is the constant in Nepal (Nightingale, in press) and as researchers and practitioners interested in how people respond to change, we must be asking 'the right questions' (Ensor *et al.* 2019). Scholars of care, including feminist political ecologists, see questions of care as the 'right ones' to be asking, as they view care not as some private or passive act, but rather as public and political practices which offer potential for more just and transformative futures (Harcourt *et al.* 2023; Di Chiro 2019). Asking questions of care allows us to surface who and what is/is not cared about, who takes responsibility in caring for others, what the work of giving care actually involves, and what it means to those who receive it. Importantly, these questions surface the political and ecological consequences and possibilities of care, for example, through calls for accountability when those deemed responsible do not give care, and in how care work is acknowledged. This centring of care and caring highlights the importance of reciprocal relationships and solidarities. It also decentres specific moments of 'change', such as an earthquake or landslide disaster, and instead centres the role and politics of care in how rural communities and landscapes are coping with ongoing social and environmental changes, operating at multiple spatial and temporal scales.

Centring questions of care also brings to the fore our own relationships and responsibilities with regard to Nepal's rural communities and forests. This paper started with fact that we all 'care' about them, but that we do so in different ways and with different outcomes, given we are all positioned differently and so the outcomes of our work are of course diverse. One of the central outcomes of centring questions of care is that it becomes obvious that we are a part of – not separate to – these (rural) webs of care and caring. Rather than 'Othering' communities and places we work with and for, we should recognise and visibilise our own (caring) relationships to them, and consider ways in which our relationships of care/uncare might be no different from theirs (Eriksen 2022). We may wish to adopt feminist and care-centred research methods and policy approaches that recognise, visibilise and engage with care and caring (Brannelly and Barnes 2022; Harcourt *et al.* 2022). This will not only help us to better recognise and promote meaningful lives and healthy ecosystems in rural Nepal, but can also challenge the systems and structures that dominate us all, and that hamper efforts for global sustainability and meaningful lives.

Sultana (2022) argues that 'Dominant discussions around climate change tend to make it seem apolitical, as a physical phenomenon to be fixed with technology and finance, instead of a restructuring of relationships to ecologies, waters, lands, and communities we are intimately, materially, and politically connected to' (p.10). This paper has centred care and the politics of

care as one way of understanding shifting relationships amongst rural villagers and forests in Nepal in the face of climate and other changes, with the aim that these relationships might be restructured through our efforts as researchers and practitioners, into something more caring and just.

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Impact of Operational Plans on Forest Cover Area: A Comparative Study of Community Forests in Nepal

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Abstract

Within the middle hills of Nepal, operational plans (OPs) were found to prescribe the same operations, irrespective of species composition, forest conditions, and forest management objectives. It is not clear how, and to what extent, the OPs play a role in practical forest management, or whether they are followed by the members of the community forest user groups (CFUGs) and how this affects the forest cover area. This study assesses whether differences in forest cover area between two community forests can be explained by differences in their OPs and their implementation by the respective CFUGs. To achieve this, three methods were applied: forest cover area measurements using annual landcover data, a directed content analysis of the OPs, and ground truthing through interviews and Likert scale questionnaires. Results revealed a significant difference in the forest cover area: Machhedanda CFUG showed more fluctuation compared to Baluwa Bhanjyang CFUG. The CFUGs differ in OP focus, with Machhedanda more focused on socio-economic development and Baluwa Bhanjyang prioritising forest conservation. Both CFUGs faced communication challenges and struggled to fully implement their OPs. These findings suggest that forest cover area outcomes are not solely influenced by written plans, but also by how CFUGs engage with and implement them.

Keywords: Forest cover area, operational plan, community forest, likert scale

INTRODUCTION

The community forest program has shown a remarkable success in forest cover growth over the last 30 years (Acharya *et al.* 2022); however, it is still in development. The Nepalese government implemented community forest programs since 1978, with 28 per cent of forest areas now managed by Division Forest offices (DFO, formerly District Forest Offices) and community forest user groups (CFUGs) (DOF 2017). Operational plans (OPs) have been in use by the CFUGs across Nepal since then. They serve as legitimate sources for executive committees and as agreements between DFOs and CFUGs. However, Baral *et al.* (2020) found that OPs in Nepal's middle hills prescribed identical operations regardless of species composition or forest conditions. OPs often fail to match ground realities as the implementations focus mostly on harvesting, neglecting silvicultural activities. Despite their importance, OPs prescribe uniform activities regardless of ecological variations, leading to sub-standard implementation (Ghimire *et al.* 2022; Toft *et al.* 2015).

Baral *et al.* (2020) conducted their research in only one district (of which the name is kept anonymous) within the middle hills, where 10 per cent of the amount of CFUGs were randomly selected to give a picture of

the OPs and their relevance. Ghimire *et al.* (2022) aligned with Baral *et al.* (2020) by showing that most CFUGs only implement harvesting related activities and neglect silvicultural practices. They highlight a disconnection between what is written in OPs and what is implemented; they point to implementation as the main weakness and not just the content by emphasising that OPs are rarely updated to reflect changing forest conditions or CFUG needs. According to Toft *et al.* (2015), inventory-based forest management plans were often unused in daily decision making by the CFUGs; the OPs are just formalities to satisfy bureaucratic requirements and do not inform management decisions on ground level. Therefore, it is difficult to make a generalisation of whether OPs are the same across all middle hill districts of Nepal, as variations in topography, ecological conditions, and socio-economic contexts may influence community forest management.

Nepal is a cultural mosaic and changes in land use are the result of interactions of multiple factors (such as diversities in ethnic, caste, linguistic and religious communities) where migration from uphill to low land and towards roads and urban places contributed to both loss and gain of forest and changed land-use patterns in the middle hills of Nepal (Bhawana *et al.* 2017; Pradhan and Visweswaran 2011).

After the government forest was handed over to community members as a management system, factors related to increasing forest cover were emigration, occupation shift, agroforestry practices, as well as particularly by plantation on barren lands, awareness among forest users, and conservation activities conducted by local inhabitants (Bhandari *et al.* 2019). To address a wide variety of resource management problems, including the assessment of forest cover change and its causes, a combined use of remote sensing and Geographic Information System (GIS) technologies can be invaluable (Tripathi *et al.* 2020).

It is unknown to what extent the OPs are followed by the members of the CFUGs and if this affects the forest cover. Ground truthing and geospatial analyses are therefore necessary to improve the current OPs and their implementation so forest cover can sustain or grow further.

Therefore, this study aims to assess whether differences in forest cover area between two CFUGs can be explained by differences in their OPs and how these are implemented by the CFUGs.

Study areas

Baluwa Bhanjyang CFUG and Machhedanda CFUG were selected from FECOFUN's database based on the availability of complete GIS data and their similar forest cover in 2019 (FRTC 2022). The CFUGs are located in Makawanpur, in the southern parts of the middle hills (Figure 1), but in different municipalities and thus coordinated by different DFOs. Baluwa Bhanjyang CFUG falls under the DFO located in Rapti and Machhedanda CFUG falls under the DFO located in Hetauda. The southern middle hills of Nepal are characterised by a subtropical to temperate climate, with a distinct monsoon season lasting from June until September, during which approximately 80 per cent of the annual rainfall occurs (Sharma and Awal 2013). The region's ecological characteristics are further influenced by elevation gradients, land use, and human activities (Bhandari *et al.* 2019; Bhawana *et al.* 2017). Both study areas are influenced by these, but in different proportions.

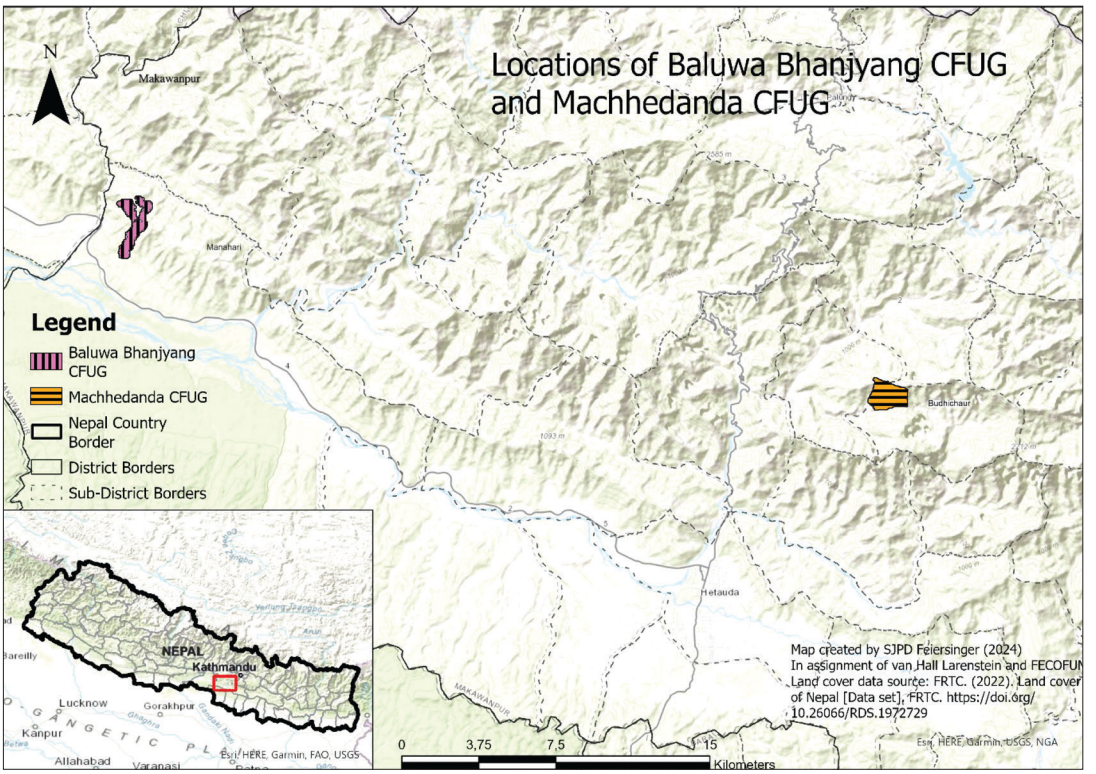

Figure 1: The location of two selected community forests: Baluwa Bhanjyang in purple, Machhedanda in orange. The CFUGs are located in the district Makawanpur. Baluwa Bhanjyang CFUG is located in sub-district, Manahari and Machhedanda CFUG is located in sub-district, Budhichaur

Machhedanda CFUG has a total population of 318 residents, of which 151 are women and 167 are men, living in 98 households. The altitude ranges from 1215 meters to 2106 meters above sea level. In the 201.9 hectares sized area, the forest cover in 2019 was 177.14 ha (87.7%) and the average growing stock is 106.41 m3/ha. The plant species khote salla (*Pinus roxburghii*), chilaune (*Schima wallichii*), bajh (*Quercus* spp.), dale katus (*Castanopsis indica*), guras (*Rhododendron arboretum*) and kafal (*Myrica esculenta*) are the most prominent tree species in the CFUG. Baluwa Bhanjyang CFUG has 298 residents, of which 158 are women and 140 are men, living in 71 households. The altitude ranges from 700 meters to 1300 meters above sea level. The community forest has a total area of 180.16 hectares with a forest cover of 161.63 hectares (89.5%) in 2019 and an average growing stock of 153.20 m3/ha. In this subtropical forest, one can find plant species such as the sal tree (*Shorea robusta*), asna (*Terminalia elliptica*), sandan (*Ougeinia oojeinensis*), chilaune (*Schima wallichii*) and bahera (*Terminalia bellirica*). These demographic characteristics may influence how forest management practices are carried out. For example, male outmigration, common in the mid-hills, can reduce available labor for forest activities, leaving women more involved in daily forest use and decision-making (Bhawana *et al.* 2017;

Bhandari *et al.* 2019; Bista *et al.* 2021). Such dynamics, as well as differences in elevation and plant species, may affect how OPs are being implemented across the two CFUGs.

METHODS

As the two community forests with a similar forest cover area were chosen, the forest cover change from 2000 to 2019 was determined by using the annual land cover data of each year provided by FRTC (2022) in GIS. The dataset (FRTC 2022) provides consistent national land cover data for those exact years with a spatial resolution of 30 meters. As this study was conducted in cooperation with FECOFUN, it utilised the same dataset used for their ongoing projects, including biomass change assessments, which aligns with their data needs and supports comparability.

Shape files of the two CFUGs were provided by FECOFUN. According to Puyravaud (2003), the following formula should be used to ease comparisons between sites of annual rates of forest change, the forest area and time of measurements:

$$P = \left(\frac{100}{t_2 - t_1}\right) * \ln\left(\frac{A2}{A1}\right)$$

Where, A1 and A2 are the forest cover in hectares at time t1 and t2 in years, respectively, and P is the percentage of forest cover loss or gain (Tripathi *et al.* 2020). This was done for each following years, giving 18 annual growth rates of forest cover area from 2000 until 2019 per CFUG. In addition to forest cover area, the analysis included other land cover classes from FRTC (2022): shrubland, grassland, and other wooded land (OWL).

A directed content analysis by Hsieh and Shannon (2005) was applied to the two OPs to examine their contents, using the *Community Forest Development Guideline* (2014), developed by the Department of Forest, as a reference document. This document comes with a framework for forest management plans and offers a set of activities and prescriptions that should be described in the OPs. The reason for using this document was that the same criteria can be applied to both OPs and allow pinpointing specific areas where the OPs vary or align with each other. Based on this guideline's framework, a coding scheme was developed by listing each prescribed activity and assigning a score from 0 to 3 for its presence and level of detail in the OPs: 0 = not mentioned, 1 = mentioned without details, 2 = some detail (what, where, when), and 3 = fully detailed including timeframes, consequences, and examples.

Both Machhedanda CFUG and Baluwa Bhanjyang CFUG were visited for interviews to assess to what extent they follow and implement their OPs and whether this influences the forest cover area. Participants were selected using a purposive sampling approach to ensure both committee and non-committee members were included. A total of 32 participants per CFUG were interviewed, representing over 10 per cent of the population, which meets the criteria for community-level surveys. The structured questionnaire included 15 statements scored on a 5-point Likert scale to measure perceptions on the implementation of OP objectives and activities. These answers were backed up with qualitative data obtained from the interviews and focus group sessions. The questions were derived from the Community Forestry Development Programme (1995), a framework used by the DFO to evaluate CFUG performance. To reflect varying levels of relevance to change in forest cover area, some questions were weighted from 0.5 to 1.5, with 1 representing a neutral weight.

The outcome of the forest cover area analysis is further explained with the results from the content analysis of OPs and the Likert scale data and interview analysis in the discussion to establish a link between OPs and forest cover area.

RESULTS

Forest cover area analysis

The forest cover area analysis revealed significant differences between Baluwa Bhanjyang CFUG and Machhedanda CFUG over the period from 2000 to 2019. Figures 2 and 3 illustrates the comparison of land cover of both years of the CFUGs, where both CFUGs show a partially gained forest cover area in 2019. In both cases, most forest cover was gained from shrubland. Table 1 presents the detailed land use transitions, quantifying how much area changed from one land cover type to another over the 20-years period. Agricultural areas remained outside the CFUG boundaries, consistent with forest policy that

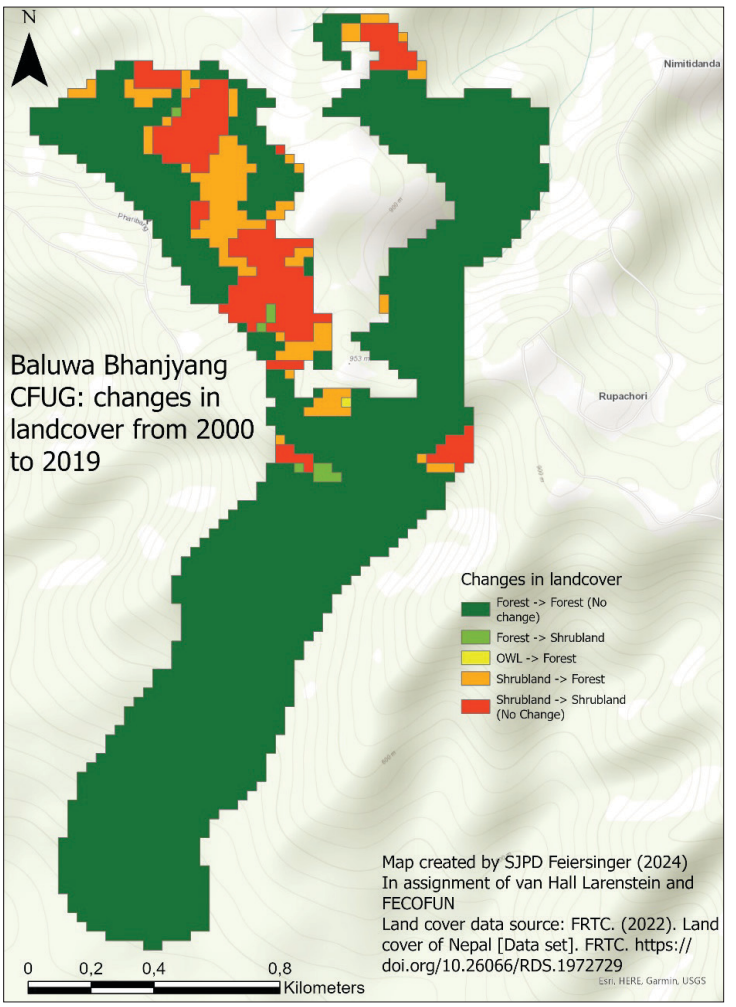

Figure 2: The landcover remained the same for the greatest part; mostly shrubland turned into forest and in a few parts, forest turned into shrubland

restricts agricultural use within community forests (FECOFUN, personal communication September 2023). Machhedanda CFUG showed a greater fluctuations in forest cover area over the period compared to Baluwa Bhanjyang CFUG; however, it showed a higher net increase in forest cover area by 2019 (Figure 4). Also in Figure 4, a slight decrease in forest cover in Baluwa Bhanjyang CFUG can be seen. Over the period from 2000 until 2019, Machhedanda CFUG had a total forest cover growth of 22.6 hectares (11.2%), whereas Baluwa Bhanjyang CFUG had a total forest cover growth of 11.36 hectares (6.3%). A difference of 11.24 hectares (4.9%) between the two CFUGs is visible. A Mann-Whitney U Test revealed a significant difference in the annual forest cover percentages between the two CFUGs (n=18, df=19, p= <0.001) over these 20 years.

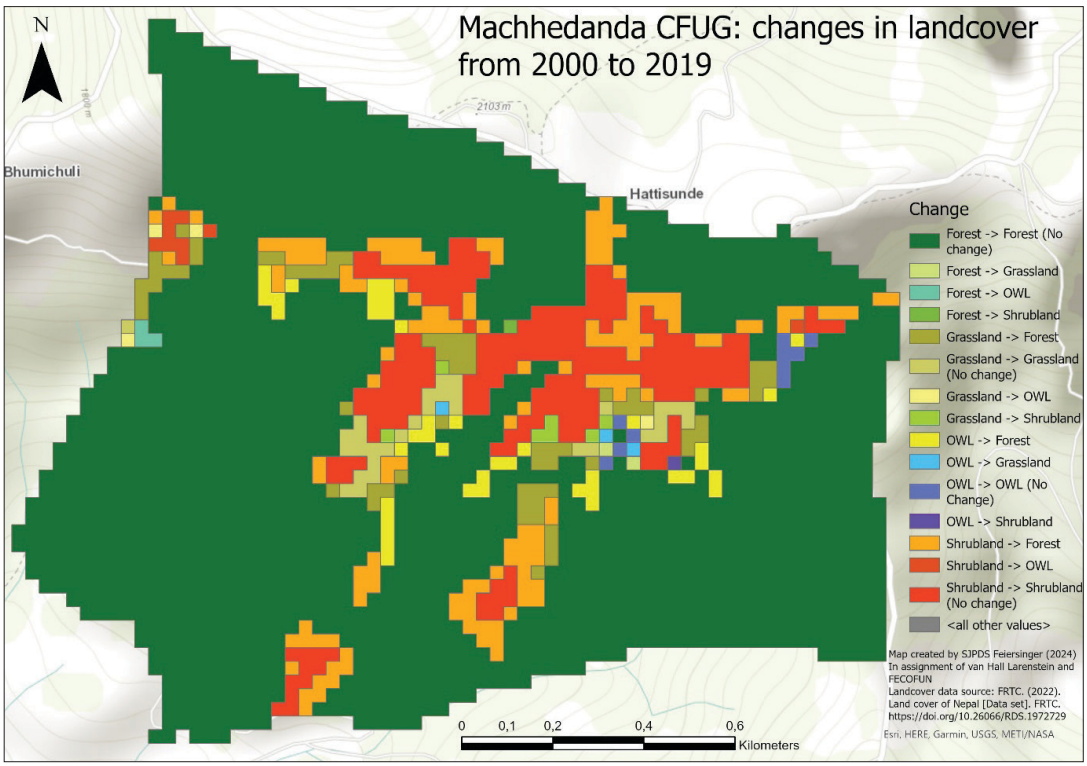

Figure 3: The map shows, in 15 categories, how the land cover changed from 2000 until 2019. Mainly the shrubland, grassland and OWL turned into forest, increasing in a net increase in forest cover

Table 1: Quantification of the changes in land cover from 2000 to 2019

Type of Change	Machhedanda CFUG		Baluwa Bhanjyang CFUG	
	Area (ha)	Percentage (%)	Area (ha)	Percentage (%)
Summary regarding forest gain/loss:				
Forest → Other landcovers	0.54	0.26	0.9	0.5
Other landcovers → Forest	23.67	11.73	13.14	7.29
Detailed land Cover Changes:				
Forest → Forest (No change)	153.90	76.27	149.22	82.73
Forest → Grassland	0.18	0.09		
Forest → OWL	0.27	0.13		
Forest → Shrubland	0.09	0.04	0.9	0.5
Grassland → Forest	6.03	2.99		
Grassland → Grassland (No change)	2.88	1.43		
Grassland → OWL	0.36	0.18		
Grassland → Shrubland	0.63	0.31		
OWL → Forest	3.87	1.92	0.09	0.05
OWL → Grassland	0.27	0.13		
OWL → OWL (No Change)	0.9	0.45		
OWL → Shrubland	0.09	0.04		
Shrubland → Forest	13.23	6.56	12.15	6.74
Shrubland → OWL	0.81	0.4		
Shrubland → Shrubland (No change)	18.27	9.05	18	9.98
Total Area and percentage (100%)	201.78	100	180.36	100

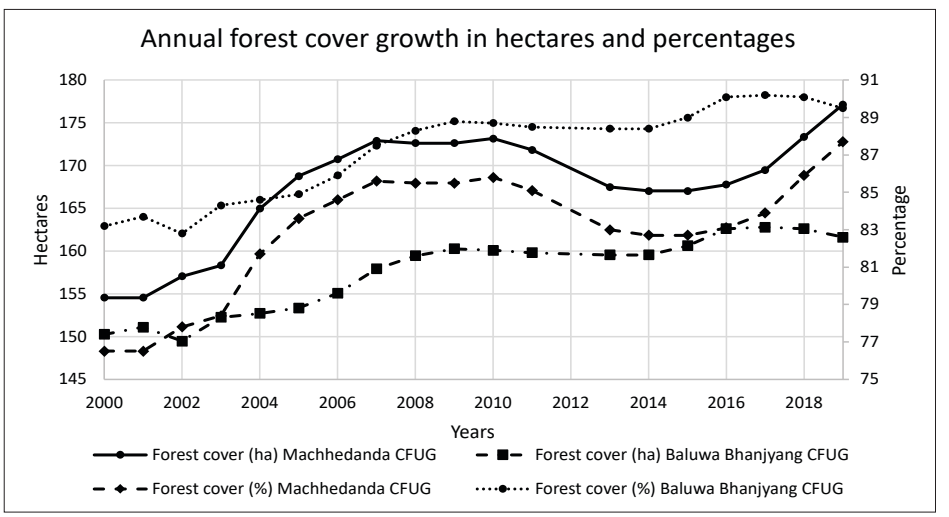

Figure 4: Reflection of the annual forest cover change (in hectares and percentages) of both CFUGs

Content analysis of OPs

In general, the objectives stated in the OPs were different; the Machhedanda CFUG, focused more on socio-economic development and status through sustainable forest management, controlling poaching, achieving crop self-sufficiency and engaging low-income members in income-generating activities. Whereas, Baluwa Bhanjyang CFUG had their focus on efficient utilisation of forest products, meeting consumers' needs, while conserving the forest and addressing landslides and erosion and implementing adaptation programs to combat climate change effects.

A directed content analysis was done based on the framework of activities found in the Community Forest Development Guideline (2014), with the code scheme in Table 2 as a result. The coding scheme was used to assess whether the activities outlined in the framework were included in the OPs and to what extent they were described. A higher total score indicates that the OP places greater emphasis on activities related to forest cover management. The total score of Machhedanda CFUG was 18, whereas Baluwa Bhanjyang CFUG scored 26.

The main difference was that Machhedanda CFUG had a tabular format with activities (without descriptive detail of the activity itself), including a budget, a time frame and frequency for each activity which was similarly written in the Community Forest Development Guideline (2014). Whereas, Baluwa Bhanjyang CFUG had a descriptive version of all their activities, where only the activities, their reasons, and consequences for (not) implementing them were explained. No budget, time frame, or frequency of each activity was seen here.

Table 2: Score explanation for activity mention: 0 = no mention of activity, 1 = basic mention of activity, but without details, 2 = activity mentioned with some details (what, where and when can be answered), 3 = activity mentioned and completely detailed with time planning, consequences, and examples. It is notable that Baluwa Bhanjyang CFUG mentions more activities, especially forest conservation activities

Activity regarding forest cover	Mentioned in OP of Machhedanda CFUG?	Mentioned in OP of Baluwa Bhanjyang CFUG?
Forest Conservation Activities (Marking)		
Theft and illegal harvest Control	0	2
Forest Fire Control	0	2
Animal Grazing Control	0	2
Encroachment Control	0	2
Forest Promotion Activities		
Nursery Establishment / Maintenance	2	0
Plant Production Wood Species	1	0
Plant production - non-timber species	1	1
Wire Fence / Biological Fence	0	1
Plantation	2	1

Replanting	0	0
Weeding and Cleaning	2	1
Bush cleaning	0	2
Pruning	2	2
Thinning	2	2
Singling	0	0
Reproduction Management	0	1
Herb/non-timber forest products Management	2	0
Forest Path Construction / Maintenance	1	2
Construction / Maintenance of fire protection line	2	1
Actions related to soil conservation	0	2
Wildlife Conservation and Biodiversity Conservation	1	2
Total score	18	26

Likert scale data and interview analysis

The weighted Likert scale scores are shown per question in Figure 5. Each CFUG shows scores of the average responses of 32 participants, including one DFO representative and one local FECOFUN member. In Figure 5, the variables labeled "O1" to "O5" match to the five objectives of the Community Forestry Development Programme (1995): promoting forest conservation (O1), implementing approved forest management activities (O2), maintaining financial transparency (O3), monitoring effectiveness (O4), and enhancing user group autonomy (O5). The variables labeled "A1" to "A10" represent ten specific forest management actions derived from the same programme, including problem identification, forest inventory, management plan preparation, resource mobilisation, capacity building, and monitoring activities.

Higher scores on the Likert scale represent a greater level of agreement with the positive impact of the CFUG on the aspects mentioned in the questions. An independent samples t-test was used to compare people's opinions about the general development regarding forest cover between the Machhedanda CFUG and Baluwa Bhanjyang CFUG. It showed no significant difference, $t(62) = 0{,}374$, $p = 0{,}711$. However, a significant difference was found between the scores given by the committee and the non-committee members (Figure 6). This was the case for both CFUGs: Machhedanda CFUG: $t(30) = 2{,}213$, $p = 0{,}035$; Baluwa Bhanjyang: $t(30)=3{,}286$, $p = 0{,}003$.

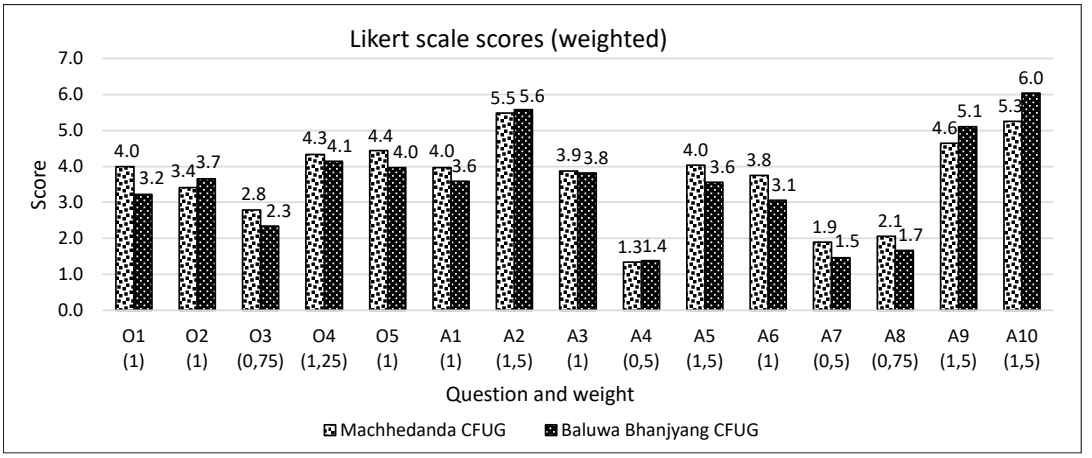

Figure 5: Average weighted Likert scale scores. O1 stands for question Objective 1 and A1 stands for question Action 1. Some interview questions were more linked to changes in forest cover area, the reason why all questions were weighted from 0,5 to 1,5, where 1 is neutral

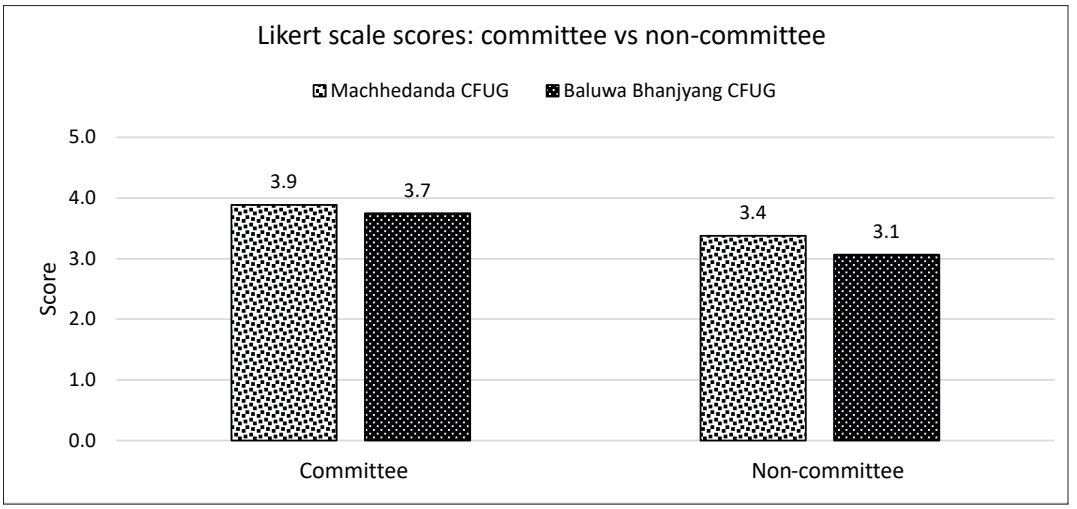

Figure 6: The difference in responses between committee and non-committee members among the two CFUGs

The committees were comprised of 13 members, with key positions equally split between genders. The committee members of both CFUGs showed more insight than the non-committee members did, and a communication gap was prevalent as non-committee members could only join meetings once per year. Machhedanda CFUG has not held a yearly meeting with the whole CFUG since the issue of the OP (2021). As only the harvest programs from the OP were followed, there was not much to communicate regarding the status of the forest. Baluwa bhanjyang CFUG mentioned having more communication with their DFO than Machhedanda CFUG. While

Machhedanda CFUG linked forest cover decrease to forest fire and road construction, Baluwa Bhanjyang CFUG emphasised forest fires and landslides to be the reason for loss in forest cover area, along with the delay in implementing programs. Similarly, Machhedanda CFUG focused on wood extraction and income-generating activities like resin tapping and medical herbs, while Baluwa Bhanjyang CFUG solely focused on wood extraction. Both CFUGs struggle with starting an enterprise as problems arise on policy levels, and they have a lack of resources to implement these programs. It was found out that Machhedanda CFUG utilised the forest in a more productive way, while Baluwa Bhanjyang CFUG focused more on the conservation aspect of the forest.

DISCUSSION

The annual forest cover growth graphs (Figure 4) of both CFUGs shows a decrease in forest cover area in Machhedanda CFUG from 2010 until 2015 and in Baluwa Bhanjyang from 2009 to 2014 and 2017 to 2019. Machhedanda CFUG had a greater decrease in forest cover from 2010 until 2015 than Baluwa Bhanjyang CFUG had from 2009 until 2014. During the interviews, the committees of both CFUGs mentioned that the reasons for the long period of forest cover decrease were mainly due to forest fires, however, the interviewees of Baluwa Bhanjyang CFUG strongly emphasised that they had more forest fires. Looking at the location and weather of Baluwa Bhanjyang CFUG, it is annually warmer and hotter in the pre-monsoon as it lies closer to the border of the Siwalik (Talchabhadel *et al.* 2019).

Regarding the objectives and activities in the OPs of both CFUGs, Baluwa Bhanjyang CFUG clearly stands out regarding forest fire control measures. However, implementation appears limited due to practical challenges, such as difficult terrain and increase in forest fires, as mentioned in the interviews. These challenges could be a reason for the forest cover area decline from 2017 to 2019, showing how the gap between documented OP priorities and real-world execution is a broader issue.

Baral *et al.* (2020) stated that the OPs in the middle hills of Nepal lack the level of detail necessary for effective implementation while being largely identical across CFUGs. They argued that many of the prescriptions are copied from one plan and pasted into another. This does not appear to be the case in this research, as the OPs of the two CFUGs list different activities used to achieve their objectives. Additionally, the way in which the activities are explained differs greatly, with one OP presenting them in a tabular format and the other in a descriptive format. This difference could be explained by the fact that the two CFUGs are located in different sub-districts and are therefore supported by two different DFOs.

Ghimire *et al.* (2022) stated that the implementation status of OPs was often found to be sub-standard, with most CFUGs focusing mainly on harvesting activities while neglecting essential silvicultural practices. This observation is applicable to the two CFUGs in this research as well. The content analysis revealed that Baluwa Bhanjyang CFUG achieved a higher total score in the OP evaluation, suggesting a stronger emphasis on forest management activities. However, the forest cover trend showed a relative decline in recent years, whereas Machhedanda CFUG, with a lower content score, showed an increase in forest cover (Figure 4). This contrast may reflect a gap between the written objectives and actions in the OPs and their

actual implementation as well, as this is a phenomenon that has been observed in community forestry in Nepal before (Ghimire *et al.* 2022; Toft *et al.* 2015). The significant division between committee and non-committee members in both CFUGs, shown by the Likert scale data, may explain this contrast as well.

The CFUG's development orientation is another aspect worth considering. Machhedanda CFUG's socio-economic focus and income-generating activities, such as Non-Timber Forest Products (NTFPs) cultivation and tourism development, may have motivated the CFUG members to actively manage their forest (Acharya *et al.* 2022; Bhandari *et al.* 2019). In addition, natural regeneration dynamics and differing ecological conditions between the two CFUGs may have influenced forest cover outcomes independently of the content of the OPs (Bista *et al.* 2021).

Only Baluwa Bhanjyang CFUG mentioned the DFO visiting them regularly to check on the status of the CFUG. This was not mentioned during the interviews in Machhedanda CFUG and it aligns with what Toft *et al.* (2015) state: the community-level manager (chairperson) appears knowledgeable about forest conditions and the management plans are not used in practical forest management since most of the activities are done superficially without looking through the OP. This is because the forestry officials (DFO) takes no action even if the prescriptions are not implemented.

CONCLUSION

This study compared two CFUGs in the middle hills of Nepal to examine how differences in OPs and their implementation affect the forest cover area. Despite both CFUGs increasing in forest cover between 2000 and 2019, Machhedanda CFUG showed a greater net gain, even though its OP received a lower content evaluation score. This suggests that written plans alone are not sufficient, as actual implementation, local engagement, and socio-ecological factors significantly influence outcomes. Among these, differences in DFO management, fire vulnerability, internal group dynamics, and the varying levels of knowledge and interest between committee and non-committee members appear to shape how OPs are implemented in practice, highlighting a need for improved communication and knowledge sharing within the CFUGs.

The challenges faced by Machhedanda CFUG and Baluwa Bhanjyang CFUG can be resolved by improving communication and aligning OPs more closely to realities in the field. With that in mind, differences in forest cover area of the two CFUGs can be explained by differences in how the OPs were implemented. Further research may be needed to better understand how a stronger connection between OP, OP implementation and forest cover change can be established.

RECOMMENDATIONS

More training and better communication and transparency could help the CFUGs to implement activities other than harvesting. The DFO could help with these two issues for better development of the CFUGs and therefore a conservation or increase in forest cover area. In agreement with Baral et al. (2020), a closer fit between the OPs and social, economic, and ecological realities is needed as the OPs in community forests in the middle hills in Nepal do not match the reality on the ground.

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Significance of Community-Based Forestry for Effective Forest Landscape Restoration

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Abstract

Following the declaration of the Decade on Ecosystem Restoration (2021–2030) by the United Nations, the Bonn Challenge 2011 and the New York Declaration 2014 which aims to restore 350 million hectares of deforested and degraded lands by 2030, Forest Landscape Restoration (FLR) has attracted global attention. FLR serves as a key strategy to bring communities together in identifying and implementing practices that balance ecological, social and economic benefits across landscapes. Studies have revealed that, despite strong commitment from national governments, the success of restoration has been limited due to multiple factors. Various studies have also highlighted the significant role of local communities in forest management, as well as the recognition of land and forest rights as vital elements in ensuring effective forest landscape restoration. However, the significance of community contribution mainly through community-based forest management (CBFM) and the need for the security of local communities' rights over forestland resources are so far largely ignored. This paper analyses the overall situation of forest landscape restoration, taking the Asia region as a reference case with quantitative data, and establishes the interrelationship between success and failure of restoration with the extent of involvement of local communities and devolution of rights. Finally, the paper suggests specific strategic directions to move forward to recognise the significance of the CBFM model in forest landscape restoration.

Keywords: Forest, restoration, sustainability, tenure security, communities

GENERAL CONTEXT OF FOREST LANDSCAPE RESTORATION

Forest Landscape Restoration (FLR) aims to regain ecological functionalities and enhance human wellbeing across deforested and degraded areas. At the global level, despite immense promises, the progress on FLR so far is too little. Data indicate that the world is losing 10 million hectares (ha) of forests each year and deforested and degraded lands comprise more than 10 billion ha at present (Tengberg *et al.* 2020; UNEP-WCMC, IUCN and NGS 2018). This shows that the scale of damage, as well as the scope for restoration initiatives, is extremely high. Therefore, FLR has become one of the global priorities to regain biodiversity and enhance human wellbeing. One of the milestones for FLR initiative is the Bonn Challenge 2011, where more than 74 countries expressed their commitment to restore 210 million ha by 2020. However, the progress remained scanty in comparison to the commitment (Dayne 2017). Similarly, Aichi Biodiversity committed to restoring 15 per cent of degraded ecosystems by 2020, whereas the New York Declaration and Sustainable Development Goals (SDGs) aim to restore

a total of 350 million ha of forestland by 2030. Target 15.3 of the SDGs aims to achieve land degradation neutrality by 2030 (FAO 2022). For all these to happen in action with priority, the United Nations has declared 2021–2030 as a decade of ecosystem restoration and has been attracting attention of global communities towards urgency of restoration.

SIGNIFICANCE OF COMMUNITY-BASED FORESTRY IN RESTORATION INITIATIVES

For the last thirty or forty years, many developing countries have been involving local communities in the protection and management of forests and forestlands. Community-based forestry models, it is believed, will address social, economic and conservation dimensions in a range of activities such as devolution of forest management role from the state to local communities, smallholder forestry programme, community–private partnership, small-scale forest-based enterprises and indigenous people (IP)-managed customary forests (Gilmour 2016). Some of the key models of community involvement include community-based forest management through community forestry, leasehold forestry, collaborative forestry, joint forest management, social forestry, participatory forestry and so on. These models have been proven as effective tools to restore deforested and degraded forestland areas and support livelihoods, as presented in Figure 1. Countries like China, India, Nepal, the Philippines and Vietnam are some of the leading countries in Asia where community-based forest management is a predominant model in practice (details with data and figure are presented in the following section). The result so far on the restoration of deforested and degraded land remains encouraging across these countries. Based on the country cases and the contribution of community-based forestry in restoration initiatives, it would be justifiable to claim that the approach of involving local communities in restoration initiatives is more effective and sustainable (Ullah and Bavorova 2024). There are multiple reasons behind the adoption of the community-based forest management model for restoration. Some of them are elaborated as below.

- Community-based forestry models encourage direct participation of local communities in forest and forestland management. This provides an environment for the local communities to take restoration as their own initiatives, thus helping to ensure sustainability.
- Community-based forestry models encourage the adoption of improved governance and tenure practices, which are fundamental elements for forest landscape restoration and management (RECOFTC 2018).
- Community-based forestry models not only help in decreasing pressures on the forest but also lead to active involvement of local communities in restoration activities at the landscape level and contribute towards local livelihood needs.
- Community-based forestry model strengthens the legitimate rights of local communities and indigenous peoples over land and forest resources of those who are directly connected with the protection and management of forests and forestlands. Forests and forestlands are the basis of culture, life, identity and customs of many indigenous peoples and local communities.

- Degradation and deforestation also have direct effects on the livelihoods of local people, mostly users of community-based forestry. Hence, local communities and indigenous peoples offer their participation in the implementation of FLR activities so as to make sure that their livelihood opportunities are not negatively affected due to deforestation and degradation.
- Local communities involved in community-based forestry know the forest landscape better and will be able to manage the restoration initiative more effectively than any outsiders.

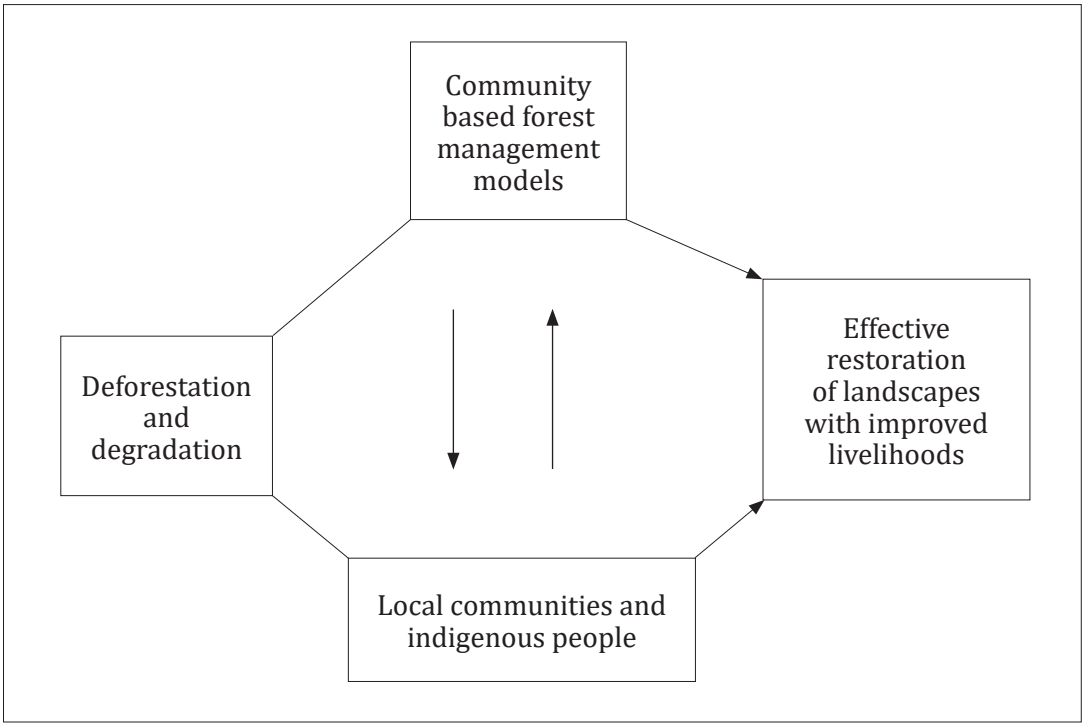

Figure 1: Conceptual basis for analysing relationship between CBFM and Forest Landscape Restoration

Considering the significance of local communities in FLR, the prevailing community-based forestry models, with active participation of local communities and indigenous peoples, have been largely successful in achieving effective restoration. However, in practice, the contribution of local communities in FLR has not been adequately accounted for so far.

SITUATION OF COMMUNITY-BASED FORESTRY AND RESTORATION IN ASIA

Despite commitments and pledges at the global and national levels, the achievement of restoration targets is meagre (Reed *et al.* 2020; Dayne 2017). Instead, in many countries in Asia, the forest areas have continually

been declining (FAO 2020). The South and Southeast Asia is the third highest region in 2020, with 31 million ha of annual forest loss, which is highly significant in terms of scale (FAO 2022). More importantly, the data from FRA 2020 provides clear trends of forest area loss or gain by countries from 1990 to 2020. For example, China has made significant progress in restoration, where the application of the collective forestry model is one of the major interventions at the community level. In the collective forestry model, there is wider involvement of local communities with strong devolved rights to them (Tables 1 and 2). However, the situation of Cambodia is relatively different, where the Cambodian government was unable to restore forestland, resulting in a loss of 2.68 per cent of forest area per year (FAO 2020).

Similarly, countries like Indonesia and Myanmar are far behind in achieving their FLR targets, and they do not appreciate the role of local communities and indigenous peoples in restoring forestlands (Table 2). Hence, they had a negative figure on the net annual change in forest areas (Table 1). Whereas in Nepal and India, the progress in restoration is positive (Table 1), where these countries have involved local communities and indigenous peoples and appreciate their role in the restoration process (Table 2).

Table 1: Trend of forest areas net annual change

Country	Forest area (in mha)				Net annual change					
	1990	2000	2010	2020	1990–2000		2000–2010		2010–2020	
					1000 ha/y	%	1000 ha/y	%	1000 ha/y	%
Bangladesh	1.97	1.92	1.88				-3.2	-0.17	-0.5	0.03
Bhutan	2.55	2.60	2.70	2.72	9.9	0.39	9.9	0.37	2.0	0.07
Cambodia	11.0	10.78	10.58	8.06	- 22.40	-0.21	-19.2	-0.18	- 252.10	-2.68
China	157.14	177.00	200.61	219.97	1986.00	1.2	2361.00	1.26	1936.80	0.93
India	63.93	67.59	69.49	72.16	365.30	0.56	190.50	0.28	266.40	0.38
Indonesia	118.54	101.28	99.65	92.13	-1726.50	-1.56	-162.10	-0.16	-752.6	-0.78
Myanmar	39.21	34.86	31.44	28.54	-435.00	-1.17	-342.7	-1.03	-289.70	-0.96
Nepal	5.67	5.78	5.96	5.96	10.08	0.19	18.1	0.31		
Philippines	7.77	7.30	6.84	7.18	-47.00	-0.62	-47.00	-0.66	34.90	0.50
Sri Lanka	2.35	2.16	2.10	2.11	-18.4	-0.81	-6.30	-0.29	0.90	0.04
Timor- Leste	0.96	0.94	0.93	0.92	-1.4	-0.15	-1.4	-0.15	-1.4	-0.15
Viet Nam	9.37	11.78	13.38	14.63	240.80	2.31	160.40	1.28	125.5	0.90

Source: FAO 2020

Table 2: Forest management regimes and supporting regulatory framework

Country	Predominant management regime	Percentage of total forest area	Regulatory framework	Year of enactment
Bangladesh	Agroforestry-based community forestry Government management of natural resources, including forests	-	Forest Act Environmental Conservation Act	1972 1995
Bhutan	Community forestry	50	National Forest Policy Land Act	2011 2007
Cambodia	Private concessionaires, government management	15	Forest Law Prakas-CF Guideline	2002 2006
China	Collectively-owned forests Villagers hold collective or individual use rights to economic forests Administrative villages or households are paid to protect ecological forests	60	Decision on Accelerating the Development of Forestry	2003
India	Joint Forest Management Forest Rights Act 2006	20	Indian Forest Policy Forest Right Act	1952 2006
Indonesia	Village forest Customary Adat forest	Negligible	Forestry Act Regulation Strategic Priority Constitutional Court Decision	1999 2021 2010 2012/13
Myanmar	Government management	None	Forest Act Forest Policy Act National Forest Master Plan CF Instruction	1992 1995 2001 1995
Nepal	Community, collaborative, pro-poor leasehold forests	33	Forest Act Forest and Regulation Forest Policy	2019 2022 2019
Philippines	Community-based forest management agreement	50	IPRA Law Executive Order	1997 1993
Timor-Leste	Customary (Tara Bandu) and government management	-	Community Forestry Strategy National Agro-forestry Strategy	2020 2022
Vietnam	Collective forest management entails allocation of forest and forestland to households, individuals and communities	60	Forestry Development Strategy Land Law Forestry Law	2007 2013 2017

Source: Author's compilation 2025

RELATIONSHIP BETWEEN COMMUNITY-BASED FORESTRY AND FLR

As presented above, in Asia, China, the Philippines and Vietnam have made significant progress in FLR initiatives, where they adopted community-based forest management models, thereby involving local communities and indigenous peoples (Tables 1 and 2). But Bangladesh, Cambodia and Timor-Leste are lagging in net annual change of forest areas (Table 1), as these countries have limited or no involvement of local communities in government restoration initiatives. Restoration is also intertwined with the level of security and clarity of forestland tenure on behalf of local communities and indigenous peoples (Cronkleton *et al.* 2017; Dahal *et al.* 2011; Larson *et al.* 2010). The studies undertaken by the Rights and Resources Initiative revealed that, at the global level, there is a gradual shift in forestland tenure categories from public ownership and management to a more community and indigenous peoples-led management and ownership over forestland (Ginsburg and Keene 2020). Such shift in land tenure categories indicates that more rights are vested to the local communities and indigenous peoples to protect and manage forests and forestland resources, considering that local people can better protect and restore their forests and land areas (Gilmour 2016).

In Asia, as presented in Tables 1 and 2, the community-based forest management model is one of the key instruments behind successful restoration. In situations where communities have been vested with full rights to make decisions about protection and management of forests and forestlands, devolution of rights can contribute towards good governance and secured tenure. Therefore, community-based forestry is a platform to achieve restoration targets more effectively and efficiently. Community-based forestry not only helps in decreasing pressure on forest but also provides opportunities for active involvement of indigenous peoples and local communities in restoration initiatives. In order to empower local communities, it is vital to have enabling legal and regulatory frameworks and secure the rights of the legitimate holders. The secured rights are fundamental to strengthening local livelihoods, helping preserve local customs and identity of indigenous peoples, forest dweller and local communities (FAO 2017).

Considering the above facts and figures, as presented in Tables 1 and 2, it is clear that FLR could be more effective through the active involvement of local communities and indigenous peoples. The country cases also substantiated that restoration of degraded and deforested areas has actively taken place in situations where the national governments have devolved rights and responsibilities to local communities to manage, protect and use forests and forestland. For example, in China, the total forest area in 2000 was 177 mha, whereas in 2020 it increased to 219 mha. This growth can be linked to the collective forestry model – a form of community-based forestry – under which villagers are granted collective or individual use rights over economic forests. Similarly, administrative villages or households are paid to protect ecological forests. In terms of tenure security, local people will have seventy-year contracts for the first time, which is renewable for another 70 years. The duration of tenure granted to the local community is adequate to get economic returns from forest management.

Similarly, in Vietnam, the increase in forest area from 11.78 mha in 2000 to 14.63

mha in 2020 is primarily attributed to the government policy of involving and authorising local people in restoration of forest areas with adequate rights to manage and use forests and forestlands either as collective or household forestland. This approach of community-based forest management relies on the allocation of forest and forestland to households, individuals and communities who can then practise forest management and other agroforestry-related livelihoods activities to harness economic benefits.

More specifically, the community forestry (CF) model in Nepal is considered as an effective model where local communities have contributed immensely to restoring degraded and deforested mid hills for more than 40 years. Now, forest areas have increased, along with increased canopy cover, with overall greenery within the four decades of CF intervention. Besides CF, other community-based forest management model such as collaborative forestry, leasehold forestry and buffer zone community forestry has contributed to the restoration of forestlands in the hills and terai lowland.

On the other hand, countries like Myanmar and Cambodia have significantly lost their forest areas where the role of local communities and indigenous peoples is largely ignored and forest management is predominantly under government administration. For example, in Myanmar, in 2000, the total national forest area was 34.86 mha, but, in 2020, the total forest area declined to 28.54 mha (FRA 2020). The rate of forest area decline within 20 years in Myanmar is one of the highest rates in Asia. Likewise, in Cambodia, the forest area declined from 10.78 mha in 2000 to 8.06 mha in 2020. Another example with large-scale forest area decline is Indonesia, where, in 2000, the total forest was 101.28 mha, whereas, in 2020, it was 92.13 mha. Interestingly, the forest policies and acts in these countries (Myanmar, Cambodia, Indonesia) have hardly appreciated the critical role of local communities and indigenous peoples in restoring deforested and degraded land areas (RECOFTC 2020; RECOFTC 2018; Sikor *et al.* 2013). The government controls and administers most parts of the country's forestlands. The concept of community involvement in restoration is a recent initiative, but within small areas only for piloting purposes.

CONCLUSION AND RECOMMENDATIONS

The analysis and interpretation of available credible data, study reports and publications on FLR showed that a strong relationship exists between the successful restoration of degraded and deforested land areas and the adoption of community-based forestry models. As of now, such a relation has not been exclusively established through credible research, studies and publications. Therefore, this paper has presented strong arguments with country cases showing existence of a correlation between effective FLR and local people's involvement through community-based forest management. The argument is substantiated with credible quantitative data from the selected countries in Asia and looks at the overall restoration outcomes on the ground. The study also identified some of the important dimensions to make sure that the community-based forestry model can contribute significantly to achieving successful forest landscape restoration. These dimensions must be considered well while implementing the FLR specifically within community-based forest areas. The recommended strategies are as below.

- Community-based forestry should promote sustainable investment in FLR so that the local communities can benefit economically from the restoration initiatives.
- Strengthen further efforts to increase security and clarity on forestland tenure, which is a prerequisite for successful restoration of deforested and degraded landscapes.
- Facilitate development of an enabling policy and regulatory framework as they are instrumental for effective implementation of community-based forest management vis-à-vis forest landscape restoration.
- Fulfill capacity gaps of key stakeholders such as government offices and local communities and indigenous peoples to attract sustainable investment and to adopt landscape approach for restoration.

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Ecosystem-based Adaptation for Increased Water Availability: A Case Study from the Hills and Mountains of Nepal

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Abstract

Water scarcity is a pressing issue for Nepal's rural hill communities, worsened by climate change, irregular rainfall and unplanned infrastructure. This study examines the impact of Ecosystem-based Adaptation (EbA) strategies on water availability and soil moisture in Dolakha, Salyan and Achham districts. Using a participatory approach, data were collected through household surveys and focus group discussions to assess community perceptions of EbA interventions, particularly construction and rehabilitation of conservation ponds. Results show that EbA measures significantly improve water availability and soil moisture, with perception scores ranging from 6.12 to 6.84 on a 10-point scale. Additionally, reduced time spent on collecting water benefits women and children, improving their quality of life. These findings underscore the importance of integrating EbA strategies into government policies and development programmes, providing sustainable solutions to water scarcity and climate variability while enhancing community resilience.

Keywords: Climate change, ecosystem-based adaptation, water conservation

INTRODUCTION

Nepal is one of the most climate change-vulnerable countries in the world. In response to this, the country has been reforming policies and implementing climate change mitigation and adaptation strategies. Key initiatives include the National Climate Change Policy 2019, the National Adaptation Plan for 2021–2050 (MoFE 2023), the Second Nationally Determined Contributions (NDC) and gender-responsive climate-resilient adaptation plans (MoFE 2020).

Irregular rainfall patterns in Nepal are severely impacting the livelihoods of farmers, particularly in rural areas. Water shortages are prevalent during the pre-monsoon season (March–May) and the post-monsoon and winter seasons (October–February) (GFDRR 2021). To address vulnerability to these erratic rainfall patterns, there is a pressing need for establishing a year-round water supply system. Water conservation ponds are an effective adaptation strategy as they capture rainwater, replenish groundwater reserves during the monsoon, and help reduce soil erosion and surface runoff, especially on landslide-prone slopes (Koirala 2021). Moreover, these ponds ensure water availability during dry periods, which is vital for traditional rural livelihoods, like

livestock farming and crop cultivation. They also support new activities, such as fish farming, and help stabilise and revegetate gullies, enabling small-scale cultivation of fodder, vegetables and fruit trees along the pond banks. Additionally, conservation ponds reduce the time women spend on fetching water (FAO 2014).

Springs and wells (*Kuwa*) are crucial water sources in the hills and mountains of Nepal. In the Hindu Kush Himalaya (HKH) region, temperatures are projected to rise by more than 2°C on average by 2050 (Shrestha *et al.* 2019). Nepal is predominantly mountainous, with about 43 per cent of its total land area classified as hills. The varied landscapes in these hilly regions create niche microclimatic habitats that support diverse ecological zones and farming systems (Shrestha *et al.* 2015).

Rural areas in the hills and mountains face significant challenges regarding water availability for drinking and irrigation. Factors such as unplanned infrastructure development, changes in land use practices, prolonged droughts and erratic rainfall due to climate change have contributed to decreased water yield. Traditional knowledge-based water management practices, which include the use of local resources and techniques, like water conservation ponds, bioengineering methods for water source protection and tree planting near water sources to enhance yield and control erosion, have declined over the past decades. There could be many reasons for the decline, but the major ones could be the lack of intergenerational knowledge transfer, outmigration from rural areas to urban centres (Koirala 2021), changes in community structures and decreasing collective efforts.

The socioecological systems refer to the interconnected and dynamic interactions between human societies and their natural environment. These systems encompass the way communities in the hills interact with, depend on and manage natural resources while adapting to environmental, social and economic changes. To adapt to climate adversities and build resilience in this socioecological systems, local communities have initiated various ecosystem-based adaptation (EbA) approaches for water management (CGED–Nepal 2024). These include promoting efficient water use through harvesting, storage, source protection and efficient usage. Several EbA measures have proven effective in building the adaptive capacity of local communities by offering simple and affordable technologies.

The EbA II project was implemented from March 2019 to April 2025 to reduce climate vulnerability in Nepal. The project was led by the Government of Nepal, Ministry of Forests and Environment (MoFE), Global Environment Facility (GEF) and United Nations Environment Programme (UNEP) and funded by the Least Developed Countries Fund (LDCF). It implemented EbA measures to restore forests and rangelands, mainly in mid-hills (Achham and Salyan) and high hills (Dolakha), reducing community sensitivity to climate change. The project adopted the approach of integrating ecosystem-based solutions to address climate change impacts, while enhancing biodiversity conservation and improving community resilience. The project emphasised the role of natural ecosystems in mitigating the effects of climate change, such as floods, landslides and droughts. By restoring and protecting ecosystems like forests, wetlands and watersheds, EbA aimed to reduce vulnerability and enhance adaptive capacities of local communities, especially in marginalised and vulnerable regions. Water conservation was one of the main achievements of the project.

This paper provides evidence of the efficiency of the EbA measures, such as recharge ponds and conservation ponds, in terms of increased water availability and infiltration in the EbA II project, implemented in Dolakha, Salyan and Achham districts in Bagmati, Karnali and Sudur Paschim provinces respectively, using a participatory approach. Proper documentation of how these measures improve water yield is essential for replicating them elsewhere. This study aims to assess and analyse the effectiveness of the EbA measures in enhancing water availability and yield, as well as their socioeconomic benefits for rural communities in the hills and mountains of Nepal. The research provides evidence-based insights into the impact of these measures and to generate recommendations for scaling up and integrating EbA practices into the local and national climate adaptation strategies.

Objectives of the study

The general objective of this study was to assess the impact of the EbA interventions on water availability and soil moisture improvement in the EbA II project areas.

The specific objectives of the study were: (i) to evaluate the impact of the EbA interventions on water availability in the spring sheds in Dolakha, Salyan and Achham districts; (ii) to assess the improvement in soil moisture levels resulting from water conservation and management measures under the EbA interventions; and (iii) to analyse community perceptions of the changes in water availability and soil moisture in the targeted areas.

STUDY METHODOLOGY

Study area

For this study, five conservation ponds and their beneficiary communities from Dolakha and Salyan districts each and six from Achham district were randomly selected. The list of the total number of conservation ponds constructed in the EbA II project sites by years is provided in Table 1. The EbA II project supported local communities in constructing and rehabilitating 92 conservation and water recharge ponds across the project districts (Table 1).

Table 1: Water conservation ponds constructed by EbA II project

District	Unit	2021	2022	2023	Total	Sample
Dolakha	Number	6	12	6	24	5
Salyan	Number	7	7	5	19	5
Achham	Number	18	21	10	49	6
Total		31	40	21	92	16

The list of water conservation ponds and communities selected for detailed household survey is presented in Table 2.

Table 2: List of water conservation ponds and communities selected for study

District	Municipality	Ward No.	Place
Dolakha	Shailung	4	Mathillo Gaon Jogidanda
	Shilung	4	Pokharidanda
	Bhimeshwor	9	Mane
	Kalinchowk	6	Okhreni
	Kalinchowk-5	5	Bandethali
	Kumakh	2	Danda Pipal Sim Narayan Takura
	Kumakh	2	Kiya Khola, Danda Kateri
Salyan	Bangaad Kupinde	1	Samaila
	Bangaad Kupinde	5	Sano Barule
	Bangaad Kupinde	7	Deutipujne
	Sanfebagar	13	Babla
Achham	Ramaraoshan	5	Badapani
	Ramaraoshan	6	Basanta, Bhatakaatiya
	Ramaraoshan	6	Sherapatalkharka, Bhatakaatiya
	Mellekh	6	Jhadigau, Sodsha
	Mellekh	6	Dudhimela, Sodsha

Sample size

Out of the 92 water conservation ponds constructed with the support of the EbA II project, 16 ponds were randomly selected: five each in Dolakha and Salyan districts and six in Achham district. This selection was made to ensure geographic diversity and manage logistical and resource constraints while maintaining statistical relevance for the study.

Research methodology

Before initiating data collection, an extensive literature review was conducted. This review primarily included national policies, programmes and archival research. The research methodology employed both quantitative (household surveys) and qualitative (FGD and key informant interview) methods.

The survey was conducted in October 2023. A total of 392 households were surveyed across the three districts using pre-designed questionnaires, representing 10 per cent of the total beneficiaries (3,920) of the EbA II project. Table 3 summarises the proportional distribution of surveyed households across the three districts, ensuring a representative sample.

Table 3: Distribution of surveyed households

District	Total beneficiaries	Surveyed households	Percentage surveyed
Dolakha	1250	125	10
Salyan	1260	126	10
Achham	1410	141	10
Total	**3920**	**392**	**10**

Additionally, 16 FGDs were conducted. The household survey aimed to gather local perceptions of the effectiveness of the EbA interventions in increasing the water yield and soil moisture. The questionnaire included a variety of multiple-choice and open-ended questions.

To avoid interviewer bias and to maintain a cost-effective approach, a self-administered questionnaire was used. For data analysis and reporting, both quantitative and qualitative data were triangulated to provide a comprehensive analysis. Microsoft Excel was used for data entry and analysis.

We applied basic statistical methods, such as calculating the mean, standard deviation and confidence interval (CI). The CI test was used to estimate the range within which the true population mean is likely to fall, with 95 per cent confidence. This was done using the formula provided by Triola (2020) for cases where the population standard deviation is unknown.

Equation 1

$$CI = \bar{x} \pm z \cdot \frac{s}{\sqrt{n}}$$

Where:

x is the sample mean,

z is the critical value from the standard normal distribution (1.96 for a 95% confidence level),

s is the sample standard deviation,

n is the sample size.

RESULTS

Major water-related problems in the study sites

The household survey and FGDs revealed that climate change poses numerous challenges related to water resources in the study areas. The major problems identified were:

1. Dry spells: The precipitation patterns have changed in the study areas. The altered patterns have resulted in, among other effects, more frequent and severe dry spells. These shifts have led to critical issues such as drying water sources and water scarcity, which have, in turn, significantly impacted agriculture, drinking water supplies and ecosystems.

2. Water scarcity: There are noticeable changes in precipitation patterns, with prolonged droughts leading to significant water scarcity.

3. Floods: More intense rainfalls are increasing flooding, leading to frequent sediment deposition in the downstream of watershed.

4. Changes in water availability: Scarcity of irrigation water during the crop cultivation period has led to a decline in agricultural productivity.

Community contribution to water conservation and management

Community contributions are crucial for achieving sustainable water conservation and management goals, as they leverage local knowledge, resources and collective action to effectively address water-related challenges. The participants reported their involvement in various water conservation and management activities. Their key contributions include constructing conservation ponds, regularly maintaining existing water sources, building water storage tanks, planting vegetation near water sources, maintaining water channels and protecting water sources.

Benefits of water conservation and management activities

Water conservation activities in the study areas are benefiting various stakeholders. The participants noted that local communities were the primary beneficiaries of these efforts, as they helped ensure reliable access to clean water for drinking, sanitation and household uses, especially during dry seasons when water availability may be scarce. They also reported improved agricultural productivity and significant enhancement of livelihoods of many community members.

Furthermore, 71 per cent of respondents reported that protecting and conserving water sources has positively impacted ecosystems and wildlife. Similarly, 62 per cent of respondents mentioned that women and girls, who are responsible for collecting water for drinking, cooking, washing, hygiene and livestock raising, have received direct benefits from these conservation activities, leading to a significant reduction in their workload.

Programme sustainability

When asked about the programme's sustainability, 71.5 per cent of respondents indicated that the community was willing to voluntarily construct additional water conservation ponds. They also planned to contribute to the maintenance of existing ponds, expansion of pond sizes and protection of other water sources. Additionally, other members of the community, such as livestock herders, will apply their acquired knowledge and participate in water conservation efforts. Local communities also expressed their intention to coordinate with rural or municipal authorities to incorporate additional ponds, catchment protection activities and budget allocations into their annual development programmes.

Perception of local people on the increase of water availability and soil moisture following the construction of conservation pond

Dolakha

Out of the total 125 respondents, 85 (68%) responded that the community was willing to voluntarily construct additional water conservation ponds.

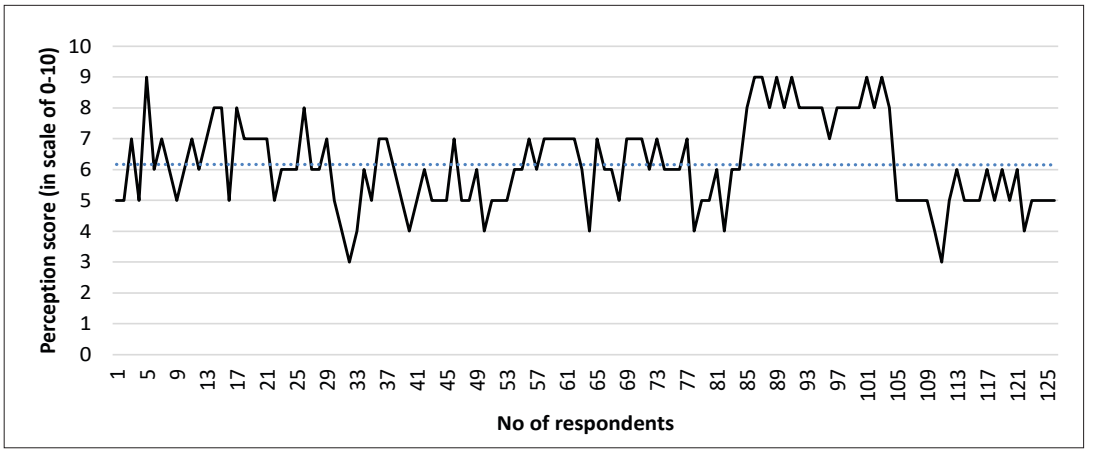

Figure 1: Perception of local people on the increase of water availability following the construction of conservation ponds in Dolakha district

The household survey shows that the residents believe there has been a significant improvement in water availability (at 95% confidence level) following the construction of conservation ponds. When asked to rate the improvement in water yield on a scale of 1 to 10, with 1 indicating no improvement and 10 indicating very good improvement, the average score for 125 participants was 6.48, with a standard deviation of ± 0.062. While calculating the CI using equation 1, the CI ranged from 6.469 to 6.491. Both limits exceed the mid value of 5 on a 1 to 10 scale. Thus, the result demonstrates a statistically significant positive community perception of improvement in water availability.

Similarly, when asked about the rating of improvement in greenery on a scale of 1 to 10, with 1 indicating no improvement and 10 indicating very good improvement, the average score for the 125 participants was 6.405, with a standard deviation of ± 1.338. While calculating the CI using equation 1, the

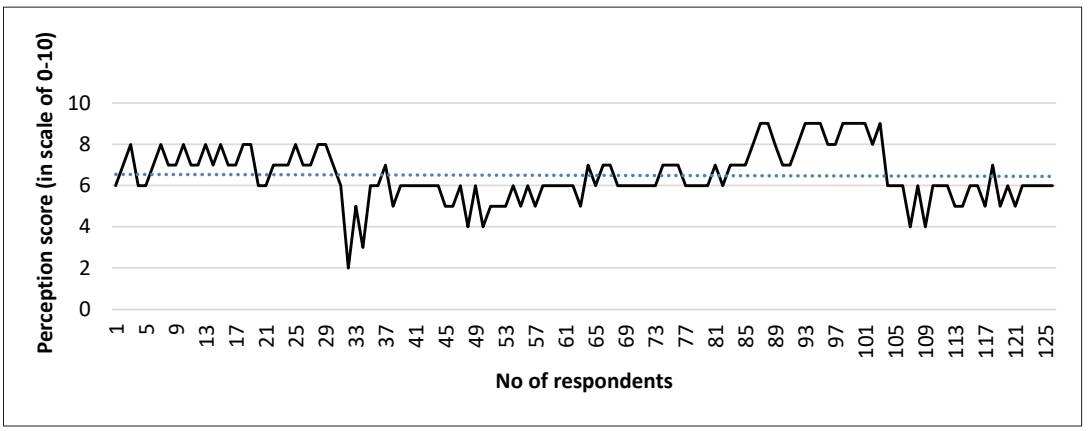

Figure 2: Perception of local people on the improvement of greenery following the construction of conservation ponds in Dolakha district

CI ranged from 6.170 to 6.640. Both limits exceed the mid value of 5 on a 1 to 10 scale. Thus, the result demonstrates a statistically significant positive perception of local people on improvement in soil moisture following the construction of conservation ponds.

Salyan

A total of 126 community members shared their perceptions of water availability in the village following the implementation of various activities. On a scale of 0 to 10, the average score given by the respondents was 6.12, with a standard deviation of ± 1.413. This indicates that the local communities perceived a significant increase in water yield in the watershed following the construction of conservation ponds. While calculating the CI using equation 1, the CI ranged from 5.873 to 6.367. Both limits exceed the mid value of 5 on a 1 to 10 scale. Thus, the result demonstrates a statistically significant positive perception of improvement in water yield after the construction of conservation ponds.

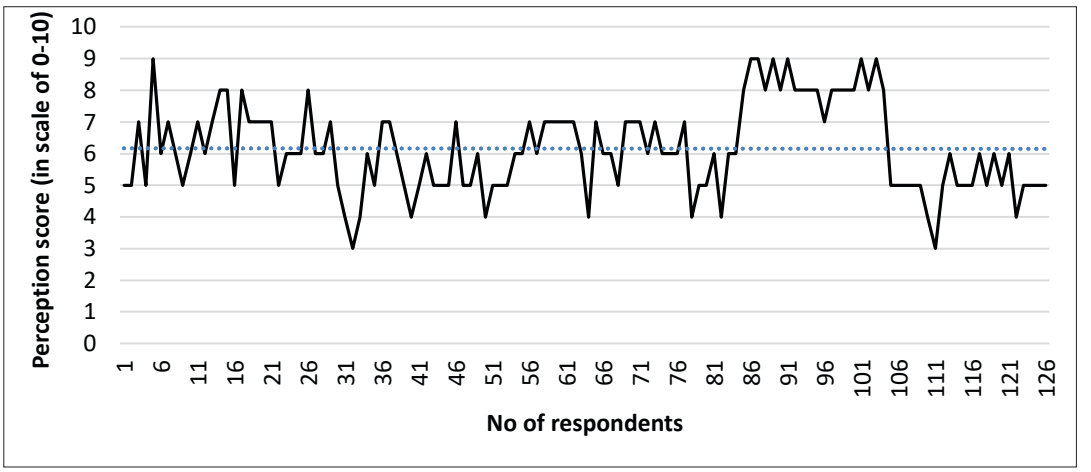

Figure 3: Perception of local people on the increase of water yield following the construction of conservation ponds in Salyan district

Similarly, when asked regarding the improvement in greenery on a scale of 1 to 10, with 1 indicating no improvement and 10 indicating very good improvement, the average score for the 126 participants was 6.14, with a standard deviation of ± 1.289. While calculating the CI using equation 1, the CI ranged from 5.915 to 6.365. Both limits exceed the mid value of 5 on a 1 to 10 scale. Thus, the result demonstrates a statistically significant positive perception of improvement in soil moisture following the construction of conservation ponds.

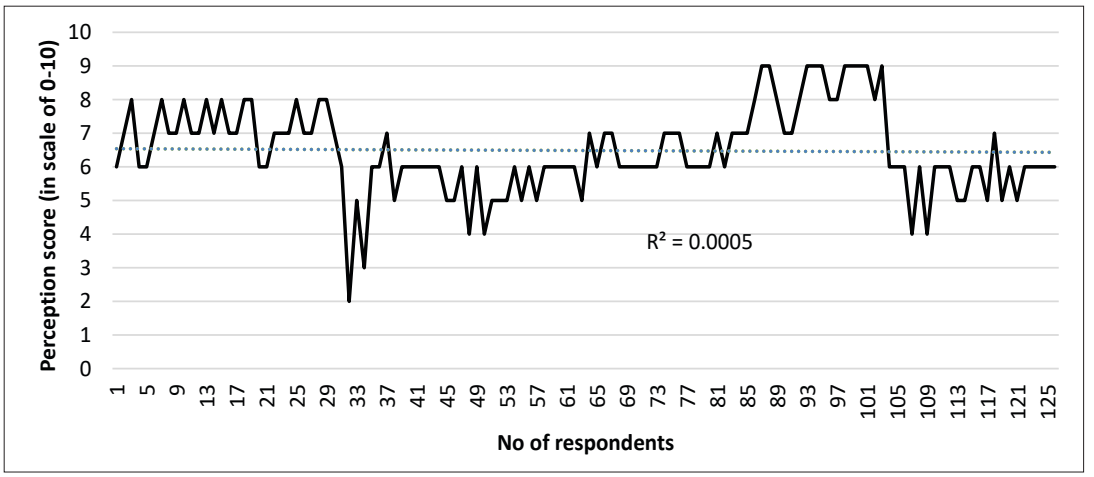

Figure 4: Perception of local people on the improvement of greenery after the construction of conservation pond in Salyan district

Achham

A total of 141 community members shared their perceptions of water availability in the village after various activities were implemented. On a scale of 0 to 10, the average score given by respondents was 6.84, with a standard deviation of ± 1.441. While calculating the CI using equation 1, the CI ranged from 6.602 to 7.078. Both limits exceed the mid value of 5 on a 1 to 10 scale. Thus, the result demonstrates a statistically significant positive perception of improvement in water availability following the construction of conservation ponds.

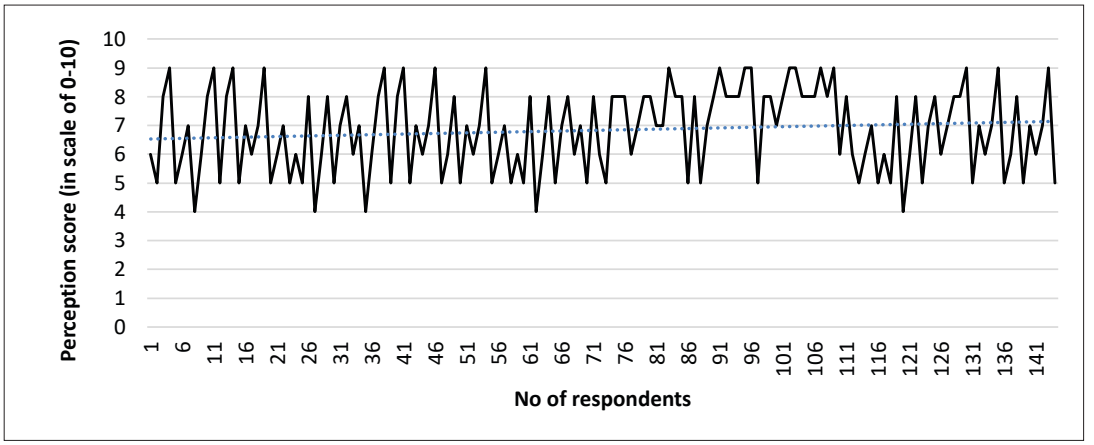

Figure 5: Perception of local people on the increase of water yield following the construction of conservation pond in Achham district

Similarly, when asked to rate the improvement in soil moisture and greenery on a scale of 1 to 10, with 1 indicating no improvement and 10 indicating very good improvement, the average score from the 141 participants was 6.84, with a standard deviation of ± 1.418. While calculating the CI using equation 1, the CI ranged from 6.610 to 7.075. Both limits exceed the mid value of 5 on a 1 to 10 scale. Thus, the result demonstrates a statistically significant positive perception of improvement in soil moisture following the construction of conservation ponds.

Figure 6: Naula Samrrakshan Pokhari of ward no. 13, Babla, Sanfebagar Municipality, Achham

Figure 7: Dudhimela Conservation Pond of Sodasa, Mellekh-6, Achham

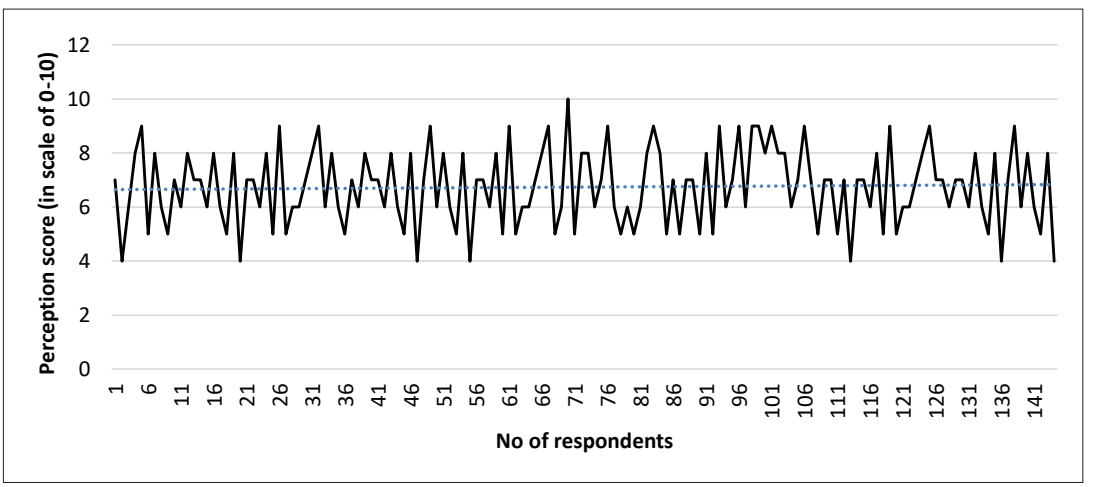

Figure 8: Perception of local people on the improvement of greenery after the construction of conservation pond in Achham district

DISCUSSION

The findings of this study underscore the critical role of the EbA interventions in enhancing water availability and soil moisture in the hill and mountain districts of Nepal. This discussion interprets the results in the context of the general and specific objectives, providing insights into the impacts, challenges and future implications of the interventions.

The general objective of assessing the impact of the EbA interventions on water availability and soil moisture improvement was met through a combination of quantitative and qualitative data collection methods. The data indicate that the EbA measures, particularly the construction and rehabilitation of conservation ponds, have positively influenced water resource availability and soil moisture levels. This aligns with global evidence on the effectiveness of nature-based solutions in addressing water scarcity and climate variability (Garcia-Herrero 2022).

Improvement in water availability

The household survey and FGDs revealed that the construction of conservation ponds has significantly enhanced water availability in the springsheds of Dolakha, Salyan and Achham districts. The average perception scores for water availability improvements ranged from 6.12 in Salyan to 6.84 in Achham, reflecting widespread community acknowledgment of increased water yield. The findings are like those of Thiaw (2013), which demonstrated that EbA interventions helped mitigate the impacts of erratic rainfall and prolonged dry spells, thereby ensuring a reliable water supply for drinking, irrigation and other livelihood activities.

Improvement in soil moisture

The study also highlights the role of the EbA measures in improving the soil moisture level. The perception scores for soil moisture and greenery improvements were consistent across the districts, with Achham reporting the highest average score of 6.84. Enhanced soil moisture has resulted in increased agricultural productivity, improved vegetation cover and reduced erosion, all of which contribute to the sustainability of local ecosystems. These findings are similar to those of Liniger *et al.* (2011). These benefits underscore the importance of integrating soil and water conservation strategies into adaptation planning.

Community perceptions of EbA benefits

Community perceptions provide critical insights into the socioeconomic impacts of the EbA interventions. The participants reported reductions in the time and effort required to collect water, particularly benefiting women and children. This finding is in line with the report of the Secretariat of the Convention on Biological Diversity (SCBD 2009), which highlights the social benefits of the EbA interventions, including improved water availability and reduced burden on women and children responsible for water collection in many regions. FGDs emphasised the broader benefits of conservation ponds, including increased biodiversity, enhanced groundwater recharge and stabilisation of gullies. This finding is consistent with the findings of the report, *Building a common vision for sustainable food and agriculture: Principles and approaches* (FAO 2014). This report highlights the contribution of water conservation practices such as pond construction to ecosystem

services, like biodiversity enhancement, water resource management and land stability. The community's willingness to contribute to the maintenance and expansion of these interventions reflects a strong sense of ownership and recognition of their value.

CONCLUSION AND WAY FORWARD

Water scarcity remains a pressing challenge for rural hill communities in Nepal, compounded by climate change, erratic rainfall and unplanned infrastructure development. This study has demonstrated how the EbA strategies, particularly the construction and rehabilitation of conservation ponds, can effectively address these challenges by enhancing water yield, improving soil moisture and contributing to agricultural productivity.

Community perceptions, supported by both qualitative and quantitative data, underscore the tangible benefits of these interventions. Respondents from Dolakha, Salyan and Achham districts reported significant improvements in water availability, soil moisture and greenery. Women and children, in particular, have experienced reduced workloads associated with water collection, improving their overall quality of life.

The findings highlight the importance of incorporating the EbA measures into local and national development policies as sustainable solutions to water resource management. By fostering community engagement and leveraging local knowledge, these interventions can enhance resilience against climate variability while supporting livelihoods and biodiversity.

The success of the EbA II project provides a model for replication in other vulnerable regions, emphasising the potential for ecosystem-based strategies to mitigate climate impacts and sustainably manage water resources for the long term.

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Role of NTFP-based Micro-enterprises in Livelihood Improvement of Forest User Group: A Case of a Sishnoo-based Microenterprise in the Mid-hills of Nepal

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Abstract

The research delves into the impact of non-timber forest products (NTFPs) on rural livelihoods, with a specific focus on a *Sishnoo* powder-making enterprise situated in the Pairakhet community forest in Nepal. Employing a combination of primary data collection techniques such as surveys and interviews alongside secondary data from diverse sources, the study meticulously evaluates the benefit–cost ratio of the enterprise. Moreover, it employs sophisticated statistical analyses, including the Likert Scale and Kendall Tau test, to gauge users' perceptions of the enterprise's influence on economic and social conditions. By scrutinising the economic, social and human dimensions of livelihoods, the study unveils notable positive transformations, mainly in employment generation and skill enhancement. *Sishnoo*-based microenterprises have emerged as a potent agent for bolstering economic prosperity and fostering capacity building, especially among marginalised communities. The findings underscore the critical necessity for nurturing NTFP-based microenterprises and implementing targeted business awareness initiatives to fortify rural livelihoods comprehensively.

Keywords: NTFPs, microenterprise, community forest, livelihood

INTRODUCTION

Community forestry (CF) and the utilisation of non-timber forest products (NTFPs) have garnered significant attention due to their potential to alleviate poverty and foster sustainable development in rural areas (FAO 1978). Around 1.6 billion individuals in rural areas rely on forest resources for their livelihoods, with approximately 0.30 to 0.35 billion depending on forests for both income and subsistence (Chao 2012). NTFPs have emerged as vital resources for millions worldwide, particularly those in rural and forest-dependent regions (Ahenkan and Boon 2011). NTFPs, encompassing forest products beyond timber, are increasingly recognised worldwide for their vital role in enhancing the resilience and livelihoods of rural communities in Africa and Asia, including both developed and developing countries (Mukul *et al.* 2010). Scholars such as Rasul *et al.* (2008) underscore how NTFPs contribute to poverty alleviation, especially among forest-dependent communities.

Economic impact

NTFP-based microenterprises have become key contributors to both forestry GDP and rural household income in Nepal (AEC/FNCCI 2012). NTFP-based enterprises make up over 90 per cent of rural household

income in Nepal. In hilly and mountainous areas, these enterprises play a major role. According to Pandit *et al.* (2009), in Nepal, over 700 plant species can produce NTFPs. About 150 of these species are regularly traded internationally (Shrestha *et al.* 2020). Despite their potential, the impact of CF- and NTFP-based enterprises on local livelihoods and economic opportunities has been minimal in certain regions (Gilmour 2016). More than 90 per cent of Nepal's NTFPs exported to India are in crude forms, resulting in fewer benefits to the local and national economies compared to the potential gains achievable through value-adding processing within the country (Subedi *et al.* 2000).

Social impact

Forest-dependent societies tend to be economically challenged and isolated from the constructive development initiatives (Choudhary 2008). There is a need for accurate benefit evaluations to harness the economic potential of Nepal's forest-based industries (Subedi *et al.* 2014). Improved management and marketing of NTFPs can significantly enhance employment opportunities in rural areas, leading to positive social benefits (Lamsal *et al.* 2017). Ludvig *et al.* (2016) has also stated that NTFP-based enterprises are found to be successful where individuals involved use their own ideas and innovation in running the enterprise. In Nepal, local communities and community forest user groups (CFUGs) have received training and other capacity-building opportunities solely because of the presence of microenterprises (Paudel *et al.* 2018). Apart from monetary exchanges through enterprises, social networks within a communal area have also improved. This necessitates a deeper understanding of the role of NTFP-based microenterprises in improving the livelihoods of user groups, particularly in areas like Myagdi district of Nepal.

This study aims to assess the role of NTFP-based microenterprises in enhancing the livelihoods of user groups in Nepal. Specifically, it seeks to evaluate the impact of microenterprises, such as the *sishnoo* (*Urtica dioica*) powder production enterprises, on livelihood improvement, determine the benefit–cost ratio of these enterprises, and identify the challenges and prospects they face. By achieving these objectives, the study will contribute to the literature on community forestry, NTFPs and rural development, with the ultimate goal of informing and guiding policies and practices in this domain.

Study area

The study was carried out in Pairakhet CF in Myagdi district, Nepal (Figure 1). Myagdi district is known for its diverse range of forest-based microenterprises, including *sishnoo* powder production, *allo* weaving, incense stick making, *lokta* paper production, *mudha* making and bamboo furniture making. Due to its active engagement in the *sishnoo* powder-producing microenterprise, Pairakhet CFUG was chosen in consultation with the Division Forest Office (DFO) and other stakeholders. This enterprise is notable for its successful operation and involvement of active users. It was also recommended by local authorities and organisations.

Notably, the *sishnoo* powder-producing enterprise in Pairakhet is led by women, reflecting a significant aspect of gender involvement in forest-based activities in the region. The enterprise operates as an

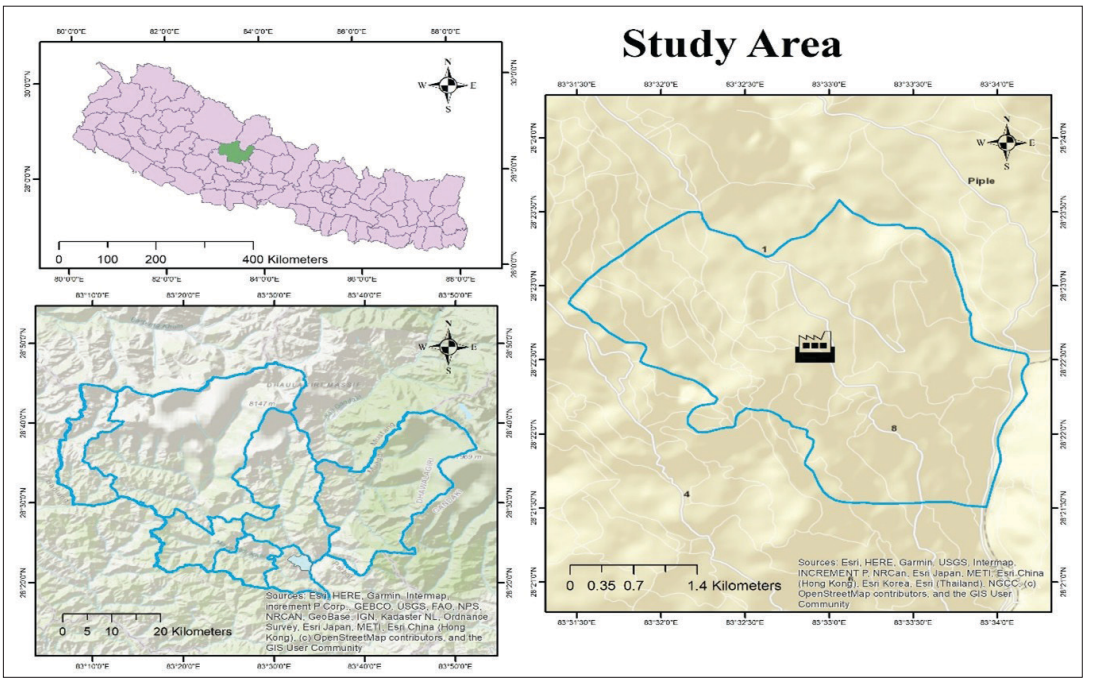

Figure 1: Pairakhet community forest, Myagdi district

extension of the Pairakhet CF and does not have a separate name. It is managed by the user group members of the community forest. Raw materials are collected from the bunds of agricultural fields, fallow lands in the community and from roadsides. Tender shoots, specifically four-leaf clovers, along with buds, are harvested. These are then dried in a solar drier or shade until the moisture content reduces to 7 to 8 per cent. Once dried, *sishnoo* leaves are grinded into a fine powder. Consumers use this *sishnoo* powder to prepare soup by mixing it with water and cooking it for five minutes. The soup has significant therapeutic properties such as anti-inflammatory, anti-rheumatic, acute diuretic and hypotensive.

METHODOLOGY

This study employed a multifaceted approach for data collection and analysis, integrating both quantitative and qualitative methods, to ensure a comprehensive understanding of the NTFP-based microenterprise. The methodology is detailed as follows:

Data collection

Primary data

Questionnaire survey: A structured questionnaire was administered to a total of 26 individuals involved in the NTFP-based microenterprise. This survey aimed to capture quantitative data on various aspects of the enterprise, including income growth, job opportunities, food provision, use of local materials and overall improvements in the standard of living. The sample size of 26 was determined based on the total number of individuals involved, ensuring that a complete census was performed within the available population.

Key informant interview (KII): Five key informants were selected for their extensive knowledge and experience with the NTFP-based enterprise and were interviewed. These informants included the chairperson of the enterprise, local leaders, organisations like Sangam Myagdi, which worked on business related to the enterprise and experts in the field, like the DFO. The interviews provided in-depth insights into the operational challenges and successes of the enterprise, offering a qualitative perspective to complement the survey data.

Focus group discussion (FGD): Three FGDs were conducted consisting of eight participants each. The discussions were designed to facilitate dialogue among various stakeholders, including employees of the enterprise and community members. The discussions aimed to explore themes and perceptions related to the enterprise's impact on the community, by gathering qualitative data through group interactions and consensus-building.

Direct observation: Field observations were carried out to collect real-time data on the daily operations and activities of the microenterprise. This method provided contextual understanding of the enterprise's functioning and its interactions with the community.

Secondary data: Secondary data were collected from published books, reports, journals and articles relevant to NTFP-based enterprises.

Data analysis

Quantitative analysis: The quantitative data obtained from the questionnaire survey were tabulated and analysed using MS-Excel and SPSS. Descriptive statistics were employed to summarise the data, and visual representations such as charts and tables were used to illustrate the key findings. The Likert scale (1 = Strongly Agree, 2 = Agree, 3 = Neutral, 4 = Disagree, 5 = Strongly Disagree) was used to gauge respondents' attitudes, and Kendall's Tau correlation coefficient was calculated to assess the strength and significance of relationships between variables. Kendall's Tau was chosen due to its effectiveness in handling small sample sizes and its robustness in dealing with ordinal data.

Qualitative analysis: Qualitative data from KIIs and FGDs were analysed thematically. This analysis involved identifying recurring themes and patterns to derive insights into the impact and operational dynamics of the enterprise through MS-Excel.

Benefit–Cost Ratio (BCR) calculation: To evaluate the economic viability of the enterprise, a Benefit–Cost Ratio (BCR) was calculated. The BCR analysis involved projecting income and expenditures over the next five years, using historical data as a reference. The present value (PV) of benefits and costs was calculated using the formula:

$$\mathrm{PV}=\frac{Future\ Value}{(1+i)^n}$$

Where, i is the discount rate and n is the number of years. The Net Present Value (NPV) was computed as the difference between the present value of benefits and the present value of costs. The BCR was determined using the formula:

$$\mathrm{BCR}=\frac{PV_{Benifits}}{PV_{Costs}}$$

Sampling methodology

Surveys: The sampling for the questionnaire survey involved all 26 individuals associated with the NTFP-based microenterprise. This complete enumeration ensured that the survey results were representative of the entire population involved in the enterprise.

KIIs and FGDs: The selection of key informants and focus group participants was purposive. Informants were chosen based on their expertise and significant role in the enterprise. FGD participants were selected to represent various stakeholder perspectives, including employees and community members. This purposive sampling approach aimed to capture diverse viewpoints and ensure that the data reflected a range of experiences and insights relevant to the enterprise's impact and operations.

RESULTS

Role on social aspect

The significant increase in relationships, partnerships and networking among users post-establishment of the microenterprises (Figure 2) is a critical indicator of social capital formation. Of the respondents, 84.62 per cent agreed that their relationship with each other has improved as also understanding among the women involved in the enterprise.

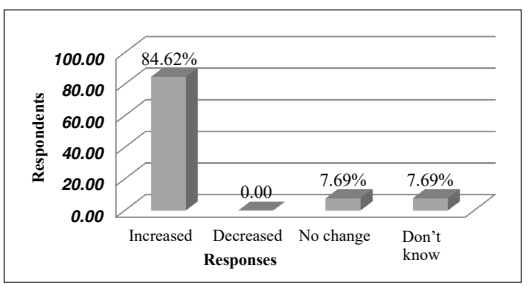

Figure 2: Relationship, partnership and networking among users

Participation of women involved in the enterprise in general assemblies and decision-making processes has increased (Figure 3). A small percentage of respondents reported "No change" or "Don't know".

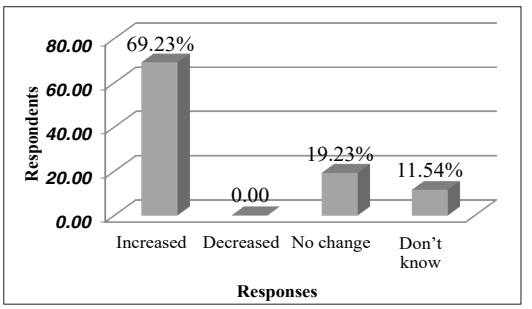

Figure 3: Participation in general assembly and decision making

Role in human aspect

The data on leadership development (Figure 4) showed that most of the community member involved in the enterprise developed leadership skills. This has enhanced their enterprise-related skills and knowledge (Figure 5) as well as common knowledge of forest product utilisation. Decision-making by women involved in the enterprise has also increased within households by 74 per cent (Figure 6).

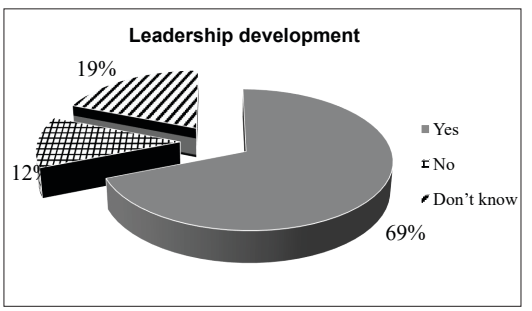

Figure 4: Leadership development

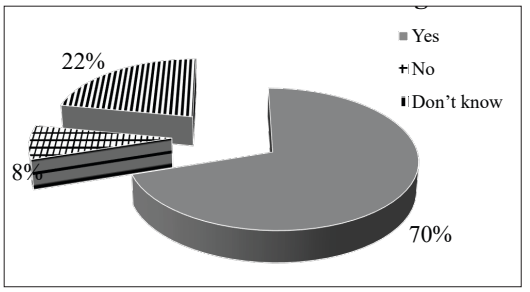

Figure 5: Rise in skills and knowledge

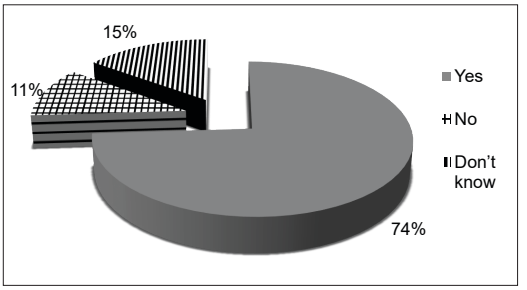

Figure 6: Role in decision making in different household activities

Role in economic aspect

Level of agreement in economic aspect

The strong positive correlations observed in the Kendall Tau analysis (Table 1) between various economic factors such as income, employment opportunities and living standards highlight the interconnected nature of economic development within the community. For example, the significant correlation between "Raise in source of income" and "Improvement of living standard of entrepreneurs" (0.933) underscores the critical role that income generation plays in enhancing overall quality of life. As income levels rise, entrepreneurs can invest more in their families' health, education and well-being, which can lead to a virtuous cycle of economic and social improvements.

Table 1: Kendell Tau correlation calculation

Variables	Kendall Tau Correlation					P-value
	Variable 1	Variable 2	Variable 3	Variable 4	Variable 5	
Variable 1	1.00	0.667	0.690	0.748	0.933	<0.01
Variable 2	0.667	1.000	0.942	0.876	0.676	<0.01
Variable 3	0.690	0.942	1.00	0.846	0.702	<0.01
Variable 4	0.748	0.876	0.846	1.00	0.728	<0.01
Variable 5	0.933	0.676	0.702	0.728	1.00	<0.01

Variable 1: Raise in source of income Variable 2: Opportunity of employment* Variable 3: Provision of food* Variable 4: Utilisation of local material* Variable 5: Improvement of living standard of entrepreneur**

Similarly, the correlation between "Opportunity of employment" and "Provision of food" (0.942) suggests that the enterprise's ability to create jobs is directly linked to food security within the community. Employment opportunities not only provide income but also ensure that households can secure adequate food, which is fundamental for health and productivity. These findings point to the enterprise's role in addressing both economic and basic needs, which are essential for its holistic development.

The economic viability of the enterprise, as shown by the Benefit–Cost Ratio (BCR) analysis (Table 2), further reinforces the potential for long-term impact. The positive NPV and BCR indicate that the enterprise is not only sustainable but also capable of generating significant returns over time. This financial sustainability is crucial for the continued success of the enterprise and its ability to contribute to community development. The upward trend in income, despite the challenges of low market demand faced in 2021, reflects the resilience of the enterprise and its capacity to adapt to market fluctuations. This resilience is a critical factor in ensuring that the benefits of the enterprise are sustained over the long term, providing a stable source of income and improving livelihoods.

The dip in income in 2021 due to low market demand highlights the importance of developing robust marketing strategies to mitigate such risks in the future. Diversifying the market base, enhancing product quality and establishing strong distribution channels could help buffer the enterprise against such downturns. By addressing these challenges, the enterprise can ensure a more stable and continuous growth trajectory, which would further strengthen its role in community development.

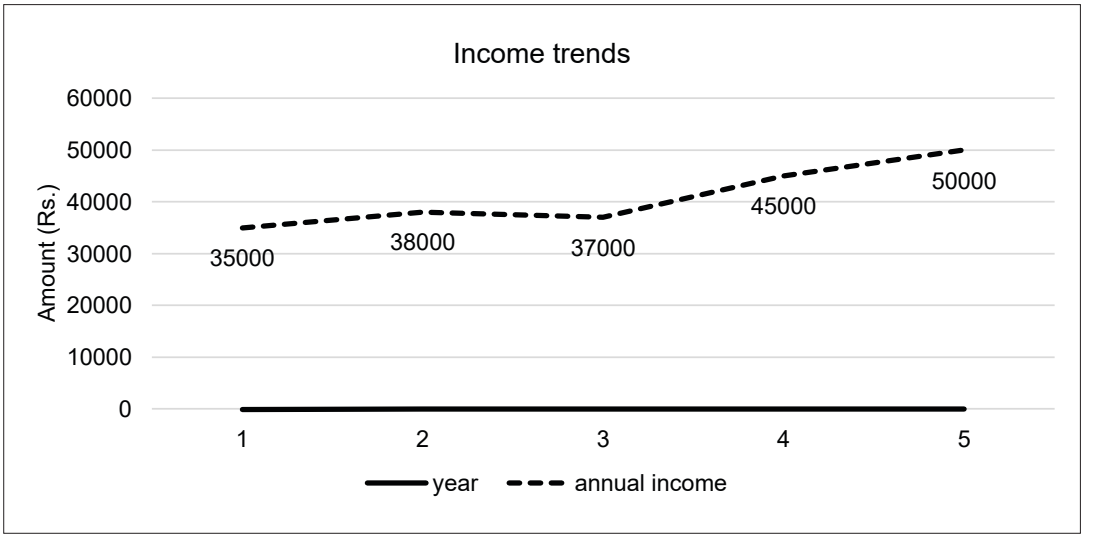

Figure 7: Annual income trends of the enterprise

NPV for the first year will be Rs 9,090.91, while for the fifth year it will be Rs 52,558.51, leading to 1.23 BCR (Table 2), indicating that it is safe to run the enterprise.

Table 2: Benefit–Cost Ratio calculation

Years	Benefit (Rs)	PV-B (Rs)	Cost (Rs)	PV-C (Rs)	NPV (Rs)	B/C ratio
First	10000	45454.55	40000	36363.64	9090.91	1.23
Second	15000	57851.23	55000	45454.55	12396.69	
Third	24000	60105.18	56000	42073.63	18031.56	
Forth	10000	54641.08	70000	47810.94	6830.13	
Fifth	10000	62092.13	90000	55882.92	6209.21	
Total	45153.04	280144.18	311000	227585.67	52558.51	

Interest rate 10 %

SWOT analysis of microenterprise

Users accepted the microenterprise as a good and supportive means to sustain their livelihood because they could get significantly more benefits than from agricultural crops on same investment, time and labour. Despite these, entrepreneurs are facing problems in running the enterprise.

Table 3: Strengths, weaknesses, opportunities and threats of the enterprise

Strengths

- Sustainable resource management
- Economic resilience through employment
- Diversified market opportunities
- Environmental stewardship and a positive image
- Community involvement for local support
- Empowering women in CFUG

Example: By implementing sustainable harvesting practices for an underused plant, *Sishnoo*, the enterprise has earned the trust and support of both local communities and environmentally conscious consumers. As a result, 26 CFUG women members were empowered through employment opportunities, with their incomes showing a positive annual trend (Figure 7). Initially, the market was limited to a few neighbouring areas, but, by the fifth year, the enterprise had expanded its reach to the neighbouring districts of Baglung and Parbat. This positive image has not only strengthened customer loyalty but also garnered robust local support, further enhancing the enterprise's sustainability initiatives and market position.

Weaknesses

- Ineffective marketing strategies
- Low product prices
- Dependence on the local workforce
- Vulnerability to raw material destruction
- High transportation costs

Example: Despite the superior quality of its products, the enterprise struggles with ineffective marketing strategies and has been unable to expand its reach across the country. The current approach relies heavily on word-of-mouth within the local community and district, with limited efforts in online presence or branding. While the enterprise can sustain the livelihoods of its workers, it is still unable to afford the high transportation costs needed for broader distribution.

Opportunities	Threats
• Expansion into new markets • Collaborative value-adding processes • Leveraging environmental stewardship • Partnerships for sustainable livelihoods • Innovative product development • Self-growth and empowerment in CFUG	• Competitors with better marketing • Pressure on profit margins • Continued migration of CFUG members to urban areas • Persistent raw material destruction • Escalating transportation costs
Example: With further advancement like eco-friendly packaging, the CFUG can add value to the product and expand the market to other regions as well. Innovative product development, such as s*ishnoo*-infused tea and skincare products, will diversify the product range and attract a broader customer base. Finally, the enterprise's focus on self-growth and empowerment, particularly for women members of the CFUG, through training and capacity-building, strengthens the overall community and ensures long-term sustainable development.	*Example:* Competitors with superior marketing strategies leverage online platforms and partnerships to reach wider markets, making it difficult for the microenterprise to expand beyond its local region. This, combined with escalating transportation costs due to its remote location, pressures profit margins and limits market expansion. Additionally, continued migration of young people to urban areas reduces the local workforce, while persistent threats to the forest ecosystem jeopardise the availability of raw materials. These challenges collectively threaten the long-term viability of the enterprise and the livelihoods of the women involved.

DISCUSSION

The analysis of the NTFP-based microenterprise highlights its significant potential for improving the livelihoods of rural communities. With a favourable BCR of 1.23, indicating profitability and positive impacts on human and social aspects, microenterprises emerge as viable options for sustainable economic development. However, despite these promising indicators, several challenges persist, particularly with regard to market access. The limited marketing reach, primarily confined to district and neighbouring areas, poses a substantial barrier to the scalability and sustainability of NTFP-based enterprises. This finding is consistent with findings from previous studies, such as Paudel *et al.* (2018), which identified the lack of adequate market access as a major constraint in Nepal's NTFP sector. The absence of technical expertise, financial resources and reliable market channels for processed NTFPs exacerbates this challenge (Shrestha *et al.* 2020). Moreover, the growing trends of foreign employment and urban migration have led to reduced engagement in local enterprises (Pandit *et al.* 2009). Not only this, the NTFP sub-sector is well-positioned to counteract this trend by offering job opportunities and income-generation avenues for rural populations. In doing so, it holds potential for mitigating poverty and curbing youth migration for employment opportunities elsewhere (Karki and Bhattarai 2012). The results also indicate that different variables, like income-generating prospects and employment opportunities within NTFP-based microenterprises, are

strongly correlated and development of one can lead to overall community livelihood development. This underscores the relevance of community forestry as not only an ecological conservation model by also a socioeconomic development tool (Gauli and Hauser 2009). Therefore, fostering the potential of NTFP-based enterprises to provide sustainable livelihood options within rural communities meaningfully contributes to the rural poverty and sustainable forest governance in Nepal. This notion is further supported by increasing community willingness to participate in such enterprises, particularly for NTFPs (Paudel *et al.* 2022). Additionally, this research states the positive impact of microenterprises on enhancing leadership skills and decision-making abilities among members, a finding also reported by previous research (Pandit *et al.* 2009). This capacity-building aspect is crucial for navigating global challenges, particularly the inequality crisis (Paudel *et al.* 2022). Inclination of the community towards conservation activities has also increased, as a result of which they are becoming aware of biodiversity conservation (Villanger 2015). Furthermore, the active involvement of women in CFUGs and their collaboration with other stakeholders signal a promising trend, echoing findings from Rasul *et al.* (2008). Such collaborations foster inclusive decision-making processes and strengthens community resilience.

CONCLUSION

The study underscores the substantial potential of NTFP-based microenterprises in bolstering rural livelihoods across Nepal, as exemplified by the *Sishnoo* powder-producing microenterprise. Encouraging outcomes were observed in terms of enhanced social cohesion, improved leadership skills and strengthened financial assets, further supported by a favourable BCR. However, persistent challenges related to market accessibility, product pricing and resource management continue to impede progress. Proposed solutions entail providing training on sustainable methods, establishing effective marketing channels and empowering women within the enterprise. Crucially, governmental and non-governmental interventions are essential to optimise market operations and foster broader social engagement. Looking ahead, concerted action is imperative to address existing constraints and fully harness the potential of NTFP-based enterprises for poverty reduction and sustainable development. Recognising the study's limitations, including its narrow geographical scope and reliance on self-reported data, the study underscores the necessity for future research to adopt broader and mixed-method approaches for a more comprehensive understanding of NTFP-based microenterprises in Nepal.

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Effects of Invasive Alien Plant Species on Native Plant Species in Three Different Altitudinal Ranges: A Case Study of Five Community Forests in Jajarkot District

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Abstract

Invasive Alien Plant Species (IAPS) pose significant threats to biodiversity and ecosystem services, particularly in ecologically sensitive regions like Nepal. This study investigates the distribution and ecological impacts of IAPS across altitudinal gradients in Jajarkot district, with a focus on forest ecosystems and agricultural landscapes. Field surveys employing quadrat plots identified four dominant IAPS, notably *Ageratina adenophora* and *Bidens pilosa*, which were more distributed across altitudes. Biodiversity indices, such as the Shannon–Weiner index, indicated impact of IAPS on distribution of native species. The Importance Value Index (IVI) revealed IAPS dominance at lower altitudes, contributing to reduction in the frequency of native species and ecosystem destabilisation. The spread of IAPS was closely linked to human disturbances, decreased canopy cover and increased IAPS cover, suggesting that these factors may facilitate their upward expansion under changing environmental conditions. Our study had uneven plot distribution and a research focus on community forests as limitations. The findings underscore the urgent need for integrated IAPS management. Strategies should prioritise targeted interventions, including community engagement, sustainable forest management practices and policy reforms, to mitigate IAPS spread and safeguard biodiversity along altitudinal gradients.

Keywords: Invasive alien plant species, biodiversity, altitudinal gradient, community forest, forest management

INTRODUCTION

Invasive Alien Plant Species (IAPS) represent a significant ecological challenge globally, threatening biodiversity hotspots and impacting various ecosystems, particularly in regions such as Asia, Africa, South and Central America, and Europe (IBPES 2019). This threat is exacerbated by human activities, including global trade, increased travel and climate change, which facilitate the spread of invasive species, disrupting natural habitats and ecological balance (Shrestha *et al.* 2017). Species from the *Asteraceae* family, such as *Ageratina adenophora, Eupatorium adenophorum* and *Ageratina riparia*, have emerged as aggressive invaders, causing habitat alteration and biodiversity loss in tropical and subtropical regions (Mccary *et al.* 2016).

In Nepal, a country heavily reliant on resource-based livelihoods, the impact of IAPS on ecosystems and agricultural productivity is particularly pronounced (Shrestha *et al.* 2017). Nepal is home to 29 IAPS (Sharma *et al.* 2020; Shrestha and Shrestha 2021; Shrestha *et al.* 2021). Four species (*Chromolaena odorata, Pontederia crassipes, Lantana camara, and Mikania micrantha*) from the listed IAPS are among the 100 worst invasive species in the world (GoN 2019). Native species, which were only imported a century ago and had time to evolve and adapt in the local climate more than IAPS as a result of human activities and impact of IAPS, are fewer in number (Zhang *et al.* 2015). IAPS are seen to migrate upwards to higher altitude from lower altitude in response to climate change, trade, tourism and anthropogenic disturbances, altering both native floral and faunal species compositions (Cramer *et al.* 2014). It is essential to track their potential response along the changing environment (Cramer *et al.* 2014; Thapa *et al.* 2018).

Climate change, coupled with anthropogenic disturbances, further exacerbates the problem, particularly in mountainous regions, where controlling invasive species presents unique challenges (Thapa *et al.* 2018). Human influence often makes them more susceptible to invasion, facilitating many alien plants by freeing nutrients, and by changing natural disturbance regimes (Davis and Thompson 2000). Pathak *et al.* (2021) has also concluded that urban areas provide suitable microhabitats for the introduction of IAPS, which subsequently disseminate their propagules for wider spread into the surrounding landscapes. In case of climate change, they cause a decrease in forms and fitness, which are expressed at different levels and have effects on individuals, populations, species, ecological networks and ecosystems (Bellard *et al.* 2016). The ability of an exotic species to overcome invasion-limiting barriers may be facilitated and increased by a high propagule pressure, which is defined as a composite measure of introduction events and number of released propagules, making them prone to invasion at higher altitudes (Holle and Simberloff 2005).

Under difficult conditions, like the upper and lower elevation range boundaries, plant fitness is severely diminished, and range-edge populations frequently serve as demographic sink (Seipel *et al.* 2016). The area with the largest canopy cover is the one that is least affected by invasive species. While forest regions with closed canopy cover act as physical barriers to dispersal paths, common light and moisture conditions act as environmental obstacles for the establishment of alien plant species (Mavimbela *et al.* 2018).

According to De Poorter *et al.* (2007), there are 106 countries where protected areas have been reported to have invasive alien species as a threat or effect. Invading alien species are seriously damaging the ecology of India's natural areas by speeding up the extinction of native and vulnerable species and decreasing the carrying capacity of pastures (Reddy 2008). According to Kavita Gupta of National Bureau of Plant Genetic Resources, about 40 per cent of India's flora is made up of foreign species, 25 per cent of which are invasive (Barceloux 2008). Given China's speedy economic growth and the country's expanding travel, tourism and business sectors, the country may face serious invasive species problems in the future (Xu *et al.* 2012).

Agroecosystems, wetlands, protected areas and forest ecosystems in Nepal have already been devastated by invasive species, putting both biodiversity and human livelihoods at peril (MFSC 2014). In Nepal, biological invasion has emerged as a fresh barrier to maintaining ecosystem services, protecting biodiversity and increasing agricultural productivity (Shrestha 2016). IAPS have also infiltrated the buffer zone of the Chitwan National Park, one of the oldest national parks in Nepal (Shrestha 2016), whereas, in the Parsa National Park, the effects of IAPS on the process of tree regeneration were seen to be closer to populated areas (Shrestha and Shrestha 2019). Most of the research on invasive species in Nepal focuses on specific regions, overlooking context-specific invasion phenomenon and delaying control measures in sensitive habitats (Bellard *et al.* 2016). Despite local people's observations, there is lack of research on the presence and influence of invasive species on biodiversity in the high mountainous district of Jajarkot, which has rich non-timber forest products (NTFP). To address this lacuna, the study aims to carry out research on the presence and influence of invasive species on native species in different altitudinal ranges in Jajarkot and answer the following questions:

1. Are invasive species affecting native species in Jajarkot, as observed by the local population?
2. How do invasive species impact the biodiversity of native species across different altitudinal gradients in Jajarkot?

MATERIAL AND METHODS

Study area

Jajarkot, a mountainous district in Nepal, is divided into three zones: High Mountain, Mountain and Riverine flatland. It is spread over 2,230 km^2 and is divided into forestland (54.9%), agricultural land (15.8%), rangeland (11.8%), shrubland (11.7%), and other lands (4.8%). According to the District Forest Office (DFO), Jajarkot (2020) and GoN (2014), based on climate, the forests of Jajarkot can be divided into the following types:

1. **Tropical (<1,000 m)**: Major tree species found are *Shorea robusta (Sal), Acacia catechu (Khaer), Terminalia elliptica (Asna), Dalbergia Sissoo (Sishoo)*, and *Pinus roxburghii (Khote Sallo)*.
2. **Subtropical (1,000 m to 1,500 m)**: Major tree species are *Shorea robusta (Sal), Pinus roxburghii (Khote Sallo), Terminalia elliptica (Asna), Adina cordifolia (Karma), Toona ciliata (Tooni), Alnus nepalensis (Uttis)*, and *Acacia catechu (Khaer)*, and major NTFP species are *Zanthoxylum armatum (Timur), Swertia chirayita (Chiraito), Terminalia bellirica (Barro), Phyllanthus emblica (Amala), Bergenia ciliata (Pakhanbed), Urtica dioica (Sisnoo), Persea spp. (Kaulo), Sapindus mukorossi (Rittha)*, and *Cinnamomum tamala (Tejpat)*.
3. **Temperate (1,500 m to 2,500 m):** Major tree species are *Pinus wallichiana (Gobre Salla), Quercus leucotrichophora (Banjh), Quercus semicordata (Khasru), Tsuga dumosa (Thingure Salla)*, and *Taxus baccata (Lauth Salla)* and major NTFP species are *Valeriana jatamansi (Sugandawal), Nardostachys grandiflora (Jatamansi), Allium wallichii (Banlasun), Paris polyphylla (Satuwa), Ipomea spp. (Kala dana)*, and *Lycopodium spp. (Jhyau)*.
4. **Alpine forest (above 2,500 m):** Major tree species are *Pinus wallichiana (Gobre salla), Tsuga dumosa (Thingure Salla), Rhododendron arboreum (Laliguras), Betula utilis (Bhojpatra),* and *Cedrus deodara (Debdar)*.

The IAPS found in the area are *Lantana camara, Ageratina adenophora, Bidens pilosa* and *Ageratum conyzoides.* The community forests (CFs) of Bheri and Nalgadh municipalities were chosen as the study area. The CFs sampled in the study area were Shyaulapakha Kalegaun CF, Bhagwati CF, Pragati CF, Thulokhola Kimuchaur, CF, and Haanschamakhola CF.

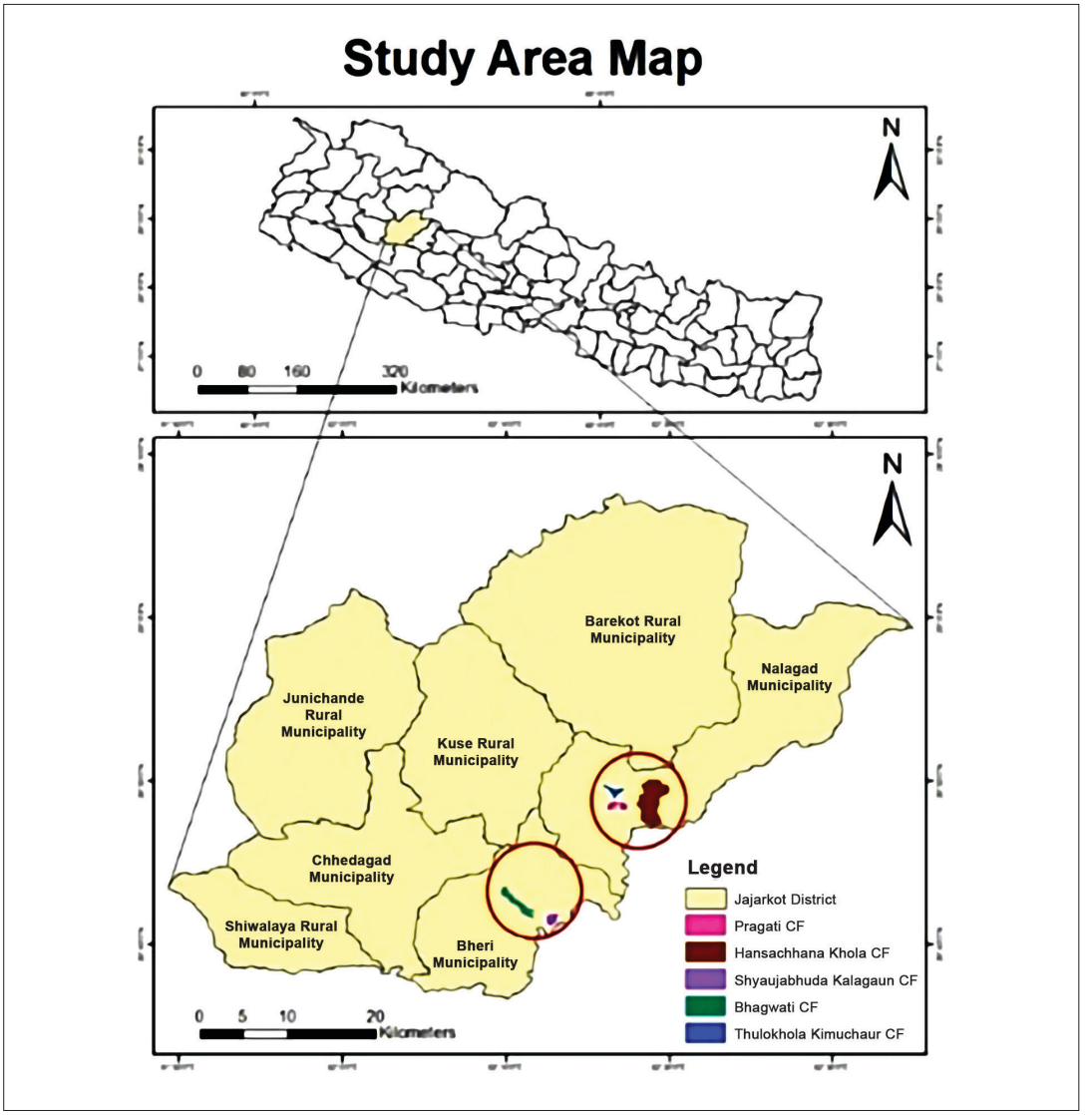

Figure 1: Map of the study area

Data collection

Field reconnaissance surveys were conducted following preliminary visits to selected CFs across varying altitudinal ranges identified in consultation with local forestry authorities and community forest user groups (CFUGs).

The abundance categories of plant species in each plot were recorded using Garmin GPS, with local inhabitants aiding in species identification. Native and invasive species were counted, and cover assessments were conducted using densitometers. Specimens were cross-referenced with plant identification applications and submitted to the National Herbarium and Plant Laboratories (NHPL) for verification. Secondary data were obtained through the review of existing documents, including research papers, thesis and articles.

Sampling method

The participatory mapping of areas affected by invasive species involved consultations with the CFUGs and key informant interview (KII) (n=40). A sketch map was created, aiding in the purposive selection of CFs impacted by invasive species. Three altitudinal ranges (<1000 m, 1000-2000 m and >2000 m) were selected based on initial surveys, revealing varying distributions of IAPS with altitude. Total 120 plots were established in three altitudinal ranges: 31 plots in <1000 m, 74 plots in 1000–2000 m and 15 plots > 2000 m. Equal plots could not be taken in all altitudinal ranges due to difficult terrain. Each 1X1 quadrat plot (Paclibar and Tadiosa 2019) was assessed along with invasive species, grass and regeneration of woody species, including trees and shrubs. The percentage cover of IAPS was recorded as very abundant (>75%), abundant (75-50%), frequent (50-25%), and rare (<25%).

Data Analysis

Vegetative Analysis

Analysis of each quadrat having different levels of abundance of invasive species vegetation were done, and all the plants present were sampled, where the relative importance of the species was determined through Importance Value Index (IVI) (Mueller-Dombois and Ellenberg 1974). The IVI was also calculated for both grass species and IAPS.

Importance Value Index (IVI) = Relative Frequency + Relative Cover + Relative density

Where,

$$\text{Relative frequency (RF)} = \frac{\text{Frequency of one species}}{\text{sum of frequency of all species}} \times 100$$

$$\text{Relative Dominance (RCo)} = \frac{\text{Cover of one species}}{\text{sum of cover of all species}} \times 100$$

$$\text{Relative density (RDe)} = \frac{\text{density of one species}}{\text{Sum of density of all species}} \times 100$$

Plant diversity was determined using Shannon Weiner's Index, Simpson's Dominance Index and Equitability of Evenness Index.

Shannon Weiner's Index,

$$H' = H' = \sum_{i=1}^{s} (pi)(\ln pi)$$

Where, H= Shannon Wiener Diversity index

Pi = fraction of the entire population made up of species I (total number of species/ number of individuals of species)

S = number of species encountered

Occurrence mapping and hotspot mapping

An IAPS distribution map was prepared by using the presence point of IAPS in the

study area. The boundary maps of the municipality and Jajarkot district were obtained from https://www.dos.gov.np/. The altitude of the plot taken was also noted through GPS. We conducted a hotspot analysis to identify the regions potentially suitable for the maximum number of IAPS using the number of IAPS and the elevation they were present at (Shrestha and Shrestha 2019). We aggregated niches for all species to generate species diversity (cells with a higher value indicating high species diversity) and extent maps (cells occupied by at least a single species). We calculated changes in the areas of both diversity and extent of potentially suitable regions. Then, a hotspot map was created in ArcGIS 10.5 following the Kernel density method and reclassification method.

RESULTS

Distribution of invasive species, grass and regeneration of woody species in different altitudinal ranges

A total of thirty-one plant species (grass, invasive and regeneration of woody species) were recorded in different altitudinal ranges. Among them *Ageratina adenophora* and *Bidens pilosa* were found in all altitudes (Table 1). There was a total of twenty regenerations of woody species, seven grass species and four IAPS in different altitudinal ranges of the study area in Jajarkot district (Table 1). Lower elevation holds very abundant category with highest invasion, followed by high elevation with abundant category of invasive species (Figure 2).

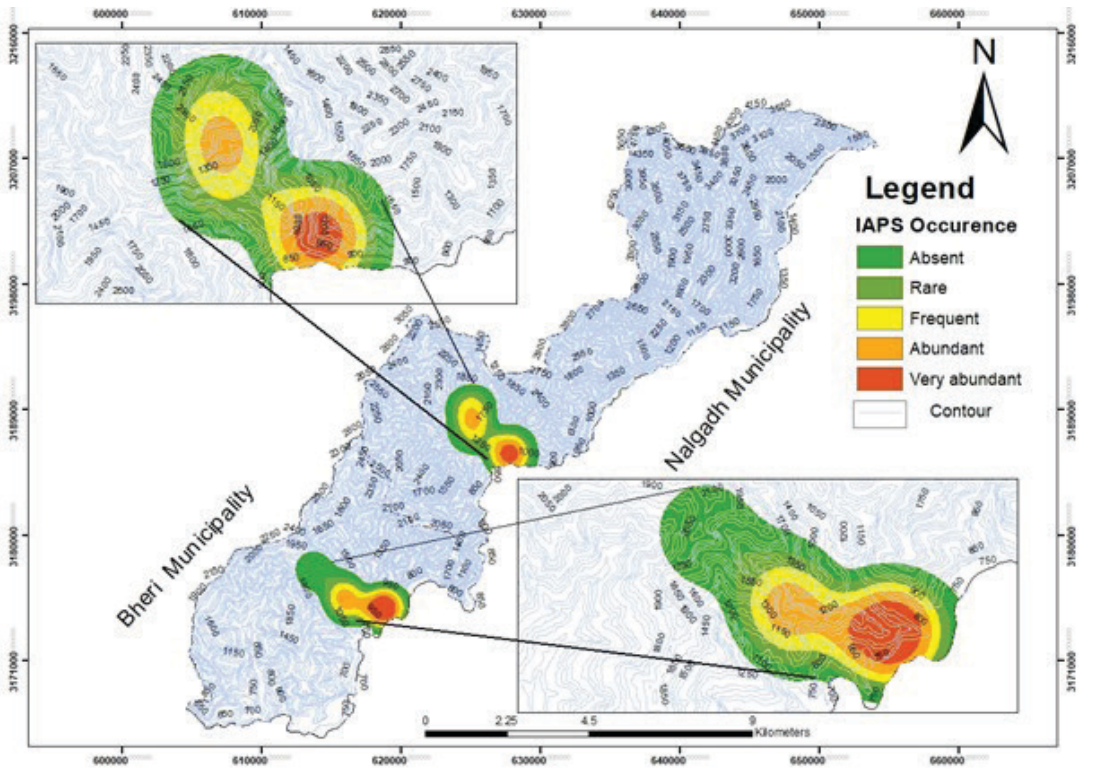

Figure 2: Hotspot mapping of IAPS in different altitudinal ranges

Table 1: Distribution of invasive, grass and regeneration of woody species in different altitudinal ranges

S.N.	Name of species	Local/common name	<1000	1000–2000	>2000
Grass species					
1	Pogonatherum Species	Muse Khar	*	*	*
2	Bothriochloapertusa	Pirye Khar/Athikre	*	*	*
3	Seteria pumila	Bale Bale Banso	*	*	*
4	Sachharum spontaneum	Kansh	*	*	
5	Eulaliopsis binate	Babiyo	*	*	
6	Miscellaneous	Pula Khari	*	*	*
7	Salvia mexicana	Nilkanthi	*		
Invasive species					
1	Ageratina adenophora	Maobadhi Jhar/ Kalo Banmara	*	*	*
2	Lantana camara	Dhungeful	*	*	
3	Ageratum conyzoides	Hanuman Jhar	*	*	
4	Bidens pilosa	Kuro	*	*	*
Regeneration of woody species					
1	Shorea robusta	Sal	*	*	
2	Grewia optiva	Bhimal		*	
3	Pinus roxburghii	Khote Salla	*	*	
4	Aesendra butyraceae	Chiuri	*	*	
5	Mallotus philippensis	Sindure	*	*	
6	Lucaena lucocephala	Ipil-Ipil	*	*	
7	Terminalia chebula	Harro	*	*	
8	Holarrhena pubescens	Khirro		*	
9	Terminalia elliptica	Sajh	*	*	
10	Syzygium cumini	Jamun		*	
11	Dalbergia Sissoo	Sissoo	*	*	
12	Rhododendron arboreum	Gurans		*	*
13	Macaranga denticulata	Maleto		*	
14	Myrica esculenta	Kafal		*	*
15	Miscellaneous	Miscellaneous regeneration		*	
16	Woodfordiaf ruticosa	Dhaero	*		
17	Quercus leucotrichophora	Banjh			*
18	Melastoma Malabathricum	Ayar/Angeri			*
19	Berberis aristata	Chutro			*
20	Pyrus species.	Mel			*

Effects of invasive species on native species in different altitudinal ranges

The Shannon–Weiner index for IAPS was highest in the altitudinal range of <1000 m (1.25), and it gradually decreased with increasing altitude, with values of 1.09 in the 1000–2000 m range and 0.40 in the >2000 m range (Table 2). Regarding regeneration, the Shannon–Weiner index was highest in the <1000 m range, while grasses had the highest index in the 1000–2000 m range (Table 2). Both categories showed the lowest values in the >2000 m altitude range.

Importance Value Index

Lantana camera had the highest IVI value (57.32), followed by *Pogonatherum* species (43.93), *Ageratum adenophora* (35.63) and *Bothriochloa pertusa* (25.82). *Terminalia elliptica* stood last with the 1.46 IVI value in the altitudinal range >1000 m (Figure 3). Here, invasive species posed 41.97 per cent of total IVI than other species.

Table 2: Biodiversity indices of invasive species, grass and regeneration of woody species

Altitudinal Range (m)	Category	Shannon–Weiner Index
<1000	Invasive	1.25
	Grass	1.35
	Regeneration	1.81
1000–2000	Invasive	1.09
	Grass	1.51
	Regeneration	1.75
>2000	Invasive	0.40
	Grass	1.08
	Regeneration	1.64

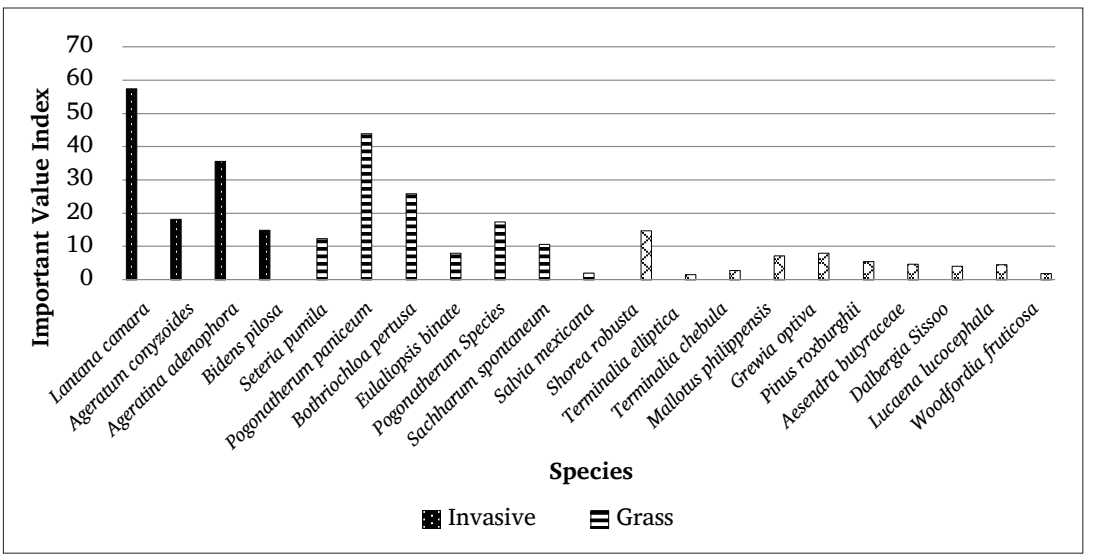

Figure 3: Importance Value Index of IAPS and native species in altitudinal range <1000m

Ageratina adenophora had the highest IVI value (59.33), followed by *Pogonatherum paniceum* (43.11), *Bothriochloa pertusa* (33.78) and *Shorea robusta* (24.81). *Myrica esculenta* had the least IVI value of 1.02 value at an altitudinal range >1000–2000 masl (Figure 4). Here, invasive species posed 35.98 per cent of total IVI than other species.

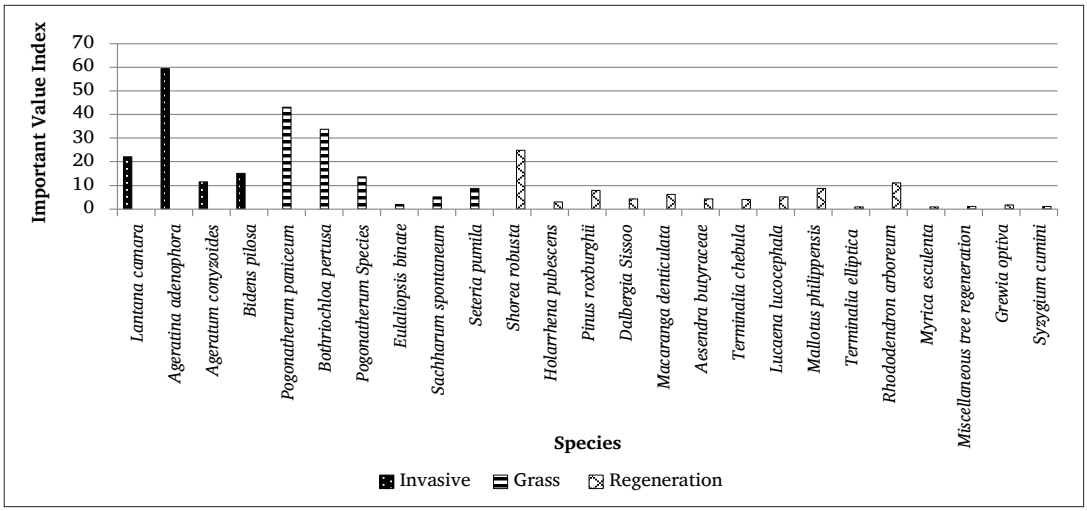

Figure 4: Importance Value Index of IAPS and native species in altitudinal range 1000–2000 m

Ageratina adenophora had the highest IVI value (55.96), followed by *Bothriochloa pertusa* (53.87), *Pogonatherum paniceum* (45.81) and *Rhododendron arboreum* (24.81). *Melastoma Malabathricum* had least IVI value, with 6.60 at an altitudinal range >2000 masl (Figure 5). Here, invasive species posed 24.12 per cent of total IVI than other species.

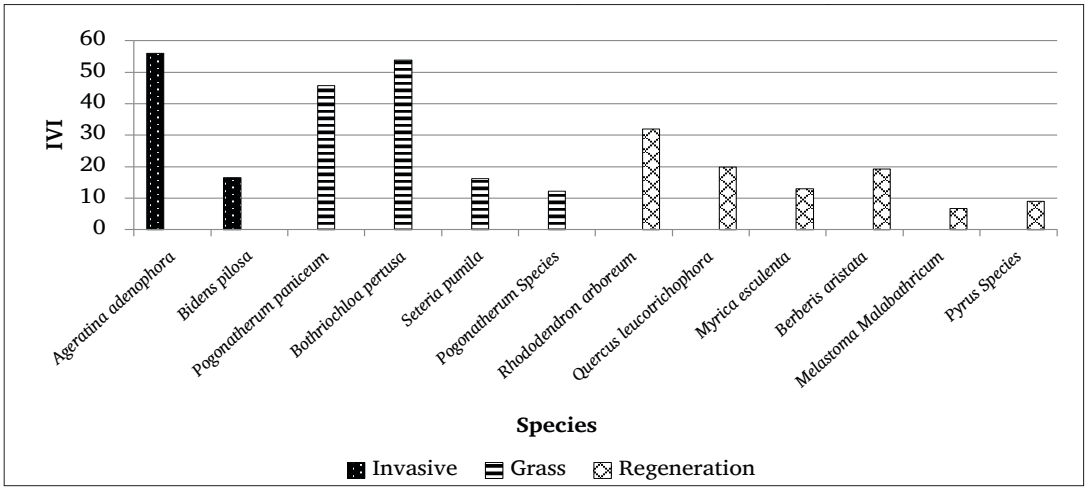

Figure 5: Importance Value Index of IAPS and native species in altitudinal range >2000 m

DISCUSSION

Our study recorded seven grass species, four IAPS and twenty regenerating woody species. Among the IAPS, *Ageratina adenophora* and *Bidens pilosa* were found to have impact on native species across all altitudinal zones, while *Lantana camara* and *Ageratum conyzoides* were restricted to elevations >2000 m. A marked decline in IAPS abundance was observed at higher altitudes (>1000 m), while it was dominant in lowland areas. This altitudinal trend was consistent with the trend found in Becker *et al.* (2005). Although the diversity of IAPS was lower than that of native species, biodiversity indices from the result showed the gradual impact on the richness and evenness of native species due to the increasing dominance of IAPS. This dominance was largely attributed to the greater cover and height of invasive species, which suppressed native flora through declining evenness rather than complete elimination. These findings align with those of Hejda *et al.* (2009), who demonstrated that IAPS suppresses native species through competitive exclusion, with the degree of impact varying by environmental context and invaders' characteristics. Similarly, Baidar *et al.* (2017) used Maxent modelling, reported adverse impacts of IAPS on sapling, shrubs and grasses in forested and grassland ecosystems.

According to GoN (2014), IAPS like *Ageratina adenophora* has been a major driver of biodiversity loss in the mid-hills. Owing to the ongoing climate change, IAPS are encroaching upon higher elevations. Our results from analysing the IVI revealed that IAPS remained dominant and influential on native species across all elevation zones. Paiaro *et al.* (2011) and Gallardo (2014) also report that IAPS with higher IVI values substantially alter the native species distribution. Likewise, IAPS exerted greater negative impact with reduced canopy cover, where their abundance was highest. Pandey *et al.* (2021) and Lawes *et al.* (2004) also stated in their findings that a negative correlation existed between canopy density and IAPS proliferation. Despite the ecological impact of IAPS across the altitudinal ranges, our data revealed a gradual expansion of IAPS richness. This trend is a mirror observation by Zhang *et al.* (2015), who reported that species richness peaked at lower elevations and declined sharply with increasing altitude. The proliferation of IAPS at lower altitudes is primarily driven by anthropogenic disturbances, such as unplanned road construction, agricultural activities, canopy cover and soil characteristics (Baral *et al.* 2017; Shrestha *et al.* 2017). Overall, our findings highlight the significant impact of IAPS on native species distribution, particularly their upward expansion to higher altitudes, facilitated by environmental disturbances and increasing distribution of IAPS.

CONCLUSION

This study in the CFs of Jajarkot district highlights the impact of IAPS on the distribution of native species across different altitudinal ranges. IAPS were predominantly concentrated at lower altitudes (<1000 m), with their diversity and influence gradually decreasing at higher elevations. However, the findings suggest a potential upward expansion of IAPS, posing significant threats to biodiversity and ecosystem integrity, particularly in areas above 2000 m if effective management is not implemented. The high IVI and diversity of IAPS at lower and mid altitudes underscore the impact on the native species that need urgent conservation measures to mitigate their impact. Future research should adopt systematic sampling

techniques, include diverse land-use types and investigate the socioecological drivers of IAPS spread. Collaborative approaches involving local communities, policymakers and conservation stakeholders are essential to safeguard biodiversity and promote ecosystem resilience.

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Understanding Local Perceptions of NTFP Availability in the Himalayan Landscape of Nepal

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Abstract

Non-timber forest products (NTFPs) are integral to the livelihoods and sociocultural practices of forest-dependent communities in Khare village, Dolakha district, located in Nepal's Gaurishankar Conservation Area. However, their availability is increasingly threatened by climate change and human-induced pressures. This study, conducted in 2023, applied a convergent parallel mixed-methods approach to assess both the status of NTFP availability and local perceptions of climate-related changes. A total of 95 randomly selected households were surveyed using a pre-tested semi-structured questionnaire (Cronbach's alpha = 0.82), supplemented by key informant interviews, focus group discussions and field observations. Results show that 95.8 per cent of respondents observed noticeable changes in NTFP occurrence. While fodder (100%) and fuelwood (99%) were most commonly used, medicinal plants (42%) and honey (21%) had lower usage, largely due to ecological degradation and overharvesting. Significant altitudinal variation was observed ($p < 0.05$ for most categories), with decreased availability reported below 1,600 m and increases above. Key stressors identified included overexploitation (75%), climate change (52%), forest fires (36%), invasive species (*Ageratina adenophora*) and pest outbreaks (*Gazalina chrysolopha*). Respondents emphasised reduced grazing and growing conservation awareness as contributors to localised recovery. The study calls for stronger regulatory mechanisms, sustainable harvesting guidelines and community-led restoration efforts to safeguard NTFPs and strengthen rural resilience in Himalayan landscapes.

Keywords: NTFP, climate change, community perceptions, local ecological knowledge, Likert scale, altitudinal gradient

INTRODUCTION

Non-timber forest products (NTFPs) are products other than timber derived from forests (Ahenkan and Boon 2011). Recently, NTFPs have gained recognition as significant forest resources, especially for rural communities. These products have long been a vital part of livelihoods (Chandrashekharan 1998). Common NTFPs include medicinal and aromatic plants, wild vegetables, wooden utensils, edible fruits, bamboo, fodder, and fuelwood (Shackleton and Shackleton 2004). Among these, medicinal and aromatic plants (MAPs) are the largest and most important component, contributing more to the rural economy and healthcare than other NTFP sub-sectors (Ghimire *et al.* 2008). NTFPs are especially crucial for mountain communities, where 12 per cent of the world's population resides and where about 10 per cent rely on NTFPs and mountain resources for their livelihoods (ICIMOD 2008). In Nepal, NTFP-based

activities can account for up to 90 per cent of rural household income (Bista and Webb 2006). Approximately one-third of rural Nepali people collect and trade forest products, which generated US$7.66 million in 2010 and benefited 78,828 participants (Chitale *et al.* 2018).

Climate change refers to long-term shifts in weather patterns over decades to millions of years (Forner and Robledo 2006; Parmesan and Yohe 2003). Globally, increase in temperature, atmospheric carbon dioxide and variations in rainfall, along with the frequency and severity of extreme weather events, have been observed (FAO 2008). These changes have significant impacts on forest ecosystems worldwide, including species (plants and animals) extinctions, prolonged or shifted growing seasons and increased forest fires. Human-induced climate change has intensified since the latter half of the 20th century (Cook *et al.* 2013; Reusswig 2013). Extreme weather and climatic conditions affect forestry and agriculture, leading to reduction in productivity and food shortages. The impacts on species populations and ecosystems alter the availability and supply of ecosystem services: provisioning, regulating, supporting and cultural (Malhi *et al.* 2020). Changes in optimal temperature ranges threaten the survival of multiple species, accelerating the loss of NTFPs by gradually changing forest structures (Leal *et al.* 2021).

In Nepal, forests cover about 46.08 per cent of the total land area (FRTC 2024), contributing NPR 0.92 billion to the national GDP in fiscal year 2072/73 (NPC 2016). Nepal's rich biodiversity makes NTFPs a vital part of its economy, providing for people's needs without causing deforestation. Despite significant potential, NTFPs are often undervalued within the forestry legal frameworks in many developing countries (Wynberg and Laird 2007). Most national forest policies categorise NTFPs as minor products, prioritising timber over other forest resources (Gautam and Devoe 2006). Local communities and forest dwellers often rely heavily on timber for income; however, the contribution of NTFPs is frequently overlooked. Policy efforts have emphasised timber value, and, recently, some countries have initiated plans for NTFP management and utilisation, yet many still focus primarily on timber. While development efforts have concentrated on timber promotion, the ecological and livelihood benefits of NTFPs are often neglected despite their potentially greater conservation and socioeconomic importance. The inhabitants of the Himalayan region possess extensive traditional knowledge of the sustainable management and use of natural resources (Chauhan *et al.* 2021). Nevertheless, understanding local perceptions of NTFP availability and management within the Himalayan region remains limited (Azhar *et al.* 2021). Gaining insights into these perceptions is vital for developing effective conservation and sustainable resource management strategies (Masoodi and Sundriyal 2020). Investigating local viewpoints is essential for creating strategies that promote the sustainable use of these resources (Baral and Katzensteiner 2009).

This study focuses on the Gaurishankar Conservation Area (GCA), specifically Khare village in Dolakha district, Nepal, renowned for its biodiversity and abundance of NTFPs. Despite their key role in supporting livelihoods and ecosystem services, the effects of climate change on NTFP availability and community perceptions in this area are poorly documented. The research aims to assess the current state of NTFPs in Khare, examine how climate

change and other factors impact these resources, and understand local perceptions of rainfall and temperature changes. By integrating local knowledge with altitude- and village-specific conservation strategies, this study aims to inform forest management and restoration efforts. The results will help shape evidence-based policies to sustain NTFPs and improve the livelihoods of forest-dependent communities in the GCA.

METHODOLOGY

Study sites

The study was conducted in Khare (27°49'N, 86°18'E), located in the Gaurishankar Rural Municipality in Dolakha district, Bagmati province, northeastern Nepal, as shown in Figure 1. This region falls under the Gaurishankar Conservation Area (GCA 2022) and spans a tropical to subalpine elevation gradient, ranging from 1,010 metres above sea level (masl) to 5,522 masl. The area comprises diverse forest types, including subtropical forests (1,000–2,000 m), temperate forests (2,000–3,000 m) and subalpine forests (3,000–4,000 m) (DNPWC 2022). Covering an area of 104.43 square kilometres, the region is home to a population of 1,718 individuals belonging to various caste and ethnic groups, such as Chhetri, Brahmin, Dalit, Tamang, Sherpa, Newar, Gurung, Magar, Thami, Surel, and Jirel (GoN and NSO 2021). Agriculture is

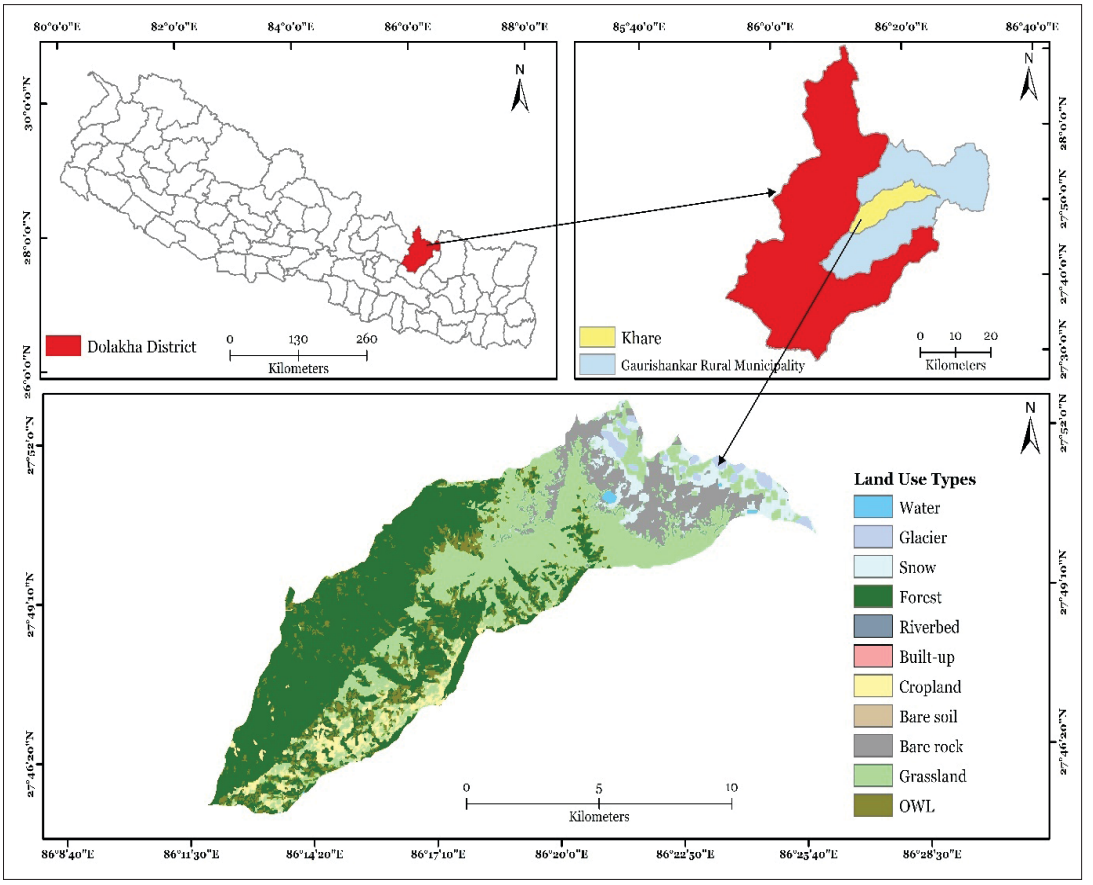

Figure 1: Study area map

the predominant livelihood, with more than 90 per cent of residents engaged in NTFP harvesting for either subsistence or income generation. Dependence on NTFPs is particularly pronounced among households with limited alternative income sources (Maharjan and Dangal 2020). Key NTFPs collected in the area are *Swertia chiraita, Curculigo orchioides, Bergenia ciliata, Rheum australe, Ophiocordyceps sinensis, Rhododendron anthopogon, Eulaliopsis binata, Paris polyphylla,* and *Astilbe rivularis* (DNPWC 2022).

Sampling strategies and data collection

A random sampling method was employed to assess the local community's perceptions of the availability of NTFPs and the impact of climate change. A total of 95 respondents from the Khare area were selected randomly. To ensure the integrity of the sample, we avoided including multiple respondents from the same household and aimed to represent various types of residents within the community. The sample size was determined using the online Survey Monkey platform, based on the formula presented in Equation 1.

$$Sample\ size = \frac{\frac{z^2 \times \rho(1-\rho)}{e^2}}{1+\frac{[z^2 \rho(1-\rho)]}{e^2 \times N}} \quad \text{equation 1}$$

Where z is the z score = 1.96 (for a confidence level of 0.95), e is the margin of error (calculated as 10%), N is the population size (the total population of Khare according to the 2021 census is 1718), and ρ is the population proportion (kept as 50%).

The survey focused on Khare villages, namely Tunitar, Suri Dobhan, Besi, Tallo Kaseri, Lamakali, Manedada, and Sothali. Data were collected during January–March 2023 by using household surveys and key informant interview (KII) questionnaires. KIIs were qualitative in-depth interviews with selected people. The participants were asked to provide all the information they perceived as identifying changes in climate and the impacts of such changes, particularly on NTFP availability. The questionnaires were semi-structured. A typical five-level Likert item (Table 1) was used (Poggie 1972) as an effective and systematic means of studying human attitudes and the factors that influence them.

Table 1: Likert scale value

Response category	Value	Range
Strongly disagree	1	1.00–1.80
Disagree	2	1.81–2.60
Neither/Nor Agree	3	2.61–3.40
Agree	4	3.41–4.20
Strongly agree	5	4.21–5.00

The questions were pre-tested through a pilot survey of selected households and were modified before the field survey. A systematic and evidence-based approach, as outlined by Yusoff (2019), was employed to ensure proper validation. The Item-level Content Validity Index (I-CVI), the Scale-level Content Validity Index based on the average method (S-CVI/Ave) and the Scale-level Content Validity Index based on the universal agreement method (S-CVI/UA) were calculated to be 0.869, 0.8452 and 0.8095 respectively. We consulted two experts for content validation. The calculated values of the Content Validity Index (CVI) exceeded the accepted CVI threshold of 0.8 recommended by Davis (1992).

For content reliability, we measured Cronbach's alpha, which assesses the

internal consistency of a test or scale and is expressed as a number between 0 and 1 (Tavakol and Dennick 2011). Acceptable values of alpha range from 0.70 to 0.95 (Bland and Altman 1997; Nunnally 1975). In this study, Cronbach's alpha for the Likert scale was calculated to be 0.82, which falls within the accepted range. Therefore, the questionnaire scale has achieved a satisfactory level of content validity and reliability.

Data analysis

Both qualitative and quantitative methods were employed to analyse the data collected from KIIs and household surveys. The household survey data were visualised graphically and analysed quantitatively using R version 4.3.2 (R Core Team2023) and ArcMap 10.8. The qualitative data obtained from the KIIs were analysed using thematic coding analysis.

To examine the association between perceived trends in NTFP availability (increasing, decreasing, or no change) and the altitudinal gradient (categorised into two elevation bands: above 1,600 masl and below 1,600 masl), Fisher's exact test was applied. This non-parametric statistical test was selected due to the categorical nature of the variables and the relatively small sample sizes within elevation categories. Fisher's exact test is particularly suitable for contingency tables where the assumptions of the chi-square test may not be met (Kim 2017). The test was performed in R using fisher. Test () function to determine whether the distribution of perceived NTFP availability was statistically independent of the altitudinal gradient.

RESULT

Demographic overview

A total of 95 per cent of the targeted households responded to the survey. Of the respondents, 51.6 per cent were male and 48.4 per cent were female. The majority of participants (53.6%) were between 30 and 60 years of age, followed by those over 60 years (33.7%) and those below 30 years (12.6%). In terms of educational attainment, a significant portion of respondents (48.4%) had no formal education, 18.9 per cent had completed primary education, 24.2 per cent had attained secondary-level education, and 8.4 per cent had education beyond the secondary level. Occupation-wise, the majority of respondents (77.9%) were engaged in farming. Other occupational categories included the service sector (11.6%), trade (6.3%), daily wage labour (3.2%), and remittance-based livelihoods (1.1%). Regarding household income, more than half of the respondents (54.7%) reported an average monthly income of less than NPR 15,000, 28.4 per cent earned between NPR 15,000 and NPR 25,000, while 16.8 per cent reported a household income exceeding NPR 25,000.

Categorisation of NTFPs based on KIIs

The communities in the study area possess rich traditional ecological knowledge, particularly in the use of NTFPs. They identified nine major categories of NTFPs: fodder, fuelwood, medicinal plants, wild vegetables, agricultural tools, bamboo, wild fruits, weaving grass, and honey. While all were used to some extent, their level of utilisation varied considerably (Figure 2), reflecting differences in daily necessity, accessibility and cultural significance.

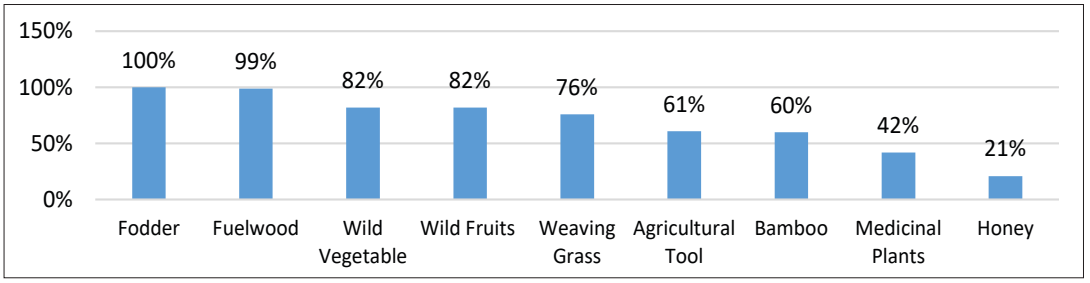

Figure 2: People's involvement in the collection of different NTFP categories

The survey confirmed the critical role of forest products, such as fodder and fuelwood, in daily subsistence, while highlighting varying degrees of reliance on wild edibles, materials and medicinal resources. Lower usage of items such as medicinal plants and honey may reflect limited access or waning traditional practices. Although key informants provided an extensive inventory, actual usage proved more nuanced and context-dependent, offering deeper insights into local perceptions and utilisation of forest ecosystem services.

Perceived trend of NTFP availability

Community perceptions of NTFP availability offer valuable insights into both social and ecological dimensions. The following sections present findings across four key areas: a) overall trends in availability, b) variations by altitude and c) perceived factors driving both increases and decreases.

Overall NTFP availability trends

The respondents perceived increased availability of fuelwood and weaving grass in the study area compared to agricultural tools, fodder, wild fruits, wild vegetables, honey, medicines, and bamboo (Figure 3). The mean score of fuelwood (3.29%), weaving grass (3.21%), agricultural tools (3%), fodder, wild fruits (2.94%), wild vegetables (2.92%), honey (2.83%), and medicines (2.71%) were within the neutral scoring range of Likert scale, ie 2.61–3.4, while that of bamboo (2.56%) lied within the decreased scoring range of Likert scale, i.e. 1.81–2.6. Hence, overall, among the major NTFPs, the availability of bamboo was perceived to have decreased in the study area.

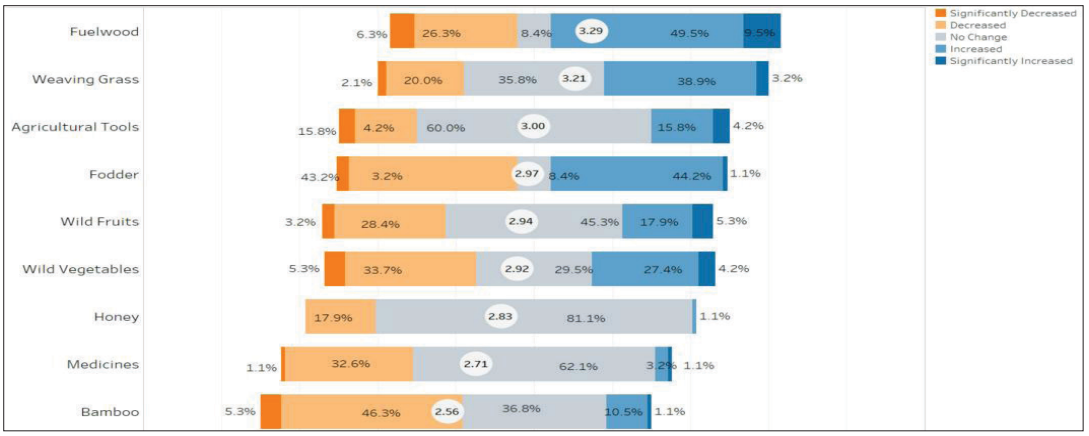

Figure 3: Overall changes in the NTFP availability (where 1: Significantly decreased, 2: Decreased, 3: No change, 4: Increased, 5: Significantly increased)

Change in NTFP availability with altitude

The availability of NTFPs has changed over the past few decades. Of the respondents, an overwhelming majority of 95.8 per cent agreed that the NTFP availability had changed. Furthermore, among them, 74 per cent reported overall increase in the NTFP availability below 1,600 masl, while 69 per cent reported overall increase in the NTFP availability above 1,600 masl. The fisher's test result showed that the availability of medicines, fuelwood, fodder, agricultural tools, weaving grass, bamboo, and wild vegetables significantly varied with altitude (Table 2). In higher altitudes, fuelwood, weaving grass, agricultural tools, fodder, wild vegetables, and wild fruits were reported to have increased, whereas bamboo, honey and medicines were reported to have decreased (Figure 4). Overall, NTFPs were perceived to be increasing with increase in altitude. However, the accessibility of medicinal plants was found to decrease along the altitude gradient.

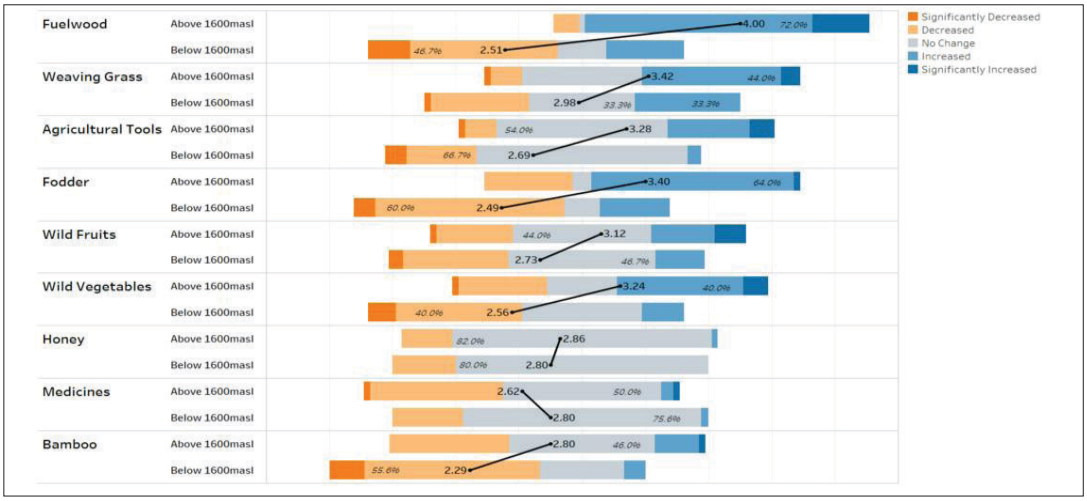

Figure 4: Perceived trends in the availability of major NTFPs above and below 1,600 masl

Table 2: NTFP availability trend against altitudinal gradient

NTFP Category against Altitude	Fisher's test
Medicines and altitude	0.04459 *
Fuelwood and altitude	1.78E-10 ***
Fodder and altitude	8.81E-05 ***
Agricultural tools and altitude	0.002555**
Weaving grass and altitude	0.04305 *
Bamboo and altitude	0.01126 *
Wild vegetables and altitude	0.003043 **
Wild fruits and altitude	0.1926
Honey and altitude	0.8893

Causes of increase in NTFP availability

The major perceived reasons for the increase in the availability of NTFPs above 1,600 masl were decreasing livestock and harvest (69%), decreasing population and family size (54%), increased awareness (40%) and reduced cultivation area (31%). Some respondents believed increment to be a result of forest conservation policy (25%). On the contrary, decreasing livestock and harvest (20%), along with increased awareness, reduced cultivation area and forest conservation policy were perceived as the major contributors to the increase below 1,600 masl (Figure 5).

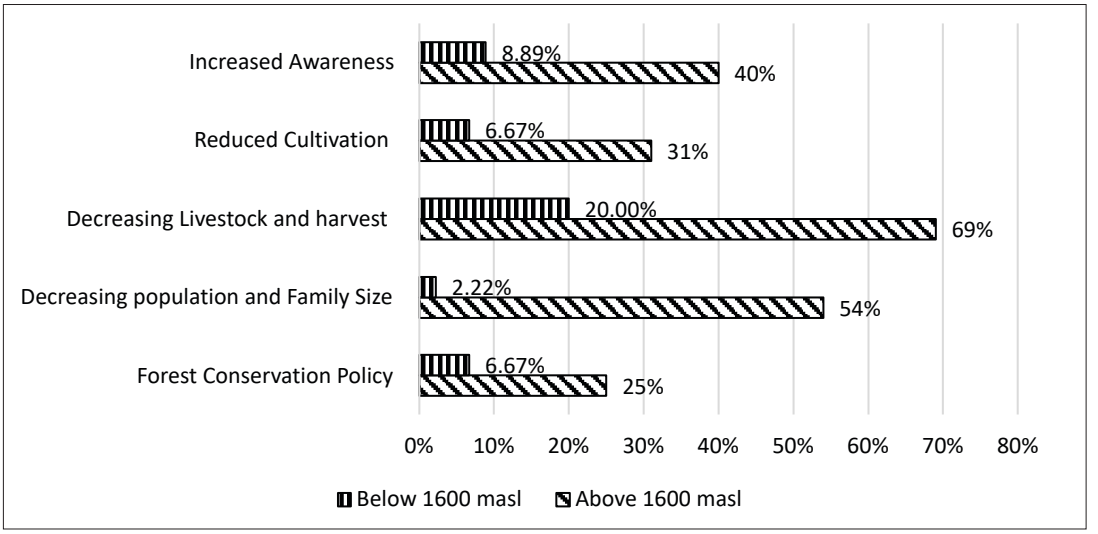

Figure 5: Comparison of perceived reasons for the increase in NTFP availability above and below 1,600 masl

Causes of decrease in NTFP availability

The major perceived reasons for the decrease in NTFP above 1,600 masl were overexploitation (75%), climate change (52%) and forest fires (36%). Some respondents attributed the decrease to earthquakes (11%) and divine wrath (16%). On the contrary, forest fires and overexploitation were perceived as the major contributors to the increase below 1,600 masl (Figure 6).

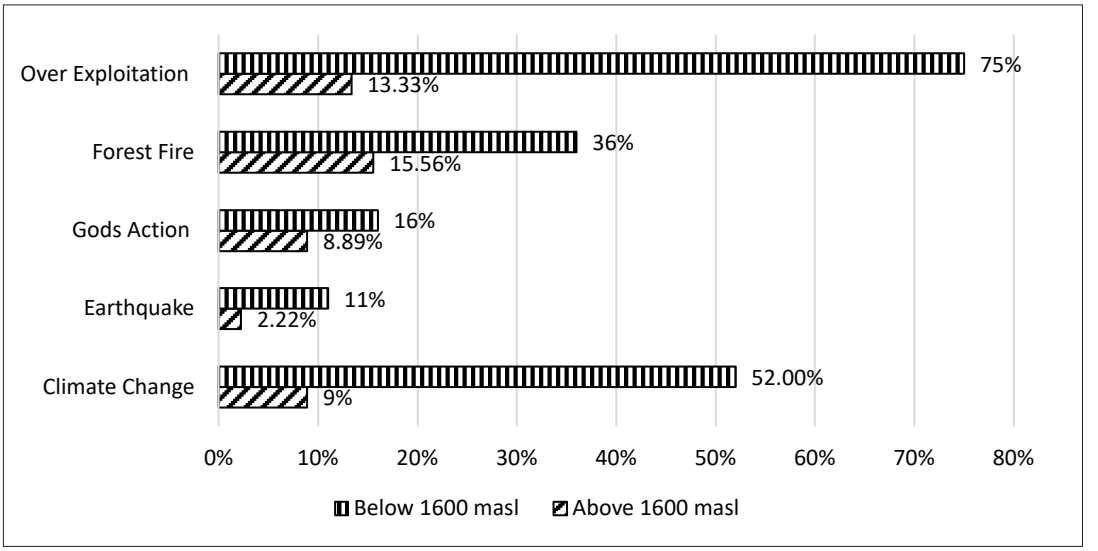

Figure 6: Comparison of perceived reasons for the decrease in NTFP availability above and below 1,600 masl

Impact of overexploitation of NTFPs

Respondents reported that fuelwood, followed by fodder and wild fruits, was the major NTFP that decreased because of overexploitation (Table 3), while weaving grass and bamboo were the least affected by overexploitation. The harvesting details of GCA for fiscal year BS 2077/078 showed that medicinal plants, like black *musli* (*Curculigo orchioides*), *pakhanbhed* (*Bergenia ciliate*), *sunpati* (*Rhododendron antopogon*) and wild honey, were harvested more than the permitted amounts.

Table 3: Ranking of NTFP availability due to overexploitation based on local perceptions

Particulars	Mean SD	Rank
Fuelwood	2.39 ± 1.07	I
Fodder	2.46 ± 0.84	II
Wild fruits	2.57 ± 0.63	III
Wild vegetables	2.64 ± 0.78	IV
Honey	2.64 ± 0.49	V
Agricultural tools	2.71 ± 0.854	VI
Medicines	2.86 ± 0.36	VII
Bamboo	2.86 ± 0.59	VIII
Weaving grass	2.96 ± 0.74	IX

Note: Particulars indicate the resources whose availability has decreased due to overexploitation

Impacts of climate change and extreme events

Respondents identified increases in the incidence of forest fires, pest and insect attacks, expansion of invasive plant species, strong wind events, changes in rainfall and temperature patterns, increased incidence of landslides and floods, and more frequent and severe winter droughts as the major drivers reducing the availability of NTFPs. Most participants perceived that forest fires have impacted the availability of most NTFPs (Figure 7). A high proportion of respondents agreed that the impact of forest fires on the availability of fruit, vegetables, fodder, fuelwood, bamboo, honey, and medicines had increased. Similarly, a majority of participants reported that an increase in landslide incidents had impacted the availability of most NTFPs, including fuelwood, fodder, bamboo, medicines, and fruit. The increased invasion and upward shift of alien species like *banmara* (*Ageratina adenophora*) was also reported. Increased insect and pest infestations were also the reasons behind the decrease in NTFPs. Similar research reported the moth caterpillar, locally called *Ghyosipiti* (*Gazalina chrysolopha* Kollar), as the major pest consuming leaves of trees, especially *Alnus nepalensis, Rhododendron arboreum* and other fodder plants around regions. Bamboo undergoing the flowering process was said to decline heavily. Reduced hailstone and snowfall incidents were also reported.

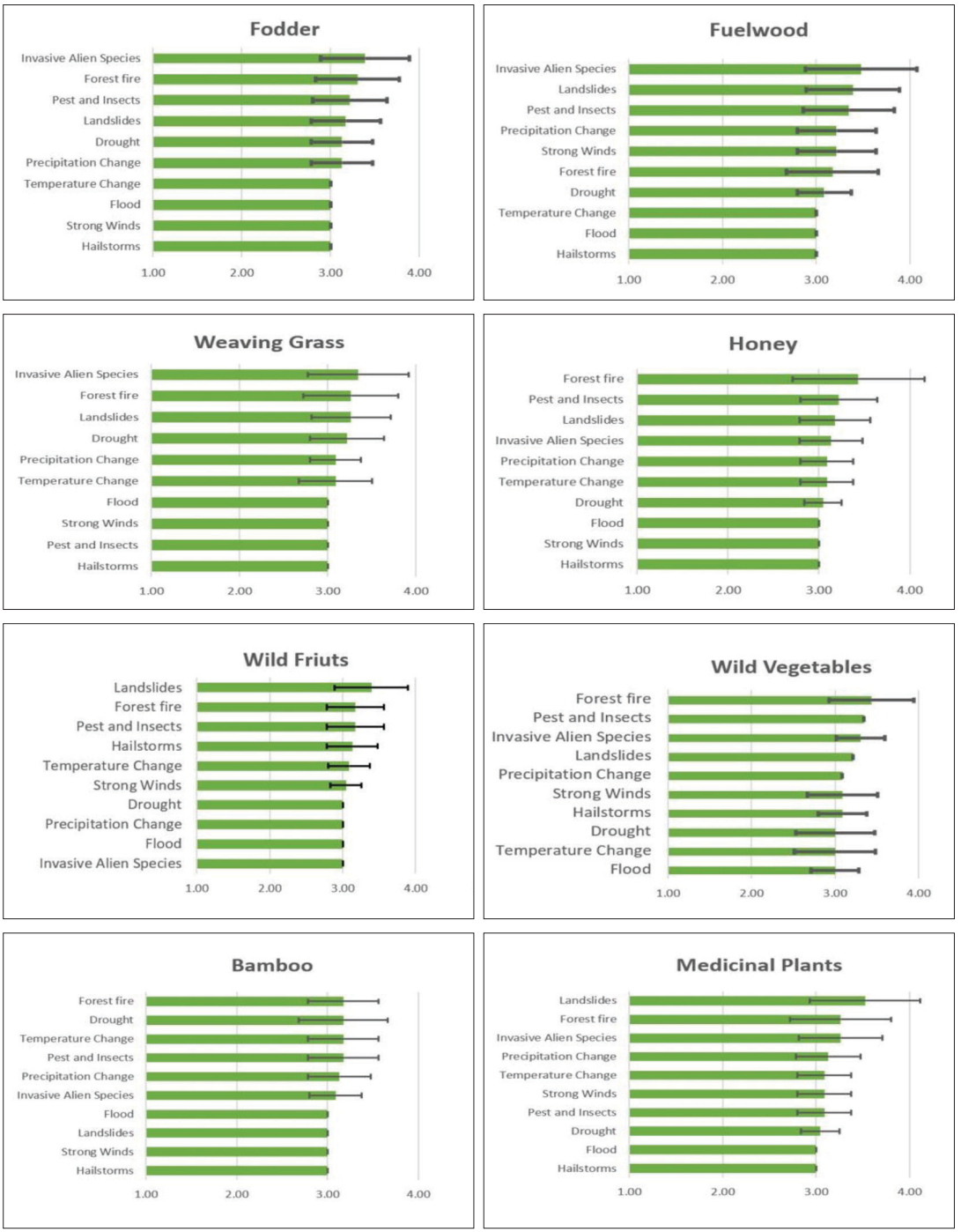

Figure 7: Perceived impacts of climate change on NTFP availability (where 1: No impact, 2: Low impact, 3: Moderate impact, 4: High impact, and 5: Very High impact; error bars represent ± 1 standard deviation)

DISCUSSION

Our findings demonstrate high subsistence dependence on NTFPs, with 100 per cent of households using forest-derived fodder and 99 per cent relying on fuelwood. This underscores a deeply-rooted livelihood–forest linkage, which is consistent with previous research across Nepal (Uprety *et al.* 2016; Sherpa 2025; Paneru 2024). For instance, Sherpa (2025) reported comparable fuelwood reliance in the Annapurna region, while Paneru (2024) highlighted similar dependence on fodder in the mid-hills. Together, these patterns reaffirm the continued centrality of NTFPs to rural economies.

In contrast, lower usage rates of medicinal plants (42%) and wild honey (21%) may signal a decline in traditional ecological knowledge and reduced availability, probably driven by overharvesting and climate-induced ecological changes (Kunwar *et al.* 2013). Notably, some respondents reported increased availability of weaving grasses and wild vegetables, especially at higher elevations. While this trend may initially appear counterintuitive, given the national biodiversity concerns, it can be linked to socio-demographic shifts, specifically declining livestock numbers, shrinking household sizes and abandoned farmlands. These findings are supported by our survey, which shows a 20 per cent drop in livestock and harvest. Such shifts mirror Nepal's broader agrarian transition, where rural outmigration and remittance-based economies are reshaping land use and labour allocation (Neupane and Poudel 2023). As traditional agricultural practices decline, forest dependence is being reconfigured in complex ways, with important implications for both livelihoods and forest management.

Furthermore, our data reveal a nuanced altitudinal pattern in NTFP availability within the GCA. Respondents perceived greater species richness at higher elevations and, at the same time, declining accessibility, particularly of medicinal plants, above 1,600 masl. These observations align with prior studies from the Himalayan region, where elevation and human accessibility jointly influence the NTFP distribution and harvestability as well as the intensity of ecological pressures (Kala 2005; Kunwar *et al.* 2013).

The apparent paradox of increased species diversity but decreased availability of medicinal plants can be explained by a combination of ecological and anthropogenic pressures. Chief among these is overexploitation, cited by 75 per cent of respondents as a primary driver of resource decline. This corroborates previous findings that attribute unsustainable extraction of high-value species, such as *Curculigo orchioides* (black musale), *Bergenia ciliata (pakhanbhed)* and *Rhododendron anthopogon (sunpati)*, to weak regulation, open-access systems and high market demand (Kunwar *et al.* 2013). These community concerns are validated by the GCA's official harvest records (FY BS 2077/078), which shows that the collection of key medicinal and aromatic plants exceeded sanctioned quotas. Such overharvesting highlights persistent gaps in enforcement, monitoring and compliance, especially in protected areas where conservation mandates are often misaligned with local livelihood needs (Shrestha and Bawa 2013; Kunwar *et al.* 2016).

The commercialisation of wild honey and alpine herbs has further intensified harvesting pressure, typically without corresponding investments in sustainable

harvesting practices or habitat restoration (Subedi *et al.* 2013). In such contexts, ecological thresholds may be breached, endangering the long-term sustainability of these forest resources.

Climate change was another widely reported factor, cited by 52 per cent of respondents as adversely affecting NTFP availability. Community members reported observing changes in rainfall patterns, rising temperatures, winter droughts and increased incidence of extreme events such as landslides and strong winds. These perceptions are supported by scientific literature showing that climate change is altering the phenology, geographic distribution and productivity of alpine species across the Central Himalayas (Shrestha *et al.* 2012; Xu *et al.* 2009). The intersection of climatic and human-induced pressures places significant stress on both species and ecosystems, necessitating urgent adaptive responses.

An additional concern emerging from community observations is the proliferation of invasive alien plant species (IAPS) and rise in pest outbreaks. Invasive species such as *Ageratina adenophora* and *Lantana camara* are known to displace native flora, reducing NTFP availability and compromising ecosystem integrity (Merow *et al.* 2017; Shrestha *et al.* 2019). Communities attributed decline in certain NTFPs to the rapid spread of IAPS. Furthermore, the rise in pest outbreaks presents another layer of stress to native ecosystems, potentially weakening plant health and regeneration capacity. These dual threats highlight the urgent need for comprehensive monitoring and management strategies that address both biological invasions and forest health.

Together, these findings underscore the multifactorial nature of threats to NTFP sustainability in the region. Biophysical drivers such as climate extremes, pests and landslides interact with anthropogenic stressors, like overharvesting, fire and spread of invasive species, to create complex and dynamic pressures on forest ecosystems. Addressing these challenges requires integrated forest management approaches that balance conservation and livelihood objectives. Key strategies should include regulatory reforms, sustainable harvesting practices, community engagement and ecosystem restoration.

Lastly, the study reinforces the importance of local ecological knowledge (LEK) in conservation planning. Respondents' insights provided valuable early warning signals of ecological change, which can inform adaptive co-management and enhance resilience. When supported by participatory monitoring and validated through scientific research, LEK can serve as a cornerstone for inclusive and context-specific forest governance (Berkes 2009; Uprety *et al.* 2012).

CONCLUSION

This study showcases the enduring and evolving dependence of rural households on NTFPs, with common dependence on fuelwood and fodder, thereby highlighting the critical role of forest resources in sustaining subsistence livelihoods. However, observed decreases in medicinal plants and wild honey, along with increased invasive species and pest outbreaks, indicate emerging ecological and socioeconomic pressures. Variations in NTFP availability

at different altitudes, driven by both environmental factors and access issues, further complicate sustainable resource management in mountainous protected areas, like the GCA.

Our findings emphasise the urgent need to shift NTFP management towards integrated and adaptable strategies. We recommend: (i) strengthening community-based monitoring systems that leverage local ecological knowledge; (ii) promoting sustainable harvesting practices and market regulation for high-demand species; (iii) expanding restoration efforts, focusing on degraded habitats and areas overtaken by invasive species; and (iv) improving climate-resilient forest management through localised adaptation planning. In particular, formal recognition and integration of local knowledge into policies and practices can improve responsiveness to ecological changes, as well as support effective and fair NTFP management. Without such comprehensive actions, the combined effects of overharvesting, land-use changes, climate change and invasive species could irreparably damage the ecological integrity and resource base that forest-dependent communities rely on. Sustainable NTFP management is, therefore, not only essential for conservation but also a socioeconomic necessity for mountain livelihoods.

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