Biodiversity Beyond Protected Areas: Gaps and Opportunities in Community Forest

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Abstract

Amidst its successes on various fronts of forest management, there are still concerns about overall biodiversity outcomes in community forests (CFs) of Nepal. The potential for biodiversity conservation is undermined by an orthodox focus of conservation efforts on protected areas and charismatic species, and the prevalence of management activities that potentially hinder biodiversity in community forests. However, the actual potential for biodiversity conservation and impacts of management activities is obscured by a lack of a robust and comprehensive accounts of biodiversity in CFs. Taking, as a case study, the 22 CFs in the remnant Jalthal forest of Jhapa district in south-eastern Nepal, we examine its biodiversity status, prevalent threats to biodiversity, management interventions and conservation outcomes. We surveyed species across taxonomic groups, identified local uses of plant species, reviewed CF operational plans, discussed with local leaders experienced in forest management, and organised forest transect walks and in situ interviews with local community forest leaders. We demonstrate the richness, uniqueness and conservation significance of Jalthal forest and highlight the key role of biodiversity for the people living in proximity to the forest. Paradoxically, it is evident that along with biodiversity richness, the forest is equally threatened by invasive alien plants. Moreover, timber-centric management is dominant and a high demand for biomass extraction exists across the CFs. Despite playing an important role in protecting and managing Jalthal forest, the existing management practices of CFs are not sufficient to conserve biodiversity and address the emerging threats - primarily because they are weakly informed by relevant biodiversity data. Building an evidence-driven basis for forest management plans and enhancing the capacities of local communities to properly implement these plans can help restore degraded forests, conserve biodiversity and meet the local need for forest products. This paper reinforces the paradigm that conserving biodiversity outside protected areas, such as in community-managed forests, can indeed contribute towards broader biodiversity conservation goals in addition to providing ecosystem services to local forest-dependent populations.

Key words: Biodiversity, community forestry, ecosystem services, Invasive species, forest management

INTRODUCTION

Nepal's Community Forestry programme has been globally acknowledged for its success in increasing forest cover and tree density, and restoring degraded forests, particularly in the mid hills (Ostrom and Nagendra 2006; Pokharel *et al.* 2007, Niraula *et al.* 2013; Oldekop *et al.* 2019). Amidst this success, there is a general oversight on biodiversity conservation issues in community forest management (Shrestha *et al.* 2010). This oversight largely stems from the fact that the

discourse on biodiversity conservation in Nepal is centred around protected areas and charismatic faunal species (DNPWC 2019), overshadowing biodiversity concerns in managed forests. In fact, prevalent management plans and interventions in community forests contribute little to improving forest condition, including biodiversity (Baral *et al.* 2018, 2019). Some routine activities like bush cleaning and pre-commercial thinning reportedly favour timber-yielding species, consequently reducing diversity and homogenising forest composition through the exclusion of other[1] species (Acharya 2004; Sapkota *et al.* 2021).

Though protected areas are important for the conservation of species requiring larger swaths of undisturbed habitats, a growing body of literature suggests that they are not enough, on their own, to protect and promote biodiversity (Rodrigues *et al.* 2004, Chape *et al.* 2005). Rather, land management activities in broader landscape appear to have a much greater impact on conservation than the legal designation and official status of the land (Hansen and DeFries 2007). In addition, managed forests, agroforests, sacred groves and community conserved areas also host significant biodiversity (Harvey *et al.* 2008, Shahabuddin and Rao 2010, Cox and Underwood 2011,) and can complement protected areas in achieving broader biodiversity goals. Further, there is an apparent gap in the geographical representation and species coverage of Nepal's network of protected areas (Shrestha *et al.* 2010, Joshi and Joshi 2022). These gaps are occupied by community forests, which cover a third of the public forestland in Nepal (GoN/MFSC 2014), and therefore hold a massive potential for biodiversity conservation outside protected areas.

Despite this opportunity for biodiversity conservation in community forests, there is a lack of credible and comprehensive data on the overall status of biodiversity in these forests. In addition, there is also a lack of analysis of the threats to biodiversity and the effectiveness of local forest management responses to these threats. In this context, this paper presents a rigorous assessment of the status of biodiversity in Jalthal, a block of remnant forest in Jhapa District in the eastern lowlands of Nepal, featuring 22 community forests (CFs). We also analyse current management interventions and approaches as well as local uses of forest plants, to provide insights for evidence-based management plans to integrate biodiversity conservation and ecosystem services in managed forests.

METHODS

Study Area

This study was carried out in Jalthal forest, which straddles across Haldibari Rural Municipality, Kachankawal Rural Municipality, and Bhadrapur Municipality of Jhapa District in the southeastern corner of Nepal. Jalthal is 6000-hectare remnant forest, shaped like a rectangular block (10.5 × 5 km) and oriented east to west (Figure 1). The forest spans an elevational range of 60 to 120 meters above the sea level, and features the lowest altitudinal point in Nepal. Bhadrapur Airport weather station is the nearest climate recording station, reporting a mean annual temperature of 25 degrees Celsius and mean annual precipitation of 2300 mm, with more than 80 per cent rainfall occurring during the monsoon season (i.e. June to September).

Jalthal forest is a remnant forest-island of a once contiguous, lush and dense forest known as *Charkoshe Jhadi*. It is a moist tropical forest and mainly consists of floristic elements from the Indo-Malayan Floristic Region (Thapa *et al.* 2003). Jalthal has a heterogeneous composition of forest types, of which 15 per cent is formed by mixed-species old growth stands, over 52 per cent by

1 Tree species other than major timber are lumped as óther' and regarded as '*Kukath*' meaning inferior wood in community forest operational plans (CFOPs)

naturally regenerating successional Sal (*Shorea robusta*) stands, 11 per cent open shrub areas, 11 per cent degraded forest and the remaining 13 per cent by other land cover, including wetlands. Over half of the forest is invaded by alien plant species, primarily in the eastern half, by *Mikania micrantha* (Nepali: lahare banmara) and *Chromolaena odorata* (Nepali: seto banmara) (Shrestha 2020).

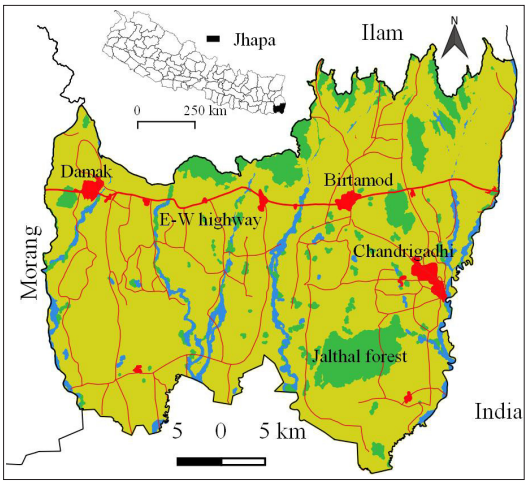

Figure 1: Location of Jalthal Forest in Jhapa District of Eastern Nepal

Local communities started managing Jalthal forest in 2003, and it was officially handed over to them in 2009. Currently 22 CFUGs (Community Forest User Groups), with a total of 80,000 users, manage different parts of Jalthal forest.

Data Collection

Biodiversity Surveys

Biodiversity surveys of Jalthal were conducted between June 2019 and March 2021. A summary of the results of these surveys is been presented in this article. These surveys were used to prepare an inventory of species in different taxonomic groups, with survey techniques varying across taxa.

An inventory of the flora was undertaken using opportunistic surveys and systematic random sampling (228 plots of 1 m radius). Plant species were categorised into different taxonomic groups (Pteridophytes, Gymnosperms and Angiosperms) as well as life-forms (such as trees, herbs and climbers). Many plant specimens were identified on-site, while some herbarium specimens were collected, dried and mounted following standard methods (Bridson and Forman 1999) for later identification. Herbarium specimens that have been prepared will be deposited at the National Herbarium and Plant Laboratories (KATH) and Tribhuvan University Central Herbarium (TUCH) in Kathmandu. Plants were identified using standard taxonomic literature (Flora of Bhutan, Flora of China), by the help of experts, and by comparing the unidentified specimens with named specimens in the national reference collection at KATH.

Birds were surveyed in all habitat types (forest, farm-forest ecotones, wetlands and open areas, tall trees) during both winter and summer seasons. Birds were recorded when their calls were identified and upon direct observation. Photographs of the species were taken whenever possible. The species of the birds were identified using Grimmett *et al.* (2016). We examined the IUCN (International Union for Conservation of Nature) status of the identified birds[2] and referred to Nepal's National Red List of Birds (Inskipp *et al.* 2017).

Mammals were surveyed using a combination of methods - camera traps, sightings during forest transect walks and opportunistic surveys. Twelve camera traps were placed for two weeks along potential wildlife trails and near waterholes during April, 2021. Direct sightings and signs of animals (droppings, foot prints, and carcasses) were used to identify species. For some species, photographs from books were shown to local people to confirm their identity.

Amphibians and reptiles were surveyed using diurnal and nocturnal transect walks in potential habitats such as streams, wetlands, log piles and tree cavities. Frog specimens were captured and

2 https://www.iucnredlist.org/

released after identification. Snakes killed by people and in road accidents were also studied and identified. Similarly, some specimens were collected for further taxonomic analysis.

Fishes were collected from local fishermen while they were fishing during different periods of the year. Fishes were recorded from all possible habitats, including rivers, streams, ponds, marshes and nearby paddy fields. Species were identified by using standard literature (Shrestha 2008).

A transect method using Pollard Walk and opportunistic surveys were used to record butterfly species. The Illustrated Checklist of Nepal's Butterflies (Smith 2011) was used as a field guide for identification.

Forest Transect Walk and in Situ Interviews

We broadly adapted ethno-botanical and ethno-ecological approaches consisting of forest transect walks and semi-structured interviews (Thomas *et al.* 2007; Gallois *et al.* 2021;) accompanied by local people and researchers. During the walks, we asked local people about the plants they collect and use. Local people showed us the plants and described their uses, to help us accurately match botanical names to local names and respective uses. We also asked about changes in forest conditions with regards to threats, including the changes caused by the invasive species. During the transect walks we noted the status of the forest and discussed various management activities. Similarly, we observed management activities like bush-cleaning, the process of conducting forest inventories for the Community Forest Operation Plans (CFOPs), and the collection of forest products by the CFUGs of Jalthal.

Community Forest Operational Plans Review

We reviewed the CFOPs of all 22 CFUGs of Jalthal forest. CFOPs are technical inventory-based documents, prepared by the CFUGs, with support from government forest technicians, to guide forest management decisions and daily operational activities. During the review, we analysed the provisions (programmes, plans and strategies) related to forest management and biodiversity conservation. We specifically looked for management activities that may have impact on the biodiversity of the forest. Management actions that potentially impact biodiversity were drawn from literature related to biodiversity conservation in the managed forest (Stork *et al.* 1997; Lindenmayer *et al.* 2000; Oettel and Lapin 2021). We also explored whether the inventories had taken any stock of forest biodiversity, be it through intensive surveys or rapid appraisals.

RESULTS

Biodiversity of Jalthal Forest

The inventories of different groups of flora and fauna demonstrated high diversity across floral life forms and faunal groups in Jalthal forest (Table 1). Among the different taxonomic groups, the diversity of tree flora is most notable in Jalthal: a total of 150 species of trees were recorded in the forest. The forest is also rich in diversity for Pteridophytes (ferns and fern-allies).

Jalthal forest provides habitats for several threatened species of flora and fauna (Table 2). The forest is home to several threatened species such as the Endangered Asiatic elephant (*Elephas maximus*), and Critically Endangered Chinese pangolin (*Manis pentadactyla*). The forest features five species of plants (four trees and one climber) listed in IUCN red list of threatened species (Table 3), including a notable population of *Cycas pectinata*. Species, such as *Dillenia indica*, *Garcinia cowa* and *Gynocardia odorata*, which are rare in Nepal, were also recorded. The floristic survey also recorded six tree species which are new additions to the flora of Nepal. These include *Drypetes assamica* (Putanjivaceae), *Pterygota alata* (Malvaceae), *Harpullia arborea* (Sapindaceae),

Table 1: Species Diversity of Jalthal Forest

Floral life forms	Number of species recorded	Faunal groups	Number of species recorded
Trees	150	Birds	230
Herbs	145	Butterflies	157
Grass	81	Amphibians	14
Shrubs	75	Reptiles	32
Climbers	50	Mammals	27
Pteridophytes	37	Fishes	43

Acronychia pedunculata (Rutaceae), *Siphonodon celastrineus* (Celastraceae), and *Discospermum sphaerocarpum* (Rubiaceae). A notable floristic element in the forest from the east Asiatic region is *Artrocarpus chama* (Nepali: Latahar) which forms rare natural stands in wet and depressed areas, such as the bottoms of small valleys.

Table 2: Threatened and Protected Fauna and Flora of Jalthal

Conservation status	Species			
	Birds	Herpetofauna	Mammals	Plants
Globally threatened	8	2	2	5
Nationally threatened	31	-	8	7*
Nationally protected	1	1	3	

*Shrestha and Joshi 1996

Table 3: Globally Threatened Plant Species in Jalthal and their Distribution within Nepal

Name of species	IUCN red list category	Distribution in Nepal and Jalthal*
Cycas pectinata	Vulnerable	Found in the Chure region of east and central Nepal; rarely reported from the Tarai
Prunus ceylanica	Endangered	Very rare, only few individual trees were recorded in Jalthal. This is the one and only tree from the Nepal Tarai classified as endangered.
Archidendron bigeminum	Vulnerable	Rare, reported from Eastern and central midhills.
Dalbergia latifolia	Vulnerable	Found in the Chure and Tarai of Nepal, but in lower densities in the east and central parts of these regions; rare in Jalthal forest.
Dioscorea hamiltonii	Near Threatened	Distributed through the Tarai up to the mid-hills; local people report a decline in its population.

*rarity refers to Nepal's case if otherwise not stated

Diversity in Ecosystem Services

The rich biodiversity of Jalthal forest is the source of a wide array of ecosystem services for local people. Ecosystem services derived from plants were categorized in terms of eight classes of forest products. Besides timber and firewood, the forest is also a source of various wild foods like mushrooms, leafy vegetables, bamboo shoots, tubers and wild berries. The forest has a high diversity of fodder trees/shrubs and wild fruits (Table 4). Many species of grasses and herbs are also used as fodder, though they have not been reported in this paper. Several species serve multiple purposes and traditional knowledge indicates that the local people have been harvesting such products for centuries.

Besides plant-based products, fishes and mollusca are also an important consumptive product collected from the wetlands of Jalthal forest. It was observed that local people collect 20 different species of fish for food.

Table 4: Forest Products Collected by Local People in Jalthal

Product class*	Number of species	Major species
Timber	34	*Shorea robusta*, *Terminalia alata*, *Artocarpus chama*, *Dysoxylum excelsum*, *Syzygium cumini*
Fodder	68	*Ficus racemosa, Garcinia cowa*, *Ficus auriculata*, *Spatholobus parviflorus*
Leafy vegetables	17	*Diplazium esculentum*, *Lasia spinosa*, *Smilax* spp., Bamboo shoots
Mushrooms	6	*Auricularia polytricha, Termitomyces* spp., *Pleurotus* spp.
Wild edible fruits (Fresh and ripe)	46	*Baccaurea ramiflora*, *Mangifera indica*, *Syzygium cumini*, *Syzygium formosum*, *Phyllanthus emblica*
Tuber foods	4	*Dioscorea bulbifera*, *Dioscorea hamiltonii*, *Asparagus racemosus*
Medicinal plants	32	*Asparagus racemosus*, *Leea macrophylla*, *Etlingera linguiformis*, *Rauvolfia serpentina*
Fibre plants	6	*Sterculia villosa*, *Bauhinia vahlii*, *Thunbergia grandiflora*
Sacred plants	12	*Ficus religiosa*, *Oroxylum indicum*, *Nyctanthes arbor-tristis*
Other uses	21	*Wallichia oblongifolia*, *Calamus jenkinsianus*

* Firewood is another major forest product, however, as almost all woody species are used as firewood, this has not been included here. Similarly, we do not account for grasses that yield fodder. Some forms of uses of sacred plants may also be considered as cultural ecosystem services.

Threats to Jalthal Forest and Management Response

As evidenced during transect walks and as reported in the CFOPs, Jalthal forest and its biodiversity is subjected to multiple threats. Some of the threats have immediate and direct consequences on biodiversity while others have potential impacts. Major direct threats include poaching, uncontrolled forest fires and invasions by alien plant species. Though CFOPs have attempted to identify most of these threats and have also made provisions to mitigate them, some threats are still not acknowledged (Table 5).

Table 5: Major Threats to Jalthal Forest Biodiversity, Provisions for Threat Mitigation in CFOPs, and Actual Management Interventions Conducted in Response to Threats

Threats	Nature of threats	Provisions in CFOPs and management responses
Biological invasion	Over half of the Jalthal forest, mainly open and moist areas, is invaded by invasive alien plant species - primarily *Mikania micrantha* and *Chromolaena odorata*.	No Invasive Alien Plant Species (IAPS) have been identified; biological invasion has not been conceptualised as a threat; local users regard bushes, including native ones, as an indication of forest degradation and remove them.
Wildlife Hunting	Unregulated hunting of wildlife (wild boar, spotted deer, pangolin) and birds by local hunters is still a problem.	Hunting is illegal and CFUGs have banned it; hunting is gradually decreasing.
Biomass Collection	Saplings and trees (including rare and threatened species) are cut and lopped for firewood and fodder, without reserving trees, as mother-trees and standards, or protecting patches for regeneration development.	Green (live) trees and saplings are not allowed to be felled/cut; however regular breaches of these rules were observed; provision of fines for breaching rules is in place; impact on rare trees has not been documented.
Plantations of exotic species	Exotic trees like *Eucalyptus camaldulensis*, *Tectona grandis* and *Swietenia macrophylla* are planted in more than 20 locations mainly adjacent to forest boundaries.	Plantations featuring exotic tree species have been prioritised for reforestation of forest margins; no distinction is made between native and exotic species
Sal-focused management	Many regenerating patches of forest have hyper-dominance of Sal. Cleaning activities are directed towards promoting Sal regeneration, ostensibly for timber production.	Sal has been prioritised in CFOP inventories; felling of standing Sal trees and saplings is strictly monitored; many other species are collectively classified as 'kukath' (i.e., inferior wood) and removed during management operations, such as thinning and bush cleaning.
Infrastructure development	Unplanned infrastructure development, especially roads through the forest.	Statutorily, the construction of infrastructure is complex; however, development activities, such as road construction, are taking place; CFUGs have divergent interests in infrastructure development and there is a lack of coordination and discussion among stakeholders.
Forest Fires	Deliberate fire during the dry season is common, initiated especially by hunters and livestock holders to allow resprouting of grasses. Widespread fire affects forest regeneration and wildlife.	Forest patrolling, awareness programmes, fire line maintenance, reactive responses in case of fire incidence.

Management Provisions and Practices

The management provisions in CFOPs, ranged from broad management objectives, such as biodiversity conservation to building climate resilient forest, to specific actions, such as the conservation of rare species and a ban on grazing (Table 6). Some provisions, for example poaching control, have positive impacts on biodiversity while others, such as tree thinning, favouring Sal, have negative impacts on biodiversity. A blanket restriction on grazing may have had both positive (regeneration protection and wildlife habitat protection) and negative effects (increase in invasive species such as *Mikania micrantha* and *Chromolaena odorata*) on forest biodiversity.

Bush cleaning and pre-commercial thinning are the most regular management activities conducted by CFUGs and are organised with a focus on increasing the growth of Sal timber resources. However, these activities only yield firewood and small poles. Management interventions that would actually produce lumber, such as commercial thinning and mature tree harvests are very rare, even though there are many successional stands of Sal undergoing intense canopy competition. Instead, most of the construction-size timber is harvested from dead, dried and fallen trees, which are primarily distributed internally among users. Other management provisions include the year-round permission to harvest grasses and fodder, and limited windows during the winter for firewood collection. An inner region of the forest of about 1000 ha has been designated as a core area with more restricted use, i.e., only fallen trees can be harvested.

Though these provisions for resource-use are included, the CFOPs do not adequately acknowledge the traditional dependencies of rural people on forest products. For instance, CFOPs have neither identified the dwindling stock of non-timber resources, for example fodder trees like Sandan (*Ougeinia oojeinensis*), Khanyu *(Ficus semicordata)* and Nibaro *(F. auriculata*), nor have they made any plans to restore these resources.

Table 6: Forest Management Activities and their Observed and Potential Impacts on Biodiversity

Management activities	Detail activities	Impact on biodiversity
Regulated felling of mature trees	Green (live) trees are not felled, only dead trees are harvested; standing live Sal trees are strictly protected.	Increase in tree density and canopy cover; Monitoring for sal is strict compared to other species, which puts pressure on species other than Sal.
Plantation	For the last decade or more, plantations have been dominated by exotic species.	Exotic plantations of Teak (*Tectona grandis*) and *Eucalyptus camaldulensis* negatively affect biodiversity and ecosystem services by precluding the natural regeneration of native forests.
Bush cleaning	Cleaning is a routine activity and it includes the removal of weeds, bushes and saplings of "unwanted" plant species.	Cleaning operations favour the protection of Sal, while species deemed as inferior *'kukath'* are removed.

Grazing prohibition	Grazing has been banned in all areas of the forest.	The prohibition of grazing protects regeneration from herbivory but might have aided the invasion *of Mikania micrantha* in the forest, which otherwise may have been trampled and grazed upon.
Fire control	Both proactive measures (fireline, patrolling, awareness) and reactive (fire control) responses are shown by community forests.	Positive effect on tree regeneration density and wildlife habitats.
Access roads for resource harvesting	Access roads are repaired annually in different parts of the forest.	The construction and use of roads for vehicular access physically damages seedlings, and causes gulley erosion and siltation of wetlands.
Wetland management	Wetlands are expanded and water restored but is often targeted towards promoting tourism.	The water table is recovering, which is beneficial for wildlife in some locations but a singular focus on tourism may have negative impacts on species which require shallow water.
Core area	A 1000 ha core area has been designated in the centre of the forest, where resource-use is restricted and management interventions are minimal.	Restrictions have allowed structural attributes like old growth trees, dead standing trees (snags), with positive impacts of biodiversity. Tree diversity is higher in the core area than outside.

The CFOPs for Jalthal provide both inventory data and free-listing of tree species, but our review found that the existing inventories by the CFUGs have failed to identify the richness, uniqueness and significance of Jalthal forest biodiversity. For instance, CFOPs contain detailed inventories and growth and stock estimations of Sal and some notable timber species, but most other species are lumped into an 'other' category in CFOPs. While we report 150 species of trees in the forest, the 22 CFOPs of Jalthal list a total of only 62 trees. Some of the CFs have over 100 tree species, but the maximum number of trees listed in their particular CFOP is 20. Surprisingly, even the iconic IUCN red-listed species of the forest, *Cycas pectinata*, has not been included in the list of trees found in the forest, whereas our study recorded this species in 11 CFs. Similarly, other rare plant species such as *Barringtonia acutangula, Syzygium formosum, Pandanus fructans* have also not been mentioned in CFOPs.

DISCUSSION

Diversity of Species and Ecosystem Services

The survey of different taxonomic groups ranging from butterflies to mammals and ferns to trees demonstrate the richness of species and ecosystem services of Jalthal forest. Our inventory has substantially added and enriched the previous floral surveys of Jalthal forest by Bhattarai (2017) and Thapa *et al.* (2003). We have found six tree species which are new additions to Nepal's flora of which two have already been recorded in publications (Poudel *et al.* 2021; Sharma *et al.* 2021). Our

floristic results showed that Jalthal could be one of the richest sites in terms of species diversity in Nepal's lowland Tarai, although comparisons of our results with other surveys is made difficult by differences in the extent and intensity of sampling. Even the overall floral species richness of Jalthal forest is far higher than studies conducted elsewhere in Terai of Nepal (Webb and Sah 2003; Timilsina *et al.* 2007; Sapkota *et al.* 2009). Despite occupying only 0.1 per cent area of Nepal's forests, Jalthal harbours over 20 per cent of Nepal's tree species (Press *et al.* 2000). A comparable richness in overall flora was reported from the Barandabhar corridor forest of Chitwan (Wesche 1997) but the richness of the tree component was far lower. Jalthal's relatively moister climate and greater heterogeneity of habitats, in comparison to central and Western Terai forests, most likely contribute to the high floral richness (Rosenzweig 1995; Dufour *et al.* 2006; Ben-Hur and Kadmon 2020).

There is generally a positive relationship between biodiversity and the range of ecosystem services provided (Hooper *et al.* 2005; Thompson *et al.* 2011). Empirical studies have reported that diversity in general, and diversity of trees and woody species in particular, promote multiple ecosystem services in forests and farmlands (Gamfeldt *et al.* 2013; Shumi *et al.* 2020). Similarly, Jalthal forest has high native tree diversity as well a great diversity of different life forms, which is the basis for its provision of a wide array of ecosystem services, as evidenced by the use of over 150 plants to generate over 12 different classes of products. If grass fodder and firewood were to be included, the number of species used by local people would be substantially greater. The diversity of provisional services along with other ecosystem services, for example, habitats for wildlife and water for irrigation, clearly demonstrate that Jalthal is a multipurpose forest and most species have more than a single use. Multipurpose forests support not only local livelihoods and economies but also local cultures. However, the current management of the forest, with its explicit bias towards Sal timber management, does not acknowledge and accommodate these diverse ecosystem services and cultural values of Jalthal forest. Conserving plant genetic resources and the broader spectrum of biodiversity of Jalthal forest would ensure the sustained flow of these ecosystem services.

Biodiversity Inventory and Management Response

In Jalthal, forest inventories, featured in CFOPs, focus on the growth and availability of a few timber-yielding species at the cost of excluding globally rare threatened species – as is the case in much of Nepal (Thani and Kandel 2021). Our review reaffirms the concern that CFOPs in Nepal lack the ability to improve the conditions of their forests (Baral *et al.* 2019). Community forests are now dense homogenous forests with high stem densities and low species diversity (Sapkota *et al.* 2021). This is due to preferential protection of timber species and minimal consideration of other species in both CFOPS and management activities, such as the removal of competing species during thinning in early successional forests, producing monocultural stands of Sal.

The shortcomings of CFOPs and management practices pertaining to biodiversity largely pertain to a lack of data, as well as knowledge gaps on forest biodiversity. For instance, local people's knowledge about global conservation status of species might be limited, influencing conservation outcomes (Nzau *et al.* 2020). However, the inadequate consideration of biodiversity conservation in CFs cannot be solely attributed to CFUGs. Rather this shortcoming must be understood in the context of the national paradigm which generally overlooks biodiversity issues in CFs, through its failure to analyse forest integrity beyond the superficial characteristics of canopy cover and stem density. In addition, the multipurpose nature of community

forests, and the positive relationship between multifunctionality and biodiversity, is also poorly acknowledged at the national level of discourse, governance and policy-making.

An improved inventory of biodiversity is necessary to take into consideration the specific features of the forest, for example, rare and threatened flora and fauna, habitat trees, etc. in management decision making. However, a comprehensive assessment of biodiversity in CFs and the management of biodiversity considering national and international contexts can be cumbersome for CFUGs, who are already burdened with various technocratic requirements. These assessments could be made more feasible through the collaboration of scientists and CFUGs.

Paradox of Diversity and Degradation, and Local Capacity

This study presents a comprehensive account of Jalthal biodiversity and highlights its richness, uniqueness and importance. However, the rich and unique biodiversity of Jalthal forest is subjected to multiple drivers of forest degradation. A recent assessment reported that nearly half of the forest has been degraded following invasion by invasive alien plant species, and has been fragmented by anthropogenic activities (Shrestha 2020).

Jalthal not only shows a paradox in its biophysical attributes, but also in its management and outcomes. On the one hand, the forest (tree cover, forest area and stem density) is protected and this can be attributed to community-based management. We can imagine that a forest situated in a such a densely populated region would have been even more degraded in the absence of CFUGs. On the other hand, the unique features of Jalthal forest are not adequately considered in planning and are not protected. It appears that current plans, programmes and allocations of financial and human resources are not sufficient to address the complex nature of the threats that interact with and exacerbate each other. First of all, our knowledge about the status of biodiversity in Jalthal is still somewhat limited. Comprehensive profiling of biodiversity is admittedly costly and technically burdensome for communities. However, low cost and rapid, yet useful, methods can be used for the inventory of flora and fauna.

CFUGs are investing time, money and labour to control bush cover, primarily of invasive species, but their success so far has been limited. Existing management practices in controlling invasive species needs to be reconsidered. IAPS management should be adaptive and be informed by species traits and interactions with local ecological contingencies. Given the nature of forest degradation and invasion by IAPS, it is imperative to manage the forest with a long-term perspective of forest restoration. Existing management practices are too skewed towards timber management, including both technical and governance aspects of harvest and distribution.

There have been efforts to restore the forest mainly through plantation, forest fire control and a grazing ban. However, these efforts to restore the forest are not well-informed by recent knowledge and scholarship on climate change, biodiversity and forest management. Restoration efforts included the plantation of exotic species like *Tectona grandis* and *Eucalyptus camadulensis*, and it appears that both government and non government organisations have been distributing seedlings and encouraging such plantations. This has grossly overlooked the enormous potential of the natural regeneration of native tree species. Protecting the existing regeneration through natural solutions would be an important step towards advancing forest restoration and increasing the resilience of forests (Cook-Patton *et al.* 2021; Di Sacco *et al.* 2021). Recent scholarship has shown that many plantation programmes around the world have failed to achieve their desired outcomes (Coleman *et al.* 2021; Wang *et al.* 2021). National policies

should prioritise and incentivise the protection of natural regeneration and discourage the planting of exotic species in natural forests. Socially accepted, ecologically-sound, and cost-effective methods of forest restoration can be developed for specific forests.

Biodiversity Conservation outside Protected Areas

Focusing only on protected areas and a few keystone species undermines biodiversity as a wider concept (Pascual *et al.* 2021). Moreover, it also produces huge societal costs by ignoring socio-economic dependence and cultural linkages of local communities to land and other natural resources (Brockington *et al.* 2006). The use and management of Jalthal by its user-groups affirm emerging views that biodiversity conservation should move beyond the species/protected area approach to embrace both societal and ecological concerns for the mutual benefit of people and nature (Lele 2021; Pascual *et al.* 2021). Locals reliance on multiple species for diverse ecosystem services and products, and their sincere efforts to mitigate some of the threats to biodiversity, advance a local decentralised form of biodiversity conservation in community forests as an alternative or complementary solution. The case of Jalthal forest also highlights the need to consider biodiversity conservation and promotion in overlooked ecosystems, such as secondary successional forests and remnant forests. Moreover, we also demonstrate that the current timber-centric approach to forest inventory and technical planning, advanced by government policy and internalised by CFUGs, needs to be reformed to acknowledge and encourage the multifunctionality of community forests.

Managing Jalthal Forest for Biodiversity and Ecosystem Services

This case study in Jalthal forest reveals an intimate relationship between forests and the culture and livelihoods of local people. In this context, we present below a conceptual outline for the effective management of Jalthal forest, which can be elaborated into specific programmes and actions (Figure 2). These are mainly to reinvigorate decentralised community-based management through the best use of the available scientific knowledge. This requires establishing a robust database and integrating this evidence into planning and implementation.

(i) Building a scientific basis through a locally-owned, rapid yet comprehensive survey of forest biodiversity to identify key ecosystems and species, and threats towards them. Survey methods to inventory biodiversity can be customised depending on financial and human resources.

(ii) Co-production of knowledge and collaboration among stakeholders: Professionals and local people jointly work to form a knowledge base to support decision making and planning. Sharing of expert knowledge on species ecology and biogeography and results of their technical assessment of the forest to local people gives a broader perspective to local people about conservation. Similarly, local people can share their traditional ecological knowledge and use of forest resources and explain the meaning and values of those resources in their culture and economy. Such exchange of knowledge can be instrumental for framing management actions with strong local ownership and comprehension.

(iii) Enhancing the technical capacity of CFUGs to monitor biodiversity and implement plans. Current human and financial resources of CFUGs are not adequate to tackle the nature of the problem. For instance, the scale of Mikania invasion that Jalthal forest is facing is well beyond the current local capacity to control it. Barring a few exceptions, existing CFUG technical competency is not even sufficient to conduct a forest survey and implement forest operational plans. Therefore, enhancing the technical capacity of CFUGs and providing additional resources is necessary. While arguing for

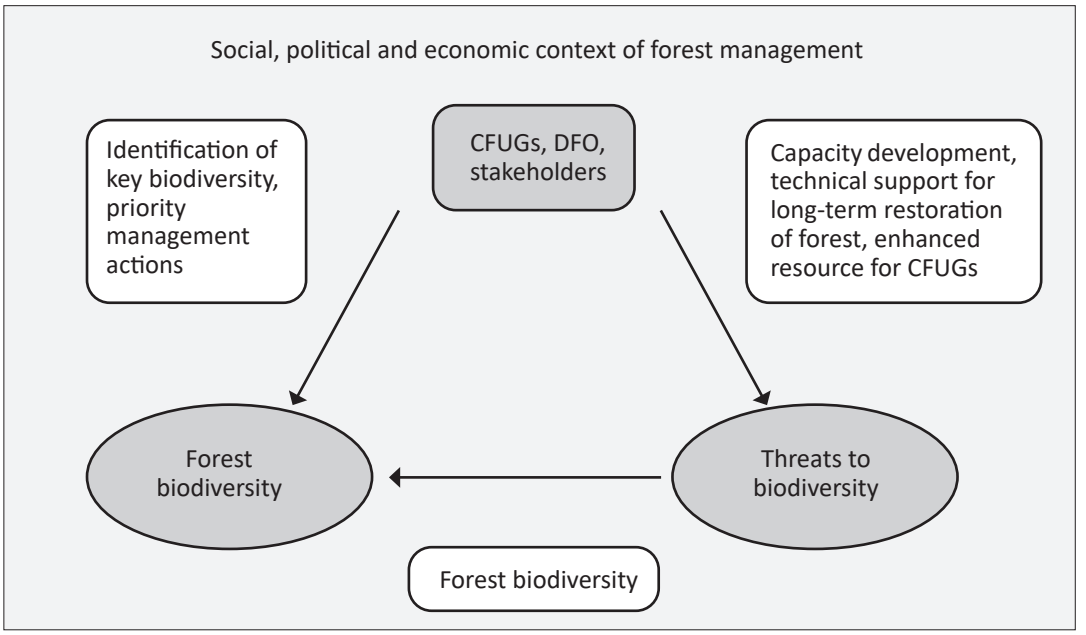

Figure 2: Conceptual Diagram showing Linkages between CFUG (and stakeholders), Forest Biodiversity and Threats, and Actions Connecting these Components for the Mitigation of Threats.

additional financial sources, it is equally important that legally binding provisions are followed, such as the requirement of the Forest Act 2019 that a minimum of 25 per cent of annual CF income be spent on forest protection and management.

(iv) Developing a comprehensive management plan establishing the multipurpose management of forests, including silvicultural systems to promote and regulate the growth and harvests of diverse products, and restoration plans for degraded forests, and rare and threatened species is essential. Current forest management activities, for example, invasive species removal, plantation and fire control are discrete in space and time, these activities should be integrated within a broader framework of forest restoration and long-term management. Low-impact harvesting and stand-specific optimised natural regeneration-based methods of harvesting can also be developed in place of the current approach of calculating a blanket mean annual increment of the entire forest. Some areas of forests, such as stagnated stands of dense Sal poles, require an immediate opening of the canopy and thinning to promote structural and compositional diversity by accelerating forest dynamics.

While suggesting these approaches, we admittedly do not discuss the complex nature of natural resource management in coupled social-ecological systems, which is beyond the scope of this paper. Similarly, we have also not provided specific programmes like biomass pressure off-set programmes, and specific management actions that have synergies and trade-offs between production and conservation.

CONCLUSION

Through this case study of the high diversity and multiple ecosystem services of Jalthal forest, we demonstrate the conservation significance and importance of the forest for local people. While highlighting the significance of biodiversity and

diversity of ecosystem services of the forest we do not mean these are the only justifications for forest conservation. Instead, these are some important aspects from a wider spectrum of values and the importance of the forest for local people. Despite its ecological and social significance, the forest is subjected to multiple threats and exemplifies the paradox of diversity and degradation. Drawing on the forest management plans and practices, we indicated that communities are doing well in terms of protecting the forest. However, their actions are currently not sufficient to conserve specific elements of forest diversity and tackle the nature of threats bearing down upon the forest. We suggest building a solid scientific basis for profiling local biodiversity, enhancing the capacity of CFUGs and grassroots organisations to manage biodiversity, enhancing collaboration between CFUGs and local governments, and preparing long-term restoration plans. We reaffirm the argument that biodiversity conservation should not be limited to key species and protected areas as practiced in conventional biodiversity conservation approach, but rather it should be broader, pluralistic and should acknowledge the wider social and ecological role of managed forests.

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Conflicts of interest: LNS, NS, MW, BA, AG, SRT were or are associated with the DI UK funded project being implemented in Jalthal.

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