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Socio-Cultural Values of Ecosystem Services from Oak Forests in the Eastern Himalaya

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Abstract: Identification and assessment of socio-cultural values of ecosystem services are increasingly important for the planning and management of forest resources. Key information necessary is how different forest user groups perceive and prioritize different ecosystem services based on their local setting. We assessed the socio-cultural values of ecosystem services of high-altitude oak forests in Western Bhutan using participatory approaches with two important forest users: local communities and forest experts. We found that these forests serve as a pool of 22 ecosystem services under four MEA categories of provisioning (9), regulating (8), supporting (2), and cultural (3) services. Fresh water was unanimously identified as the most valuable service, as well as the most vulnerable, by both the groups. The priorities of local communities inclined towards provisioning and cultural services due to their dependence on these services for their livelihood and wellbeing. Forest experts' priorities were more evenly spread over three categories of services: provisioning, regulating, and supporting services, reflecting their broader interest in resource management, biodiversity conservation, and climate change mitigation. Several regulating and supporting services were not easily identified by many villagers, suggesting that bridging the priorities of local interests with broader national forestry goals may require public partnerships and integrated decision-making about the entire suite of ecosystem services. Several management interventions proposed by the groups were presented for consideration by local users, scientists, and policy makers. For all ongoing and future ecosystem service assessments, we recommend the integration of socio-cultural values with biophysical and monetary assessments to fully value the benefits from the high-altitude oak forests.

Keywords: Bhutan Himalayas; socio-cultural values; mountain ecosystem services; *Quercus semecarpifolia*; oak forest; integrated decision-making

1. Introduction

Socio-cultural valuation approaches to assessing ecosystem services are increasingly recognized as an important tool for understanding the contribution of ecosystems to human well-being [1,2]. Ecosystem service assessments that focus on biophysical quantification and monetary valuations help to identify and quantify the functional values of ecosystems [3–5]; whereas assessments that focus on the importance that people place on ecosystem services for both material (e.g., food, water, timber) and non-material benefits (e.g., spiritual inspiration, sense of place, aesthetic values), provide information

on the priorities and needs of local residents and other stakeholders [6–10]. The socio-cultural values of ecosystems are associated with all categories of ecosystem services: provisioning, regulating, supporting, and cultural services [1], and are thus also distinct from assessments of the cultural services of ecosystems, or the strictly non-material well-being provided by natural ecosystems, such as spiritual, aesthetic, and recreational values [11,12]. While ecological and economic valuation can help to guide technically accurate ecosystem management decisions, understanding the importance that people place on ecosystem services, or the social value, is essential for making socially equitable management decisions [2].

Recent advances in ecosystem service assessments using the social values perspective have been made in diverse ecosystems such as the sea [6] and rivers [13], and in management schemes such as community-based forestry [14]; agriculture [7]; and a combination of forests, shrub lands, and agricultural ecosystems [15]. These studies have integrated the perspectives, needs, and values of local stakeholders in meaningful ways to inform management decisions about those ecosystems.

Although human-ecosystem interactions are complex, there is evidence of a declining trend in ecosystem services worldwide [16,17]. As quantitative information on many degraded ecosystems is limited or fails to address social values, there is a need for rapid qualitative assessments to help set priorities for conservation actions and to prevent further deterioration [18,19]. Social valuation through qualitative approaches enables researchers to gain a sense of the range and importance of the ecosystem services while also identifying threats that require immediate attention [19,20]. Qualitative approaches to social valuation such as focus group discussions [21], participatory mapping, and stakeholder interviews involve the collection of information directly from stakeholders and attempt to link ecosystem services directly to human well-being, as defined by the stakeholders themselves [22,23]. The choice of method differs based on the objectives of the assessment, range of ecosystem services, and different stakeholder groups [22,24]. Using a combination of social, ecological, and ecosystem models is most effective for environmental planning and management [25].

The decline in forest ecosystem services can be addressed through sustainable forest management, which itself has gradually evolved over time from being driven by purely economic goals—seeing the forest for timber production—to a broader perspective of forest as a socio—ecological system, one that is inclusive of ecological, social, and cultural values [26]. Multidisciplinary approaches to forest management through the use of scientific and technical information in combination with historical information [27] or traditional and local knowledge [28] are found to be highly effective. Furthermore, the involvement of local stakeholders, with attention to community values and local ecological knowledge, in local ecosystem management is increasingly being recognized at all levels of the decision-making process [28,29], and they are linked with positive conservation outcomes [30].

The resilience of rural communities to adverse impacts of climate change and poverty can be enhanced through the formulation of conservation policies that are based on assessments of ecosystem services and that directly link to rural livelihood [29]. Recent research suggests that local communities' knowledge and perceptions of ecosystem services provide important insights into opportunities and challenges in ecosystem management [31,32]. Involving local communities helps to identify how various stakeholders value, perceive, and prioritize ecosystem services differently [15]. It also enforces linkages between ecosystem managers and local users in mainstreaming ecosystem services and adaptation needs into policies [29]. The process of integrating priorities of local communities into management decisions is important for developing countries where the economy largely depends on ecosystem services and where these services particularly benefit poor people [14]. Assessment of ecosystem services and the valuation of benefits can bring local and international partnerships in conservation efforts through the payment for ecosystem service mechanisms [33].

Assessing the biophysical character of ecosystem services in mountain ecosystems can be especially challenging due the scarcity of data in some regions [34] and limited understanding of trade-offs and synergies among ecosystem services and uncertainties induced by climate change [35]. The complexity of defining and classifying ecosystem services among disparate populations in mountain regions makes

comparisons difficult. Several tools and approaches for a comprehensive assessment of mountain ecosystem services were highlighted for the Himalayan region [36]. Recent studies conducted in Nepal have shown that information collected on social values and people's perception can be an important tool for ecosystem service assessment of mountain forests [14,34,37].

In the eastern Himalaya, natural forest ecosystems form an important component of rural livelihood, wellbeing, and economy. Bhutan's forests, covering 71 percent of the total geographical area, are home to rich biodiversity and comprise the largest contributor of ecosystem services [5]. An initial assessment using the benefit transfer method has valued Bhutan's ecosystem services to be worth USD 15.5 billion year^{-1}, with many of the services providing benefits at the global scale [5]. The country has a constitutional mandate to maintain at least 60 percent of its land under forest cover for all time and has pledged to remain carbon neutral. This strong commitment to nature conservation is deeply rooted within Bhutanese culture and the Buddhist value of coexistence with nature [38]. The natural goods and services from Bhutan's forests are the source of material prosperity, health, and happiness, and they are strongly linked with the country's development philosophy of Gross National Happiness [39]. In this richly forested nation, ecosystem service assessments are an increasingly important tool to value the natural capital and integrate ecosystem services in decision-making processes. This is due to the strong dependence on the forest ecosystems and their services by the country's vital economic sectors like hydropower, agriculture, and tourism [40].

In May 2017, Bhutan held the regional symposium on natural capital where key stakeholders, researchers, and policy makers met together to understand the value of natural capital and valuation methods. The country launched the first assessment report on ecosystem services from a single river basin and secured funds for a nationwide assessment of ecosystem services. Those assessments are focused on biophysical quantification and monetary valuation of ecosystem services [5,41], giving limited attention to the social values of ecosystem services. Ours is part of a broad study in Bhutan on the social values associated with ecosystem services from local forests [42]. Such assessments are important for Bhutan to balance forest utilization with the national goal of forest conservation to meet the constitutional mandate to maintain 60 percent of land under forest cover and in fulfilling the pledge to remain carbon neutral at all times.

Focusing on Himalayan oak forests in Western Bhutan [43], our study aims to identify the priorities and perceptions of ecosystem services, or the socio-cultural values, by two stakeholder groups: local communities and forest experts. Historically, local communities have been marginalized from national forest planning processes, while the forest experts—professional civil servants—have been tasked with implementing these plans. We suggest that each group should be carefully consulted to ensure that opinions and priorities of user groups are taken on board for future forest management policies. Furthermore, we suggest that assessing social values of local ecosystems from both local community and manager standpoints will provide a basis to identify more equitable and representative options for the sustainable management of forests and other natural resources. To address this objective, we assess the socio-cultural values ascribed to the provisioning, regulating, supporting, and cultural services by two important forest user groups and compare their preferences and variations. Priority ecosystem services that are recognized by both stakeholder groups to be highly valuable and vulnerable were identified and conservation measures proposed. This kind of study on how perceptions and priorities of ecosystem services differ among different user groups can help to inform decision-making for truly sustainable forest management that harmonizes forest utilization and ecological function.

2. Materials and Methods

2.1. Study Area

Our study was conducted in western Bhutan, where oak forests dominate the elevational belt between 2400 m and 3100 m above sea level. We worked in seven villages adjacent to oak-dominant forest, and where social conditions, household occupation, and forest use were similar (Figure 1).

Villages were identified in consultation with local range offices and extension agents. Due to the small size of the villages, each village was considered as a study site for the purpose of this study. The livelihoods of local people in the study area are directly dependent on subsistence agriculture, forest products, and livestock farming (Table 1).

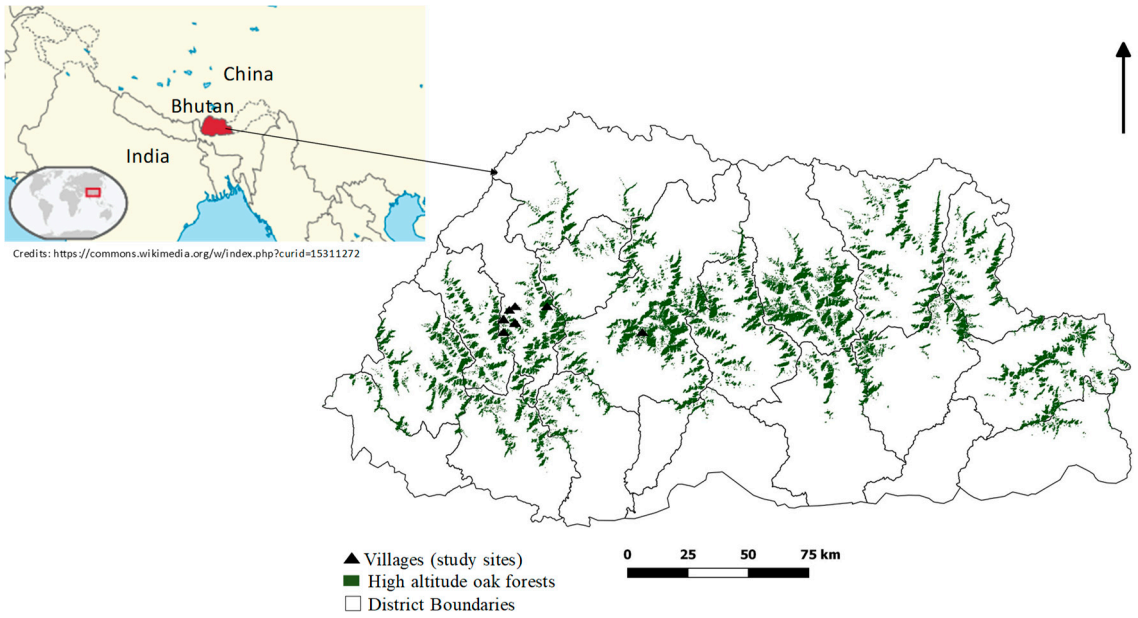

Figure 1. Map indicating the location of Bhutan in Asia (top left), and the location of study sites within Bhutan (shaded triangles). Black lines show district boundaries. Green shaded area indicates the distribution of oak forests.

Table 1. Description of study sites indicating the district, elevation, and coordinates of their location, and the main source of occupation of farmers.

Study Village	District	Altitude (m)	Coordinates	Main Source of Income
Shelling	Wangdue	2539	27°23′24.19″ N 89°58′41.26″ E	Agriculture (Potato), forests, livestock
Jadingkha	Thimphu	3036	27°27′02.61″ N 89°30′18.69″ E	Forests, agriculture, livestock
Shari	Thimphu	2681	27°27′28.98″ N 89°31′32.87″ E	Agriculture, forests, livestock
Nubri	Thimphu	2776	27°27′37.41″ N 89°31′15.38″ E	Agriculture, forests, livestock
Chimithankha	Thimphu	2618	27°26′36.30″ N 89°31′37.51″ E	Agriculture, forests, livestock
Gemina	Thimphu	2459	27°25′36.41″ N 89°32′58.31″ E	Business, livestock, agriculture, forests
Yusipang	Thimphu	2830	27°28′09.15″ N 89°42′04.12″ E	Agriculture, forests, livestock

The mean annual temperature recorded by a weather station at one of the study sites was 8.5 °C, with a mean maximum temperature of 17.1 °C and mean minimum of −3 °C. The mean annual rainfall is 750 mm. Most of the rain falls in the months of June to September, with two to three snow falls every year. The soils are rich in organic matter content, slightly acidic, and well-drained, varying from silty clay loam to sandy loam.

Though no formal assessment has been made to categorize these forests in western Bhutan as old-growth, they are commonly referred to as such by Himalayan ecologists, foresters, and

conservationists due to the large stature of trees, the structural complexity, and the high diversity [44]. The overstory of the forests at all sites is dominated by the evergreen oak *Quercus semecarpifolia*, mixed with conifers such as *Tsuga dumosa*, *Picea spinulosa*, *Abies densa* at higher elevations, and *Pinus wallichiana* at lower elevations. The middle layer is occupied by rhododendrons, maple, Himalayan birch, and Alnus trees. The understory is very diverse, with shrubs and herbaceous plants. These forests, along with the adjoining alpine meadows, have been historically grazed by herds of migratory and sedentary cattle.

The forests are part of the Bhutan government's reserve forest system, which provides access to residents for the utilization of forest resources, though under stringent rules. The forests are utilized under forest management plans which aim to minimize significant change in species diversity while providing forest goods and services to local people [45]. During the late 1990s, increased harvesting of the oak trees to meet the urban demand for fuelwood in cold winters led to a nationwide ban on both commercial and subsistence felling of oak trees in 2000 [46]. However, the harvest of conifer and other broadleaf trees as timber and fuelwood from these forests continued as a single tree selection system that follows close-to-nature silviculture to minimize forest disturbance, retain old-growth characteristics, and promote tree diversity [47]. Most parts of the forest that are distant from the human settlements are intact. In Bhutan and in the study areas in particular, conifers are preferred for timber, for the ease of working with it, while oak is preferred for fuelwood due to its high calorific value [48].

The study site forms a part of the Himalayan oak forest belt, where the regeneration of oak species is reported to be inadequate [43,44,49,50]. Because successful forest regeneration is key to sustainable forest management [51], restoration and conservation of these forests has become a top priority for ecologists, conservationists, and foresters. In the context of Bhutan, studies have linked the poor regeneration of oak to overgrazing by large herds of migratory and domestic animals [52,53].

2.2. Data Collection

To assess the socio-cultural values that are placed on these oak forests, we used participatory rural appraisal techniques to identify the ecosystem services from the forests and the values and priorities that people place on them. The methods consisted of a combination of household and expert interviews, focus group discussions (FGD), and preference point ratings (Figure 2). The stakeholders were split into two groups: 1. villagers consisting of farmers and village heads (hereafter referred to as the "local community") who utilize the forest on a regular basis, and 2. forest experts, consisting of, local foresters and senior forestry officials of the forest department who deal with conservation ecology and the management of old-growth oak forests (hereafter referred to as "experts").

From April to June 2017, a total of 84 households were interviewed using structured perception questionnaires to collect information on household dependence and individual perceptions of the availability trend in ecosystem services derived from the forests over the last 10 years. Sixty-one percent of the respondents were female. The average age of the participants was 53 (± 15 SD) and 43 (± 12 SD) for men and women, respectively. Prior to the start of the survey, our team organized group meetings and awareness programs with the communities to acquaint the residents with the terminology associated with ecosystem services. The participants were chosen based on village records of households. Through the household interview, we also identified six to ten key informants per village who were included in the focus group discussion (FGD).

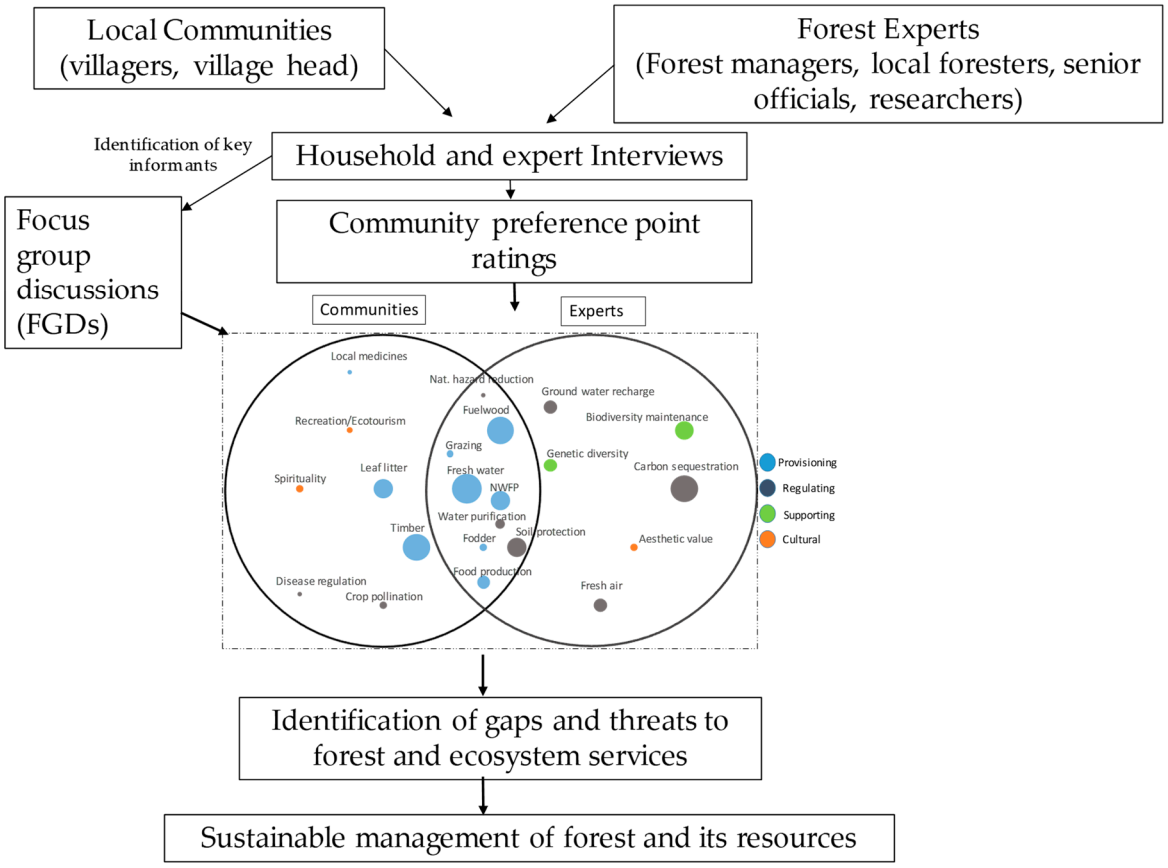

Figure 2. Methodological framework for the assessment of socio-cultural values of ecosystem services from the oak forests and pathway to forest management policies.

FGDs were conducted in each village to collect information on their priorities of ecosystem services and on their perceptions of the availability of and threats to them. We also solicited their ideas for management interventions based on their traditional knowledge. Due to the large number of FGD participants in the two villages, we split these groups into further smaller groups. Thus, a total of nine FGDs were carried out in the seven villages. Group members were from middle-aged to elderly men and women with a good knowledge of past and present interventions in oak forests. Prior to the conduct of FGDs, and based on a narrative analysis of interviews combined with a study of the four pillars of Gross National Happiness, we defined a set of shared social values that represent community aspirations, which we call "community values". These are socio-economic development, general well-being, environmental conservation, coexistence, spiritual sustenance, and cultural vitality. We then used the FGD to identify links between the local forest ecosystem services and these community values (Table 2).

For the expert group, we interviewed eleven forestry professionals in total (two female, nine male), representing local forest office and senior forest officials from the forest department (5), researchers (5), and an experienced forest ecologist who had previously worked with the forest department (1). Because of our focused interest on the perception of ecosystem services from the oak forests, and to avoid confusion over other forest types, we limited our interviews to only those experts who were educated and experienced with this forest type. Each had high qualifications (ranging from a bachelor's degree in forestry to a PhD) and at least 10–15 years of work experience. Open-ended interviews spanning their opinions on priority ecosystem services, availability trends, drivers of change, and management recommendations were conducted. The average age of the experts was 42 (± 6 SD).

Table 2. Community values associated with ecosystem services in the study area.

Community Values	Link to Ecosystem Services
Socio-economic	Use of forest to obtain timber, fuelwood, food, NWFPs for subsistence and income
Well-being	Services derived from forests important for health, life sustenance and happiness such as fresh air, disease regulation, aesthetic values and spirituality
Environmental conservation	Living in a healthy environment, balancing between conservation and economic development, e.g., forest protection for biodiversity, carbon sequestration, genetic diversity, homestead plantations and agroforestry.
Coexistence	Forest provides an avenue to appreciate Buddhist values of human beings living in harmony with nature, through awareness, kindness and wisdom, e.g., habitat for wild plants and animals.
Spiritual sustenance	Forest acts as an incubator of spiritual well-being and contentment by harbouring local deities and important religious sites.
Cultural vitality	Forests offer opportunities to display rich culture which can be promoted and passed on to future generations, e.g., cultural values, ecotourism, spiritual sustenance.

These surveys were carried out by a multidisciplinary team comprising foresters, researchers, and extension agents as a part of CIFOR's Sloping Lands in Transition (SLANT) research program.

Prioritization of ecosystem services was assessed through questions based on which service respondents valued the most. From the list of ecosystem services identified, each FGD listed the five most important ecosystem services. The ecosystem services were then ranked (from one to five in decreasing order of preference) according to their importance to the community [15]. Participatory resource mapping using charts was employed to encourage equal participation by all the members within the group. The group facilitator also ensured that all participants within the group contributed equally in the discussion, and the information collected represented the views of the whole group rather than only one or two spokespeople [10]. All ecosystem services were grouped into the four categories of provisioning, regulating, supporting, and cultural services following the Millennium Ecosystem Assessment framework [16].

In a subsequent activity, 49 participants from local communities and the 11 experts were asked to distribute 100 preference points across different ecosystem services based on their priority. A 'community priority index' was calculated for each ecosystem service based on weighted scores [14,54]. Average priority ratings were calculated for each ecosystem service within each stakeholder group. Similarities and variations in the preferences of ecosystem services were determined. Finally, based on their priorities and resource availability trend, both the groups identified potential threats and key conservation areas anticipated to be relevant to forest managers, local stakeholders, and policy makers.

For a comparison of priority ratings between the two groups, we used the lmer function in the lme4 package [55] to conduct mixed effects model analysis [56] of the relationship between stakeholder groups and their priority values ascribed to ecosystem services. We entered the group (local communities and experts) and gender of respondents as fixed factors in the model. Respondents nested within location (villages and offices) and their age were the random factors in the model. Visual observation of residual plots did not show any obvious deviations from homoscedasticity or normality. The *p*-values and test of main effects and interactions were computed by Wald Chi-Squared tests using the Anova function in the car package [56,57]. Pairwise group comparisons were done using Tukey's HSD test. All analyses were conducted using R software [58,59].

3. Results

3.1. Perception of Ecosystem Services

Twenty-two ecosystem services were identified in this study and categorized based on the MEA categories of provisioning (9), regulating (8), supporting (2), and cultural (3) services (Table 3). Local communities easily identified ecosystem services related to provisioning and cultural services. The services, such as timber, water, and spiritual sites, are directly seen and highly related to local culture

and rural livelihood. Mushrooms were the most extensively utilized resource from the forest. Overall, local communities listed 32 different types of mushrooms collected for household consumption and sale. Regulating services were less known to many of the local communities, as these services provided indirect benefits that were difficult to visualize. For example, only a few farmers who had some formal education knew about ground water recharge, water purification, carbon sequestration, disease regulation, crop pollination, maintenance of genetic diversity, and soil protection.

Table 3. Ecosystem services identified in the study, with description, indicators, and associated community values. Ecosystem services based on the MEA ecosystem services group.

ES Category	ES Identified Locally	Description Based on Perceived Importance	Indicator of ES	Associated Community Values
Provisioning services	Freshwater	Water for domestic, agriculture, prayer wheels and hydropower	Number and volume of water bodies	Wellbeing, Socio-economic
	Timber	Timber stock at harvestable age	Harvestable trees ha^{-1}	Socio-economic, Wellbeing
	Fuelwood	Fuelwood obtained from forests	Number and volume of fuel wood	Socio-economic, Wellbeing
	Food	Provision berries, wild fruits, mushrooms, wild vegetables	Amount of food materials	Socio-economic
	Leaf litter	Leaf litter for cattle bedding and farm manure	Amount of leaf litter collected	Socio-economic
	Grazing	Area available in the forests for grazing	Number of grazing animals	Socio-economic
	Fodder	Forage production potentials of forests for livestock	Number of fodder species	Socio-economic
	Local medicines	Variety of plant and fungal species with biomedical value	No. of species and harvestable amount	Wellbeing
	High-value NWFP	Plants and animals with high bioprospecting potential	No. of species and production potential	Socio-economic
Regulating services	Fresh air regulation	Trees provide fresh oxygen and absorb dust particles from atmosphere	Total leaf area; amount of pollutant in air	Wellbeing
	Carbon sequestration	Atmospheric carbon captured by forests and stored as carbon in their biomass	Forest cover, wood biomass per ha	Environmental conservation
	Groundwater recharge	Good forest with vegetative cover regulates runoff and retains water in the soil	Ground water recharge rate (water availability throughout the year)	Environmental conservation
	Natural hazard regulation	Forests act as a natural buffer, protection from winds, landslides and other disasters	No. of hazard incidences per year	Wellbeing
	Water purification	Pure water running in streams from the base of forests	Quality and quantity of clean water	Wellbeing, Environmental conservation
	Disease regulation	Reduced diseases by regulating fresh air and water purification	Number of people affected by water and air borne diseases	Wellbeing
	Crop pollination	Increased production of crops from population of bees and other pollinators	Number of pollinator species	Socio-economic, Environmental conservation
	Soil protection	Forest vegetative cover prevents soil erosion and improve soil fertility through nutrient cycling.	Incidences of landslides, soil erosion or degradation	Environmental conservation
Habitat/supporting services	Biodiversity/habitat	Home to a diverse plants and wild animals	Increasing/decreasing wild flora and fauna	Coexistence, environmental conservation
	Genetic diversity	Forests conserve the genetic diversity for future generations	Appearance of new plants and animals; genetic diversity of populations	Coexistence, environmental conservation
Cultural services	Spiritual and religious values	Forest harbours religious and spiritual sites (temples and caves, sacred sites for local deities) important for wellbeing	No. of locations; no. of people visiting these locations	Spiritual sustenance, Wellbeing,
	Aesthetic values	Forests offers scenic beauty to the landscape for enjoyment by local residents and outsiders	No. of visitors appreciating the visual quality of the landscape	Wellbeing, Socio-economic
	Recreation and ecotourism	Forests used for recreation and ecotourism purposes	No. of recreation sites; no. of visitors	Socio-economic, Wellbeing

After the group trainings employed to promote an understanding of the technical definitions of ecosystem services and an awareness of the linkages and indirect benefits, many villagers were better able to identify specific services and their local importance. For example, in a village primarily dependent on commercial vegetable farming, participants recognized the importance of adjoining

forests for harboring pollinators in increasing their crop production. Similarly, farmers living close to a forest management unit associated the drying of perennial springs in the area to forest logging activities and disturbances of ground water recharge. Villagers pointed out that ecosystem services were less recognized and mostly taken for granted because of the assumption that these services are provided free and forever by nature. They recognized these rich resources as an outcome of strong conservation efforts of the past, and thought that their duty was to do the same for future generations. Overall, both stakeholder groups favored provisioning services over the other three categories, primarily due to their direct link to the sustenance of rural livelihood.

3.2. Prioritization of Ecosystem Services

Interviews indicated that fresh water from the forest was the most highly valued ecosystem service by both local communities and experts. FGDs further confirmed this by ranking water as the top priority ecosystem service in all group discussions (Table 4).

Table 4. Village wise ranking of ecosystem services (top five) based on which natural asset the focus group valued the most in their community. For the expert group, preference points were used for prioritization. Letter in brackets indicates the MEA ecosystem service categories (P provisioning, R regulating, S supporting, C cultural).

Location	Ecosystem Services Ranking Based on Focus Group Discussions				
	First	**Second**	**Third**	**Fourth**	**Fifth**
Sheling	Freshwater (P)	Fuelwood (P)	Spiritual (C)	Litter (P)	Natural hazard regulation (R)
Jedingkha	Freshwater (P)	Fuelwood (P)	Timber (P)	NWFP (P)	Grazing (P)
Shari	Freshwater (P)	Groundwater recharge (R)	Fuelwood (P)	NWFP (P)	Timber (P)
Nubri	Freshwater (P)	Timber (P)	Fuelwood (P)	Fodder (P)	Fresh Air regulation (R)
Chimithankha	Freshwater (P)	Fuelwood (P)	Timber (P)	Grazing (P)	NWFP (P)
Gemina	Freshwater (P)	Fresh air regulation (R)	Fuelwood (P)	Timber (P)	Spiritual (C)
Yusipang	Freshwater (P)	Timber (P)	Fuelwood (P)	Biodiversity (S)	NWFP (P)
Experts	Fresh water (P)	Carbon sequestration (R)	Biodiversity (S)	Fuelwood (P)	Groundwater recharge (R)

Water in the study areas was mainly used for household consumption and agricultural purposes. Communities also highlighted the importance of water for rotating the prayer wheels (prayer mills) set over streams and water's strong association with spiritual wellbeing and contentment of the villagers. In the past, flowing water was used to run traditional water mills for grinding grains, but these have been replaced by electric mills. The high priority of water indicated by experts could be driven by increasing water scarcity in the Himalayas and due to economic values of rivers.

Our results showed key areas of agreement between the two groups of stakeholders, as well as variations in the preferences of priority ecosystem services. Common preferences for provisioning ecosystem services were water, fuelwood, NWFP, food, and fodder production; regulating services were fresh air regulation, soil protection, water purification, and natural hazard reduction (Figure 3). In general, local communities' preferences were more centred towards provisioning and cultural services that were directly obtained from the forests and linked to their daily lives. On the other hand, expert's priority ecosystem services were more or less spread over the provisioning, regulating, and supporting ecosystem services, with a strong emphasis on carbon sequestration and biodiversity/habitat maintenance services.

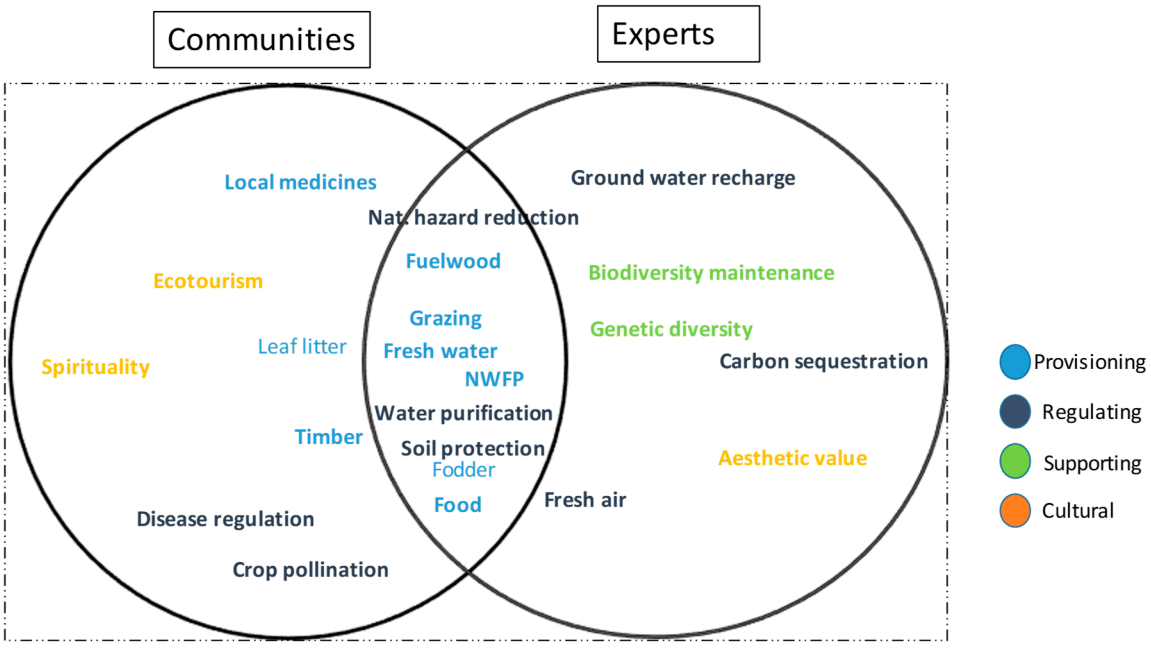

Figure 3. Priority ecosystem services assigned by the two forest user groups; local communities and experts indicating common preferences and variations. Color of the text represents the ecosystem service category.

Results from the community priority index showed strong variations in the scores attributed to various ecosystem services by the stakeholder groups (Figure 4). Although both the groups prioritized fresh water as the most important ecosystem service, the relative importance of water perceived by local communities (30.4 ± 1.4; mean ± SE) was significantly higher ($p < 0.05$) compared to the experts (21.7 ± 3.9; mean ± SE). Similar trends were observed for timber and spiritual services from the forests. In general, local communities' priorities for provisioning services (73 ± 2.4) were significantly higher ($\chi^2 = 9.7$, df = 1, $p < 0.01$) than experts (43.9 ± 8.2). On the other hand, the regulating ($\chi^2 = 5.2$, df = 1, $p < 0.05$) and supporting services ($\chi^2 = 27.4$, df = 1, $p < 0.001$) from the forests were significantly higher for the expert's group (36.8 ± 5.1 & 14.2 ± 2.4) compared to local communities (21.4 ± 2.2 & 1.3 ± 1.0). There was not enough evidence of significant difference ($\chi^2 = 0.44$, df = 1, $p > 0.05$) in the scores attributed to cultural services between the groups. No significant differences were found for the main effects of age, gender, and gender/group interactions in the scores assigned to the four ecosystem categories ($p > 0.05$).

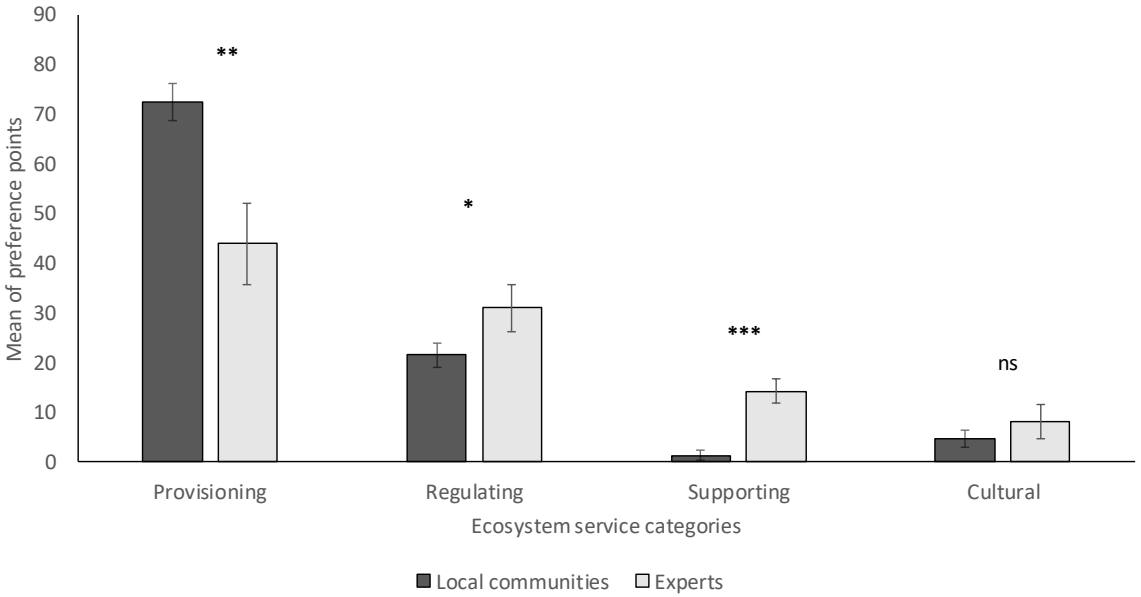

Figure 4. Priorities of rural community vs. experts across the four broad categories of ecosystem services based on preference points (total of 100 points) assigned by the participants of two groups. Labels indicate results of the mixed effects model and Tukey's HSD test, *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, ns = not significant. Bar represents standard error of the mean.

3.3. Perception of Trends in the Availability of Ecosystem Services, Threats, and Management Interventions

Both local communities and experts perceived a declining trend in several ecosystem services, especially fresh water, timber, firewood, and high value NWFPs, over the last ten years (Figure 5). The concerns for declining trends were greater for experts than for community members, with an additional emphasis on biodiversity, groundwater, and carbon. Both groups believed that these trends were due to high pressure resulting in the overexploitation of those forest resources. In the focus group discussions, many farmers pointed out that in the past, fuelwood, fodder, and timber were easily available in the nearby forests, but that now they had to travel 20 km to 30 km inside the forests to fetch these goods. Forest grazing and food production services from the forests were believed to have remained constant; however, they indicated that utilization of these services has declined over the years due to changing life style patterns as a result of socio-economic development. For example, traditional livestock farming, which relies on open forest grazing, is being replaced by improved breed farming, which requires stall feeding at home. Similarly, modern agricultural farming and readily available food options in the market have reduced local people's dependence on forest fruits and berries.

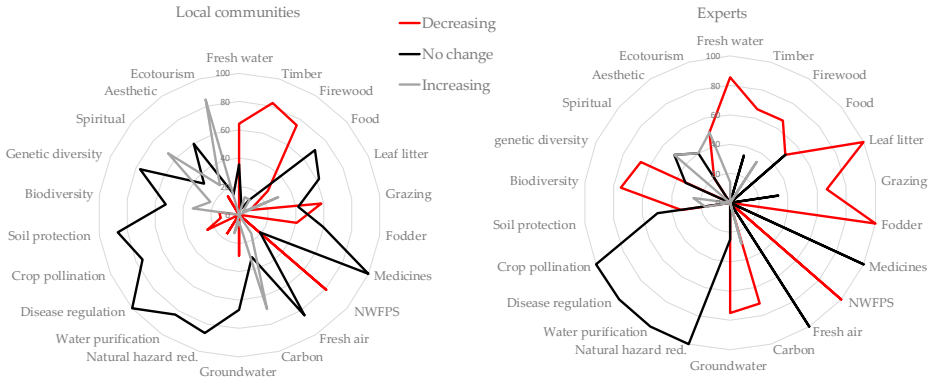

Figure 5. Perceptions of rural communities and experts on the change in availability of ecosystem services over the past ten years. Scale represents the number of respondents expressed as a percentage.

Local communities' perceptions of regulating, supporting, and cultural services from the forests were more positive than for provisioning services, and they felt the availability of these has remained constant or improved over time. Local communities think that these values will only grow as forest cover increases as a result of strong conservation commitments and gradual colonization of open pastures by vegetation with decreasing grazing pressure. They indirectly related the increasing forest cover to more tree growth and increased carbon sequestration capacity of old-growth forests. Experts had mixed opinions about carbon sequestration services. Only 29 percent of expert views were in line with the perception of local communities; they attributed the increase in forest cover to the decreasing use of oak as a result of the nationwide ban of oak tree felling to prevent overharvesting in the early 2000 s. However, 71 percent of the experts felt that carbon sequestration potentials were declining due to the extraction of other timber and fuelwood species (e.g., Conifers), fuelled by road access and an increasing population. They also highlighted the failing reforestation programs and poor natural regeneration problems in these forests as other reasons for the decline.

There were synergies among the groups in terms of their perception of increasing trends in the access to forests for their spiritual and aesthetic values. Paricipants attributed the increase to economic progress like road connectivity, more disposable income, and the increasing number of people looking for tranquility and spiritual wellbeing. The focus group discussions strongly supported this view. Eight out of nine focus groups suggested community-based ecotourism as a future enterprise with high potential in their communities. They associated this to the increasing number of local and international tourists seeking natural beauty and tranquility. This is further complemented by the intact forest cover in their locality with rich cultural and spiritual values.

Local communities perceived that the threats to the sustainability of provisioning, regulating, and supporting services from the old-growth oak forests were the result of the overexploitation of resources driven by population growth and economic development, as well as changing conditions associated with climate change (Table 5). Similarly, the expert group emphasized high pressure on forest resources due to the growth in populations of both human and cattle over the years. Overharvesting of resources and overgrazing by cattle were identified as the main threats for the rapid decline in the natural resources and failure of regeneration by oak. While local communities agreed on the overharvesting of resources, they were less aware of the regeneration problem in their local forests. Both groups stressed the importance of reforestation programs to protect their water and other resources and increase the carbon sequestration services.

The local communities raised the need for training and education on appropriate harvesting guidelines in relation to the provisioning services from the forests to alleviate overexploitation by both villagers and outsiders in these open-access forest areas. While strict rules are in place for the harvest of forest resources in these forests, they are not always followed or enforced. Some felt that the rules themselves needed reviewing, since allowable harvest levels might be too high for the ecosystem to support the practice. In addition, the groups felt that improving the local governance of these local forests through the empowerment of local communities and establishment of custodianship could be a potential management intervention to promote sustainable use and safeguard the resources.

Table 5. Summary of key findings from FGD on priority ecosystem services, perceived threats, and potential management options indicated by local communities and experts.

Ecosystem Service	Perceived Threats/Opportunities	Potential Management Interventions	
		Communities	Experts
Freshwater	Forest disturbance; high pressure on resource due to increasing population and climate change	Protection of water source through revegetation; Prohibition of disturbance at the water source.	Water budgeting; identification of critical watersheds and proper management; Prohibition of forest harvesting in upper catchment forests.
Timber/Fuel wood	Over-exploitation both local and outside residents; longer tree rotation period	Empowering local communities to safeguard their resources through community forestry	Transfer of forest ownership over to local communities; Assist regeneration of forests through plantation programs.
High-value NWFP	Over exploitation of resources by local and outside residents	Education on proper harvesting techniques, ownership to community	Ownership should be given to local communities; Domestication of high value medicinal species in farmers field.
Carbon sequestration	Reforestation failures; over-extraction of wood resources	Community based plantation programs	Detail study on regeneration ecology of oak forests; Replenish felled trees with plantations.
Maintenance of genetic diversity	Keystone species are not regenerating in the forests; Prey-predator balance	Addressing human-wildlife conflicts as the population of prey species; boar, deer have increased.	Detailed study on the ecology of oak forests and wildlife population dynamics. Restoration of oak forest through artificial plantations need to be adopted to address regeneration failures.
Spiritual /Ecotourism	Increased connectivity, Better income; More people seeking tranquillity	Creation of awareness campaigns and advertisements	Protecting spiritual/religious sites from forest logging; providing adequate amenities (e.g., toilets, clean water, guest house) to encourage tourism.

3.4. Community Values and Their Linkage to Ecosystem Services

The community values most strongly associated with these oak forests by community members were socio-economic, well-being, and environmental conservation. Socio-economic and environmental conservation values were each associated with seven ecosystem services from these forests, followed by well-being values with six (Figure 5). Cultural values such as coexistence, and spiritual and cultural vitality were associated with fewer ecosystem services. Participants of the FGDs felt that their community and the old-growth forests could be a special focus for environmental- and cultural-based ecotourism. They attributed this to their location close to the alpine peaks used by tourists for trekking and the presence of several cultural and religious spots of national significance. They expressed the need for an awareness of such services by the general public through newspaper advertisements and TV broadcasts. Both groups in our study strongly felt that local governance and community-based management of these old-growth forests through community forestry can ensure sustainability. Both groups expressed a need for research on forest ecology and restoration and community-based plantation programs. The stakeholder groups identified several potential areas related to forest management and conservation that required active local and government partnerships. Public consultations, awareness campaigns, and integrated decision-making on all aspects of natural goods and services were proposed during the focus group discussions (Figure 6).

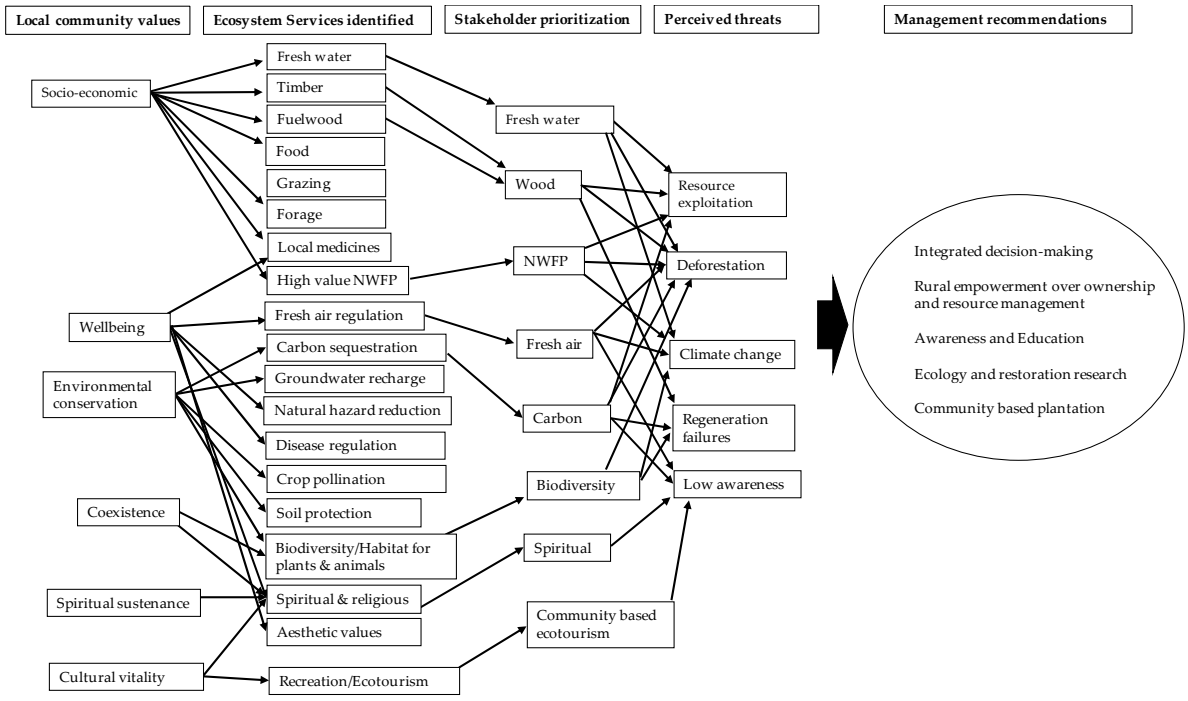

Figure 6. Framework on bridging local community priorities with national interests through the incorporation of community values and perceptions of ecosystem services.

4. Discussion

Our social valuation revealed a diverse range of forest ecosystem services provided by oak forests in western Bhutan and their relative importance to two distinct forest users groups: local communities and forest experts. By pairing the concept of community values to the perceptions of the full suite of ecosystem services, our study provides a social valuation of these forests centered on the perceptions and needs of two stakeholder groups. In-depth understanding of how different forest users perceive and value ecosystem services is important for landscape-level decision-making [15]. This approach further nurtures partnerships and trust among stakeholders and develops a sense of local ownership over local resources, which is important for wider sustainable forest management goals.

In line with other research in the region [14,42], our study confirms that community members understand and prioritize provisioning and cultural ecosystem services over regulating and supporting services. This is probably due to their historic and cultural interactions with these services for livelihood sustenance [15]. Cultural services identified in this study represented an important component of rural culture, spiritual contentment, and happiness consistent with findings from other studies [11]. Less tangible regulating and supporting ecosystem service categories, which are difficult to see or measure, were not emphasized by local communities. They were, however, recognized for their importance to local wellbeing. All of these ecosystem services were considered by residents and managers alike to be an important reward of a well-maintained forest ecosystem, a perception that is consistent with positive attitudes by local communities on the regulating services from oak forests of Nepal [60]. The most important reward is the conservation of soil and water, also highlighted by other studies [61,62].

The expert group was aware of the full suite of ecosystem services, and their preferences were distributed more equally across the four service categories. This could be due to their broader interest in forest resource management, biodiversity conservation, and climate change mitigation. Members of this group were educated in all aspects of forest ecology and regularly participate in national and international seminars, and environmental awareness programs. Such forums help make it easier to understand the less tangible benefits of regulating and supporting ecosystem services. For example, it was reported elsewhere that regular environmental awareness programs were even more influential

than the formal education levels in valuing the perceived importance of regulating services to the communities [63]. Given that residents of rural communities in the Himalayas are not highly educated, special consideration should be given to creating regular environmental awareness sessions focusing on all services, with emphasis on regulating and supporting services, so that communities can fully value the importance of their local forests [42].

Priorities for certain ecosystem services among community members were strongly influenced by the individual's environment where they live and their socio-economic background, which was found in similar studies from Nepal [34,37]. For example, all the FGDs prioritized fuelwood in the top five ecosystem services, which, according to the participants, was due to their high-altitude location and strong dependence on fuelwood for housewarming during most of the year [46]. Similarly, villagers from Gemina and Nubri included fresh air regulation services in the top five, reflecting their location close to an industrial estate and realizing the value of forests in fresh air regulation to their wellbeing. In general, all the local communities' priorities for water, timber, fuelwood, leaf litter, NWFP, and forest grazing indicated their strong dependence on forest resources for their rural livelihood.

The influence of demographic factors such as cultural identity, gender, and income levels of participants on the variations in their socio-cultural values are described in studies conducted outside Bhutan [34,63]. While we did not explicitly explore these areas, our results suggest that gender and age did not influence the socio-cultural values assigned to ecosystem services.

The level of socio-economic development in the village does seem to affect the dependence on forest resources, if not the values people put on them. We found a lower dependence on several ecosystem services by the local communities as a result of socio-economic development and lifestyle changes. For instance, villager dependence on provisioning services, such as local medicines, wild vegetables, wild fruits, and berries, was reported to have significantly declined over the years, even though their availability in the forest was perceived to have remained constant. Local medicinal plants, which were widely used in the past, are now hardly used due to improved access to modern medicines. Similarly, food and fruits are rarely collected due to the availability of various food options in farms and markets. It is thus predicted that with economic growth and the availability of alternative service options, the dependence on and traditional ecological knowledge about these products will decline over time. Documenting indigenous knowledge and practices should be given priority for transmission to future generations.

Stakeholder priorities of ecosystem services were strongly governed by their perceived trend in the availability of ecosystem services. Ecosystem services that were highly important and perceived to be vulnerable, such as water, fuelwood, and NWFP, received high priority ratings from both the communities and experts. These critical, and vulnerable, ecosystem services are highly important for the wellbeing of local communities and should be a priority conservation area for inclusion in forest management. Experts also gave high scores to carbon sequestration and biodiversity values because they believed that old-growth forests are deteriorating due to human disturbances and poor regeneration. This perception differed from that of local communities, where residents perceived that carbon sequestration services of forest had increased over the years as a result of increasing forest cover brought about by strong conservation programs and the colonization of open pastures by new forests. Local perceptions about increasing forest cover in the region are consistent with remote sensing studies that related forest cover increase to land abandonment and gradual replacement by pine forests [64,65]. These results highlight a need for studies on the carbon storage dynamics related to the forest colonization of abandoned pastures and fields in this landscape.

While local people perceived an overall expansion of forest cover, they were less aware of the regeneration failures by the primary oak species in their forest. This could be due to the presence of very large oak trees in the forest, which mask the lack of young ones to replace them in the future. The regeneration failure is a considerable threat to the future of these oak forests and the important ecosystem services they provide. Their decline could directly impact the wellbeing of temperate farmers [43,49,53,60,66–68]. We call for a detailed study on the ecology and restoration of the oak

forests in Bhutan and the transmission of ecological knowledge to local communities. As ecosystem restoration is becoming a global priority, and one in which the engagement of experts and resource users will be increasingly involved [69], we suggest that the active participation of local stakeholders in all aspects of decision-making and forest management would be beneficial. We propose the organization of environmental awareness programs and community-based, small-scale restoration projects as initial steps to protect and restore these important forests.

Improving local forest governance through empowering local communities in all aspects of management and ownership with strong technical support from Bhutan's forestry department could be a promising way forward for the sustainable management of these forests and resources. Promising experiences show that common-pool resource management mechanisms and institutions, such as community forestry, are effective in regulating and managing valuable natural resources by communities in Bhutan [70–72]. Similarly, the ecotourism sector represents considerable potential for benefit-sharing from ecosystem services, which can ensure environmental sustainability and socio-economic development in Bhutan [40]. For a start, forest managers and extension workers can capitalize on promoting the natural, cultural, and spiritual values through community-based ecotourism. The high biodiversity of these rich forests coupled with their spiritual importance and cultural diversity present a major opportunity for appreciating the secret value of these forests. We support the current government initiative of promoting community forestry in which local communities serve as the primary custodians of the forests. This local empowerment contributes to long-term sustainability of the forests.

5. Conclusions

Our study presented an important social perspective to identify and assess ecosystem services from one Himalayan forest type: the high-altitude oak forest. Contrasting with many valuation studies that focus on biophysical models and monetary aspects of ecosystem services, we carried out an assessment focused on the socio-cultural values of these forests and found strong linkages between these forests and human well-being. We used participatory rural appraisal tools, including household and expert interviews, participatory resource mapping, focus group discussions, and preference point ratings, in seven villages of Western Bhutan, to study preferences and bridge differences in the perspectives ascribed by two stakeholder groups to ecosystem services, local communities and forest experts.

Our results indicated that for both local communities and experts, fresh water, followed by timber and fuelwood, were highly valuable, as well as highly vulnerable, ecosystem services in the study region. We suggest that these ecosystem services should receive the highest priority in forest management and planning. Based on the comparison of four broad categories of ecosystem services, we demonstrated that both stakeholder groups preferred provisioning services over others. However, the preferences and understanding of local communities were remarkably higher than experts from the perspective of provisioning services, but lower from regulating and supporting services, indicating the need for investments in awareness programs and environmental education so that local communities fully value the wide range of forest ecosystem services.

Our qualitative approach of identifying the perception of ecosystem services from local people has high potential to identify areas of socio-ecological conflict and bridge the local perspectives within the framework of wider national goals for long-term sustainable management policies in the Himalayan region. Threats to these forests identified in this study included the overharvest of forest resources, over grazing by cattle, and climate change. These mainly affected the availability of resources to community members and the natural regeneration of oaks. To address these threats, both community members and experts emphasized the need for improved local governance and community-based management of these forests, research on forest ecology, and restoration to support sustainable forest management decisions. They also identified the need for local awareness campaigns about forest ecosystem services and sustainable forest management, as well as integrated decision-making with relation to all ecosystem

services. These conditions would lead to more socially equitable and environmentally sustainable management decisions and forest use.

We propose that the social valuation of ecosystem services should be included in all ecosystem service assessments as a critical complement to biophysical quantification and monetary valuations. In this way, a more robust and comprehensive assessment can be achieved, one that reflects both the diverse values of forests and the full needs of forest stakeholder groups.

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