PUBLICATION INFORMATION

Design considerations in supporting payments for ecosystem services from community-managed forests in Nepal[1]

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Abstract

Despite widespread implementation of payments for ecosystem services (PES), benefits to poor people in developing countries have been limited. The success of PES varies with the local context, policy environment and PES design and its implementation. Until recently, there have been few studies of factors that might contribute to the success of PES and associated outcomes. *Ex-ante* analysis of design considerations is critical in developing a robust and sustainable PES scheme. This research aimed to determine the key elements of PES design and prioritise those likely to support successful PES for community-managed forests using a case in the Phewa watershed in western Nepal. Community perceptions and expert opinion were used to identify 19 design considerations relevant to stakeholders. These were integrated into a PES design index. Analysis using this index indicated that livelihoods, pro-poor participation, tenure arrangements, transaction and opportunity costs, payment structures and government policy were perceived as most important to stakeholders. Although the effectiveness of a PES scheme has often been measured economically or biologically,

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our results indicate that the most important design considerations for stakeholders were policy, social, financial and institutional arrangements. The analysis indicated that there are often trade-offs between equity, efficiency, and effectiveness involved in achieving livelihood improvements for rural poor and, consequently, the longer-term sustainability of a PES scheme.

Keywords: Nepal, community forestry, ecosystem services, market instruments, opportunity cost, poverty reduction, environmental justice

1. Introduction

Payment for ecosystem services (PES) has emerged as an increasingly popular policy tool for natural resource management. While payment for ecosystem goods has been common throughout human history, payments for services were instituted in the 1990s (Wunder et al., 2008) as part of a conservation paradigm to integrate ecosystem services (ES) in economic systems (Bennett and Gosnell, 2015; Wegner, 2016). This paradigm acknowledges first, the positive externalities of activities to conserve and protect natural environments and second, the costs of these activities bring into the market system to provide financial compensation and incentives for adopting management practices that maintain and enhance ES (Grima et al., 2016; Wegner, 2016). In developing countries, PES can encourage improved environmental stewardship of agricultural land and forests (Kosoy et al., 2008) and discourage activities that lead to deforestation and forest degradation (MEA, 2005).

Hundreds of PES schemes are currently being implemented throughout the world (Brimont and Karsenty, 2015; Ezzine-De-Blas et al., 2016) with design features guided by both environmental and ecological economics (Gomez-Baggethun et al., 2010). Much of the current focus of PES research is aimed at understanding how to shape the design of these schemes to improve their efficiency and effectiveness (Farley and Costanza, 2010; Muradian et al., 2010; Tacconi, 2012) and to address trade-offs in the delivery of different types of goods and services (Porras et al., 2013). Other PES design issues are associated with equity issues, including participation of multiple stakeholders, the scale of

application and the type of financing (Ezzine-De-Blas et al., 2016) for optimisation of benefits (Kolinjivadi et al., 2015b).

PES schemes have therefore usually been customised to the local context. This is a complex task as local issues have an impact on the extent to which payment schemes prioritise social equity and benefit sharing as well as economic efficiency and effectiveness (Guerra, 2016). In addition, the effects may be spatially and socially heterogeneous (Adhikari and Boag, 2013). A deeper understanding of the local social, economic and political context is therefore required for a robust and sustainable PES scheme (Guerra, 2016; Kaczan et al., 2013). PES schemes need to consider the biophysical aspects of the ecosystems in question and the economic theories that underpin markets (Farley and Costanza, 2010). Only a few studies have addressed institutional dynamics (Kosoy and Corbera, 2010; Muradian et al., 2010; Rai et al., 2016), policy dialogue (Muradian et al., 2013) and social inclusion (Pagiola et al., 2010). In developing countries, many environmentally important areas are impacted by poor people to sustain their subsistence livelihoods (Milder et al., 2010), but few studies have focused on how livelihoods and poverty reduction goals can be integrated into the PES (Fisher et al., 2014, 2013). Therefore, design considerations should be examined to integrate equity, effectiveness and efficiency and to increase social acceptance of PES scheme (Kolinjivadi et al., 2015a; Schomers and Matzdorf, 2013).

The equitable distribution of burdens and rewards between individuals or groups of people is a central pillar of sustainable development (WCED, 1990) and a key criterion for successful environmental governance (Adger et al., 2003; Klein et al., 2015). Equity in obtaining benefits from natural resources is related to resource access, decision-making roles, a fair share in outcomes, livelihood security and respect for the choices and priorities of local communities (Corbera et al., 2007; Poudel et al., 2015). However, forest conservation and management actions can benefit some groups more than others, and this raises questions about their sustainability (Klein et al., 2015). Equity has therefore emerged from environmental justice and fairness concerns, particularly for those people most affected by conservation actions and highly dependent on natural resources for their livelihoods

(Klein et al., 2015). In the case of CBF, such concerns have been raised for the welfare of those communities who are disadvantaged and whose livelihoods are vulnerable to the changes that PES seeks to drive.

Therefore, a key concern in the design of a PES scheme in the developing world is whether people living in poverty participate in, and benefit from, the scheme. Tenure security over community resources can be critical in this context (Larson et al., 2013). Inclusion, collective actions and access to information can enhance local capacity that is crucial for PES success. On the other hand, high transaction costs and financial incentives that are less than the opportunity costs incurred can hinder the adoption of PES in developing countries (Adhikari and Agrawal, 2013). If appropriate considerations are taken into account during PES design, poor people can participate and receive benefits (Bennett and Gosnell, 2015; Pagiola et al., 2010), building the public support that is vital for longer-term sustainability and effectiveness of such schemes.

In Nepal, vast areas of forests were severely degraded or converted to farmland from the 1950s to the 1970s as a result of forest nationalisation in the late 1950s (Gautam et al., 2004). The prospect of an environmental crisis as a result of massive deforestation was voiced by the mid-1970s (Eckholm, 1976, 1975) with concerns raised over landslides and water scarcity in the mountains and flooding in the lowlands (Gautam et al., 2004). Although the focus on the cause of the landslides was later found to be exaggerated, the failure of traditional state forest management to maintain forest cover and subsequent loss of local forest benefits and services led to the development of community-based forestry (CBF) in the late 1970s (Gautam et al., 2004). The success of this movement in restoring forest cover has been underpinned by local community forestry users groups (CFUGs). These groups have been supported by the national government and international donors but there has generally been no explicit link drawn between their activities and the provision of ES or improved biodiversity (Birch et al., 2014; Paudyal et al., 2017b, 2015). Growing understanding of the relationship between forest cover and the provision of different types of services, and the mechanisms to provide financial incentives associated with these outcomes indicates a potential opportunity to boost funding for these

groups (Paudyal et al., 2018). While some lessons have been learnt from PES-like mechanisms and REDD+ initiatives in Nepal that illustrate the potential for improved livelihoods and poverty reduction from such payments and incentives (Bhatta et al., 2014), the requirements for an efficient and sustainable PES system for CBF have not been explored (Paudyal et al., 2016).

This study focuses on the Phewa watershed, a landscape that was heavily degraded (Fleming and Fleming, 2009) resulting in heavy siltation to the Phewa Lake, a major water and tourism asset in western Nepal (Fleming, 1983). Landscape restoration started in the late 1970s, initially with a focus on engineering solutions but later shifting to community-based conservation and CBF (Paudyal et al., 2017c). Continuous efforts from the local communities, government and international agencies resulted in the restoration of forest cover, reduction in soil erosion, improved water quality and biodiversity (Baral et al., 2017; Fleming and Fleming, 2009).

The study aimed to investigate design considerations for applying PES in the Phewa watershed and to prioritise such considerations to achieve effective policy decisions and successful implementation. It sets out an approach for assessing and prioritising PES design considerations based on an analysis of the views of rural and urban people, as well as experts, living and working in the watershed.

2. Methods

2.1 Analytical framework

The PES designs and their intended outcomes require consideration of both their effectiveness in meeting biophysical objectives for service beneficiaries, the efficiency of allocation of resources to achieve these objectives and if equity is a goal, the level of participation and distribution of payments transparently to a range of potential service providers (Loft et al., 2017). PES schemes have often focused on maximising economic efficiency in meeting environmental outcomes at the cost of equity (McDermott et al., 2013; Pascual et al., 2014). Although the Coasean approach of maximising

efficiency and minimising transaction costs may not consider equity, others suggest that equity should be the core element of a PES scheme (Corbera et al., 2007; Loft et al., 2017; Pascual et al., 2010), in order to provide benefits to and engage the rural poor (McDermott et al., 2013). Meeting both equity and efficiency goals is feasible, if institutional factors, local interactions and power relations are considered in the design of schemes (Calvet-Mir et al., 2015; Pascual et al., 2010, 2014) that is 'fairly efficient and efficiently fair' (Leimona et al., 2015).

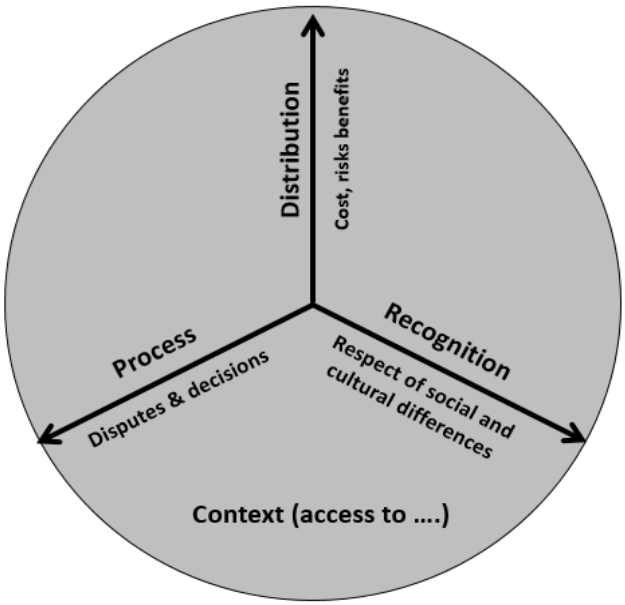

Fig. 1: An analytical framework for this study. This figure presents dimensions of equity. The figure summarises the core context of equity which is considered as a basis to analyse the important of design consideration of payment for ecosystem services (after Loft et al., 2017, Martin et al., 2014; McDermott et al., 2013). This concept applies to PES design at the various spatial scales (local, regional, national) and ES types, e.g., single or of multiple services in a buldles. The equity intends for a positive descrimination of poor local communities providing additional support in facilitation of PES process and capacity development which enahnces local ownership, good governance and suatatibility of the PES schemes.

Figure 1 illustrates the core components of equity. In considering equity in natural resource management (NRM), distributive outcome refers to the ability of different actors to enjoy environmental benefits and avoid environmental harm, while those managing the resources take on a fair share of the costs and management responsibilities and receive a fair share of benefits (He and Sikor, 2015). Participation in decision making is another aspect of equity that includes the rules governing the scheme and roles of stakeholders in decisions (Loft et al., 2017). The contextual equity

refers to the social conditions of (in)equity, such as access to the decision-making process and distributions of benefits, and the capabilities and power to gain access (McDermott et al., 2013). These initial social conditions may affect the ability of stakeholders to participate in and benefit from a PES implementation. In this case, recognition of distinct identities, histories and community characteristics can support both PES effectiveness and equity (Martin et al., 2014). Such acknowledgement calls for respect for social and cultural differences that are likely to result in different desired outcomes. Given that equity is a fundamental principle in ensuring community involvement in forest conservation and management (Poudel et al., 2015) and the growing recognition of the need for consideration of equity in PES, an equity framework was used as the fundamental basis for analysis and used to explore the relationships between equity and efficiency in PES schemes from both theoretical and practical points of view.

2.2 Study area

The watershed area of Phewa Lake lies between 28°11'39 to 28°17'25 north latitude and 83°47'51 to 83 ° 59’17 east longitudes, adjacent to the Pokhara Metropolitan City (Fig. 2). The population of the watershed area is 198,333 with an average density of 665.51 per km^2 that is spread across rural areas with only 27% in the city (Paudyal et al., 2017b). The topography is steep (average slope 40%) and ranges in altitude from 850 m at the lake surface to 2508 m at the peak of Panchase, an important tourist destination. Proximity to Pokhara city and trekking routes to the nearby Annapurna range make the lake and watershed area a popular tourist destination (Fleming and Fleming 2009). The annual monsoon regulates the climate in the watershed; this is characterised by the humid subtropical monsoon, moderate temperatures, heavy monsoon rainfall (~5000 mm) and distinct seasonal variation (Regmi and Saha, 2015). Forests occupy a substantial portion of the watershed (49%) followed by cropland (41%) (Paudyal et al., 2017b; Rimal et al., 2015). Built-up areas and agriculture occupy the flat and gently sloping area, while forests are found in steeper areas. The lake surface has been estimated to cover 3.3% of the watershed area (Leibundgut et al., 2016), with a water storage capacity of 42.18 million m^3 and an annual average sedimentation rate of 18 000 m^3 (Sthapit and Balla 1998).

More than 60% of forests (2,739 hectares) is under CBF and is managed by 75 CFUGs, representing 12,739 households in the watershed (DFO 2016). The CFUGs together make up the largest people's network in the watershed. They have rights to manage and use their forests according to an approved constitution (rules and regulations) and a forest management operation plan. However, their existing rights are limited to tangible forests; rights over water provision and other ECs supplied by their forests are undefined (Paudyal et al., 2017a). Although the siltation was perceived as a significant threat to the Lake about 40 years ago, four-decades-long efforts of participatory watershed conservation and CBF have significantly reduced the siltation of the Lake in recent years (Sthapit and Balla, 1998). As a result of community efforts in conservation, the area which has a variety of forest types and restored forests in good condition has the potential for PES implementation.

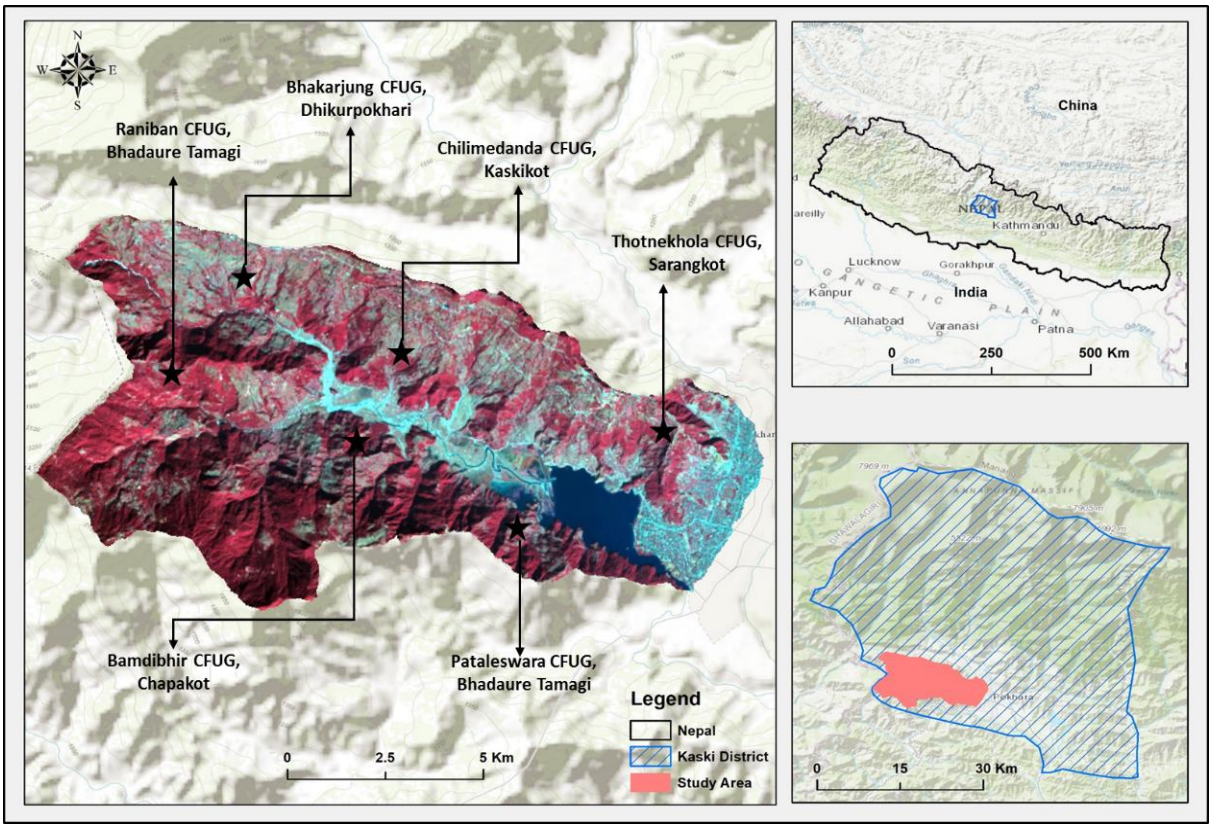

Fig. 2: Phewa Lake watershed and location of six community forestry users' groups (CFUG) that were used for a case study. The standard false colour composite Landsat image of study area shows vegetation in the dark to light red, water in dark blue, the built-up areas in light cyan and open areas in grey.

2.3 Study design

The research used a participatory approach to explore local perceptions (Smith and Sullivan, 2014) and expert opinions (Burkhard et al., 2012; Paudyal et al., 2015). Although a participatory approach provides credible and transferable contextual data (Salihu et al., 2015), results are subjective, and the accuracy and reliability depend on the extent of participation and the degree of understanding among participants of the local situation (Baral et al., 2014). A key informant survey (KIS), focus group discussions (FGD) and a stakeholder workshop were used for data collection. Data were analysed in two stages (Fig. 3). In the first step, PES considerations were compiled from the literature and then these were refined and prioritised in a workshop (Petrokofsky et al., 2010). A combined community priority index (CCPI) was formulated by considering multiple criteria and respondent groups. During the research planning, human ethics approval was acquired from the Human Research Ethics Committees of the University of Melbourne.

2.4 Sampling and sample selection

An orientation workshop (OW) in July 2015 in Pokhara was used to obtain advice for selection of research participants and to identify criteria for assessment of design considerations. Based on recommendations from this workshop, the study population was stratified into three social strata for purposive sampling: (a) upstream communities (UC), members of CFUGs, (b) business communities (BC), people engaged in business and trade associations in the Lakeside town area and (c) experts, natural resources management officials in the watershed. Upland communities were given higher weight in sampling because of the highly scattered pattern of settlements and their contribution to watershed restoration. Six criteria were selected for comparing design criteria: sustainability, local ownership, equity, effectiveness, efficiency and user confidence (Table A1). In this type of multi-criteria approach, a higher number of criteria can deliver a better result (Salihu et al., 2015).

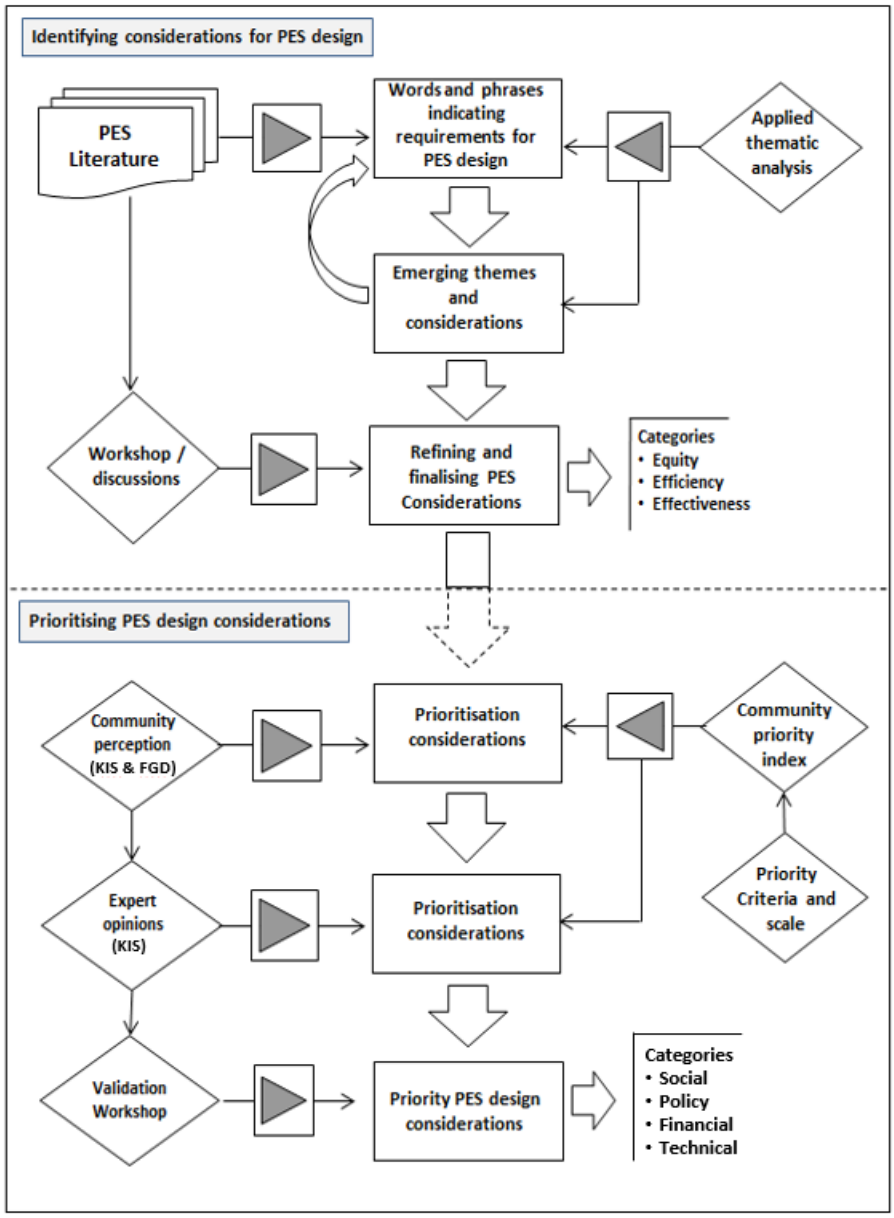

Fig. 3: A methodological framework for the study. The process starts from the literature review to identify some related to the PES considerations. A list of considerations was identified from these themes using applied thematic analysis techniques which were finalised through a stakeholder workshop. Then, KIS was conducted among various stakeholder groups to rank these considerations to prepare priority list which as concluded again from another stakeholder workshop. Acronyms: FGD - Focus group discussions, KIS - Key Informants Survey, PES - Payments for ecosystem services.

In case of UC, one CFUG was randomly selected from among the CFUGs in each local government unit (formerly called Village Development Committee - VDC) from upstream, resulting in a sample of six CFUGs: *Totnekhola*, *Chilimedanda*, *Bhakarjung*, *Raniban*, *Bamtibhir* and *Pataleswora* (Table A2). A separate OW identified ten participants from experts and the business communities for KIS.

An OW was also conducted in each selected CFUG, and ten respondents for KIS and the date for a FGD were fixed. Out of 60 selected respondents from UC, 65% were men, and 35% were women. Most of them (48%) were 45-60 years old, 27% were 30-45 years, and 22% were over 60 years. Respondents from BC and experts were all men, aged between 30 and 45 years. A final workshop for stakeholders (representatives from upstream communities, business people and experts) was organised in Pokhara for validation of initial results.

2.5 Design considerations

The keywords related to specific considerations for PES design in developing countries were identified through a review of the literature conducted in March-April 2015. We used an 'applied thematic analysis' framework (Guest et al., 2012) in which PES related articles were selected, examined and analysed to recognise key themes corresponding to possible considerations (Paudyal et al., 2017a; Sitas et al., 2014). The search first identified published articles containing keywords such as 'principles' OR 'criteria' OR 'conditions' OR 'preconditions' OR 'requirements' OR 'considerations' AND 'payments for ecosystem/environmental services' in the title, abstract and among the keywords using Scopus (www.scopus. com), the single largest abstract and indexing database (Burnham, 2006; Falagas et al., 2008; Kulkarni et al., 2009). We conducted a quick review of the abstracts of the articles retrieved to evaluate their relevance to PES considerations. Out of the 149 papers scanned, this search revealed only 36 papers relevant to the study (Table A3). Although many documents included relevant keywords, we excluded most of them because the purpose of these words was different from what we were looking for. Starting from these keywords, an in-depth review identified words or phrases relevant to PES considerations. Twenty-five initial considerations were identified (Table A4). The list of considerations (translated into the Nepali language) was presented to the workshop and finalised following a discussion regarding the relevance of PES design in the Phewa watershed. Nineteen considerations were selected for further analysis. These were grouped into four broad categories: policy/institutional, social/human capital, financial and technical.

2.6 Prioritising design considerations

We developed the combined community priority index (CCPI) based on the community priority index (CPI) of Salihu et al. (2015). The CCPI provided the ability to consider uneven sample sizes and responses for multiple evaluation criteria to prioritise PES considerations in this study (Fig. A1).

(a) Data collection

Using a five-point Likert scale, participants ranked 19 considerations as 1= not relevant, 2= slightly relevant, 3= moderately relevant, 4=relevant, and 5=highly relevant in the provided format (Table A5). For this, we visited each selected participant at their home or another preferred location. Before moving to asking the structured questions, we discussed the importance of the considerations and their relationship to the criteria. Every participant was requested to rank each consideration against each criterion in succession. They were permitted to move back and forth between considerations to amend the ranking. Respondents were not required to rank all considerations and, therefore, there were missing values as only a few considerations were ranked by all participants. All responses were recorded. This process was repeated for all ten respondents in each community. This prioritisation was also conducted with ten members of the downstream business community and ten local experts.

(b) Data analysis

Data from the three respondent groups (local communities, downstream business community and experts) were entered into an Excel spreadsheet and analysed using R-software. The R code for the algorithms for the CPI were modified from Salihu et al. (2015) for the data analysis. The CPI is the product of the mean of each criterion (Salihu et al., 2015) and means for each criterion were calculated by dividing each sum of the scores for each consideration by the number of respondents for each consideration. Acknowledging the greater roles of upstream communities in supplying ecosystem services in the watershed, the stakeholder workshop decided unanimously to allocate 50% of the weight to them, while weightings for experts and downstream business people were set at 30 % and 20%, respectively for priority calculation.

The following formulas were used to calculate the CCPI adapted from Salihu et al. (2015).

$$\bar{x}_{*rc} = N_I^{-1} \sum_{i=1}^{N_I} x_{irc} \quad (1)$$

Where N_I is the number of respondents, r the number of considerations, c the number of criteria for each consideration and x_{irc} is a 5-point value that represents the rating of the c^{th} criterion of the r^{th} consideration of the i^{th} respondent.

The CPI is the product of the mean of the c^{th} criteria of the r^{th} consideration; CPI_r calculated as:

$$CPI_r = \prod_{c=1}^{N_c} \bar{x}_{*rc} \quad (2)$$

A higher CPI score indicates a higher priority. However, the CPI for each consideration was scale-dependent and not comparable with other indices. Thus, the CPI score was standardised to range from 0 to 1 as:

$$Standarised\ CPI = \frac{Actual\ CPI - Lower\ bound\ CPI}{Upper\ bound\ CPI - Lower\ bound\ CPI} = \frac{CPI_r - 1}{15624} \quad (3)$$

The standardised CPI scores for each consideration were calculated separately for the three communities. There was significant variation in priority considerations between the three types of respondents. The CCPI provided a single priority score based on the sum of weighted CPI of each respondent group, as follows:

$$CCPI_r = \sum_{p=1}^{N_p} [CPI_r \times W_p] \quad (4)$$

Where N_p is the number of respondent groups, and W_p is the assigned weight to p^{th} respondent group.

Finally, priority index values were grouped based on expert opinion for qualitative interpretation: a score of less than 0.10 was classed as only slightly relevant, between 0.10 and 0.20 as moderately relevant, between 0.20 and 0.30 relevant and higher than 0.30 was highly relevant. Also, we set 0.30 as a threshold of CCPI value based on expert opinion from stakeholder workshop to delineate the priority considerations. The increase in threshold could decrease the number of priority considerations

perceived as more important to the stakeholders and vice-versa. Hence, we conducted sensitivity analyses with a variation of the threshold value by ±50%.

2.7 Trade-offs and synergies among priority considerations

When PES design includes multiple considerations, interactions among them may alter the effectiveness of a PES scheme. For example, there is generally a trade-off between equity and efficiency of a PES design (McDermott et al., 2013; Pascual et al., 2014, 2010). Potential synergies and trade-offs were analysed in a workshop involving 35 participants from upland communities, business owners and experts. A pairwise comparison method was used to find the interactions and relationships (positive and negative) between each pair of considerations. For this, we identified five possible outcomes of interactions/relationships between considerations: strong synergy (++), weak synergy (+), indifference (0), strong trade-off (- -), and weak trade-off (-). In the workshop conducted in the Nepali language, considerations were presented and the possible relationships between each pair were discussed. The workshop was facilitated interactively, with the result that stakeholders were fully engaged with the trade-offs and synergies and these were decided through consensus. Participants were asked to provide an assessment for each pair of considerations, based on their understanding of the nature of trade-offs or synergies. They were permitted to move back and forth between each pair of considerations to amend the assessment. Workshop outcomes were systematically documented. Finally, we produced a matrix representing synergies (positive) and trade-offs (negative) between each pair of considerations. We used network analysis to visualise such relationships by using Social Network Visualiser (SocNetV software - http://socnetv.org) (Hicks et al., 2013; Smith et al., 2017). We also calculated centrality to measure the number of connections between considerations.

3. Results

3.1 PES design considerations

Of the 19 design considerations identified for further analysis, most (seven) were related to social/human capital such as pro-poor participation, livelihoods, pro-poor benefits, social value and preferences, capacity building, community characteristics and facilitating organisations. This was followed by technical considerations. Policy/institutional and financial categories had four and three considerations, respectively (Table 1). Five technical considerations were put forward, but these were not ranked high compared with other types.

Table 1: Considerations and their relevance for design of payment for ecosystem services (PES) in community-based forestry (CBF) landscape of Phewa watershed, Nepal

Types	Considerations	Supports to	Relevance of considerations in the watershed
Policy and institutional	PES governance	Effectiveness	Governance frame ensures the participation, transparency, accountability, efficiency and equity that is based on lessons learnt from CBF governance.
	Local institutions	Effectiveness	Community forests users groups (CFUG) is a legitimate grassroots institution for forest management. As most of the people are under the CFUG network, the existing institutional competency can be an entry point for PES effectiveness.
	Property rights and tenure arrangement	Effectiveness	While current acts and regulations provide resource rights, especially tangible forest products, CFUG's rights over all ecosystem services (ES) are yet to be defined.
	Government policy	Effectiveness	An overarching policy with a clear guidance is important for PES implementation. Existing policies are fragmented, often lack cohesion, and the PES is not considered.
Social/human capital	Pro-poor participation	Equity	The PES sustainability depends on the participation of the poor in design. Otherwise, the actions to achieve restoration objectives can be undone through incursions or lack of ongoing community input.
	Livelihoods	Equity	Subsistence economy and livelihoods depend on agriculture, and related forest land uses. By prioritising payments for activities integrated with livelihood strategies, PES can demonstrate support for, and capacity to work with, existing land uses and overcomes concerns about opportunity costs.
	Pro-poor benefits	Equity	Ensuring PES benefits to the poor in PES can build greater alignment with other policies. For example, CBF has provisions for a share of benefits (at least 35%) to pro-poor programs. Aligning PES to the country's framework for poverty reduction can potentially mobilise more finance for PES.
	Social value and preferences	Equity	Using indigenous knowledge and respecting social values, local norms, beliefs and preferences can build wider community support and involvement in PES.
	Capacity building	Effectiveness	Lack of skills and knowledge and competent institutions are recognised barriers to effective PES. Strengthening local skills and capacity in ES assessment, accounting,

Types	Considerations	Supports to	Relevance of considerations in the watershed
			trading and financial management (including contracts and legal arrangements) can build more sustainable models that are less dependent on outside resources and inputs.
	Community characteristics	Equity	Understanding demographic characteristics (age, sex, ethnicity), economic status (occupation, farm size and income source), and human capital (skill, education, experience) can be used to determine people's participation in the PES.
	Facilitating organisations	Effectiveness	Facilitating organisations play important roles in the capacity building, coordination and networking among ES suppliers, users and government agencies that increase confidence in PES mechanism.
Financial	Payment structure	Efficiency	Benefits distribution is a major source of conflict. Developing a widely accepted payment structure including reward for effort, payment frequency and balancing community versus individual payments will enhance PES acceptance.
	Transaction cost	Efficiency	High transaction cost and high initial investment obstruct the PES initiation that requires minimising design costs such as fees, charges and administration costs.
	Opportunity cost	Efficiency	Past restoration efforts were often implemented without consideration of income from alternative land uses because CBF was state-driven on state-owned land. Now, local people are aware of alternative land uses and can seek income opportunities elsewhere. They will not participate in practices to deliver ES if payments are lower than what they might receive through other opportunities.
Technical	Access to information	Efficiency	Information (baseline data on services, the effects of different land uses and management and costs and benefits) is required so that stakeholders are fully informed about ES and can make informed decisions about PES participation
	Bundling of ES	Efficiency	Bundling of non-excludable ES for a single payment can be a cost-effective arrangement that increases benefits to ES suppliers and may reduce transaction costs.
	Boundary of PES scheme	Effectiveness	Lack of alignment of political units, such as CFUG boundaries with biophysical units for ES accounting may cause a problem in the PES design. Networking groups of CFUGs that cover a watershed may provide a better platform for PES but will also present potential political complications and challenges for benefit sharing.
	Quantification and valuation of ES	Effectiveness	ES quantification and valuation are required for PES negotiations and contracts. Given the uncertainty about causation for services such as water values, agreed intermediate indicators might be required to establish the system and quantify the link between management actions and benefits. Valuation will depend on beneficiaries' willingness to pay but can be informed by payment levels in other schemes.
	Scale of PES	Effectiveness	PES can operate at a variety of spatial scales (i.e. local to international) for single or multiple ES. Only a few ES may be relevant on a local level while others need to be considered on a wider scale, where beneficiaries may be quite far from the watershed. So, scale factors need to be taken into account in PES design.

3.2 Priority considerations for PES design

Based on the combined community priority index (CCPI), nine considerations were ranked highly relevant and perceived as most important for PES design: livelihoods, pro-poor participation, property rights and tenure, payment structure, government policy, local institutions, opportunity cost, governance and transaction costs (Fig. 4). Three considerations were ranked relevant: social values, capacity building, and pro-poor benefits. Access to information, PES scale, bundling of ES, facilitating organisations, ES quantification and valuation, community characteristics and PES boundaries were ranked as moderately to slightly relevant considerations. Generally, policy/institutional and financial and social/human capital-related considerations were given a higher priority by participants in this study, while technical considerations were rated as a lower priority. Among highly prioritised PES considerations, two belonged to social/human capital, four to policy/institutional and three were in the financial category. The sensitivity analyses revealed that the number of priority considerations was sensitive to the threshold value. If the threshold value increased by 25% (0.375) and 50% (0.45), priority considerations were seven and only one, respectively (Table A6). Likewise, if the threshold value decreased by the same percent, priority considerations would be 12 and 14, respectively.

The perception of priority considerations varied according to background, interests, location, values and the aim of resource management of respondents. The different groups assigned high relevance to similar numbers of considerations (upland communities ten, business communities seven, and experts eight) and all gave higher relevance ranking to livelihoods, property rights and tenure, and payment structure (Table A7-9). Other priority considerations differed among these groups. Upland communities gave greater relevance to pro-poor participation, local institutions and opportunity costs. Business communities assigned a higher priority to government policy and transaction costs. Likewise, experts gave higher priority to government policy and governance of PES schemes.

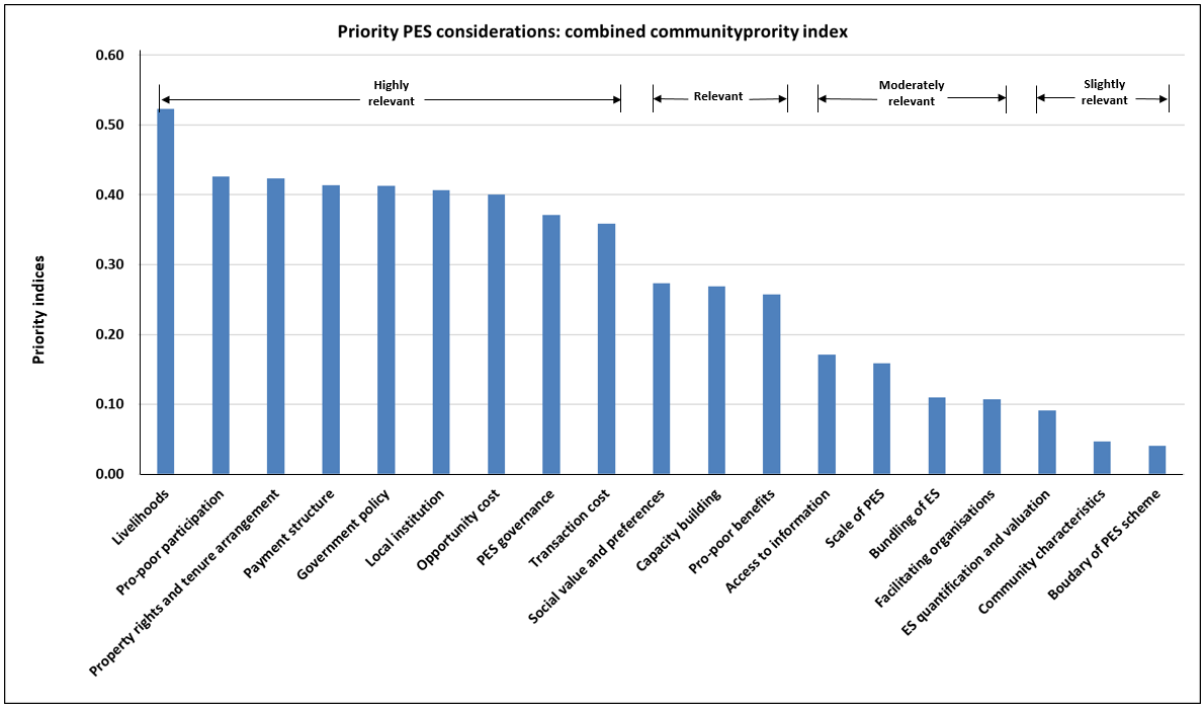

Fig. 4: Combined community priority index (CPPI) for priority considerations that are perceived relatively relevant to the design of payment for ecosystem services (PES) in community-based forestry landscape, Phewa watershed, Nepal.

3.3 Interaction among priority considerations

In considering potential synergies and trade-offs in achieving equity, efficiency and effectiveness of outcomes in PES design, out of 19 considerations, half were considered by workshop participants to contribute to PES effectiveness and one-quarter each to equity and efficiency (Table 1). In a pairwise comparison of nine priority considerations, 20 pairs indicated potential synergies (nine strong and 11 weak) and 11 trade-offs (six strong and five weak) out of 36 possible pairs, while five pairs of considerations were thought to have no direct relationship (Fig. 5). Pro-poor participation and transaction costs were key considerations that created many synergies and trade-offs. Trade-offs were apparent between equity and efficiency-related considerations, while synergies were evident between equity and effectiveness-related considerations. For instance, pro-poor participation and livelihoods showed synergies with property rights and tenure arrangement, government policy, local institutions and governance, but involved trade-offs with transaction costs. The level of transaction costs involved trade-offs with all other priority considerations. Opportunity costs and payment structure were

considered to interact positively with pro-poor participation and livelihoods. In general, synergies were identified between social and policy considerations while trade-offs were seen between financial design considerations and other considerations.

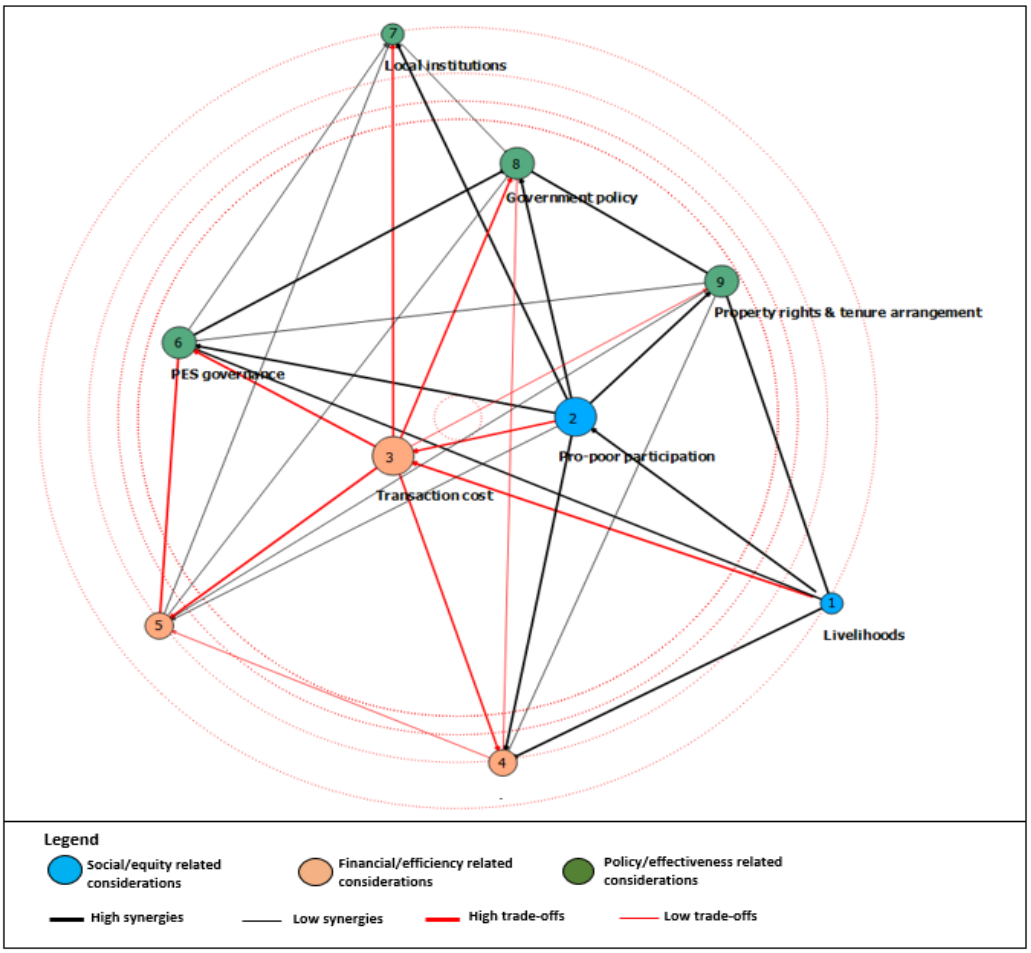

Fig. 5: Network diagram showing interactions among priority PES considerations and evidence of various sets of synergies (positive relationships) and trade-offs (negative relationships) among them which may alter equity, efficiency and effectiveness outcomes when they are integrated into PES design in the study area. Different colours of lines and their thickness were used to visualise positive and negative associations, and their strength (thicker the higher) respectively. The position of consideration nearer to the centre would indicate the higher number of connections/associations (trade-offs and synergies) and vice versa if they positioned at the outer area red-dotted concentric circles.

4. Discussion

4.1 PES design considerations

This study has identified several important design considerations for a PES scheme in the Phewa watershed, Nepal. Results revealed that social, policy/institutional and financial considerations were perceived as highly relevant, while technical considerations were slightly and moderately relevant to stakeholders. While others have paid much attention to the biophysical, technical and economic aspects of PES, sustainability may be jeopardised if the socioeconomic and policy considerations are not included in the design for the PES (Adhikari and Boag, 2013; Ingram et al., 2014). In line with the results of this study, many recent studies have also identified similar design considerations such as equity and participation (Pagiola et al., 2010), benefit distribution (Sommerville et al., 2010), technical matters (Meyer et al., 2015), ecological factors (Prager et al., 2016), equity (Razzaque, 2017) and payment structure (Adhikari and Boag, 2013). In contrast, our study presents a complete list of priority considerations reflecting the views of multiple stakeholders.

Stakeholder knowledge and perceptions can be helpful to identify and prioritise PES design considerations and reflect learnings from watershed conservation and CBF management in the last four decades. CBF has recovered large areas of forests, enhanced forest quality, enriched biodiversity, offset carbon emissions and supported rural livelihoods (Baynes et al., 2015; Chhetri et al., 2013). The success of CBF has been influenced by a range of factors such as governance, property rights, social-economic and gender inequality and level of support from the government, NGOs and donors (Baynes et al., 2015). However, social and gender disparities and financial fraud have been significant barriers to successful implementation of CBF, resulting in CFUG members suffering a sense of injustice in situations where resource rights were not shared equitably (Chhetri et al., 2013; Sapkota et al., 2016). Hence effective governance, secure property rights and social equity have been recognised as enabling condition for successful community-based PES schemes (Larson and Dahal, 2012; Macqueen, 2013). While use rights (of tangible forest products) have been partially devolved to CFUGs, commentators have flagged that providing new opportunities for income to communities

through PES will depend on the communities holding secure rights over the services being paid for (Baynes et al., 2015).

Understanding the consequence of these problems reinforces the need for a broad suite of considerations in PES design, based on the linkages between the provision of ES and livelihoods and the possibility for a new incentive through the PES mechanism that supports the modification of land use. Some participants in this study identified governance and policy as key considerations because these have ensured inclusive participation in CBF (Lacuna-Richman et al., 2016; Yadav et al., 2017). Support from external agencies in facilitation and capacity building have been instrumental in the success of CBF, and acknowledgement of this was considered important for PES design. Lack of capital has constrained the CBF from developing livelihood activities, and differences in ethnicity and wealth have inhibited the broader distribution of benefits from CFUG actions (Chhetri et al., 2013; Sapkota et al., 2016). Despite widespread evidence of improvements to local livelihoods (Gurung et al., 2013), benefits realised by the poor are deficient and remain uncertain (Yadav et al., 2017). Thus, the payment structure (both income sources and distribution system) is perceived as important in the design of PES. This might be achieved through incorporating pro-poor design arrangements, such as those in Costa Rica (Pagiola, 2008; Pagiola et al., 2010; Porras et al., 2013). Transaction costs are also generally a critical factor in community forest enterprises (Carias Vega and Keenan, 2014) and design arrangements. The case of Costa Rica demonstrates that poor people can participate in and share benefits if PES is designed for low transaction cost (Bhatta et al., 2017; Pagiola et al., 2010). The transaction costs would be lower through an arrangement of in-kind contributions to increase participation by the poor in PES schemes (Rai et al., 2015).

This study highlighted nine important considerations that were perceived as priority by stakeholders for successful PES schemes in developing countries. The numbers of priority considerations depend on the threshold values. The range of priority considerations was from seven to twelve if the threshold value changed by ±25% which showed a moderate elasticity. If the threshold value changed by ±50%, there would be a significant impact on the number of PES considerations, with a range from one to

fourteen with high elasticity. Thus, the assigned threshold value was an appropriate and realistic estimate of the priority considerations in the local context. Previous studies have found that experts tend to prioritise technical considerations in PES design, focusing on assessment and verification (Meyer et al., 2015; Prager et al., 2016; Reed et al., 2014; Sattler et al., 2013). In contrast, and similar to several other studies, our results showed that social and policy considerations were highly relevant for PES design (Calvet-Mir et al., 2015; Guerra, 2016; Rawlins and Westby, 2013; Sommerville et al., 2010; Wegner, 2016). Among priority considerations, livelihoods were perceived as being most important as recognised by 100% of respondents. Respondents pointed out that limited social benefits to forest-dependent communities meant potential problems in long-term social sustainability that could lead to failure to sustain their environmental gains in the long run (Adhikari and Agrawal, 2013; Gong et al., 2012). Social benefits enhance the ability of the CFUG members and upland communities to participate in the PES programs as the main stakeholders and suppliers of ES (FAO, 2007; Pagiola et al., 2010). A focus on supporting the livelihoods of the poor can increase positive impacts on PES outcomes and reinforce the environmental and social benefits of the changes in behaviour promoted through CFUGs (Adhikari and Boag, 2013).

Property rights and tenure arrangements were ranked as priority considerations by 90% respondents. These provide the basis for clearly identifying ES suppliers and distributing benefits (Adhikari and Agrawal, 2013). Although forest rights and tenure security has been the central component for successful of CBF in Nepal (Bastakoti and Davidsen, 2014; Cronkleton et al., 2017), the study revealed several concerns regarding how ES rights can be attuned local people's rights to PES design. Forestry sector policies and draft PES policy and legal instruments lack explicit provisions for the shift of ES tenure rights and benefit sharing mechanisms (MFSC, 2016; Paudyal et al., 2017a). Unclear provision of property rights creates conflicts between upland and lowland people that are likely to impede the PES success. Recognition and clear arrangements of the local community's rights are the keys to the long-term sustainability of PES schemes.

Priority over specific considerations varied among members of the stakeholders' group as they have different interests and management objectives. The UC favoured appropriate compensation through the PES scheme with equity outcomes by considering livelihoods, pro-poor participation and local institutional dynamics in PES design in a line of many studies (Corbera et al., 2007; Milder et al., 2010). Upstream communities claimed that they had contributed to watershed conservation but in doing so had compromised their own basic needs for subsistence livelihoods for four decades by supporting conservation. However, the BC favoured technical and economic considerations for effectiveness and efficiency of PES schemes (Engel et al., 2008; Kinzig et al., 2011) as they had interests in the protection of the Lake from sedimentation. Experts were in favour of policy-related considerations and prioritised other considerations which would enhance local ownership and sustainability of PES. They emphasised capacity building of local institutions for PES implementation. For instance, an appropriate institutional framework has been found critical for proper management control and payment distribution arrangements as well as the success of community-based forest enterprises in Latin America (Carias Vega and Keenan, 2014, 2016).

The concept of 'stakeholder' is often controversial, and the groups identified are rarely homogenous (Hicks et al., 2013). Community and expert group valuations were the source of primary data in this study; this may introduce some uncertainty, although they were heterogeneously composed. Furthermore, the language barrier might result in misunderstandings due to the use of many specific technical terms that do not have any equivalent words in local languages (Burkhard et al., 2015). Thus, it could not be ensured that all information provided was appropriately understood and reflected in their responses. Consequently, a level of uncertainty might occur in the selection of priority considerations, although we adopted a consultative process.

It is also essential to note that the selection was based on a specific group of stakeholders and beneficiaries. Many stakeholders were left out of the study because of limited time and resources. They were mainly indirect beneficiaries of community forests such as those living lower down in watersheds or tourists, representatives from the Chamber of Commerce and Industries, and experts

from other sectors. In addition, it is possible that other stakeholders have a different set of priorities compared to those we consulted. However, our study opens opportunities for future research related to these issues.

4.2 Interaction among priority considerations in PES design

Integration of priority considerations into the PES design creates a variety of synergies and trade-offs that can change PES outcomes. The results indicated that pro-poor participation was the key consideration which created most synergies with considerations in PES design except for transaction cost. Also, the participation created the synergetic relationships between social and policy/effectiveness-related considerations. In line with other studies, this study indicated that the participatory process and pro-poor participation ensure clear and transparent benefit sharing systems with a strong equity component in PES design and implementation that trigger the welfare of those affected by PES schemes (Adhikari and Agrawal, 2013). PES lessons from Vietnam and Costa Rica shows that equity is essential for smallholders with an interest in poverty reduction and improving livelihoods (Galbraith et al., 2017). However, economic efficiency generally needs to be compromised when aiming for social equity and economic returns to the poor (Klein et al., 2015; Wegner, 2016); this finding aligns with Nepal's current development focus on poverty reduction and social justice through inclusive development (NPC, 2015).

However, the study also pointed out that transaction cost traded off with all priority considerations. Transaction costs might increase when social and policy considerations are taken into account in PES design. The costs of assessment, negotiation and operation (i.e., meetings, travel, communication to wider stakeholders) will certainly be higher and will impact on PES efficiency (Wegner, 2016). While the low capacity of stakeholders was recognised as a negative factor, local capacity building and networking during PES implementation will incur huge costs. Although these trade-offs arise in the short term, synergies can be achieved in the long term (Martin et al., 2014). While pro-poor participation is traded-off with transaction cost in the initial stage, successful implementation of PES

reduces poor people's dependency on natural resources. This may generate additional global environmental benefits in the long term (Paudyal et al., 2017a).

5. Conclusion

This study indicates that specific considerations are required to be taken into account in the design arrangements for effective implementation of PES schemes, and such considerations can be identified through a consultative approach with stakeholders. PES considerations are specific to a locality and may also depend on local resource management practices. Out of 19 considerations relevant to PES design in CBF, nine were considered highly relevant to stakeholders. While much of the focus by scientific communities in supporting PES is on measurement and assessment, stakeholders in this study prioritised social and policy-related considerations such as livelihoods, participation, local institutions, equity and payment distribution arrangements. Trade-offs were identified between equity and efficiency related considerations whereas synergistic relations were likely between equity and effectiveness related considerations. These findings signal that a detailed analysis of priority considerations and necessary arrangements has to be made in PES design. A concerted need for additional research is also required regarding the integration of these considerations into an institutional and investment PES model applicable to CBF regimes in developing countries. This can be advantageous to the sustainable management of resources by generating additional benefits at local to global scales. The priority considerations for a customised PES design identified in this study are also relevant to other parts of Nepal and to other developing countries seeking to support the integrated approach to poverty reduction and environmental conservation.

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Appendix A: Online supplementary materials

Table A1: Criteria used to evaluate PES design considerations regarding scale of relevance and importance of each consideration

Criteria	Importance and relevance of consideration in PES design
Sustainability	PES scheme should be sustainable, and each requirement should support the sustainability of PES at a different scale.
Effectiveness	PES implementation may be effective if we consider a particular condition at a certain level.
Local ownership	Research suggests that forest management and conservation programs are successful if such programs ensure ownership of local people. So, a successful PES design should consider those requirements which enhance local ownership in PES design that ensures smooth implementation.
Equity	Equity fosters the opportunity to bring poor and marginalised people into the decision-making process of PES.
Efficiency	High transaction cost may cause the failure of PES in CBF context. Does a particular condition help to reduce the cost of PES design and implementation at some scale?
User confidence	User confidence may increase if support from various stakeholders is available in design and implementation of PES scheme.

Acronyms: 'CBF - Community-based forestry,' 'PES - Payments for ecosystem services.'

Table A2: Community forestry user groups (CFUG) and their community forests (CF) in the Phewa Watershed

Description	**Thotnekhola CF**	**Chilimedanda CF**	**Bhakarjung CF**	**Raniban CFUG**	**Bamdibhir CF**	**Pataleshwara CF**
Location (address)	Pokhara-26, Kaski	Kaskikot-4, Kaski	Dhikurpokhari-4, Kaski	Bhadauretamagi-1, Kaski	Chapakot 3,4,5,6	Phumdibhumdi -5, Kaski
Distance from Village	Adjoining village	Adjoining village	Adjoining village	300 m	Adjoining village	500m
Distance from road	500 m	200 m	Contiguous	Contiguous	1 km	2 km
No. of households	152	179	189	241	134	80
Total Population	811	598	736	1216	712	355
CF initiated	13 April 1993	12 July 1996	05 Sep. 1993	12 June 1995	22 June 1993	22 June 1993
Official registration	28 June 2004	15 July 2001	19 Dec. 1999	06 May 1999	16 July 2002	13 March 1999
Exe. Committee (No.)	14	9	11	11	11	9
Total forest area (ha)	88.3	104.1	107.8	14.2	48.5	51.4
Slope and, aspect	North-east	West	East	North-east	North-east	North

Source: Paudyal et al. 2018

Table A3: List of articles reviewed or PES considerations

SN	Articles	Full citation
1	Adhikari and Agrawal, 2013	Adhikari, B., Agrawal, A., 2013. Understanding the social and ecological outcomes of PES projects: A review and analysis. Conserv. Soc. 11, 359. doi:10.4103/0972-4923.125748
2	Adhikari and Boag, 2013	Adhikari, B., Boag, G., 2013. Designing payments for ecosystem services schemes: some considerations. Curr. Opin. Environ. Sustain. 5, 72–77. doi:10.1016/j.cosust.2012.11.001
3	Baral et al., 2013	Baral, H., Keenan, R.J., Fox, J.C., Stork, N.E., Kasel, S., 2013. Spatial assessment of ecosystem goods and services in complex production landscapes: A case study from south-eastern Australia. Ecol. Complex. 13, 35–45. doi:10.1016/j.ecocom.2012.11.001
4	Bastakoti and Davidsen, 2014	Bastakoti, R.R., Davidsen, C., 2014. REDD+ and forest tenure security: Concerns in Nepals community forestry. Int. J. Sustain. Dev. World Ecol. 21, 168–180. doi:10.1080/13504509.2013.879542
5	Brimont and Karsenty, 2015	Brimont, L., Karsenty, A., 2015. Between incentives and coercion: The thwarted implementation of PES schemes in Madagascar's dense forests. Ecosyst. Serv. 14, 113–121. doi:10.1016/j.ecoser.2015.04.003
6	Clements et al., 2010	Clements, T., John, A., Nielsen, K., An, D., Tan, S., Milner-Gulland, E.J., 2010. Payments for biodiversity conservation in the context of weak institutions: Comparison of three programs from Cambodia. Ecol. Econ. 69, 1283–1291. doi:10.1016/j.ecolecon.2009.11.010
7	Fisher et al., 2014	Fisher, J.A., Patenaude, G., Giri, K., Lewis, K., Meir, P., Pinho, P., Rounsevell, M.D.A., Williams, M., 2014. Understanding the relationships between ecosystem services and poverty alleviation: A conceptual framework. Ecosyst. Serv. 7, 34–45. doi:10.1016/j.ecoser.2013.08.002
8	Fisher, 2012	Fisher, J., 2012. No pay, no care? A case study exploring motivations for participation in payments for ecosystem services in Uganda. Oryx 46, 45–54. doi:10.1017/S0030605311001384
9	Grima et al., 2016	Grima, N., Singh, S.J., Smetschka, B., Ringhofer, L., 2016. Payment for Ecosystem Services (PES) in Latin America: Analysing the performance of 40 case studies. Ecosyst. Serv. 17, 24–32. doi:10.1016/j.ecoser.2015.11.010
10	Guerra, 2016	Guerra, R., 2016. Assessing preconditions for implementing a Payment for Environmental Services initiative in Cotriguacu (Mato Grosso, Brazil). Ecosyst. Serv. 21, 31–38. doi:10.1016/j.ecoser.2016.07.009
11	He and Sikor, 2015	He, J., Sikor, T., 2015. Notions of justice in payments for ecosystem services: Insights from China's Sloping Land Conversion Program in Yunnan Province. Land use policy 43, 207–216. doi:10.1016/j.landusepol.2014.11.011
12	Kinzig et al., 2011	Kinzig, A.P., Perrings, C., Chapin, F.S., Polasky, S., Smith, V.K., Tilman, D., Turner, B.L., 2011. Paying for Ecosystem Services--Promise and Peril. Science (80-.). 334, 603–604. doi:10.1126/science.1210297
13	Kolinjivadi et al., 2015	Kolinjivadi, V., Grant, A., Adamowski, J., Kosoy, N., 2015. Juggling multiple dimensions in a complex socio-ecosystem: The issue of targeting in payments for ecosystem services. Geoforum 58, 1–13. doi:10.1016/j.geoforum.2014.10.004
14	Kosoy et al., 2008	Kosoy, N., Corbera, E., Brown, K., 2008. Participation in payments for ecosystem services: Case studies from the Lacandon rainforest, Mexico. Geoforum 39, 2073–2083. doi:10.1016/j.geoforum.2008.08.007
15	Leimona et al., 2015	Leimona, B., van Noordwijk, M., de Groot, R., Leemans, R., 2015. Fairly efficient, efficiently fair: Lessons from designing and testing payment schemes for ecosystem services in Asia. Ecosyst. Serv. 12, 16–28. doi:10.1016/j.ecoser.2014.12.012
16	Meyer et al., 2015	Meyer, C., Reutter, M., Matzdorf, B., Sattler, C., Schomers, S., 2015. Design rules for successful governmental payments for ecosystem services: Taking agri-environmental measures in Germany as an example. J. Environ. Manage. 157, 146–159. doi:10.1016/j.jenvman.2015.03.053
17	Milder et al. 2010	Milder, J.C., Scherr, S.J., Bracer, C., 2010. Trends and Future Potential of Payment for Ecosystem Services to 15.
18	Narloch et al., 2013	Narloch, U., Pascual, U., Drucker, A.G., 2013. How to achieve fairness in payments for ecosystem services? Insights from agrobiodiversity conservation auctions. Land use policy 35, 107–118. doi:10.1016/j.landusepol.2013.05.002

19	Noordwijk and Leimona, 2010	Noordwijk, M. Van, Leimona, B., 2010. Principles for Fairness and Efficiency in Enhancing Environmental Services in Asia: Payments, Compensation, or Co-Investment? Ecol. Soc. 15(4) 15, 17.
20	Pagiola et al., 2008	Pagiola, S., Rios, A.R., Arcenas, A., 2008. Can the poor participate in payments for environmental services? Lessons from the Silvopastoral Project in Nicaragua. Environ. Dev. Econ. 13, 299–325. doi:10.1017/S1355770X08004270
21	Pagiola et al., 2010	Pagiola, S., Rios, A.R., Arcenas, A., 2010. Poor Household Participation in Payments for Environmental Services: Lessons from the Silvopastoral Project in Quindio, Colombia. Environ. Resour. Econ. 47, 371–394. doi:10.1007/s10640-010-9383-4
22	Pascual et al., 2010	Pascual, U., Muradian, R., Rodríguez, L.C., Duraiappah, A., 2010. Exploring the links between equity and efficiency in payments for environmental services: A conceptual approach. Ecol. Econ. 69, 1237–1244. doi:10.1016/j.ecolecon.2009.11.004
23	Pascual et al., 2014	Pascual, U., Phelps, J., Garmendia, E., Brown, K., Corbera, E., Martin, A., Gomez-Baggethun, E., Muradian, R., 2014. Social equity matters in payments for ecosystem services. Bioscience 64, 1027–1036. doi:10.1093/biosci/biu146
24	Prager et al., 2016	Prager, C.M., Varga, A., Olmsted, P., Ingram, J.C., Cattau, M., Freund, C., Wynn-Grant, R., Naeem, S., 2016. An assessment of adherence to basic ecological principles by payments for ecosystem service projects. Conserv. Biol. 30, 836–845. doi:10.1111/cobi.12648
25	Rawlins and Westby, 2013	Rawlins, M.A., Westby, L., 2013. Community participation in payment for ecosystem services design and implementation: An example from Trinidad. Ecosyst. Serv. 6, 117–121. doi:10.1016/j.ecoser.2013.09.004
26	Scheufele and Bennett, 2013	Scheufele, G., Bennett, J., 2013. Payments for environmental services: concepts and applications. Research Report No. 1, "Effective Implementation of Payments for Environmental Services in Lao PDR" project. Crawford School of Public Policy, Australian National University, Canberra.
27	Schomers and Matzdorf, 2013	Schomers, S., Matzdorf, B., 2013. Payments for ecosystem services: A review and comparison of developing and industrialized countries. Ecosyst. Serv. 6, 16–30. doi:10.1016/j.ecoser.2013.01.002
28	Sikor et al., 2014	Sikor, T., Martin, A., Fisher, J., He, J., 2014. Toward an Empirical Analysis of Justice in Ecosystem Governance. Conserv. Lett. 7, 524–532. doi:10.1111/conl.12142
29	Singh et al., 2016	
30	Sommerville et al. 2010	Sommerville, M., Jones, J.P.G., Rahajaharison, M., Milner-Gulland, E.J., 2010. The role of fairness and benefit distribution in community-based Payment for Environmental Services interventions: A case study from Menabe, Madagascar. Ecol. Econ. 69, 1262–1271. doi:10.1016/j.ecolecon.2009.11.005
31	Swallow et al., 2010	Swallow, B.M., Leimona, B., Yatich, T., Velarde, S.J., 2010. The conditions for functional mechanisms of compensation and reward for environmental services. Ecol. Soc. 15, 6. doi:10.5751/ES-03636-150406
32	Tacconi, 2012	Tacconi, L., 2012. Redefining payments for environmental services. Ecol. Econ. 73, 29–36. doi:10.1016/j.ecolecon.2011.09.028
33	Wegner, 2016	Wegner, G.I., 2016. Payments for ecosystem services (PES): a flexible, participatory, and integrated approach for improved conservation and equity outcomes. Environ. Dev. Sustain. 18, 617–644. doi:10.1007/s10668-015-9673-7
34	Wunder, 2008	Wunder, S., 2008. Payments for environmental services and the poor: concepts and preliminary evidence. Environ. Dev. Econ. 13, 279–297. doi:10.1017/S1355770X08004282
35	Wunder, 2015	Wunder, S., 2015. Revisiting the concept of payments for environmental services. Ecol. Econ. 117, 234–243. doi:10.1016/j.ecolecon.2014.08.016
36	Wunder et al., 2009	Wunder, S., Engel, S., Pagiola, S., 2008. Taking stock: A comparative analysis of payments for environmental services programs in developed and developing countries. Ecol. Econ. 65, 834–852. doi:10.1016/j.ecolecon.2008.03.010

Table A4: Key themes and associated word or phrases from wide range of literature to identify PES design consideration

Key themes	Words or phrases found from various literature related to each theme	References	Corresponding considerations	Types of considerations
Participation	Participation, community participation, pro-poor participation, participatory decision-making, stakeholder participation, community participation, pro-poor participation, participatory decision-making, stakeholder participation, community participation, pro-poor participation, participatory decision-making, stakeholder participation, participation, participation, participation, participation, pro-poor participation, pro-poor participation, pro-poor participation, community participation, stakeholder participation,	Adhikari and Boag, 2013; Guerra, 2016; kosoy et al., 2008, Milder et al. 2010; Noordwijk and Leimona, 2010; Pagiola et al., 2010; Rawlins and Westby, 2013; Singh et al., 2016; Wegner, 2016;	1. Pro-poor participation	Specific
Livelihoods	Poverty reduction, poverty alleviation, local livelihoods strategies, global poverty, pro-poor benefits, poverty reduction, poverty reduction, poverty reduction, global poverty, pro-poor benefits, livelihoods, livelihoods, livelihoods, livelihoods, local livelihoods	Adhikari and Boag, 2013; Fisher et al., 2014; Kinzig et al., 2011; Milder et al. 2010; Leimona et al., 2015; Noordwijk and Leimona, 2010; Pagiola et al., 2010	2. Livelihoods 3. Poverty reduction	Specific
Incentives	Rewards, rewards, rewards, rewards, compensation, co-investment, payment-methods, payments instruments, source of fund, incentive structure, fund flow system, uniform payment, direct payment, indirect payment, distribution of resources, revenue-sharing mechanisms, compensation, compensation, compensation, incentive structure, incentive-structure, incentive structure, incentive structure, incentive structure, fund flow system, payment methods,	Adhikari and Boag, 2013; Bastakoti and Davidsen, 2014; Guerra, 2016, Noordwijk and Leimona, 2010; Pascual et al., 2010; Swallow et al., 2010; Sikor et al., 2014;	4. Payment structure	Specific
Benefits	distribution of benefits, equity, pro-poor benefits, social co-benefits,	Adhikari and Boag, 2013; Milder et al. 2010;	5. Pro-poor benefits 6. Benefits distribution	Specific
Tenure	Property rights, tenure arrangements, resource rights, local-rights, land rights, ES rights, natural resource dependency, endowments, entitlements, access to, and control of ES, carbon rights, the devotion of rights, tenure regimes, water rights, property rights, tenure-arrangements, resource rights, tenure arrangements, tenure	Bastakoti and Davidsen, 2014; Brimont and Karsenty, 2015; Fisher et al., 2014; Pagiola et al., 2010; Swallow et al., 2010; Sikor et al., 2014;	7. Tenure arrangements 8. Property rights	Specific

Key themes	Words or phrases found from various literature related to each theme	References	Corresponding considerations	Types of considerations
Cost for PES	Transaction cost, marginal cost, opportunity cost, implementation cost, minimum cost, economic conditions, willingness to pay, willingness to accept, payment negotiation, economic fairness, efficiency, transaction cost, transaction cost, opportunity cost, opportunity cost,	Adhikari and Boag, 2013; Clements et al., 2010; Guerra, 2016; Milder et al. 2010; Pagiola et al., 2010; Pascual et al., 2010;	9. Transaction cost 10. Opportunity cost 11. Willingness to pay	Specific
Information	Communication, communication, access to information, access to information, access to information, bio-physical information, sufficient information, abundant information, information flow; information channel	Brimont and Karsenty, 2015; Clements et al., 2010; Guerra, 2016;	12. Access to the information	Specific
Governance	Governance-framework, decision-making-structures, regulatory framework, inclusion, efficiency, equity, effectiveness, participatory, flexibility, transparency, governance-framework, governance-framework, regulatory framework,	Bastakoti and Davidsen, 2014; Fisher et al., 2014; Meyer et al., 2015; Milder et al. 2010; Prager et al., 2016; Sommerville et al. 2010; Sikor et al., 2014;	13. PES governance	Specific
Institution	Institutional conditions, market network, local trust, tenure of local institutions, network of local agencies, community forestry users groups, community forestry users groups, intermediary agencies, facilitating organisations, community organisations, local actors, institutional arrangements, robust local agencies, regulatory framework, inclusion, weak institutions, intermediary agencies	Clements et al., 2010; Fisher, 2012; Meyer et al., 2015; Milder et al. 2010;	14. Local institution 15. Facilitating organisations	Specific
Capability	Capability, capacity-building, local capacity, capacity building, local capacity, networking building	Kolinjivadi et al., 2015;	16. Capacity building	Specific
Policy	Government policy, PES policy, policy instruments, legal instruments, acts, regulations, PES working modality, government policy, PES policy	Bastakoti and Davidsen, 2014; Swallow et al., 2010; Wegner, 2016;	17. Government PES policy	Specific
Community dynamics	community characteristics, household characteristics, local needs, social relation, power dynamics, ethnicity, community dependency, economic activities, community characteristics, community characteristics, population structure,	Adhikari and Agrawal, 2013; Adhikari and Boag, 2013; Kolinjivadi et al., 2015; Pagiola et al., 2010;	18. Community characteristics 19. Household characteristics	Specific

Key themes	Words or phrases found from various literature related to each theme	References	Corresponding considerations	Types of considerations
Social values	Cultural conditions, social responsibility, local preferences, stakeholders' priority, traditional norms, cultures, traditional systems, local acceptability, local ownership,	Guerra, 2016; Fisher et al., 2014; Sommerville et al., 2010; Wunder, 2009, 2008	20. Social values and preferences	Specific
Assessment	ES assessment, ES valuation, single ES, multiple ES, ES bundling, ES assessment, ES valuation, ES assessment, ES valuation, ES bundling, ES bundling, ES bundling, single vs multiple ES, participatory ES assessment &evaluation, ES monitoring	Baral et al., 2013; Guerra, 2016, Grima et al., 2016	21. ES assessment 22. Valuation of ES 23. ES Bundling	Specific
Scale	Local PES, local PES, national PES, regional PES, international PES; PES for single vs multiple ES, PES boundary, physical boundary, administrative boundary, resource flow-direction, flexible PES, watershed-based PES, watershed-based PES, local PES	Fisher et al., 2014; Schomers and Matzdorf, 2013; Wegner, 2016;	24. Scale of PES 25. Congruence between biophysical and political boundaries	specific
Desirable conditions	Transparency, additionality, voluntariness, conditionality, necessary conditions, sufficient conditions, transparency, additionality, voluntariness, conditionality, necessary conditions, sufficient conditions	Meyer et al., 2015; Wunder et al., 2008, 2009, Tacconi, 2012; Scheufele and Bennett, 2013; Schomers and Matzdorf, 2013;	✓ transparency ✓ additionality ✓ voluntariness ✓ conditionality	Desirable or Common
Criteria	Equity, efficiency, effectiveness, sustainability, user confidence, trade-off, equity-efficiency, equity, equity, interdependency, equity-efficiency combinations, economic fairness, justices, PES ownership, equity, efficiency, effectiveness, sustainability, user confidence, trade-off, PES ownership, justices, effectiveness, sustainability	He and Sikor, 2015; Pascual et al., 2010; Prager et al., 2016; Sikor et al., 2014; Schomers and Matzdorf, 2013; Narloch et al., 2013; Wegner, 2016;	1. equity, 2. efficiency, 3. effectiveness sustainability 4. user confidence 5. local ownership	
Miscellaneous	Key preconditions, basic conditions, specific considerations, minimum conditions, necessary criteria, competitive pre-conditions	Guerra, 2016, Wunder, 2015, 2009, 2008; Scheufele and Bennett, 2013;		

Figure A1: Methodological framework for the Computation process of community priority index (CPI) and - Combined community priority index (CCPI) for selecting priority PES (payments for ecosystem services) design considerations (adapted from Salihu et al., 2015a, 2015b)

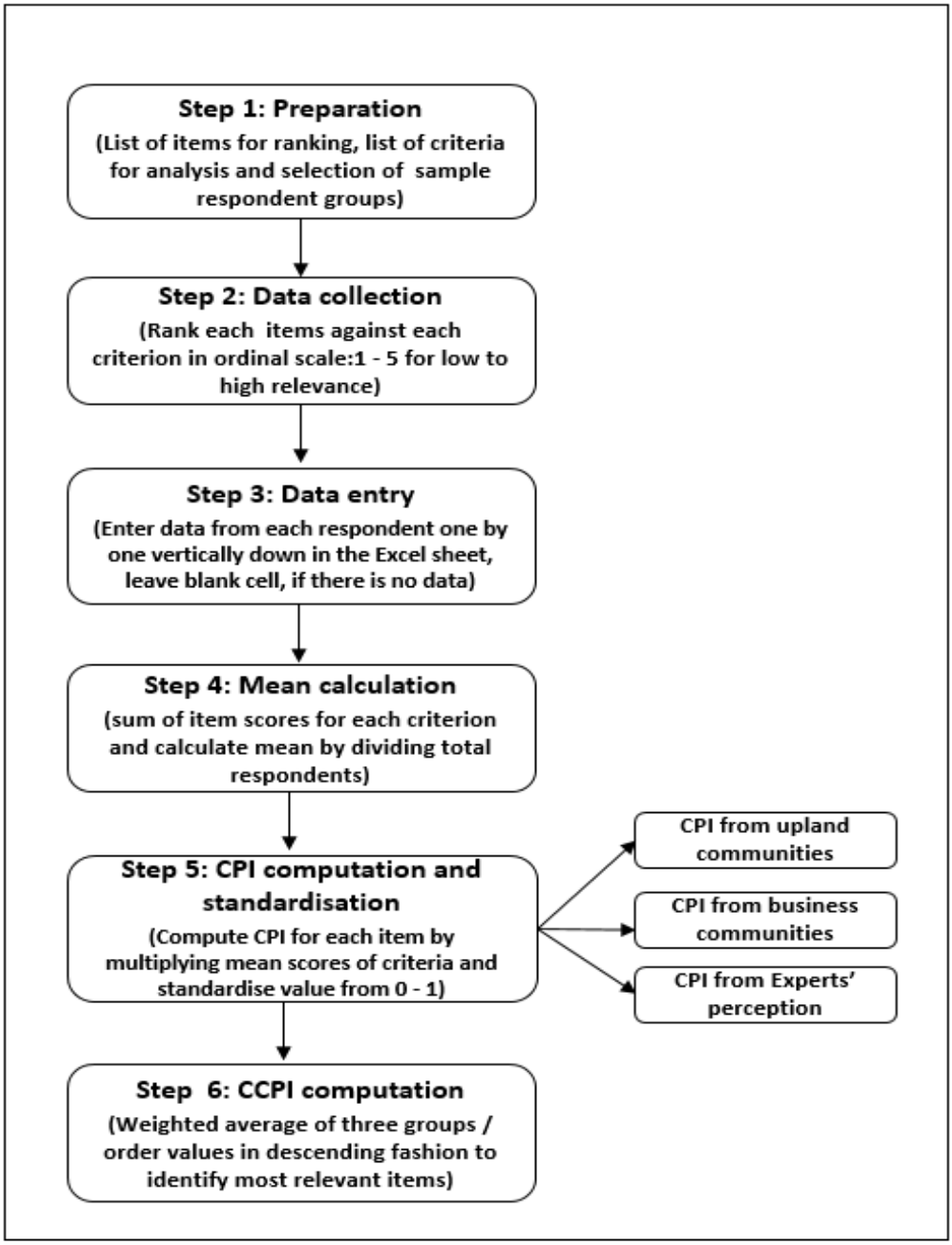

Table A5: Format used to collect local community's perception and expert's opinion for priority PES considerations.

What are major requirements and conditions to be considered in designing PES for CF? How are these conditions relevancy during the designing process? Please **tick or circle** one option among five and provide reasons for relevancy of that condition.

Scale of relevancy: 1 – no relevant, 2 – slightly relevant, 3 – moderately relevant, 4 – relevant, 5 - highly relevant

Requirements/conditions	**Criteria for effective conditions of PES***						**Comments (why, how etc.)**
	Sustainability of PES	**Effective in PES implementation**	**Local ownership**	**Equity from PES**	**Economic efficiency of PES**	**Buyer confidence**	
Pro-poor participation							
Social value & preferences							
Efficiency and fairness							
Livelihoods							
Pro-poor benefits/equity							
Land and resource tenure							
PES Governance							
PES sustainability							
Household and community characteristics							
Property rights & tenure security							
Government policy							
Role of facilitating organisations							
Capacity building							
Access to information							
Congruence between bio-physical processes and administrative boundaries							
Environment sustainability							
Quantifying & valuing ES							
Bundling of ES							
Incentive or payment structure & scale							

* Please judge each listed each condition against each condition the criteria. We are sorry that it may take a bit longer time. I will be very grateful for your patience.

Table A6: Details of calculation for combined community priority indices

PES considerations	CPI_UC	CPI_BC	CPI_Ex	WCPI_UC	WCPI_BC	WCPI_Ex	CCPI	Rank
Pro-poor participation	0.493	0.332	0.377	0.246	0.066	0.113	**0.426**	2
Social value and preferences	0.350	0.127	0.242	0.175	0.025	0.073	**0.273**	10
Transaction cost	0.383	0.477	0.239	0.192	0.095	0.072	**0.359**	9
Livelihoods	0.544	0.522	0.488	0.272	0.104	0.146	**0.523**	1
Pro-poor benefits	0.310	0.165	0.230	0.155	0.033	0.069	**0.257**	12
Opportunity cost	0.437	0.284	0.417	0.219	0.057	0.125	**0.400**	7
PES governance	0.366	0.340	0.402	0.183	0.068	0.121	**0.371**	8
Local institution	0.468	0.190	0.450	0.234	0.038	0.135	**0.407**	6
Community characteristics	0.040	0.049	0.057	0.020	0.010	0.017	**0.047**	18
Property rights and tenure arrangement	0.479	0.457	0.310	0.239	0.091	0.093	**0.424**	3
Government policy	0.385	0.506	0.397	0.193	0.101	0.119	**0.413**	5
Facilitating organisations	0.110	0.048	0.140	0.055	0.010	0.042	**0.107**	16
Capacity building	0.304	0.240	0.229	0.152	0.048	0.069	**0.269**	11
Access to information	0.213	0.139	0.124	0.106	0.028	0.037	**0.171**	13
Congruence between biophysical processes and administrative boundaries	0.038	0.020	0.060	0.019	0.004	0.018	**0.041**	19
ES quantification and valuation	0.086	0.087	0.103	0.043	0.017	0.031	**0.091**	17
ES bundling	0.087	0.063	0.178	0.044	0.013	0.053	**0.110**	15
Payment structure	0.421	0.391	0.416	0.211	0.078	0.125	**0.414**	4
Scale of PES	0.216	0.136	0.079	0.108	0.027	0.024	**0.159**	14

Acronyms: CPI – community priority index, WCCI – weighted community priority index, CCPI – combined community priority index, UC – upstream communities, BC – business communities, Ex – experts, ES – ecosystem services, PES – payment for ecosystem services

Table A7: Community priority index (CPI) for priority considerations based on the perception of upland communities

PES considerations	Criteria for rating PES considerations						CPI Observed	Lower bound CPI	Upper bound CPI	Standardised CPI	Rank
	Sustainability	Effectiveness in implementation	Local ownership	Equity	Efficiency	User confidence					
	c1. Mean	c2. Mean	c3. Mean	c4. Mean	c5. Mean	c6. Mean					
Pro-poor participation	4.7	4.7	4.9	4.8	3.8	3.9	7,700	1	15625	0.493	2
Social value and preferences	4.5	4.4	4.5	4.5	3.8	3.6	5,476	1	15625	0.350	10
Transaction cost	4.3	4.2	4.3	4.1	4.7	4.0	5,986	1	15625	0.383	8
Livelihoods	4.7	4.6	4.9	4.9	4.2	3.9	8,503	1	15625	0.544	1
Pro-poor benefits	4.7	3.7	4.9	4.7	3.1	3.9	4,849	1	15625	0.310	11
Opportunity cost	4.7	4.6	4.5	4.4	4.2	3.8	6,832	1	15625	0.437	5
PES governance	4.7	4.1	4.2	4.1	4.1	4.2	5,714	1	15625	0.366	9
Local institution	4.8	4.5	4.5	4.6	4.3	3.8	7,306	1	15625	0.468	4
Community characteristics	2.3	3.0	3.3	3.5	2.8	2.8	625	1	15625	0.040	18
Property rights and tenure arrangement	4.7	4.5	4.6	4.6	4.4	3.8	7,483	1	15625	0.479	3
Government policy	4.3	4.1	4.3	4.2	4.5	4.2	6,018	1	15625	0.385	7
Facilitating organisations	3.3	4.0	2.8	3.4	3.7	3.7	1,720	1	15625	0.110	15
Capacity building	4.6	4.4	4.2	3.6	4.3	3.6	4,744	1	15625	0.304	12
Access to information	3.9	4.1	4.5	3.2	3.8	3.8	3,325	1	15625	0.213	14
Congruence between biophysical processes and administrative boundaries	3.2	4.6	2.9	2.4	2.9	2.0	594	1	15625	0.038	19
ES quantification and valuation	4.1	3.9	3.0	2.5	3.6	3.1	1,338	1	15625	0.086	17
ES bundling	4.1	3.7	2.9	2.6	3.5	3.4	1,361	1	15625	0.087	16
Payment structure	4.4	4.3	4.7	4.5	4.7	3.5	6,583	1	15625	0.421	6
Scale of PES	3.9	4.2	3.7	3.9	4.2	3.4	3,375	1	15625	0.216	13

Acronyms: ES – ecosystem services, PES – payment for ecosystem services

Table A8: Community priority index (CPI) for priority considerations based on the perception of lowland business communities

PES considerations	Criteria for rating PES considerations						CPI Observed	Lower bound CPI	Upper bound CPI	Standardised CPI	Rank
	Sustainability	Effectiveness in implementation	Local ownership	Equity	Efficiency	User confidence					
	c1. Mean	c2. Mean	c3. Mean	c4. Mean	c5. Mean	c6. Mean					
Pro-poor participation	4.2	4.0	4.7	4.8	3.8	3.6	5,185	1	15625	0.332	7
Social value and preferences	3.5	3.1	4.5	4.5	3.2	2.8	1,990	1	15625	0.127	14
Transaction cost	4.8	4.2	4.6	4.1	4.9	4.0	7,452	1	15625	0.477	3
Livelihoods	4.4	4.6	4.9	4.9	4.2	4.0	8,164	1	15625	0.522	1
Pro-poor benefits	3.7	3.6	4.9	4.7	2.9	2.9	2,580	1	15625	0.165	11
Opportunity cost	4.4	3.6	4.5	3.9	4.1	3.9	4,445	1	15625	0.284	8
PES governance	4.7	4.0	4.0	4.1	4.1	4.2	5,309	1	15625	0.340	6
Local institution	3.7	4.3	3.5	3.6	3.9	3.8	2,971	1	15625	0.190	10
Community characteristics	3.3	3.4	3.7	3.3	2.8	2.0	767	1	15625	0.049	17
Property rights and tenure arrangement	4.7	4.5	4.6	4.6	4.2	3.8	7,143	1	15625	0.457	4
Government policy	4.5	4.6	4.3	4.2	4.5	4.7	7,907	1	15625	0.506	2
Facilitating organisations	3.3	4.0	2.8	2.4	3.7	2.3	755	1	15625	0.048	18
Capacity building	4.4	4.3	4.0	3.6	4.3	3.2	3,757	1	15625	0.240	9
Access to information	3.9	4.1	4.0	3.2	3.8	2.8	2,178	1	15625	0.139	12
Congruence between biophysical processes and administrative boundaries	3.2	3.2	2.6	2.0	2.9	2.0	309	1	15625	0.020	19
ES quantification and valuation	4.4	3.8	3.0	2.5	3.6	3.0	1,354	1	15625	0.087	15
ES bundling	4.0	3.6	2.7	2.6	3.5	2.8	991	1	15625	0.063	16
Payment structure	4.4	4.3	4.7	4.3	3.9	4.1	6,114	1	15625	0.391	5
Scale of PES	3.8	4.0	3.7	2.9	4.2	3.1	2,124	1	15625	0.136	13

Acronyms: ES – ecosystem services, PES – payment for ecosystem services

Table A9: Community priority index (CPI) for priority considerations based on the perception of experts working in the Phewa watershed

PES considerations	Criteria for rating PES considerations						CPI Observed	Lower bound CPI	Upper bound CPI	Standardised CPI	Rank
	Sustainability	Effectiveness in implementation	Local ownership	Equity	Efficiency	User confidence					
	c1. Mean	c2. Mean	c3. Mean	c4. Mean	c5. Mean	c6. Mean					
Pro-poor participation	4.4	4.5	4.8	4.3	3.7	3.9	5,897	1	15625	0.377	7
Social value and preferences	4.1	4.1	4.3	4.4	3.4	3.6	3,784	1	15625	0.242	11
Transaction cost	4.5	3.7	4.4	3.8	4.2	3.2	3,742	1	15625	0.239	9
Livelihoods	4.9	4.2	4.8	4.5	4.4	3.9	7,628	1	15625	0.488	1
Pro-poor benefits	4.3	4.0	4.5	3.9	3.4	3.5	3,592	1	15625	0.230	10
Opportunity cost	4.8	4.5	4.1	4.7	4.6	3.4	6,510	1	15625	0.417	3
PES governance	4.9	4.7	4.3	3.6	4.1	4.3	6,285	1	15625	0.402	5
Local institution	4.7	4.4	4.4	4.5	4.4	3.9	7,026	1	15625	0.450	2
Community characteristics	3.3	3.3	3.1	3.5	3.0	2.5	886	1	15625	0.057	19
Property rights and tenure arrangement	4.2	4.2	4.4	3.9	3.9	4.1	4,840	1	15625	0.310	8
Government policy	4.7	4.5	4.4	3.8	3.9	4.5	6,206	1	15625	0.397	6
Facilitating organisations	3.9	4.1	3.3	3.4	3.6	3.4	2,196	1	15625	0.140	13
Capacity building	4.2	4.2	3.9	3.5	3.8	3.8	3,586	1	15625	0.229	14
Access to information	3.8	3.6	3.4	3.6	3.4	3.4	1,936	1	15625	0.124	15
Congruence between biophysical processes and administrative boundaries	3.6	3.5	2.8	2.6	3.4	3.0	936	1	15625	0.060	18
ES quantification and valuation	3.8	3.6	3.3	3.1	3.7	3.1	1,605	1	15625	0.103	16
ES bundling	4.2	4.2	3.4	3.3	3.7	3.8	2,783	1	15625	0.178	12
Payment structure	4.6	4.6	4.7	4.4	4.5	3.3	6,498	1	15625	0.416	4
Scale of PES	4.1	3.9	3.1	2.5	4.0	2.5	1,239	1	15625	0.079	17

ES – ecosystem services, PES – payment for ecosystem services