From denuded to green mountains: process and motivating factors of forest landscape restoration in Phewa Lake watershed, Nepal

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SUMMARY

Global initiatives to promote large-scale forest landscape restoration (FLR) require adaptive approaches consistent with locally relevant models of land use, management, ownership and economic incentives. The Phewa Lake watershed was subject to severe degradation leading to high siltation of the lake. Forests were restored to this hilly and mountainous landscape as a result of four-decades of conservation and community-based forestry (CBF) efforts. This study assessed the process and key motivating factors for community-based forest landscape restoration. The main finding is that community participation, promoted by Nepal's policy of decentralised forest management, was a key motivating factor for the success of forest landscape restoration and increased local ownership of restoration efforts. Promotion of natural forest regeneration through CBF was an effective landscape conservation method compared to the government-led investments in structural engineering. The CBF approach can make a significant contribution to forest restoration and achieving national and international restoration targets.

Keywords: restoration, decentralisation, participation, natural regeneration, community-based forestry, hilly and mountainous systems

D'une montagne dénudée à une montagne verte: processus et facteurs motivateurs d'une restauration de paysage forestier dans le bassin versant du lac Phewa, au Népal

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Les initiatives globales lancées pour promouvoir des restaurations de paysage forestier à grande échelle (FLR) nécessitent des approches adaptatives en ligne avec les modèles locaux appropriés d'utilisation de la terre, de gestion, de système foncier et de motivations économiques. Le bassin versant du lac Phewa a été victime d'une sévère dégradation, qui a conduit à son tour à un fort envasement du lac. Les forêts furent restaurées dans ce paysage montagneux et boisé ; le fruit de quatre décennies d'efforts de conservation et de foresterie à bases communautaires (CBF) dans le bassin versant. Ce papier évalue le processus et les facteurs de motivation-clés pour une restauration de paysage forestier basé sur la communauté. La découverte principale s'est trouvée être que la participation de la communauté, promue par la politique népalaise de décentralisation de la gestion forestière, était un facteur de motivation clé pour le succès de la restauration du paysage forestier, témoignant d'une prise en charge croissante des efforts de restauration par la communauté. La promotion d'une régénération forestière naturelle au moyen de la CBF était une méthode de conservation du paysage plus efficace que les investissements dans les structures du génie, lancées par le gouvernement. L'approche CBF est à même de contribuer largement à la restauration forestière et de parvenir aux buts de restauration nationaux et internationaux.

De laderas desnudas a montañas verdes: proceso y factores de motivación de la restauración del paisaje forestal en la cuenca del lago Phewa de Nepal

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Las iniciativas mundiales para promover la restauración del paisaje forestal (RPF) a gran escala requieren enfoques adaptativos que estén en consonancia con modelos relevantes a escala local para el uso, la gestión y la propiedad de la tierra, y los incentivos económicos. La cuenca del

lago Phewa estaba sujeta a una enorme degradación, causante de un severo aterramiento del lago. La restauración de los bosques en este paisaje de colinas y montañas fue el resultado de cuatro décadas de esfuerzos de conservación y de silvicultura de base comunitaria (SBC). Este estudio evalúa el proceso y los factores motivadores clave para la restauración del paisaje forestal comunitario. El hallazgo principal fue que la participación de la comunidad, promovida por la política de gestión forestal descentralizada de Nepal, fue un factor motivador clave para el éxito de la restauración del paisaje forestal y un mayor sentido de propiedad local de los esfuerzos de restauración. La promoción de la regeneración de los bosques naturales a través de la SBC fue un método de conservación del paisaje eficiente, en comparación con las inversiones gubernamentales en estructuras de ingeniería. El enfoque RPF puede aportar una contribución significativa a la restauración de los bosques y al logro de objetivos nacionales e internacionales de restauración.

INTRODUCTION

Deforestation is one of the causes of global environmental change and the degradation of ecosystem services of value to humanity (MEA 2005). The global rate of net forest loss is 3.39 million ha per year (Food and Agriculture Organisation of the United Nations 2015, Keenan *et al.* 2015), with much of this occurring in developing countries. For this reason, forest conservation is a critical environmental priority across the developing world (Leblois *et al.* 2017, Sears *et al* 2017). With rapidly increasing population and a growing demand for land and food, forests are being converted for other land uses, including agriculture and settlements, impacting biodiversity and long-term human well-being. Forest loss and degradation is an impediment to achieving the United Nations' Sustainable Development goals of hunger eradication, poverty alleviation, and climate change adaptation (Fleskens and Stringer 2014, Steiner 2016). Reversing the rate of deforestation and degradation through forest restoration is key to increasing the capacity of landscapes to provide ecosystem goods and services in support of those goals.

Forest Landscape Restoration (FLR), defined as a "planned process that aims to regain ecological integrity and enhance human well-being in deforested or degraded landscapes" (Sabogal *et al.* 2015), has gained increased attention over the past two decades (Lamb 2014). FLR is now a global agenda, embodied in several key institutions. The strategic plan of the Convention on Biological Diversity established a goal of restoring 15% of all degraded lands by 2020 (SCBD 2010). The 2011 Bonn Challenge and the 2014 New York Declaration on Forests represent commitments in around forty countries to restore 150 million ha of the world's degraded and deforested lands by 2020, and 350 million ha by 2030 (Jacobs *et al.* 2015). Through these targets and associated investments, countries aspire to implement widespread FLR to improve ecological and socioeconomic conditions (Chazdon and Guariguata 2016). However, despite a great deal of attention arising from ambitious target-setting and subsequent promotion, FLR has been slow to make progress towards desired outcomes due to lack of clarity on restoration objectives, difficulty in balancing ecological and socioeconomic goals, insufficient understanding of processes and motivating factors, lack of direct and indirect incentives to local communities, and the high financial costs of restoration (Sayer *et al.* 2004). Achieving large-scale restoration remains a challenge, despite increased policy support and a growing body of related scientific knowledge (Ciccarese *et al.* 2012).

While approaches incentivising local community involvement in FLR remain insufficient, forest restoration initiatives that have engaged local communities have been remarkably successful (Global Forest Coalition 2010). In particular in Nepal, community-based forestry (CBF) can be considered as a model for community-led FLR. Civil society began to participate in forest management in the late 1970s when local communities were granted rights and technical support to restore and manage degraded forests, and in return to obtain access to forest products (Paudyal *et al.* 2018a, 2018b). This approach resulted in the wide-scale conversion of eroded and shrublands to forests (Gautam *et al.* 2004). Today, more than 2 million ha of forests in Nepal are managed under CBF, delivering multiple ecosystem goods and services to local users and remote beneficiaries (Paudyal *et al.* 2017a).

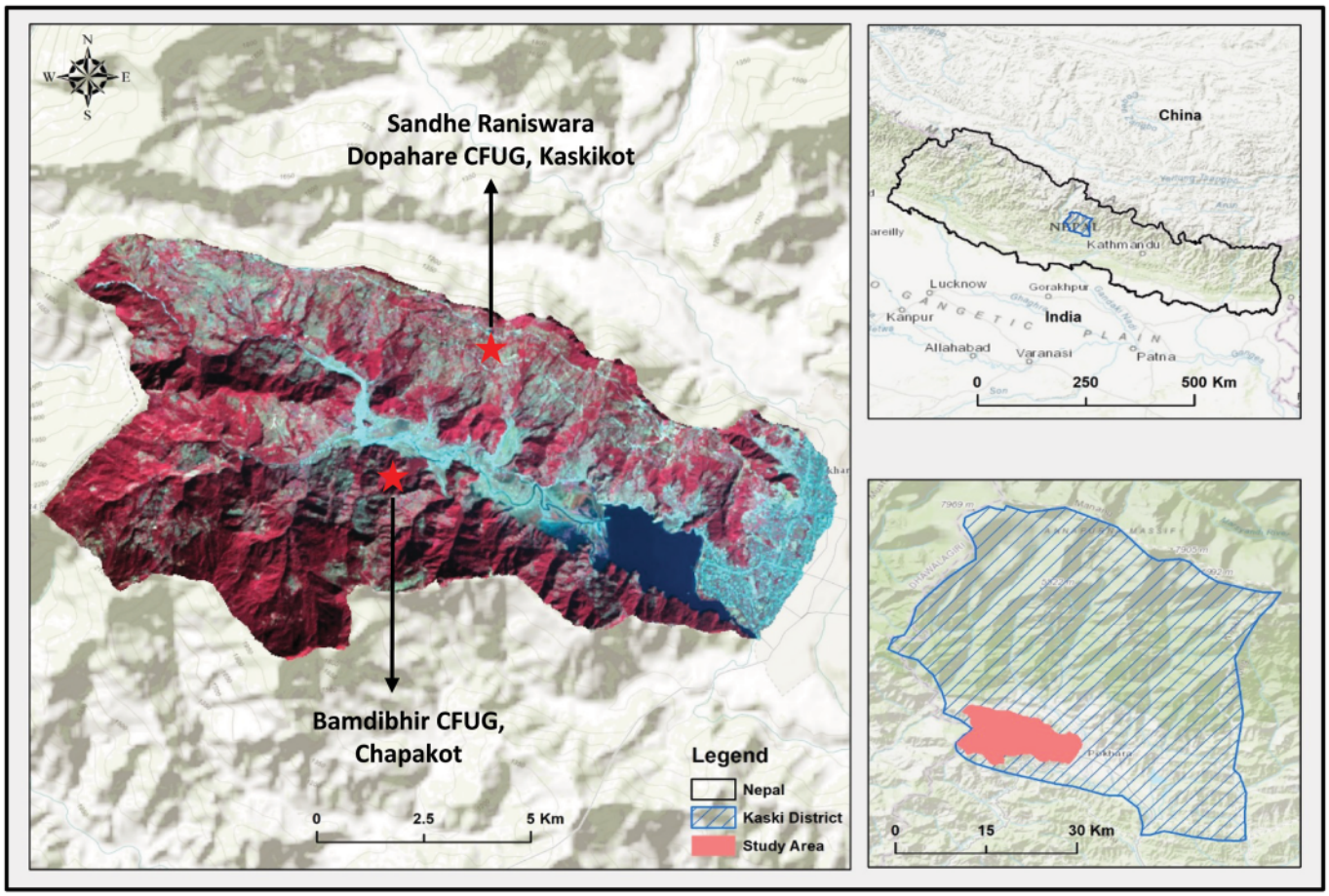
The community-based forest restoration model included natural regeneration of forests. Forest restoration through the promotion of natural regeneration is often a practical approach to FLR and costs less than planting seedlings (Lamb 2014, Chazdon and Uriarte 2016). While one size does not fit all, experience is needed to improve current and future practices (Haugo *et al*. 2015, Sabogal *et al.* 2015): the success of Nepal's community-based restoration model indicates potential for similar community-based models to achieve large-scale restoration in other countries and regions in support of global forest restoration objectives. Towards this, it is essential to understand the processes and motivating factors of CBF to inform the design of models in other developing countries (Nijsen *et al.* 2012, Van Oort *et al.* 2015). In fact, the motivating factors for forest restoration in community-based forest management system remain insufficiently known. This study aims to shed light on the factors and processes contributing to the success of community forest restoration. Through a case study from the Phewa watershed of the Western Nepal, we identify motivating factors revealed in the perceptions and opinions of local people and experts, as well as in related written sources.

METHODOLOGY

Study area

The Phewa watershed forms the catchment for Phewa Lake, a water body and surrounding wetland of significant economic and ecological value. The watershed is not only the basis for local livelihoods, tourism and agricultural irrigation but also

FIGURE 1 *Location of Phewa Lake and its watershed with the chosen community forestry users groups (CFUG)*



a habitat for many plant and animal species. The area was chosen for the study as the watershed has largely recovered from extreme degradation due to community restoration. Surrounding communities have been highly involved in a number of initiatives to restore the watershed (Regmi and Saha, 2015). The watershed lies between 28°11′39 to 28°17′25 north latitudes and 83°47′51 to 83°59′17 east longitudes, adjacent to the Pokhara Sub-Metropolitan City (PSMC). It covers an area of 123 km^2 and extends over the whole or parts of six Village Development Committees (*Pumdi Bhumdi, Chapakot, Bhadaure Tamagi, Dhikurpokhari, Kaskiko*t and *Sarangkot*) and the seven wards of the southwestern part of the PSMC (Figure 1). The estimated population of the watershed area is 198 333, unevenly distributed between village and city, with an average density of 665.51 per km^2 (Regmi and Saha 2015).

The topography of Lake Phewa watershed is steep (with an average slope of 40%) and ranges in altitude from 850 m at the lake surface to 2 508 m at the peak of Panchase, a tourist destination. In addition to the lake, alluvial plains, fans and moderate-to-very-steep slopes are dominant landforms of the watershed (Regmi and Saha 2015). The watershed consists of 19 streams, including brooks that drain into the lake. 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). The annual monsoon regulates the climate in the watershed, resulting in a humid subtropical microclimate in the valley compared to the temperate climate of the High Mountain region to the north. Heavy monsoon rains (~5 000 mm) trigger landslides and flash floods, contributing to the natural degradation of the steep terrain (Leibundgut *et al.* 2016, Regmi and Saha 2015). Some 40 years ago, siltation was a significant threat to the Phewa lake ecosystem but significantly decreased through forest restoration over the years (Regmi and Saha 2015).

Land cover of the watershed comprises forests (54.1%), agriculture (42%), bodies of water, swamp areas (4.7%), built-up areas (5.1%) and degraded land, including sand deposits (1%) (Paudyal *et al.* 2017b). Built-up and agricultural lands occupy the majority of the flat and gently sloped area, and forests account for all the remaining land (Regmi and Saha 2015, Rimal *et al*. 2015). Biodiversity reflects the climatic and altitudinal variation of the catchment area, where sub-tropical forests are dominant at the lower belt and temperate forests in the upper catchment (JICA/SILT 2002). More than 60% of the forested land is under community control (DFO 2016, Fleming and Fleming 2009), with management divided among 75 community forestry users' groups (CFUG) representing 12,739 households (DFO 2016).

In the 1970s, the lands in the Phewa watershed were heavily degraded due to overgrazing and overharvesting of timber,

fuelwood, and fodder (Fleming and Fleming 2009). This resulted in severe erosion in the uplands of the watershed and sedimentation in the lake. As concerns over the degradation of the lake grew, a series of structural and non-structural interventions such as check dams, retaining walls and plantation were implemented to protect the watershed from further degradation. However, these proved to be of limited success. CFUGs were then formed and mobilised as part of a new approach to forest landscape restoration. After four decades, there has been a significant increase in dense woody vegetation cover composed of a wide diversity of species that are used for fuelwood, fodder, and other local uses and a considerable reduction in sediment input (Paudyal *et al.* 2017b). This shows a significant motivation from the community-based forest management initiative to protect and conserve the watershed. We are therefore interested in exploring the motivational factors for restoration. The motivational factors can be both: 1) intrinsic (driven by internal factors to perform, achieve or meet personal and local needs; and 2) extrinsic (given or controlled by external agencies societies).

Study approach

Participatory approaches were used to collect qualitative data (Bhatta *et al.* 2016; Paudyal *et al*. 2015, Zarardian *et al.* 2016) including focus group discussions (Gray 2004), key informant surveys (Bryman 2001, Patton 2002), collection of expert opinions (Burkhard *et al.* 2012, Palomo *et al.* 2013) and direct field observation (Garrard *et al.* 2012, Niraula *et al.* 2013). CFUG members, local entrepreneurs and experts who have worked in, or in conjunction with Phewa watershed, in the fields of agriculture, forestry and land management were consulted to understand the processes involved in the restoration and to identify motivating factors for this process from March to April 2016. An applied thematic analysis approach was used to analyse data (Paudyal *et al.* 2017a), focusing on how the restoration process was initiated and how it shifted from a technical approach to a participatory approach. As a first step, a range of literature was collected and reviewed to identify the motivating factors for restoration. These motivating factors were presented in focus group discussions and a workshop in March 2016. A list of motivating factors was then finalised and prioritised. The effectiveness of restoration regarding time and cost and restoration benefits such as ES and biodiversity were taken into consideration during the analysis. A flow diagram and word cloud were constructed, and the table was used to summarise the results.

Sample selection and data collection

Two CFUGs (*Bamdibhir* and *Sandhe Raniswara Dopahare*) were purposefully selected from 75 CFUGs (Table 1) in consultation with the District Forest Office and the District Soil Conservation Office in Kaski district. These CFUGs were highly successful in restoring the watershed through the pioneer watershed conservation and CBF programs. Two focus group discussions (FGDs), one from each selected CFUG were conducted. We assured equal participation of the male and female members during FGDs. Subsequently, ten respondents from each CFUG were selected for key informant survey (KIS). The selected respondents were the executive members of CFUGs such as general secretary, treasurer, and general members for KIS. Finally, a workshop was organised in Pokhara among local communities, business people, government officials and civil society representatives.

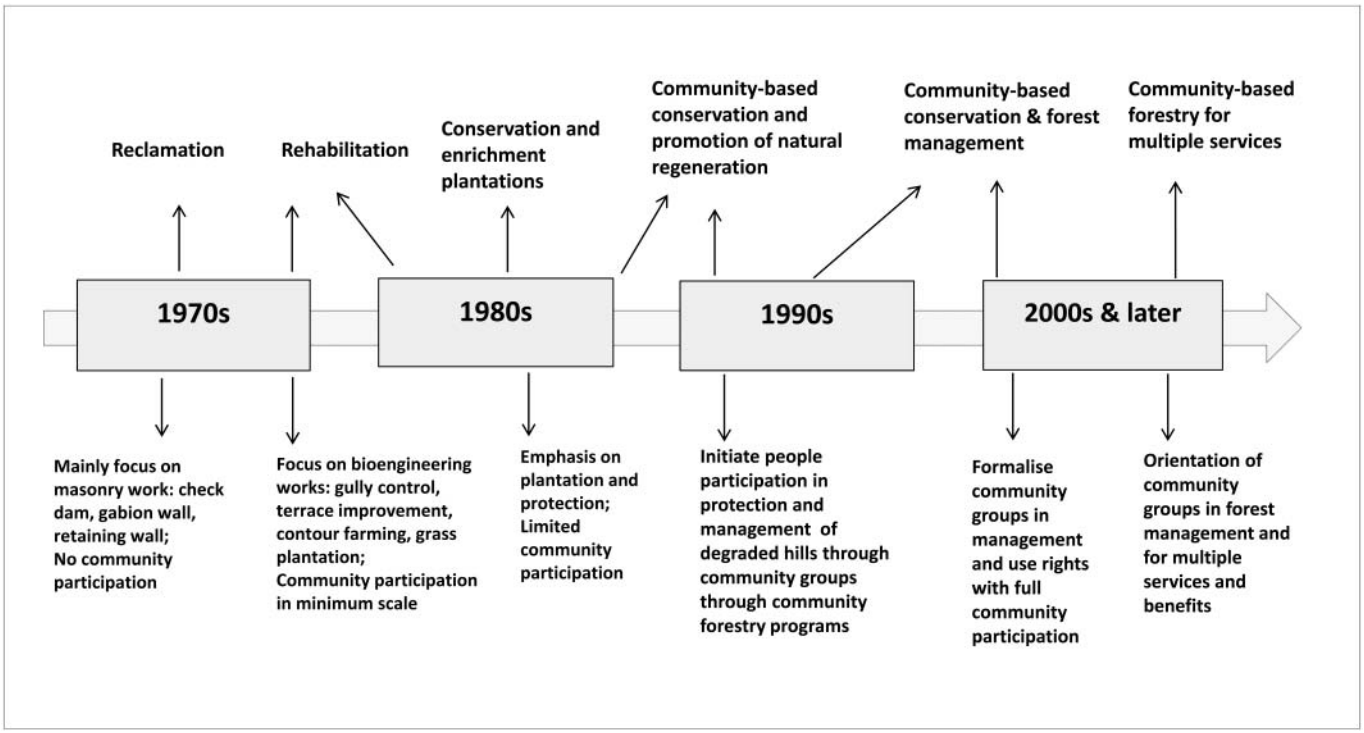
In each CFUG, there was a discussion regarding details of activities implemented and its outcomes and impact since the mid-1970s. Interviewees were asked to relate what had occurred during the different stages of forest restoration. Responses were recorded and transcribed for analysis. The relevance of each motivating factor (identified in the process described above) was discussed. Responses were recorded and presented in a table. These factors were also categorised relative to their characteristics and influence on restoration.

TABLE 1 *Description of two community forests (CF) selected for key informant survey and focus group discussion in the Phewa watershed*

Description	***Bamdibhir* CFUG**	***SandheRaniswara Dopahare* CFUG**
Location(address)	Chapakot VDC-3,4,5,6	Kaskikot VDC 6,7, Kaski
Ethnic composition	Mixed ethnicity (*Brahmin, Chhetri*, and *Dalit*).	Mixed ethnicity (*Brahmin, Chhetri*, and *Dalit*).
No. of HH in CFUG	134	219
Total population	712	1 302
Year of CF initiation	22 June 1993	23 June 1993
CF official registration	16 July 2002	13 March 2007
No. of executive members	11	9
Total forest area (ha)	48.5	22.23
Forest types	Natural forests and plantation (*Alnus* and *Schima*)	Natural forests and plantation (*Schima* and *Prunus*)
Condition of forests	Medium	Medium
Main use of CF	Wood, fuelwood, fodder	Wood, fuelwood, fodder

Note: 'CFUG' – community forestry users' groups; 'HH' – households, 'VDC' – village development committee

FIGURE 2 *Stage of community-based forest landscape restoration in the Phewa watershed, Nepal*



In the second step of the process, respondents in the FGDs and KIS were asked to rank motivating factors in terms of their importance in contributing to the success of restoration (0 = relatively unimportant driver, 1 = less important driver, 2 = important driver and 3 = highly important driver) based on their knowledge and experience (Burkhard *et al.* 2015). Average response scores were calculated from both informant interviews and focus group discussions for each CFUG and summarised in a table with motivating factors in rows and scale of relevance in columns. After creating the importance-ranking table, a word cloud (Paudyal *et al*. 2015) was prepared to present the relative importance of motivating factors. For the word cloud, all contributing factors were written as equivalent to their average value and imported into the online Wordle (http://www.wordle.net) program (Paudyal *et al*. 2015, Wu 2012).

RESULTS

Stages in forest and catchment management in the Phewa watershed

The study showed that over the past four decades, land management in the Phewa watershed went through various phases from land reclamation for flood and erosion control to a wider landscape focusing on multiple benefits (Figure 2). The different stages of restoration in the Phewa watershed were: (i) reclamation; (ii) rehabilitation; (iii) conservation and enrichment plantations; (iv) CBF and promotion of natural regeneration, and (v) CBF for multiple services. During these stages, the participation and control of local communities in the management of forests and the watershed increased. These stages of restoration were consistent with the general development of forest management and watershed conservation in Nepal with a focus on technocratic solutions towards people-based approaches. Different programs were designed and implemented at various stages of restoration (Table 2).

Reclamation stage (the 1970s)

During this stage, respondents reported large-scale landslides and heavy sedimentation in the lake. For instance, in the case of *Bamdibhir* CFUG, a massive landslide washed away part of the hills and deposited a significant amount of debris in the agricultural lands in the foothills. Meanwhile, loose soil and debris washed away and was deposited in the Phewa Lake. In response, catchment management in this stage focused on engineered structures as solutions for reclaiming and rehabilitating the watershed, which was being severely degraded by flash floods and landslides (Table 2). With technical and financial assistance from the Food and Agriculture Organization of the United Nations (FAO), the government of Nepal deployed technical professionals to identify causes and take initiatives to address flash floods and landslides directly. Based on findings, restoration interventions were mostly focused on installing retaining walls, check dams and gabion walls to prevent landslides and reclaim land destroyed by floods. Fast-growing tree species and grass species were planted, and access to the areas by local residents was restricted. This top-down expert-oriented approach largely excluded local communities.

Rehabilitation stage (the early 1980s)
During this phase, catchment and land management focused on different types of preventive measures, including terrace improvement to retain soil and water, water harvesting ponds for controlling floods, water storage for irrigation during the dry season, as well as broom grass, agave, and bamboo plantation. The combination of earthworks and bioengineering projects improved drainage and regulated surface flows. Results were encouraging, but these activities were implemented only in a few localised intervention sites. Stakeholders considered an effective means of restoration for the small hilly areas but not for the watershed. Government and project experts continued to employ a top-down approach. Community participation was insignificant, and the community did not feel ownership of the program.

Conservation and enrichment plantations (the late 1980s)
The focus of watershed conservation at the end of the 1980s was mainly the establishment of tree plantations as part of rehabilitation works. Records from two CFUGs showed that the Phewa Watershed Conservation Project (PWCP) focused on afforestation programs with the help of local communities. They planted more than 50 000 seedlings in two community forests and constructed fencing for protection. The project also deployed a full-time forest guard to protect plantation sites. Although the PWCP initiated the Plantation Protection Committee for local participation, local community involvement in decision-making was limited. In the absence of meaningful participation of local people, this management approach was considered relatively ineffective.

Community-based forestry and promotion of natural regeneration (1990–2000)
In support of the Forestry Extension Project (1991–1994) funded by the Japan International Cooperation Agency (JICA)-Nepal, conservation efforts shifted to the protection of degraded landscapes to allow natural re-growth. Degraded areas were fenced off to prevent animal grazing and human disturbance. Due to the failure of the top-down approaches of previous interventions, these efforts sought greater involvement of the local community. New national policies supported the establishment of a community-based forestry system transferring rights to manage forest patches to communities. A CFUG was established, and a constitution with detailed rules and regulations was prepared. An executive committee was formed by the CFUGs to make decisions on behalf of users and to govern community forests. The CFUGs identified degraded sites within the community forests and protected those sites to encourage natural regeneration. For instance, *Sandhe Raniswora Dopahare* CFUG claimed to have protected seven different locations for natural regeneration during this period. To achieve this goal, government and other agencies increased CFUG capacity through an institution-building program enabling communities to manage forests better. Ultimately, protection of degraded land for natural regrowth proved an effective means to restore the watershed. The Community Development and Watershed Conservation Project and Greenery Promotion and Cooperation Project (Government of Nepal /JICA) provided continuous support in Phewa watershed conservation.

Community-based forestry for multiple services (2000 onwards)
This 'multiple services' phase was a continuation of the previous phase, building on the increasing strength of CBF and empowered local decision-making for forests and land. Local communities engaged with CBF not only as a means of watershed conservation but as a source of multiple benefits. Forests protected by the local community and allowed to regenerate delivered forest products and reduced lake sedimentation. The restored forest landscapes resulted in improved water quality for irrigation and supported a variety of flora and fauna. At the same time, agroforestry approaches maintained agricultural productivity. Ecotourism opportunities such as bird watching, hiking, rainforest viewing and boating on the lake flourished, directly benefitting local communities. The area also became famous for educational and research activities.

Key motivating factors

The study revealed 12 motivating factors contributing to the successful implementation of forest restoration in the Phewa watershed (Table 3). While sedimentation of the Lake was a motivating factor during the 1970s and 1980s, decentralised forest policies in later years inspired local communities to get involved in restoration. Motivating factors were categorised into four different groups: social, political, ecological and economic. Communities and experts surveyed recalled and described the importance of each factor associated with restoration. Various stakeholders had a similar understanding of the contributing factors for successful forest restoration.

There were 12 important motivating factors for forest restoration (Figure 3). These can be categorised into proximate factors – such as sedimentation in the lake, decentralised forest policy, agriculture productivity, local livelihoods and tourism opportunities – and remote factors such as global concern over environmental degradation and water provision. Ecological and economic factors were important for restoration in the 1970s and 1980s, but restoration accelerated after a democratic political regime came into power with new policies for decentralisation.

Concern regarding lake sedimentation was identified as the most important driver for the restoration initiative. Maintaining and enhancing capacity for tourism in the area was identified as the second most important motivating factor, followed by the decentralised forest policy. Most respondents expressed interest in expanding enterprises based on recreation and eco-tourism, building on the already a flourishing tourism industry in the Phewa Lake area and the region around Pokhara. However, concerns over decreased food production in the area and the consequences for local livelihoods were also regarded important. Shortage of forests products for local communities (particularly firewood) was acute, but this was considered less influential for the watershed restoration.

TABLE 2 *Summary of activities implemented by* Bamdibhir *community forestry users' groups (CFUG) and* Sandhe Raniswara Dopahare *CFUG in Phewa watershed and outcomes*

Stage	Major activities	Outcomes
Reclamation	• Mainly engineering works: construction of check dams, breast walls, retaining walls • Planting of grass and easy-to-grow tree species • Degraded areas were restricted to access • Constructed sedimentation basins (siltation dams)	• Quick recovery of land at few sites, expensive and time-consuming work • Less effective because of lack of ownership of local people
Rehabilitation	• Bioengineering for gully control • Terrace improvement • Water harvesting ponds to control flood and to supply water during dry season • Plantation of grass species for soil stabilisation, such as bamboo and broom grass • Fully restricted access to the forest	• The rate of soil erosion decreased, but the rate was slow • Scattered programs had an insignificant impact on conservation
Reforestation – enrichment plantation	• Plantation in denudated area – native species, mainly *Alnus* spp., *Pinus* spp., bamboos. • Enrichment plantation in degraded forests • Wire fencing around plantations and degraded forest • Initiated community involvement in plantation and protection work - forest protection committee and provision of a forest guard	• Forest cover and quality increased • Decreased water runoff and soil loss decreased • Initiated local community involvement in conservation
Community-based forestry and promotion of natural regeneration	• Delineated degraded forests and wire fencing • Involved people in protection and management of forests through community-based forestry system • Identified households which have associated with forests • Formed CFUGs, their constitutions (rules, regulations, offences and fines) • Formed an executive committee among CFUGs elected for three-year terms • Conducted various program for local capacity building, such as training, exposure visits, and action research. • Activities implemented based on approved community forest operation plan • Focus on conservation and limited use of resources	• Local forest management system regained • Management land use right of natural resources established • Forest cover and quality increased • Loss of soil reduced • Increased biodiversity and supply of various ecosystem services in the watershed
Community-based forestry for multiple services	• Continued to protect the degraded forests, but allowed to use forests products unrestrictedly based on the approved forest management plan • Focused on institutional capacity building through CFUG's regular meetings and annual assembly. • Federated CFUGs in the district and central for further capacity building and advocacy for additional rights over forests	• CFUGs managed their forests through the approved statute and the forest management plan • Explored the potential of eco-system services approach to realise additional benefits through various payment mechanisms

Water provision for hydropower, irrigation, the supply of other ecosystem services and an adaptive management approach were perceived to be less important and to have little influence in watershed restoration. Although lake sedimentation and tourism potentially contributed to initiating restoration, the process was slow until the enactment of policies to decentralise forest management and control in the late 1980s.

Perceptions regarding motivating factors that influenced restoration varied between the groups (Figure 4). While local communities considered the impact of the shortage of forest products on their livelihoods as one of the most influential factors, experts had different views. For instance, the community categorised environmental degradation, the adaptive management approach, freshwater provision and supply of the ecosystem services as less important factors, while experts considered these to be highly important motivating factors.

DISCUSSION

The shift in watershed restoration from engineering measures to the participatory management of degraded watershed through the promotion of natural regeneration coupled with afforestation was a major change in approach. From a reliance on technocentric and engineering-based solutions, the shift

TABLE 3 *Motivating factors of community-based forest landscape restoration, describing how they support restoration in Phewa watershed*

Types	Motivating factors	Description	References
Political	Decentralised forest policy	Devolution of forest management authority from the state to the local community established thousands of local forest management organisations that contributed to rejuvenate denuded hills.	Gautam *et al.* 2004
	Global concern about environmental degradation	This theory, popularised by Eckholm in 1975, led to global concerns over environmental degradation in Nepal exacerbated by the World Bank prediction that all forests from the access areas of the Mountains would disappear by 1993 and in the Terai by 2003 unless large-scale compensatory actions were undertaken.	Kanel and Acharya, 2008, Ojha *et al.* 2014
Social	Stakeholders' interests	Combined interests of local people, government and international donors were a dominant driving force in the restoration of degraded mountains in Nepal.	Devkota 2010, Schusser *et al.* 2015
	Increased awareness of participatory forest management	In contrast to Hardin (1968), Ostrom (1990) identified and analysed many cases and conditions in which user groups have successfully managed natural resources.	Kanel and Acharya 2008
	Adaptive management approach	Nepal's forest policy adopted this approach in planning and implementing conservation activities at the grassroots level.	Kanel and Acharya 2008
Ecological	Phewa Lake sedimentation	Deforestation and forest degradation in the watershed caused landslides and soil erosion which flushed into the lake. The high rate of deposition had created a serious threat to the existence of Phewa Lake.	Sthapit and Balla 1999
	Ecosystem services provision	The flow of ecosystem services as catchment values is an important factor for landscape restoration.	Birch *et al.* 2010
	Water provision	Clean water in Phewa Lake has been used for hydropower production and irrigation in the lower belt. Watershed conservation was initiated with the aim of making a regular supply of water available.	Paudyal *et al.* 2015
Economic	Tourism opportunity	The tourism-based economy of Pokhara depends on the prolonged life of the Phewa Lake and the beautification of the surrounding landscape that motivated restoration of the degraded lake watershed.	Raya *et al.* 2008
	Forest product demand	Deforestation and forest degradation caused a shortage of forest products in the mountains.	MFSC 2013
	Local livelihoods	Local livelihoods became vulnerable from continuously declining landscape productivity in the watershed.	MFSC 2013
	Decreased agriculture productivity	Farm production declined due to land degradation in the watershed.	Fleming and Fleming 2009

to ecologically- and socially-driven approaches resulted in greater efficiency and effectiveness. Structural engineering approaches are expensive, requiring substantial investments of both money and time (Chazdon 2008; Chazdon and Gauriguata 2016; Ciccarese *et al*. 2012). Adequate construction materials were not available in the local area, and support from local people was low. Community members found employment as unskilled labour in restoration work but had little personal interest in the outcome. This corroborates findings from other studies suggesting that engineering solutions are only feasible where there is a need to address specific problem areas in catchments, where there are adequate financial resources and where there is limited direct interaction with local people (Chazdon 2008; Ciccarese *et al*. 2012).

With forest policy changes after enactment of the Master Plan of Forestry Sector, 1998 and the Forest Act of 1995 (MFSC 2013), as well as the amendment of Soil and Water Conservation Act of 2000 (MFSC 2013), increased participation and encouraged local residents to conserve and restore forests. Instead of concrete masonry, the government promoted natural regeneration and forest management by local community organisations. The benefits of this shift were twofold

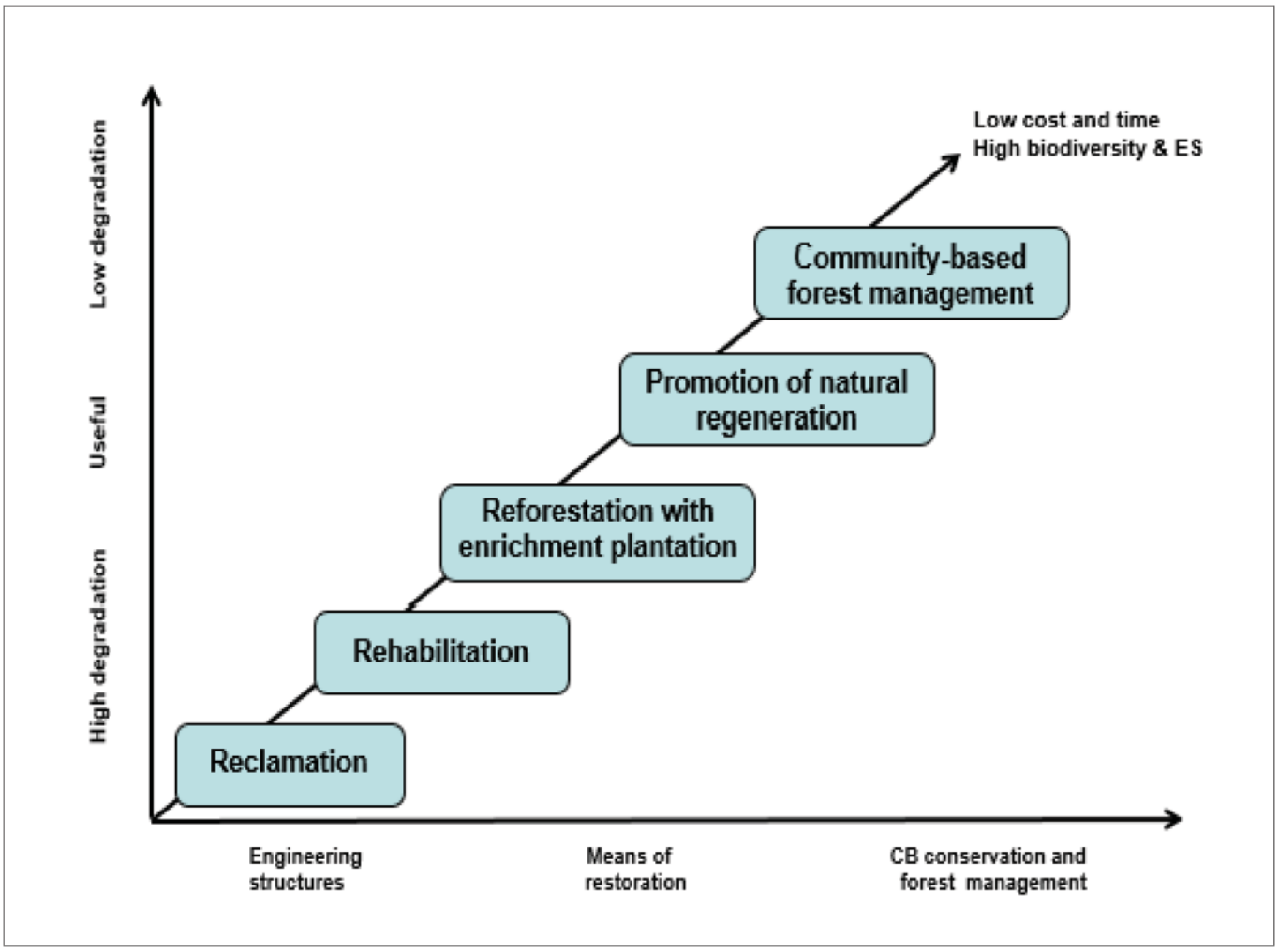
FIGURE 3 *Word cloud shows the relative important key motivating factors for restoration in Phewa watershed based on community perception and expert opinion retrieved from key informant surveys, focus group discussions and stakeholders' workshop. The word size indicates the relative importance of motivating factors of restoration (the larger text size indicates proximate factors that were highly influential in restoration, while smaller text size indicates distant factors with influence in restoration)*

FIGURE 4 *Matrix for the assessment of relative importance of motivating factors of restoration in the Phewa watershed*

Categories	Motivating factors of restoration	Bamti KIS	Bamti FGD	Bamti Ave.	SRD KIS	SRD FGD	SRD Ave.	Experts WS	Aggregate	Aggregate (%)	Level of influence
Political	Decentralised forest policy (P)	3.5	5.0	4.3	3.0	5.0	4.0	5.0	4.4	88	High
	Global concern over environmental degradation (D)	0.0	3.0	2.0	2.0	3.0	2.5	5.0	3.0	60	Low
Ecological	Phewa Lake sedimentation (P)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	100	High
	Ecosystem services provision (D)	0.0	3.0	1.5	3.0	3.0	3.0	3.0	2.7	50	Low
	Water provision (D)	0.0	3.0	1.5	1.0	3.0	2.0	3.0	2.3	43	Low
Social	Stakeholders' interests (D)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	60	Low
	Increased awareness of participatory forest management (D)	4.0	3.0	3.5	4.0	3.0	3.5	5.0	4.0	73	Low
	Adaptive management approach (D)	0.0	3.0	1.5	3.0	3.0	3.0	3.0	2.5	50	Low
Economic	Tourism opportunity (P)	4.0	5.0	4.5	4.5	5.0	4.8	5.0	4.8	95	High
	Local livelihoods (P)	5.0	4.0	4.5	5.0	4.0	4.5	3.0	4.0	80	High
	Forest products need (D)	4.0	5.0	4.5	4.0	5.0	4.5	1.0	3.3	67	Low
	Decreased agriculture production (D)	5.0	5.0	5.0	5.0	5.0	5.0	3.0	4.3	87	High

Note: Scale of the matrix: '0' – rosy colour = not relatively important factors, '1 – 3' – light blue colour = less important factors, '3 – 4' – light green colour = important factor, and '4 – 5' – dark green colour = highly important factors. Acronyms used: 'P' – proximate factors; 'D' distant factors; 'KIS' - key informant survey; 'FGD' - focus group discussion; 'WS' - Workshop; 'Badti' - *Badtihir* community forestry user group (CFUG), 'SRD' - *Sandhe Raniswara Dopahare* CFUG; 'Ave.' - Average.

FIGURE 5 *Development of community-based forests landscape restoration in the Phewa Lake watershed, Nepal. At the outset, restoration focused on engineering works with minimal community participation, then shifted to tree planting, then to the promotion of natural regeneration and local community control. This was lower cost and more effective than government-led engineering works (Figure inspired by CHAZDON 2008.)*



(Fleming and Fleming 2009): they resulted in reasonably rapid, low-cost change in forest cover (Paudyal *et al.* 2017a) and increased local access to benefits such as timber and non-timber forest products and provision of common goods such as clean water and aesthetic benefits (Paudyal *et al.* 2016). Many respondents identified a reduced rate of landslides and a remarkable reduction of soil erosion. Community ownership and rapid, visible evidence of success resulted in a cycle of positive feedback encouraging greater local efforts in forest management and an overall shift in awareness, attitudes and behaviours of local communities towards forests (Figure 5).

The Phewa watershed was a typical example of a degraded mountain landscape, where sedimentation posed a severe threat to water resources (Fleming and Fleming 2009, Sthapit and Balla 1998). Political, ecological, social and economic factors contributed to the successful forest restoration in the watershed. Motivating factors changed due to cost, time, needs and development of national policies. Learning was also important: local communities became more aware that ecosystem services such as clean water and aesthetic benefits could be linked to wider global concerns for mitigation of climate change and biodiversity conservation. Our finding is in line with Suding *et al.* (2015), i.e. the integration of local needs with wider global factors is important in achieving forest restoration at larger scale.

In Nepal, the 1976 National Forestry Plan recognised the need for community participation and decentralisation in forest management for the first time (Gautam *et al.* 2004). Community ownership classes of *Panchayat* Forest and *Panchayat* Protected Forest were introduced in 1977, following amendments to the Forest Act 1961. The Master Plan for the Forestry Sector (1988) was the cornerstone of the participatory policy reform that provided the foundation for the CBF as a high priority program for the subsequent 25 years. This movement gained momentum after democracy was established in 1990. In 1993, the landmark Forest Act was enacted, which legitimised local CFUGs as independent, autonomous and self-governing local organisations responsible for protecting and managing forests (Ojha *et al.* 2014).

CONCLUSION

This study explored the patterns of change, processes and key motivating factors contributing to successful forest restoration in the Phewa watershed of Nepal. A combination of intrinsic factors of local people and extrinsic factors employed by government and project appeared critical motivation factors for the success of Phewa Watershed restoration. While extrinsic factors such as sedimentation, tourism and policy played a vital role, intrinsic factors including a realisation among local communities of decreasing food production and a shortage of forest products became crucial in strengthening community engagement leading to improvement of the restoration process. Concerns about lake sedimentation, forest policy change and the desire for increased tourism opportunities and increased agricultural productivity were the key motivating factors for the success of landscape restoration. While the concern for lake sedimentation initiated the restoration process, forest policy change supported successful participatory forest management. Forest policy changes gave rights to local communities, motivating them to restore degraded lands by planting native species, promoting natural regeneration and implementing local rules for forest use. Community engagement in the process was crucial for successful restoration. Today, restored forest landscapes provide forest products to fulfil basic needs, to maintain water quality, to provide habitat for biodiversity and to increase the aesthetic beauty of the watershed which contributes to the local economy by increasing tourism opportunities. Community empowerment and control provided the basis for more efficient and cost-effective approaches to landscape restoration. These lessons have considerable potential for broader application in developing countries, and could make a significant contribution to global forest restoration targets outlined by the Convention on Biodiversity, the Bonn Challenge and the New York Declaration.

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REFERENCES

BIRCH, J.C., NEWTON, A.C., AQUINO, C.A., CANTARELLO, E., ECHEVERRIA, C., KITZBERGER, T., SCHIAPPACASSE, I. and GARAVITO, N.T. 2010. Cost-effectiveness of dryland forest restoration evaluated by spatial analysis of ecosystem services. *Proceedings of the National Academy of Sciences* **107**: 21925–21930. doi:10.1073/pnas.1003369107

BHATTA, L.D., CHAUDHARY, S., PANDIT, A., BARAL, H., DAS, P.J. and STORK, N.E. 2016, Ecosystem Service Changes and Livelihood Impacts in the Maguri-Motapung Wetlands of Assam, India. *Land* **5**: 15.

BRYMAN, A. 2001. *Social Research Methods*. Oxford University Press, Oxford, United Kingdom.

BURKHARD, B., KROLL, F., NEDKOV, S. and MÜLLER, F. 2012. Mapping ecosystem service supply, demand and budgets. *Ecological Indicators* **21**: 17–29. doi:10.1016/j.ecolind.2011.06.019

BURKHARD, B., MÜLLER, A., MÜLLER, F., GRESCHO, V., ANH, Q., ARIDA, G., BUSTAMANTE, J.V.J., VAN CHIEN, H., HEONG, K.L., ESCALADA, M., MARQUEZ, L., THANH TRUONG, D., VILLAREAL, S.B. and SETTELE, J. 2015. Land cover-based ecosystem service assessment of irrigated rice cropping systems in southeast Asia-An explorative study. *Ecosystem Services* **14**: 76–87. doi:10.1016/j.ecoser.2015.05.005

CHAZDON, R.L. 2008. Beyond deforestation: Restoring forests and ecosystem services on degraded lands. *Science* **320**: 1458–1460. doi:10.1126/science.1155365

CHAZDON, R.L. and GUARIGUATA, M.R. 2016. Natural regeneration as a tool for large-scale forest restoration in the tropics: prospects and challenges. *Biotropica* **48**: 716–730. doi:10.1111/btp.12381

CHAZDON, R.L. and URIARTE, M. 2016. Natural regeneration in the context of large-scale forest and landscape restoration in the tropics. *Biotropica* **48**: 709–715.

CICCARESE, L., MATTSSON, A. and PETTENELLA, D. 2012. Ecosystem services from forest restoration: Thinking ahead. *New Forests* **43**: 543–560. doi:10.1007/s11056-012-9350-8

DEVKOTA, R.R. 2010. Interests and power as drivers of community forestry. *PhD thesis*, Gottingen University, Germany (http://univerlag.uni-goettingen.de), ISBN: 978-3-941875-87-6.

DFO. 2016. *Community forestry database.* District Forest Office (DFO), Kaski. Pokhara, Nepal.

FLEMING, B. and FLEMING, J.P. 2009. A watershed conservation success story in Nepal: Land use changes over 30 years. *Waterlines* **28**: 29–46. doi:10.3362/1756-3488.2009.004

FLESKENS, L. and STRINGER, L.C. 2014. Editorial: Land management and policy responses to mitigate desertification and land dedradation. *Land degradation & development* **25**: 1–4. DOI: 10.1002/ldr.2272

FOOD AND AGRICULTURE ORGANISATION OF THE UNITED NATIONS 2015. Global guidelines for the restoration of degraded forests and landscapes in drylands Building resilience and benefiting livelihoods. *FAO Forestry Paper* **175**.

GARRARD, R., KOHLER, T., WIESMANN, U., PRICE, M.F., BYERS, A.C. and SHERPA, A.R. 2012. Depicting

community perspectives: repeat photography and participatory research as tools for assessing environmental services in Sagarmatha National Park , Nepal. *Journal on Protected Mountain Areas Research* **4**: 21–31.

GAUTAM, A.P., SHIVAKOTI, G.P. and WEBB, E.L. 2004. A review of forest policies, institutions, and changes in the resource condition in Nepal. *International Forestry Review* **6**: 136–148. doi:10.1505/ifor.6.2.136.38397

GLOBAL FOREST COALITION 2010. Getting to the Roots. Underlying Causes of Deforestation and Forest Degradation, and Drivers of Forest Restoration. Global Forest Coalition.

GRAY, D.E. 2004. Doing research in the real world. London: SAGE Publications.

HAUGO, R., ZANGER, C., DEMEO, T., RINGO, C., SHLISKY, A., BLANKENSHIP, K., SIMPSON, M., MELLEN-MCLEAN, K., KERTIS, J. and STERN, M. 2015. A new approach to evaluate forest structure restoration needs across Oregon and Washington, USA. *Forest Ecology and Management* **335**: 37–50. doi:10.1016/j.foreco.2014.09.014

JACOBS, D.F., OLIET, J.A., ARONSON, J., BOLTE, A., BULLOCK, J.M., DONOSO, P.J., LANDHÄUSSER, S.M., MADSEN, P., PENG, S., REY-BENAYAS, J.M. and WEBER, J.C. 2015. Restoring forests: What constitutes success in the twenty-first century? *New Forests* **46**: 601–614. doi:10.1007/s11056-015-9513-5

JICA/SILT 2002. *Conservation Development study on the environmental conservation of Phewa Lake in Pokhara, Nepal*. Final report submitted by SILT Consultants to JICA/ Nepal, Kathmandu.

KANEL, K.R. and ACHARYA, D.P. 2008. Re-inventing forestry agencies: institutional innovation to support community forestry Nepal. *In*: DURST, P., BROWN, C., BROADHEAD, J., SUZUKI, R. and LESLIE, R. (eds.) *Re-Inventing Forestry Agencies: Experiences of Institutional Restructuring in Asia and the Pacific*. Food and Agriculture Organization of the United Nations, Regional Office for Asia and the Pacific Bangkok, Thailand, pp. 133–160.

KEENAN, R.J., REAMS, G.A., ACHARD, F., DE FREITAS, J.V., GRAINGER, A. and LINDQUIST, E. 2015. Dynamics of global forest area: Results from the FAO Global Forest Resources Assessment 2015. Forest Ecology and Management **352**: 9–20. doi:10.1016/j.foreco.2015.06.014

LAMB, D. 2014. *Large-scale forest restoration*. Earthscan from Routledge, Abingdon and Newyork. ISBN: 1004 15663180.

LEBLOIS, A., DAMETTE, O. and WOLFERSBERGER, J. 2017. What has Driven Deforestation in Developing Countries Since the 2000s? Evidence from New Remote-Sensing Data. *World Development* **92**: 82–102. doi:10.1016/j.worlddev.2016.11.012

LEIBUNDGUT, G., SUDMEIER-RIEUX, K., DEVKOTA, S., JABOYEDOFF, M., DERRON, M.-H., PENNA, I. and NGUYEN, L. 2016. Rural earthen roads impact assessment in Phewa watershed, Western region, Nepal. *Geoenvironmental Disasters* **3**: 13. doi:10.1186/s40677-016-0047-8

MEA. 2005. Ecosystems and Human Well-being: Synthesis. Island Press, Washington, DC.

MFSC, 2013. *Persistence and Change: Review of 30 years of community forestry in Nepal*. Ministry of Forests and Soil Conservation (MFSC), Government of Nepal, Kathmandu, Nepal.

NIJSEN, M., SMEETS, E., STEHFEST, E. and VAN VUUREN, D.P. 2012. An evaluation of the global potential of bioenergy production on degraded lands. *GCB Bioenergy* **4**: 130–147. doi:10.1111/j.1757-1707.2011.01121.x

NIRAULA, R.R., GILANI, H., POKHAREL, B.K. and QAMER, F.M. 2013. Measuring impacts of community forestry program through repeat photography and satellite remote sensing in the Dolakha district of Nepal. *Journal of Environmental Management* **126**: 20–9. doi:10.1016/j.jenvman.2013.04.006

OJHA, H.R., BANJADE, M.R., SUNAM, R.K., BHATTARAI, B., JANA, S., GOUTAM, K.R. and DHUNGANA, S. 2014. Can authority change through deliberative politics? *Forest Policy and Economics* **46**: 1–9. doi:10.1016/j.forpol.2014.04.005

PALOMO, I., MARTÍN-LÓPEZ, B., POTSCHIN, M., HAINES-YOUNG, R. and MONTES, C. 2013. National parks, buffer zones and surrounding lands: Mapping ecosystem service flows. *Ecosystem Services* **4**: 104–116. doi:10.1016/j.ecoser.2012.09.001

PATTON, M.Q. 2002. *Qualitative research and evaluation methods* (Third edition). SAGE Publications, Newbury Park, California, United States.

PAUDYAL, K., BARAL, H., BHANDARI, S. and KEENAN, R.J. 2018a. Design considerations in supporting payments for ecosystem services from community-managed forests in Nepal. *Ecosystem Servervices*. ***Under Revision***.

PAUDYAL, K., BARAL, H., BURKHARD, B., BHANDARI, S.P. and KEENAN, R.J. 2015. Participatory assessment and mapping of ecosystem services in a data-poor region: Case study of community-managed forests in central Nepal. *Ecosystem Services* **13**: 81–92. doi:10.1016/j.ecoser.2015.01.007

PAUDYAL, K., BARAL, H. and KEENAN, R.J. 2018b. Assessing social values of ecosystem services in the Phewa Lake Watershed, Nepal. *Forest Policy and Economics*. ***Under Revision***.

PAUDYAL, K., BARAL, H. and KEENAN, R.J. 2016. Local actions for the common good: Can the application of the ecosystem services concept generate improved societal outcomes from natural resource management? *Land Use Policy* **56**: 327–332. doi:10.1016/j.landusepol.2015.11.010

PAUDYAL, K., BARAL, H., LOWELL, K. and KEENAN, R.J. 2017a. Ecosystem services from community-based forestry in Nepal: Realising local and global benefits. *Land Use Policy* **63**: 342–355. doi:10.1016/j.landusepol.2017.01.046

PAUDYAL, K., BARAL, H., PUTZEL, L., BHANDARI, S. and KEENAN, R.J. 2017b. Change in land use and ecosystem services delivery from community-based forest landscape restoration in the Phewa lake watershed, Nepal. *International Forestry Review* **19**(S4): 1–14.

REGMI, R.R. and SAHA, S.K. 2015. Impact assessment of land use land cover change on soil erosion status in Phewa Lake watershed of Nepal. *International Journal of Current Engineering and Technology* **5**: 1708–1717.

RAYA, R.B., SHARMA, S. and GURUNG, G. 2008. Impact of Land Use on Water Quality of Phewa- Lake Pokhara, Nepal. In: SENGUPTA, M. and DALWANI, R. (eds.), *Proceeding of Taal* 2007: The 12th World Lake Conference. pp. 703–716.

RIMAL, B., BARAL, H., STORK, N.E., PAUDYAL, K. and RIJAL, S. 2015. Growing city and rapid land use transition: Assessing multiple hazards and risks in the Pokhara valley, Nepal. *Land* **4**: 957–978. doi:10.3390/land4040957

SABOGAL, C., BESACIER, C. and MCGUIRE, D. 2015. Forest and landscape restoration: Concepts, approaches and challenges for implementation. *Unasylva* **245**(66): 3–10.

SAYER, J., SUNDERLAND, T., GHAZOUL, J., PFUND, J.-L., SHEIL, D., MEIJAARD, E., VENTER, M., BOEDHIHARTONO, A.K., DAY, M., GARCIA, C., VAN OOSTEN, C. and BUCK, L.E. 2013. Ten principles for a landscape approach to reconciling agriculture, conservation, and other competing land uses. *Proceedings of the National Academy of Sciences* **110**: 8349–8356. doi:10.1073/pnas.1210595110

SCBD (SECRETARIAT OF THE CONVENTION ON BIOLOGICAL DIVERSITY) 2010. The Strategic Plan for Biodiversity 2011–2020 and the Aichi Biodiversity Targets, Document UNEP/CBD/COP/DEC/X/2. Conference of the Parties to the Convention of Biological Diversity, Tenth meeting (CoP 10. Agenda item 4.4), Nagoya, Japan, 18–29 October 2010 (https://www.cbd.int/doc/decisions/cop-10/cop-10-dec-02-en.pdf viewed on 10 Nov. 2017). doi:10.1111/cobi.12383

SCHUSSER, C., KROTT, M., YUFANYI MOVUH, M.C., LOGMANI, J., DEVKOTA, R.R., MARYUDI, A., SALLA, M.and BACH, N.D. 2015. Powerful stakeholders as drivers of community forestry - Results of an international study. For. *Forest Policy and Economics* **58**: 92–101. doi:10.1016/j.forpol.2015.05.011

SEARS, RR, PHUNTSHO, S, DORJI, T, CHODEN, K, NORBU, N and BARAL, H. 2017. Forest ecosystem services and the pillars of Bhutan's Gross National Happiness. Occasional Paper **178**. Bogor, Indonesia: CIFOR.

STEINER, F. 2016. Opportunities for urban ecology in community and regional planning. *Journal of Urban Ecology* **2**: 1–2. doi:10.1093/jue/juv004

STHAPIT, K.M. and BALLA, M.K. 1998. *Sediment monitoring of Phewa Lake. Watershed management and environmental science*. Institute of Forestry, Kathmandu, Nepal.

WU, J. 2012. Key concepts and research topics in landscape ecology revisited: 30 years after the Allerton Park workshop. *Landscape Ecology* **28**: 1–11. doi:10.1007/s10980-012-9836-y

VAN OORT, B., BHATTA, L.D., BARAL, H., RAI, R.K., DHAKAL, M., RUCEVSKA, I. and ADHIKARI, R.2015. Assessing community values to support mapping of ecosystem services in the Koshi river basin, Nepal. *Ecosystem Services* **13**: 70–80.

ZARANDIAN, A., BARAL, H., YAVARI, A.R., JAFARI, H.R., STORK, N.E., LING, M. and AMIRNEJAD, H. 2016. Anthropogenic decline of ecosystem services threatens the integrity of the unique Hyrcanian (Caspian) forests in Northern Iran. *Forests* **7**: 1–27. doi:10.3390/ f60x000x