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RESEARCH ARTICLE

Making ecosystem services approach operational: Experiences from Dhauladhar Range, Western Himalaya

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Abstract Payment for ecosystem services (PES) has emerged as a promising tool to participatory natural resource management and sharing of benefits among the stakeholders. However, very few successful models of PES are available for replication. This study deals with an analysis of a PES model currently operational in the Dhauladhar Range, Western Himalaya, where upstream villagers are paid for maintaining the spring-shed that supplies drinking water to the downstream township. To understand the flow of various ecosystem services (ES), institutional mechanism, and governance, we conducted an in-depth analysis of this project. The study identified lack of monitoring and weak governance as factors affecting smooth operation of PES. To revamp the PES model more effectively at the present and new sites in future stakeholder integration, valuation of ES and inputs in terms of capacity building of primary and secondary stakeholders would be critical.

Keywords Governance · Himalaya · Management · Participatory approaches · PES · Water

INTRODUCTION

Natural resource management (NRM) has seen a paradigm shift in the recent decades with ecosystem services (ES) taking the center stage in integrated development planning (Moore et al. 2017). The ES came into limelight after their values were estimated in economic terms (De Groot 1992; Costanza et al. 1997). Globally, efforts are underway to develop efficient frameworks for identification, mapping, and valuation of ES (MEA 2005; Fisher and Turner 2008; TEEB 2008; Díaz et al. 2015; Potschin and Haines-Young 2016a, b). Millennium Ecosystem Assessment (MEA 2005) was the first major effort that emphasized relationship between ES and human well-being. Lack of economic perspective on biodiversity and ecosystem degradation in MA framework led to upcoming of The Economics of Ecosystems and Biodiversity (TEEB). TEEB highlights ecological and economic linkages of ES (TEEB 2008). However, its integration into policy-making has been slow because of scarcity of local data. To ensure sustainable use of biodiversity for humanity, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) was formed (Díaz et al. 2015). However, IPBES lacks inclusion of non-living components and valuation of ES at local scale. Therefore, recent focus is on developing site-specific frameworks (Rasul et al. 2011; Damastuti and De Groot 2019). In brief, the concept of ES is based on the premise that (i) reduction in the flow of ES negatively affects peoples' livelihoods and sustainable development; (ii) ecological processes and functions give rise to ES in the presence of a human beneficiary (La Notee et al. 2017); and (iii) the values of ES can be assessed in monetary and non-monetary terms and the values are often contextual varying in space and time.

Conceptual tools have been developed for the valuation of ES and designing PES (Pandeya et al. 2016). PES is linked to equitable sharing of benefits among beneficiaries and suppliers of the ES by the policy planners (Asquith et al. 2008; Tallis et al. 2008; Kubiszewski et al. 2013; Grima et al. 2016). Grima et al. (2016) reviewed 40 cases of PES in Latin America of which only 12 were successful. Waite et al. (2015) who reviewed over 100 studies on coastal ecosystem valuation in the Caribbean found that

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only 17% guided decision-making. Despite its popularity, PES implementation has been challenging (Naidoo et al. 2008; Pham et al. 2015). Main challenges include poor understanding of ES among the stakeholders and lack of participation (Tallis et al. 2008; Muradian and Rival 2012; Davies et al. 2015; Lautenbach et al. 2019). Communities living close to nature although cognizant of its services do not put a monetary value on ES (Martin-Ortega et al. 2013), making PES difficult to execute.

Therefore, existing models of ES need to be tested at multiple sites following participatory approaches to make it easier to implement (Probst and Hagmann 2003). Participatory approach includes active involvement of the local communities in the designing and developing PES (Berkes 2004; Brownson et al. 2019). A pilot PES project with Caura community revealed that community-based PES (CB-PES) yielded fruitful results (Rawlins and Westby 2013) and overcame larger challenges (Damastuti and De Groot 2019). Presently, ongoing pilots based on CB-PES need to be assessed to understand how place-based context influences implementation (Heidi et al. 2015).

The present study, therefore, assesses a PES model for water governance in the Bohal Spring-shed located in the foothills of Dhauladhar Range, Western Himalaya. Downstream of this spring-shed lies the picturesque town of Palampur, which largely depends on the Bohal Spring for drinking water. In 1952, the Palampur Municipal Council (PMC) purchased the rights of the Bohal Spring from the upstream villages. However, the forests in the upper recharge zone of this spring fall under the administrative control of the Himachal Pradesh Forest Department (HPFD). Since the villagers had the right to fuel wood and fodder from these forests, there was an unabated biomass extraction leading to degradation of forests by 1990s (Banyal 2010). This not only resulted in paucity of biomass for the local people but also led to significant reduction in the spring discharge from 8 l s^{-1} in 1950s to 2 l s^{-1} in the 1990s (Agarwal et al. 2007). Consequently, the inhabitants of Palampur faced a drinking water crisis. To overcome this crisis, villagers realized the need for forest conservation. Initially, a few women's self-help groups (WSHG's) were formed in the year 1999. Forest restoration activities of these groups were supported by Deutsche Gesellschaft fur Internationale Zusammenarbeit (GIZ) by forming Village Forest Development Society (VFDS) under a program called, Palampur Water Governance Initiative (PWGI). Studies carried out by "Advanced Center for Water Resources Development and Management" (ACWADAM) highlighted the importance of broadleaf forests for the recharge of the spring. Therefore, to maintain forest cover and protect forest in the recharge zone, a 20-year agreement was signed between PMC (beneficiary—the secondary stakeholder) and VFDS (suppliers—the primary stakeholders) in October 2010 (GIZ 2011) following PES framework (Rawlins and Westby 2013). As per agreement, PMC payed a sum of Rs. 10 000 $year^{-1}$ (increment of 10% every 5 years) to the VFDS for the conservation of the upstream forests so that continuous flow of drinking water from the spring was maintained (Anonymous 2013). Since it was one of the few pilot sites in the Himalayan region where the PES concept was implemented, success of this model can lead to further implementation in other parts of Asia. We realize that under the existing agreement only one service, i.e., drinking water has been taken into consideration while several other ES flowing from the spring-shed have not been accounted for. To understand the institutional mechanism and operational aspect of the case study, we conducted a detailed study in Bohal with the following objectives: (i) to identify and assess key ES flowing from the spring-shed and analyze people's perception of them, (ii) to study the current status of water governance, and (iii) to identify the limitations and challenges of the present model and suggest improvements for the long-term viability of the PES model.

MATERIALS AND METHODS

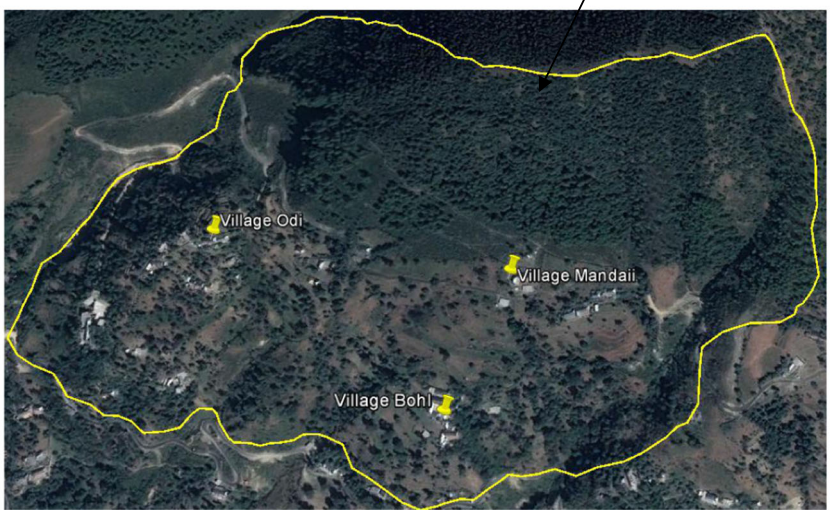
Study area

Bohal Spring-shed (catchment area ca. 286 ha; 31° 13′ 51.1″ to 32° 08′ 31.8″ N and 77° 55′ 33.2″ to 76° 32′ 59.4″ E) lies in the foothills of the Dhauladhar Range, Western Himalaya (Fig. 1). Administratively, it forms part of Kangra District in Himachal Pradesh (India). The altitude of the study site ranges from 900 to 2100 m above sea level. The forests, dominated by oak and rhododendron, occupy ~ 56% of the total catchment area and form the main recharge zone of Bohal Spring. Primary stakeholders of the ES in this spring-shed live in three human settlements viz., Bohal, Mandai, and Odi. Of these, Odi is the largest hamlet with 29 households and Mandai the smallest with 10 households. The total population of the three hamlets is 313. The inhabitants primarily belong to migratory *Gaddi* (shepherd) community. Livestock composition of the villages shows the dominance of sheep and goats (67% of total 316 livestock units) followed by cattle (32%). On average, each household keeps 1.6 cattle and 10 sheep/goats, which are grazed in the designated areas. All villages share the natural resources of the spring-shed for their biomass needs; however, water from Bohal spring is generally used by the people of Bohal village.

The secondary stakeholders of the spring-shed include HPFD, PMC, and 5000 residents and more than 10 000 floating population based in Palampur, some 15 km downstream, who depend on this spring-shed for drinking

(a) Location of Kangra in Himachal Pradesh

(b) Dhauladhar range



(c) Bohal Spring-shed

Fig. 1 Map of the study area showing Bohal Spring-shed in the foothills of Dhauladhar Range and location of study villages (Courtesy Google maps, GPS points collected by authors). **a** Location of Kangra in Himachal Pradesh. **b** Dhauladhar Range. **c** Bohal Spring-shed

water and occasionally for dairy/livestock products. HPFD is responsible for maintaining the forest cover and controlling illegal activities such as theft of timber and poaching.

Methods

Field surveys were carried from August 2016 to July 2018. Prior to group discussions and participatory rural appraisal, the concept of ES (the benefits that the ecosystems provide for human well-being) was explained to the primary stakeholders who were already aware of natures' contributions to human well-being. Focused group discussions (FGD, $n = 10$) (Fig. 2) and semi-structured interviews following Martin (1995) were conducted with both primary and secondary stakeholders. Group discussions with villagers were held in local dialect, facilitated by two to three local assistants. The number of participants in FGD with

Fig. 2 Focus group discussions with the stakeholders in Bohal Spring-shed. Photo by Sanjay Kr. Uniyal

primary stakeholders was 30.5 ± 7.5, while for secondary stakeholders, it was 2.5 ± 0.75. FGDs helped in identifying different ES, documenting benefits shared by them and their individual roles in the NRM model. The data gathered through interviews were corroborated with observations in the field. Perceptions of different respondents were measured using Conceptual Content Cognitive Mapping (3CM technique—a score based scale) (Kearney et al. 1999; Zahvoyska and Bas 2013). It involved ranking responses by individual respondents on a 0–10 score (where 0 refers to least and 10 to highest). Key ES were listed following Common International Classification of Ecosystem Services (Haines-Young and Potschin, 2011). The data collected have been analyzed for descriptive statistics.

RESULTS

Key ES from the spring-shed

The three major ecosystems identified in the Bohal Spring-shed were forest, grassland, and agro-ecosystem (Table 1). Almost all the primary stakeholders (100% respondents from the three villages) recognized the importance of all these ecosystems for supplying provisioning services (Supplementary Table S1). The role of forest ecosystem for regulating services such as spring recharge, erosion control, nursery functions for various organisms, and air purification was well recognized by about 47% respondents while open grasslands was given almost equal importance by the villagers as a place for social gatherings vis-à-vis provider of cultural services (48%). Of the 25 ES identified (Supplementary Table S2) in the Bohal Spring-shed, provisioning services were given more importance by the primary stakeholders while regulating services, especially recharge of spring and enhanced biodiversity, were given higher importance by the downstream communities. Of the provisioning services, fuel wood received the highest score (9.82) followed by green fodder (9.36) (Fig. 3). As many as 98 plant species in this spring-shed provide provisioning services in the form of big and small timber, subsidiary food, and medicinal and aromatic plants (Supplementary Table S3). Of the 9 regulating services, spring recharge was given the highest mean score (9.19) followed by 8.94 score for air purification (Table 2) by both stakeholder groups. Spring recharge has a regional reach as water from

Table 1 Key ecosystem services identified by the villagers in the Bohal Spring-shed (n = 66 households)

Ecosystem	Services perceived (% response)	Types	Sub-types
Forest	Provisioning (100)	Nutrition	Fodder, water, wild food, herbs
		Material	Bamboo, wood for agricultural implement
		Energy	Fuel wood
	Regulating (46.97)	Flow regulation	Spring recharge, erosion control
		Regulation of physical environment	Local rain and snow fall
		Regulation of biotic environment	Habitat, nursery function
	Cultural (18.18)	Sacred, aesthetic	Temple
		Educational	PES model
Grassland	Provisioning (100)	Nutrition	Fodder
	Regulating (36.36)	Regulation of biotic environment	Habitat, gene pool
		Regulation of physical environment	Prevent runoff, maintain soil fertility, nutrient cycling
	Cultural (13.64)	Symbolic	Place for village meetings
Agro-ecosystem	Provisioning (100)	Nutrition	Food, fodder
		Energy	Fuel wood
	Regulating (18.18)	Regulation of physical environment	Bind soil, maintain soil fertility, nutrient cycling
	Cultural (6.06)	Aesthetic/experiential	Feels good

Fig. 3 Collection of grass fodder from the forest. Photo by Anjali Uniyal

the spring is supplied to the downstream population of Palampur (Fig. 4). Air purification has a global impact when considering carbon sequestration. Most of the respondents (72.7%, all who scored it > 8; n = 66) recognized that forests play an important role in regulating local climate (8.35 score). They also reported that forests serve as habitat for wild animals such as goral (*Naemorhedus goral*), barking deer (*Muntiacus muntjak*), sambar (*Rusa unicolor*), and wild pig (*Sus scrofa*). Of the four cultural services provided by the spring-shed, education surpassed the local region of influence, as a large number of researchers and students visit Bohal to understand the

Table 2 Significance of various ES's flowing from Bohal Spring-shed as perceived by the villagers (based on 0–10 score)

ESS	Sub-types	Score ± SE
Provisioning (12)	Green fodder	**9.36 ± 0.20**
	Dry fodder	8.33 ± 0.29
	Water	5.27 ± 0.44
	Wild food	1.55 ± 0.21
	Aromatic herbs	0.79 ± 0.09
	Medicinal plants	1.59 ± 0.22
	Bamboo for baskets/mats	**3.76 ± 0.35**
	Wood for agricultural implements	1.35 ± 0.19
	Timber for houses	0.76 ± 0.07
	Poles for fencing	3.45 ± 0.36
	Grass for broom/ropes	0.47 ± 0.07
	Fuel wood	**9.82 ± 0.04**
Regulating (9)	Spring recharge	**9.19 ± 0.15**
	Regulate soil erosion	7.49 ± 0.35
	Purify air	**8.94 ± 0.14**
	Purify water	7.21 ± 0.34
	Soil moisture	5.98 ± 0.35
	Soil fertility	6.8 ± 0.31
	Regulate local rain/snow fall	8.35 ± 0.21
	Habitat for wild animals	8.89 ± 0.15
	Regeneration of native species/nursery function	8.42 ± 0.18
Cultural (4)	Temple of a local deity	5.94 ± 0.35
	Satisfaction for pure environment	**6.76 ± 0.32**
	National/international students visit to study community management	5.076 ± 0.35
	Nature lover	6.53 ± 0.36

mechanism of PES and it has national and international influence. For the primary and secondary stakeholders, however, visits to a sacred site dedicated to a local deity "Bheerni mata" can be classified as cultural service. Hence in addition to water, there are many other ES bundles flowing from the spring-shed which are not only important for the subsistence of the villagers but have national and global significance.

Natural resource management and ES benefit sharing

Presently, the three main stakeholders in the Bohal Spring-shed are as follows: VFDS, HPFD, and the PMC (Table 3). At the beginning of the project GIZ, WSHGs, Village Council (*Gram Panchayat*), and a few line agencies from the state government viz., irrigation and public health served as key partners. However, their involvement in the post-implementation phase was not visible. In the agreement, roles and responsibilities of stakeholders were clearly identified (Supplementary Fig. S1). Villagers dependent directly on forest, agro-ecosystem, and grassland ecosystem for their subsistence needs and Forest Department—managing the protected forest are the upstream stakeholders. PMC—getting drinking water from Bohal Spring is the downstream stakeholder.

Primary stakeholders

The VFDS—the primary stakeholder in NRM has 11 executive members (6 female and 5 male) with representation from all villages (5 from Bohal, 4 from Odi, and 2 from Mandai) including the Ward Panch and Forest Guard (*Rakha*) as *ex-officio* members. Every 5 years, the members of VFDS are re-elected. The VFDS regulates the use of forest resources following agreement guidelines and the management plan prepared by HPFD. Livestock grazing and lopping/cutting of trees is prohibited within the protected forest. Extraction of grass/leaf fodder is permissible only once in a year based on a date decided by the mutual concern of three hamlets. People violating rules are fined accordingly. Most of the villagers (90%, $n = 66$) are members of VFDS that is responsible for regulating resource collection, participating in the activities related to forest management (that are financially supported either by HPFD or by other organizations) and generating awareness about traditional pro-conservation practices. For the above-mentioned duties, PMC provides PES to the VFDS. However, the traditional ways of managing agro-ecosystem and common pasturelands have changed in recent decades. A high percentage of villagers (72.73%) reported that traditional organic farming and use of organic manure (leaf litter/cow dung) is increasingly being replaced by chemical fertilizers and pesticides. Fringes of agricultural fields and common pasturelands are infested with invasive species such as *Ageratina adenophora*. Traditional agricultural practices such as cooperative farming, system of crop protection on a rotational basis, and controlling invasive species from the common places are declining rapidly. This has serious implications as presently VFDS is mainly concerned with the management of forest ecosystem.

Forest Department

HPFD provides technical support for planning and enforcement of the management plan and extends financial support for executing forestry activities such as eradication of invasive species, construction of check dams for soil and water conservation and plantation. Though HPFD carried out eradication of Lantana and Ageratina from some areas with the help of VFDS, a large area of forest (> 50 ha) is still heavily infested with these invasive species. A closer observation of forest governance reveals that forest management needs strengthening in terms of scientific planning

Fig. 4 Water tank built by PMC near Bohal Spring source. Photo by Anjali Uniyal

and management of ecosystems for sustaining services, post-implementation monitoring and participatory approaches to conservation. Increasing human–wildlife conflicts, such as crop damage by wild animals in the recent years, and lack of effective mitigation measures have led to mistrust between the VFDS and HPFD.

The Palampur Municipal Corporation

Presently, PMC is responsible for supplying drinking water to 907 households, 168 commercial entities, and 78 public owners within Palampur that comes from Bohal Spring. It charges Rs. 100 $month^{-1}$ from commercial users, Rs. 50 $month^{-1}$ from the families who are above poverty line, Rs. 20 $month^{-1}$ from people living below poverty line as water tax [poverty line is Rs. 32($0.5) per day spent by a person]. With a large population getting water from PMC, it earns ca. Rs. 65 000 $month^{-1}$. As per agreement, PMC has to pay Rs. 10 000 $year^{-1}$ (increase of 10% every 5 year) to VFDS for water services. PMC is also responsible for regularly monitoring the spring discharge, maintaining the spring source and capacity building/awareness programs for the villagers to improve their socioeconomic status. However, FGDs with villagers and head of VFDS revealed that except for monetary benefits to the VFDS, other responsibilities were not discharged by PMC. This is a major cause of resentment among the villagers. Analyses of information collected through FGDs with different stakeholders (Table 3) revealed that there is a gap in fulfilling individual responsibilities effectively in the post-implementation phase of water governance. Interaction, feedback for actions previously implemented, and voluntary involvement of different stakeholders that generate scope of improvement for effective management of springshed are lacking in the project area. This is one of the emerging threats that have serious implications for the long-term sustenance of NRM and subsequently the continuous flow of ES.

Limitations of current PES model

Initial implementation of the PES scheme and strict adherence to the rules framed for the use of forest resources did improve the conservation status of forest, leading to enhanced flow of ES (Table 4) for a few years. However, due to lack of an adaptive community management approach and absence of coordination among various stakeholders over time, the institutional mechanism for

Table 3 Sharing of benefits among different stakeholders in Bohal Spring-shed and their roles and responsibility in the NRM

Stakeholder	Benefits	Role	Responsibilities[a]
Village Forest Development Society (VFDS) (primary stakeholder-upstream)	Provisioning services	Conservation of forest and grassland ecosystems	**Regulate resource use**
			Plantation of MPS
		Management of agro-ecosystem	Eradicate invasive species
			Pro-conservation traditional practices
			Avoid chemicals
HP Forest Department (HPFD) (secondary stakeholder-upstream)	Provisioning and regulating services	Management of forests	Plantation of multi purpose species
		Technical support to VFDS	**Eradication of invasive species**
		Financial support for forest development activities	**Demarcation of boundaries**
			Monitor flora and fauna
			Regulate human–wildlife conflict
Palampur Municipal Council (PMC) (secondary stakeholder-downstream)	Provisioning services	Adequate benefits to upstream communities	**PES to villagers**
		Monitor discharge from spring	Maintain the record of quality and quantity of spring discharge
		Capacity building and awareness	**Cleanliness of spring source and tanks**
			Training and awareness camps for villagers

[a]Responsibilities in bold are actively taken care of while others are lacking

Table 4 Status of NRM in the Bohal Spring-shed based on peoples' perception

Indicators	% Response (n = 66)	Indicators	Score ± SE
Very good	81.8	Forest is dense	9.18 ± 0.05
Good	18.1	Wild animals increased	9.08 ± 0.17
Degraded	0	Regeneration of oak improved	7.96 ± 0.18
		Leaf litter is rich	5.17 ± 0.33
Flow of services			
Increased	86.3	Quality and quantity of fuel wood and fodder improved	9.74 ± 0.06
Maintained	13.6	Spring recharge improved	9.18 ± 0.11
		Mud erosion is less	6.86 ± 0.33
		Bamboo availability increased	6.59 ± 0.33
		Travel time for collection reduced	8.31 ± 0.17
Emerging problems			
Invasive species	10.6	*Ageratina adenophora* and *Lantana camara* is spreading fast	9.09 ± 0.18
Wild animals	28.7	Crop raiding by wild pig and ungulates	7.24 ± 0.35
Both	48.4	Few cases of leopard attack on livestock	0.92 ± 0.14
Economic burden	7.5	Monthly charge for forest guard's (Rakha) salary	7.36 ± 0.36
		Fine from members not following rules	1.33 ± 0.33
Participation of other stakeholders			
Yes	10.6	Invasive species eradication program and check dams by FD	8.27 ± 0.16
No	89.3	Plantation and hedging of forest	0.61 ± 0.14
		Monitoring of biodiversity and wild life	0.56 ± 0.11
		Monitoring of spring discharge	0.16 ± 0.05
		Awareness and training program for local people by PMC	0.06 ± 0.03

effective natural resource governance in the Bohal Spring-shed is on the verge of disintegration. There is no standard operating procedure in place and no mechanism to measure the supply of ES. Likewise, there is neither any system to measure the spring discharge nor any way to monitor the health of the spring-shed which is essential for the revision of PES amount. Lack of periodic monitoring and scientific management is reflected in the preponderance of invasive alien plants in the spring-shed. Approximately 50 ha of the forest is heavily infested with *A. adenophora* and *Lantana camara*. Impacts of invasive species on regeneration of the native biomass species and soil quality are evident at the study site (Uniyal unpublished data) which would negatively affect the supply of provisioning and regulating services in the coming decades. Crop raiding by wild animals is also a cause of concern and in the absence of any effective mitigation measures agricultural production may decline. It could also generate aversion for forest conservation among villagers in the long run. One of the major limitations of current PES model in the Bohal Spring-shed is the lack of a comprehensive and scientific valuation of ES. Villagers were not aware of the concept and values of ES at the time when the project was being formulated and the amount agreed for PES was just nominal. Although there has not been any attempt at participatory valuation of ES, this concept has had a positive influence on policy and local practices. However, in the absence of technical backing and handholding of VFDS, long-term sustainability of agreement is being challenged by a section of villagers. Absence of adequate awareness and capacity for negotiations with the secondary stakeholders and local government makes VFDS helpless. Its members have not been able to convince HPFD that protection of upstream forests is primarily its responsibility and with participatory approaches cost of protection could be reduced considerably and the amount received under PES could have been used for activities such as restoration of degraded forests rather than protection. However, under the present model, the VFDS has engaged one Forest Guard at the monthly salary of Rs. 1500. Since the PES amount is inadequate to meet the annual salary of the Forest Guard, the villagers contribute a sum of Rs. 30 $month^{-1}$ $house^{-1}$ to meet the additional cost. Arguably, the villagers too receive ES benefits from the protected forests and they should pay this amount on a voluntary basis but this is not the case and there is aversion among a considerable section of the villagers. Moreover, under the wake of globalization, rural youth do not see any incentive in investing their time and energy in protecting the surrounding forests and they have a strong tendency to out-migrate to nearby towns in search of jobs. Thus, present model of PES reflects several weaknesses in terms of science, policy, and practices.

DISCUSSION

Measurement, valuation, decision-making, and good governance are the four pillars of sustainable management of natural resources including water (Garrick et al. 2017). Adaptive community-based conservation that includes inclusive approaches, expert knowledge, involvement of all stakeholders, and voluntary cooperation is more effective than adhering to rules and regulations (Meff et al. 2002). Absence of any of these components hampers the equitable sharing of benefits and regular flow of ES. The present study reveals that (i) the upper catchment of Bohal Spring-shed provides much greater ES to the local as well as distant stakeholders and a comprehensive valuation of all the services is far from complete; (ii) the model of PES initiated in Bohal Spring-shed was based more on a mutual trust at that time which worked well for a short period; and (iii) with a growing body of knowledge and advancement of science of ES, all the stakeholders need to understand the pitfalls of current institutional mechanism and revamp their respective roles so that the ES are allowed to flow sustainably. Power relationships among different stakeholders play an important role in NRM and should be factored in PES design (Felipe-Lucia et al. 2015). In the present study, PMC—the main beneficiary has legal rights of the spring source. This power played an important role in negotiations for PES amount to be paid to VFDS in the project implementation phase. On the other hand, although the HPFD does not use the services flowing from the recharge zone, it holds managerial power of the forests. The VFDS is entrusted with the maximum responsibility of conserving forests by regulating resource extraction, but has little power and a meagre role in decision-making. This power relationship is ultimately affecting the sustainability of PES in the current scenario.

Several studies in the Himalaya (e.g., Kubiszewski et al. 2013; Paudyal et al. 2015; Joshi and Joshi 2019) have demonstrated sustainable use of natural resources through participatory approaches. Paudyal et al. (2015) found that community involvement in managing degraded lands helped to restore forests in Nepal Himalaya, which further enhanced the flow of various ES beneficial at local, regional, and global scale. Adaptive community management in the Philippines provided better livelihood options for the local communities along with long-term sustenance of the ecosystems (Yuliani 2003). The value of intact forest ecosystems (free from anthropogenic disturbances) has been highly recognized for averting biodiversity crisis and rapid climate change to achieve sustainability goals (Watson et al. 2018). In the Bohal Spring-shed, a small patch of intact forest not only supports biomass requirements of over 300 villagers and $>$ 10 000 people in the downstream area (Uniyal and Rawat 2018), but also

delivers many regulating and cultural services that have regional and global significance. Carbon sequestration is an another important regulating service of forests that have global implications (Mukul et al. 2016) and community-managed forests in the Himalaya contribute significantly to the total forest pool, i.e., ca. 5.4 billion tons. One hectare of these forests sequesters about 3.7 tons of carbon per year (Singh 2007); hence, the role of ca. 160 ha of conserved forest in Bohal, in seizing carbon is quite perceptible. Therefore, effective governance should realize the economic and ecological implications of carbon capture (Kelvin et al. 2016). Integration of local communities in measurement of carbon credits in some parts of Nepal and Kailash Sacred Landscape has not only strengthened the NRM but also increased livelihood options for the villagers (Singh 2007). It is reported that eliminating inequity by launching trainings on more need-based livelihood activities encourages active involvement of villagers in conservation efforts (Chaudhary et al. 2016). However, in the present area even after 8 years of implementation of PWGI, such initiatives are lacking. Had they been incorporated in the post-implementation plan, they would have not only enhanced the economic benefits attained through PES, but would have also revived the interest of the younger generation in NRM activities such as monitoring and measurements. Hejnowicz et al. (2014) identified that monitoring, participation, and compliance are some of the practical obstacles that hinder long-term sustenance of PES. This is visible in the Bohal Spring-shed where PWGI enthusiastically launched a few years ago is slowly showing signs of deterioration. More than 50 ha of forest has now been taken over by invasive alien species. Rapid spread of invasive species leads to poor regeneration of native species and hampers the flow of ES (Pejchar and Mooney 2009). Basic PES design that involves the valuation of ES so that there is equitable sharing of benefits among stakeholders is also lacking. It is noted that market prices change over time and so does the value ascribed to ES (Adams 2014). This has not been factored in the PES design implemented in Bohal which has increased financial burden on the cash-poor rural people. Evaluating PES design after its initial implementation in community-managed ecosystems and its improvement for its long-term success has been globally highlighted (Yuliani 2003; Kumar et al. 2014; Costanza et al. 2017). PWGI focused on planning and implementation; however, it lacked in post-implementation policies that have severe implications for its long-term sustenance as reported elsewhere (Thu et al. 2015). Stakeholder engagement using a five-feature framework that includes clear objectives, systematic representation of stakeholders, relevant methodologies, co-ownership, and engagement reflexivity (Talley et al. 2016) is missing in the present area. PES-involving multi-stakeholders require an adaptable mechanism to bridge the gap between its theoretical and practical implementations on the ground (Felipe-Lucia et al. 2015). A mix of cash and non-cash benefits based on local needs promotes PES participation (Torres et al. 2013). However, an absence of non-cash benefits to villagers was observed in the present area. The facilitator's role in initial negotiations among different PES stakeholders is very important (Kovacs et al. 2016); however, after the withdrawal of facilitators, the handholding and empowerment of the villagers by the government play a more important role which is not evident in the Bohal spring-shed.

CONCLUSION

Initial agreement for PES between the primary and secondary stakeholders in the present case was based on partial valuation of ES and without ensuring institutional mechanism to implement the scheme in the long run. The study also reveals that there was a lack of monitoring and cooperation among different stakeholders which weakened institutional mechanism. Therefore, it would be prudent to provide non-financial incentives to the primary stakeholders such as capacity building, training to improve livelihood options and develop skills of the rural communities to implement PES successfully. This would help in improving the socio-economic status of the villagers and inculcate interest among younger generation for NRM. Institutional mechanism needs to be strengthened through voluntary participation of different stakeholders so that sustenance of a working model of PES in the Bohal Spring-shed is assured and it can be implemented in similar areas at a global scale.

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