



Forest ecosystem services and the pillars of Bhutan's Gross National Happiness

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RESEARCH
PROGRAM ON
Forests, Trees and
Agroforestry

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Occasional Paper 178

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ISBN 978-602-387-062-2
DOI: 10.17528/cifor/006631

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.

Tarina Valley, western Bhutan.
Photo by Karma Wangdi

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We would like to thank all donors who supported this research through their contributions to the CGIAR Fund. For a list of Fund donors please see: <http://www.cgiar.org/about-us/our-funders/>

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Acknowledgements

This research is being carried out by the Center for International Forestry Research (CIFOR) as part of the CGIAR Research Program on Forests, Trees and Agroforestry, and is funded by the Republic of Austria. The authors thank the many public servants and private individuals in Bhutan who have provided information and insight on forests. They are also grateful for the comments from three peer reviewers.

Abbreviations

| | |
|-------|---|
| CFMG | community forest management group |
| DoFPS | Department of Forests and Park Services |
| FES | forest ecosystem services |
| FMU | forest management unit |
| GDP | gross domestic product |
| GNH | Gross National Happiness |
| GRF | government reserve forest |
| masl | meters above sea level |
| NWFP | non-wood forest product |
| PES | payment for ecosystem services |
| RGoB | Royal Government of Bhutan |
| SDG | Sustainable Development Goal |

1 Introduction

In the eastern Himalayan Kingdom of Bhutan, culture, society, economy and environment are linked in the development framework of Gross National Happiness (GNH). In this holistic concept and approach, development goals and activities are defined based on their relevance to promoting the psychological and cultural well-being of the people along with the sustainable development of a nation and society (GNHC 2013). This approach of taking the “middle path” (Rapten 2008) often requires balancing benefits and tradeoffs among competing objectives.

In Bhutan, the economy and culture are inextricably linked to the forested landscape. Forests and trees provide vital benefits and services. The economy is largely driven by natural resources – such as water, wood, non-wood forest products (NWFPs), minerals and arable land – and intact natural ecosystems provide the milieu for cultural practices and festivals, tourism and trekking. In many ways, thus, the natural forested ecosystems are at the center of this country’s well-being.

People living in mountain regions have a long history of adapting to and developing natural resource management systems to protect agrobiodiversity and biodiversity and other ecosystem goods and services to meet their livelihood needs (Fricke 1989). Recently, in a response to climate change, upland farmers in Asia are being called on by their governments to change their land use patterns to favor practices that reforest or conserve forest cover. China’s Conversion of Cropland to Forest Program is one such effort, where the government requires and supports the transition of agricultural lands to forest (Bennett et al. 2014). In Vietnam, forest rehabilitation for social, environmental and economic objectives has been supported by strong government policy since the mid-1950s (de Jong et al. 2006). Nepal and Bhutan’s community forestry programs are another example, where they encourage communities to

restore degraded hillsides through reforestation and management (Phuntsho et al. 2011; Paudyal et al. 2017). Such policies for reforestation will likely increase across the Himalaya as governments seek ways to mitigate the effects of climate change, ameliorate slope stabilization and reduce the impacts of local flooding.

Land and forest management policies, goals and strategies take place in a dynamic context. Demand for timber and water resources changes with economic development and demographic shifts, land use changes as people move away from agrarian lifestyles, and weather and hydrological dynamics change as the global temperature rises.

Conflicting demands for forest products and land result from differential dependencies on forests according to people’s economic status and geographical location. Rural agrarian and herding people depend directly on forests and forest products, while urban people may use processed forest products, such as handicrafts, lumber and medicines, although some do maintain a direct relationship to rural forestland. Of particular interest for this mountain region are the dependencies that people living downstream have on forest management upstream. Thus, it is important to identify the plausible causal pathways of impact of upstream forest condition and activity on downstream landscapes and stakeholders.

Although forest cover appears to be increasing in Bhutan, by an estimated 0.2% annual gain (equivalent to 59 km² per year) over 20 years, mostly through reforestation (Gilani et al. 2015), there are concerns that forest quality may be declining in some areas (Nkonya et al. 2014; NSSC 2014). Specific threats to upland forest areas include forest fires, fuelwood collection, timber harvest and forest grazing. Additionally, a changing climate will likely drive changes in forest composition, soil function and hydrology (Hoy et

al. 2016). Severe weather events and rapid melting of glaciers also threaten both rural and urban settlements and populations in the Himalaya, and the quality of the forested landscape as a safeguard is highly relevant.

As a result, the Royal Government of Bhutan (RGoB) is prioritizing restoration and reclamation of degraded lands through reforestation, afforestation and watershed management programs. These programs and approaches involve rural residents and farmers and have implications for their land use practices. Questions remain, however, about the precise role forests play in meeting development goals, and how forest use and land cover change impact local and downstream users.

The purpose of this paper is to conceptualize the links between forests and Bhutan's development framework (GNH) and the UN Sustainable Development Goals (SDGs), and to identify evidence for these through a comprehensive literature review. We focus on three main themes: forest ecosystem services (FES), forest governance schemes and GNH. Our intent is to inform policy makers so that they might develop regulatory frameworks that encourage and facilitate the design and implementation of forest management strategies and practices that balance multiple and sometimes conflicting goals. A secondary goal is to guide the development of future studies to qualify and quantify the roles that forests play in the well-being of Bhutan's people and economy, and to document the impacts of deforestation or forest degradation on FES, and in turn, on local communities and forest users.

2 Method and hypothesis

We conducted a search of the literature on a specific region and theme: relating forests in Bhutan to ecosystem services and forests to development goals. We first developed a hypothetical framework about the relationship between forests and GNH, and relevant components of the nation's most recent Five Year Plan. From the GNH framework we identified specific indicators related to FES. From this comparative framework, we then proposed probable causal pathways about those relationships,

that is, what specific FES could be linked to specific development goals.

We selected peer-reviewed articles and reports published in academic journals and by government offices and/or research institutions that met certain pre-defined criteria. Various online databases were used (e.g. Science Direct, Ebsco) (Table 1). We also followed subsequent links in some articles. We searched articles relating to the themes of forests, ecosystem services and GNH, limiting the search

Table 1. Search topics and terms used, in Boolean format

| Topic | Boolean keywords for search | Additional terms |
|--|--|--|
| Ecosystem services in Bhutan | Bhutan AND "ecosystem service" | |
| Forest and GNH | forest* AND happiness forest* AND "gross national happiness" forest* AND GNH forest* AND Bhutan AND development | |
| Forest in Bhutan | forest* AND Bhutan "sacred forest" OR "sacred grove" AND Bhutan | |
| Forest in Bhutan combined with specific functions or aspects | forest* AND Bhutan | AND degrad* AND "food security" AND "ecosystem service" AND "flood mitigation" AND livelihood AND water AND cultur* AND development |
| Restoration/ reforestation in Bhutan | Bhutan AND restoration OR reforestation Bhutan AND plantation | |
| Forest policy management in Bhutan | forest* AND Bhutan | AND policy OR regulation AND management AND silviculture |

GNH = Gross National Happiness.

to studies conducted in Bhutan. We ultimately used 50 articles in the review, in addition to supporting articles from other countries and regions.

The GNH framework is conceived of as a wheel, where each pillar is related in multiple ways to the other three. The wheel can also describe the relationship between forests, by the four main categories of ecosystem services they can provide, and the GNH framework (Figure 1). The multiple categories of FES are both impacted by and supportive of elements of the four GNH pillars.

The GNH pillars are further defined by nine domains, and the GNH index comprises 124 indicators and sub-indicators. We have identified 23 GNH index indicators that could be directly or indirectly related to forest ecosystems and/or the benefits they provide (Table 2). Notably, under the domain of “good governance”, the sub-indicator “protecting environment” appears to cross almost all development sectors. Under the domain “ecological diversity and resilience” the sub-indicator “feelings of responsibility towards environment” also has cross-cutting implications.

Our hypothesis is that forests directly contribute to Bhutan’s development goals as defined in the GNH framework, through providing a specific suite of ecosystem services. We consider these services, listed in Table 3, to be the causal pathways between the environment – specifically forests – and Bhutan’s development goals.

The links are thus (GNH pillars in *italics*, FES in **bold**): The existence of the forest contributes to *cultural preservation* through providing a medium for social relationships with the environment. *Cultural preservation* includes and depends on the maintenance of knowledge of the environment and on sociocultural norms and rules about protecting the forest environment (e.g. mountain closure, *sokshing*). *Cultural preservation* also presumably underpins *good governance*, which in

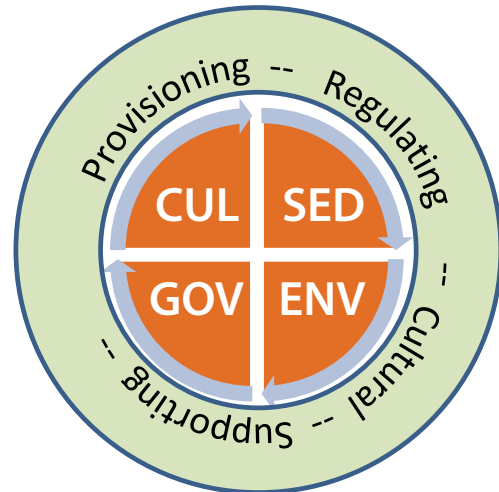


Figure 1. The relationships among the four pillars of Gross National Happiness and the four categories of forest ecosystem services

Note: The four pillars of Gross National Happiness are: equitable and sustainable socioeconomic development (SED), cultural preservation and promotion (CUL), environmental conservation (ENV) and good governance (GOV). The four categories of forest ecosystem services are regulating, provisioning, cultural and supporting.

turn drives *environmental conservation* through well-informed and enforced policies and customary social norms. *Environmental conservation* results in the sustained provision of **forest ecosystem services**, which supports *socioeconomic development* both directly, through the **provision** of goods and regulation of water services (to support hydropower), and indirectly, through providing **regulating** services of soil and slope stability, water regulation (and resulting flood mitigation) and carbon sequestration.

Specific FES directly related to human well-being in Bhutan are highlighted later on in the paper, with evidential support provided in the literature. The services are organized according to the Millennium Ecosystem Assessment framework of provisioning, regulating, cultural and supporting services (Millennium Ecosystem Assessment 2003).

Table 2. Forest-related links between Gross National Happiness indicators and eight broad classes of development goals

| GNH pillar | Domain | GNH sub-indicator or question | Development goal | | | | | | | | | | |
|------------|-------------------------------------|--|------------------|----------------|--------------------------|--------------------------------|------------------------|------------------------|-----------------------|--|---|---|---|
| | | | Rural livelihood | Water security | National economy (hydro) | Soil stability/ weather events | Wood products/ shelter | Farming/ food security | Cultural preservation | | | | |
| CUL | Community vitality | Trust in neighbors | | X | | | | | | | | X | |
| | | Number of days volunteered | | | | | | | | | | X | |
| | | Sense of belongingness in the community | | | | | | | | | | X | |
| ENV | Ecological diversity and resilience | Cultural diversity and resilience | X | | | | | | | | | X | |
| | | Feelings of responsibility toward environment | X | X | X | X | | | | | | X | |
| | | Pollution of rivers and streams | | X | | | | | | | | | |
| | | Was wildlife a constraint to your crops during the last year? | | | | | | | | | X | | |
| | | In the past one year, have your crops been damaged by wild animals? | | | | | | | | | X | | |
| | | Are landslides an environmental issue of concern in your community? | | | X | | | | | | | | |
| | | Is soil erosion an environmental issue of concern in your community? | | | X | | | | | | | | |
| | | Are floods an environmental issue of concern in your community? | | | X | | | | | | | | |
| | | Reducing gap between rich and poor | X | | | | | | | | | X | |
| | | Protecting environment | X | X | X | X | X | | | | | X | X |
| GOV | Good governance | What is the main source of water for your household? | | | | | | | | | | | |
| | | How would you rate the quality of your drinking water? | | X | | | | | | | | | |
| | | Electricity | | | | | | | | | | X | |

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Table 2. Continued

| | | Development goal | | | | | | | |
|------------|---|--|------------------|----------------|--------------------------|--------------------------------|------------------------|------------------------|-----------------------|
| GNH pillar | Domain | GNH sub-indicator or question | Rural livelihood | Water security | National economy (hydro) | Soil stability/ weather events | Wood products/ shelter | Farming/ food security | Cultural preservation |
| SED | Living standards | Roof material | | | | | x | | |
| | | How many acres of land does your household own? | | | | | | x | |
| | Psychological well-being | How many heads of livestock does your household own? | | | | | | | x |
| | | Household per capita income | | | | | | | |
| Education | Satisfaction with standard of living | | x | | | | | | |
| | Knowledge of local legends and folk stories | | | | | | | | x |

Note: The Gross National Happiness (GNH) pillars are: equitable and sustainable socioeconomic development (SED), cultural preservation and promotion (CUL), good governance (GOV) and environmental conservation (ENV).

Table 3. List of forest ecosystem services, their description, significance to Gross National Happiness, and citations

| Ecosystem service type | Description | Related to GNH (pillar) | Published evidence from Bhutan |
|--|---|-------------------------|--|
| Food (P) | Provision of wild foods such as mushrooms, berries, fruits | SED | Brooks 2010 |
| Raw materials (P) | Provision of raw materials for construction, pulp and wood, biofuels and essential oils | SED | Forests: Roder et al. 2003; Dorji and Phuntsho 2007; Covey et al. 2015; Feuerbacher et al. 2016 Timber: Phuntsho 2015 Community forestry: Wangdi and Tshering 2006; Tempel and Beukeboom 2007; Phuntsho et al. 2011; Tempa 2011; Moktan 2014; Rahut et al. 2015; Moktan et al. 2016; Rahut et al. 2016 Non-wood forest products: Namgay et al. 2007; Meijboom et al. 2008; Moktan et al. 2009 Fuel: Wangchuk et al. 2014b <i>Sokshing</i> : Dorji et al. 2003; Dorji et al. 2006; Kinga 2010 Roder et al. 2002; Norbu 2003; Wangchuk 2003; Darabant et al. 2007; Buffum et al. 2009; Wangchuk et al. 2014a Kusters and Wangdi 2013; Hoy et al. 2016 |
| Forest grazing (P)* | Forest area open to grazing of domestic animals | SED | |
| Fresh water (P) | Filtering, retention and storage of freshwater available for human consumption or industrial use | ENV | |
| Medicinal resources (P) | Availability of plants for traditional medicines as well as raw material for pharmaceutical industry | CUL, SED | Wangchuk 2008; Wangchuk and Tobgay 2015 |
| Local climate and air quality (R) | Enhancement of rainfall and water availability at local scale, and regulating air quality by removing pollutants from atmosphere | ENV | Shrestha et al. 2012; Dorji et al. 2016a |
| Carbon sequestration and storage (R) | Regulation of global climate by sequestering and storing greenhouse gases | ENV | Wangdi et al. 2013; MoAF 2016 |
| Moderation of extreme events (R) | Buffering against extreme weather events or natural hazards, such as floods, storms and landslides, and hence reducing damaging impacts | ENV | Hamilton 1987; Cheki and Shibayama 2008; Dunning et al. 2009; Hoy et al. 2016 |
| Erosion prevention and maintenance of soil fertility (R) | Capacity to provide vital regulating services by preventing soil erosion | ENV, SED | Chhetri et al. 2007; Tsering 2011; GEF-SGP/COMDEKS 2013; Nkonya et al. 2014; NSSC 2014 |

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Table 3. Continued

| Ecosystem service type | Description | Related to GNH (pillar) | Published evidence from Bhutan |
|---|--|-------------------------|--|
| Water regulation (R) | Provision of land cover and hence regulation of erosion and hydrology | ENV | Chhetri et al. 2007; Uddin et al. 2007; GEF-SGP/COMDEKS 2013; Gilmour 2014; Dorji et al. 2016b |
| Pollination (R) | Capacity to support habitat for insects and birds that provide pollination and other services essential for the development of products (e.g. fruit, vegetables and seeds) | ENV | |
| Biological control (R) | Habitat for natural fauna and flora that act as natural controls of predators and parasites | ENV | |
| Habitat for species (S) | Habitat for a variety of native plants and animals | ENV | [many] |
| Maintenance of genetic diversity (S) | Capacity to support high biodiversity – by number of species, which makes them more genetically diverse than others | ENV | Lee et al. 1998 |
| Recreation and mental and physical health (C) | Provision of scenic and natural landscapes that provide recreation areas important in maintaining mental and physical health | CUL | MoAF 2016 |
| Spiritual value (C)* | The spiritual and cultural value of forests through sacred groves, folklore | CUL | Wangdi et al. 2015 |
| Tourism (C) | Natural ecosystems as sites for eco-tourism, outdoor sport, local tourism opportunities | SED | Gurung and Seeland 2008 |

CUL = preservation and promotion of culture; ENV = environmental conservation; GNH = Gross National Happiness; SED = equitable and sustainable socio-economic development.

Note: Letters in brackets represent the Economics of Ecosystem and Biodiversity (TEEB 2010) ecosystem services categories: provisioning (P), regulating (R), supporting (S) and cultural (C). Ecosystem services categories are adapted from Baral et al. (2016); services indicated with an asterisk (*) are specific to Bhutan.

3 Forests in Bhutan

Forests are highly relevant to society in many ways. For rural inhabitants in Bhutan, local forest management “has its roots in the ancient history of rural livelihood, particularly with regard to four important forest products: *tsa* [grass] and *sok* [leaf litter], *chu* [water] and *shing* [wood]” (Dorji et al. 2003, 342). Forests support multiple sectors of the national economy, including forestry, agriculture and energy directly through the provision of goods – such as wood products, medicine, food and fresh water – and services, such as pollinator habitat and soil stabilization.

Around the world, forests are celebrated and honored in culture and spiritual life, and featured in the arts and humanities. For example, sacred forests are designated as such based on spiritual beliefs (Ormsby and Bhagwat 2010), with some ecological underpinnings (Tiwari et al. 1998). National security depends on maintaining intact and productive forest ecosystems to mitigate natural disasters (Seymour and Busch 2016), and to avoid conflict over forest resources. Finally, forests provide essential ecosystem regulating services related to water (Gilmour 2014; Ellison et al. 2017), the carbon cycle (Peng et al. 2014; Baral et al. 2016) and soil stabilization (Hartanto et al. 2003). Together these goods and services from forests comprise the FES (Millennium Ecosystem Assessment 2003).

3.1 Forests cover

Forests are the dominant land cover in Bhutan, comprising the matrix in which other land uses and infrastructural development take place. Current forest cover in Bhutan is reported to be 71% (MoAF 2016).

Bhutan has 11 main forest types, corresponding primarily to configurations of elevation and precipitation (Table 4). The greatest area comprises

Table 4. Forest cover by forest type in Bhutan

| Forest type | Forest area (km ²) | Forest cover (% of land area) |
|------------------------------|--------------------------------|-------------------------------|
| Cool broadleaved | 9,868 | 26 |
| Warm broadleaved | 6,937 | 18 |
| Fir | 3,526 | 9 |
| Subtropical | 2,418 | 6 |
| Blue pine | 1,372 | 4 |
| Chir pine | 986 | 3 |
| Hemlock | 883 | 2 |
| Evergreen oak | 315 | 1 |
| Spruce | 402 | 1 |
| Juniper – Rhododendron scrub | 572 | 1 |
| Dry alpine scrub | 27 | 0 |
| Total forest area | 27,306 | |

Source: Adapted from MoAF (2016).

the broadleaf forests, including warm broadleaf in the lower elevations starting at 500 meters above sea level (masl) blending to the cool broadleaf species to 1500 masl. Subtropical forests are found below these to the southern border of the country at 200 masl. Second in coverage are the conifer forests, which are located in the higher elevations from 2000 masl to the tree line. Each forest type provides a distinct suite of FES and serves as the matrix in which rural livelihoods are pursued. Plantation forestry in Bhutan, while very small, has resulted in increased forest cover (Bruggeman et al. 2016), with 126 km² planted between 1987 and 2012 (Gilani et al. 2015; reporting data from MoAF).

An early rough estimate of the value of Bhutan’s natural capital suggests that ecosystem services

provide about USD 15 billion annually, with 94% coming from forests (Kubiszewski et al. 2013).

Broad categories of FES, as are listed in Table 3, are useful for national policy making and strategic planning. However, managing natural capital through design and implementation of specific local interventions requires a fine level of detail, where the services, people's dependencies on them, and the impacts of alterations to forest ecosystems are identified and prioritized locally (van Oort et al. 2015).

3.2 Forest governance and management regimes

Prior to 1969, when Bhutan's forests were nationalized, much of the forestland was governed locally and managed under customary rules and traditional forest management practices (Wangchuck 2005). The first National Forest Policy was introduced in 1974, which established the modern framework for forest governance and management in Bhutan (Wangchuck 2005; Dorji and Schmidt 2014). The policy set out to centralize forest governance and establish forest management regulations based on scientific forestry. Social forestry concepts and goals were integrated in the Forest and Nature Conservation Act of 1995 in an effort to return some forest areas to local communities (RGoB 1995; Penjore and Raptan 2004). The goal became to increase forest area under formal management through strengthening local governance of forests.

Today, almost all of the forest area in Bhutan is held under public administration, with fully half (51%) of that designated as protected area. The remainder is "government reserve forest" (GRF), a category that encompasses several governance types and management regimes, including "forest management unit" (FMU), "local forest", and "community forest". Less than 1% of Bhutan's forest land is held as private forest.

Due to the mountainous terrain, only 14% of Bhutan's forest area is considered to be economically accessible and available (RGoB 2011a). Not all of the GRF is supervised under formal management plans, but the government aspires for this to be so. By 2015, 6% of Bhutan's forest area, less than half of the targeted area for commercial forest production, was designated

in 20 formal FMUs for commercial timber production (Figure 2). The sizes of these forest units differ, depending on the availability of potential production forest area. The Department of Forests and Park Services (DoFPS) develops a management plan for each FMU, while the Natural Resources Development Corporation Limited, a government corporate agency, oversees harvest. There is some concern about excessive harvest of fuelwood from the GRF outside of FMUs (Moktan 2014) and from FMU areas (Phuntsho 2015), and unsubstantiated informal claims of downstream impacts of harvest from FMUs.

Community forests are areas over which governance has been turned over from central government to a local community forest management group (CFMG) for the purposes of protection, restoration and the harvest of subsistence and commercial timber, and NWFPs. By 2016, 3% of Bhutan was covered in 677 community forests, involving and benefitting 33% of the rural population. The government aspires to have 10% of public forest land under local governance through community forests.

Private forest accounted for only 400 hectares in 2010, but private interest in forest management is on the rise. The government objective for promoting private forestry is to encourage people to plant, grow or "nurture" forest crops on registered private land. Private forests are usually managed for fuelwood and timber production, both subsistence and commercial, and some are claimed for conservation purposes. Timber production is regulated, however, and any felling or harvest of any tree on private land requires a proper permit or license, except in certain cases.

People rely on all of these units as sources of timber: GRF areas outside of FMUs, the FMUs, community forests and, increasingly, private forests. The timber stocks in GRFs and FMUs are under mounting pressure from various social welfare programs. The Subsidized Rural Timber Supply (SRTS) program, which provides an allotment of wood for housing and fuelwood to Bhutanese citizens, relies heavily on timber from the GRF areas, and citizens have certain rights to enter these areas for subsistence activities and some commercial NWFP collection. Poaching of timber from GRFs occurs mainly in the southern forests. The impacts of these pressures on timber stocks and FES are not well known.

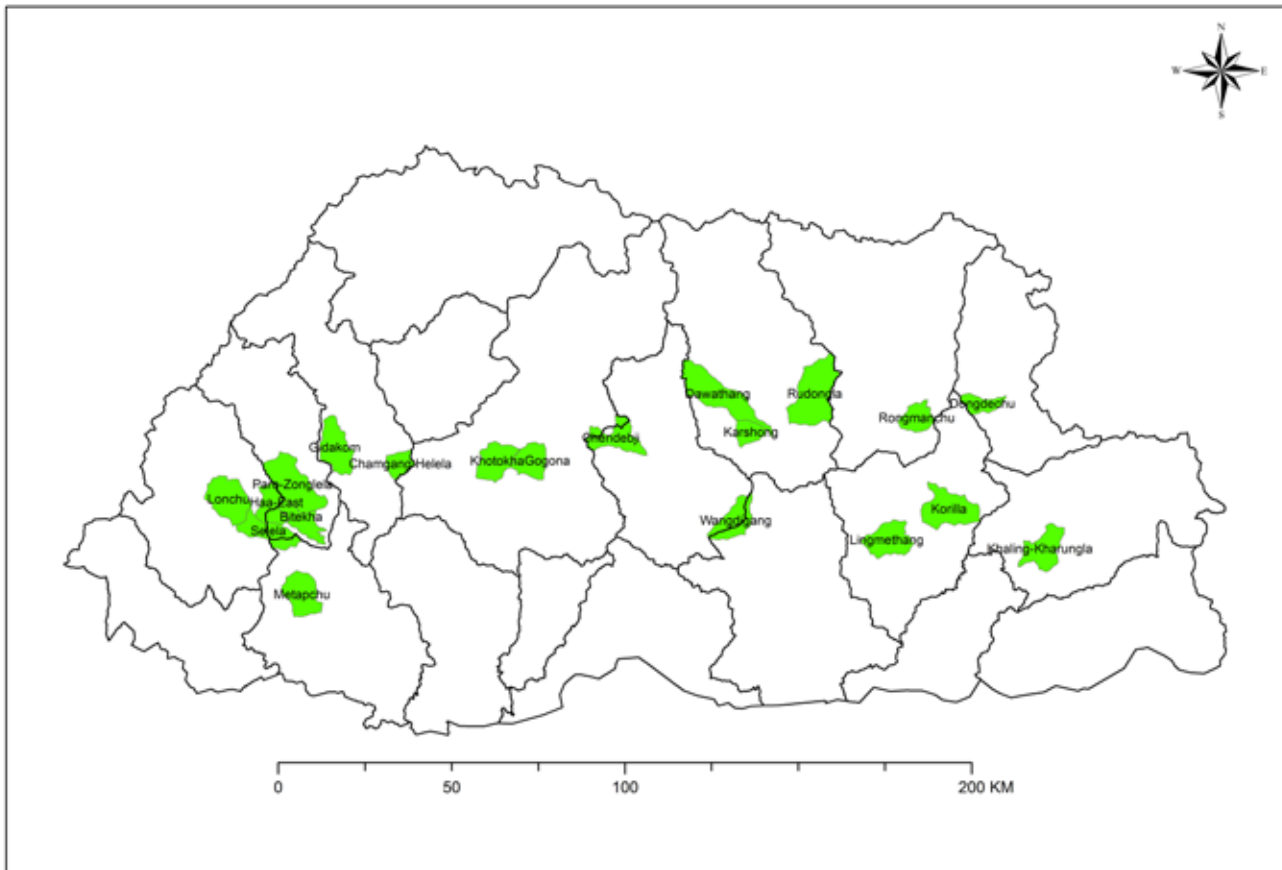


Figure 2. Locations and names of the forest management units

Source: Map created by the Ministry of Agriculture Department of Forests and Park Services.

Some areas of GRF are considered by local people to be under local customary management schemes and restrictions, either associated with seasons or specific areas under permanent protection. Among these customary norms is *Reedum*, or closing of the mountains, which is a seasonal restriction on any sort of forest activity in certain areas (Wangdi et al. 2015). Local elders indicate that *Reedum* is enforced to pacify local deities so they will not deliver natural disasters. Scientists point out that the period of restriction (March–October) corresponds with the spring and summer growth periods so important for woody recruitment in forests (Wangdi et al. 2015), suggesting an ecological basis for the restrictions. Year-round restrictions endure for certain forest areas, considered sacred forests (WWF 2011). *Sokdum*, restriction on killing animals, and *Tsadum*, restriction on grazing in pastureland, are two other traditional social restrictions on forests and meadows, both of which appear to have been important in the management of natural resources and the landscape (Wangdi et al. 2015).

It is not known how much forest land is under these customary rules, or how many sacred groves exist. While indications are strong that the customary protection afforded to sacred groves is highly effective, the forest policy has no formal protection category for them and thus offers no legal protection (Wangdi et al. 2015). Threats to these forests appear to be increasing due to demographic change and economic development (WWF 2011).

There is some concern that the displacement traditional forest management practices by scientific forestry practices may be detrimental to the forest ecosystem and to rural livelihoods (Dorji et al. 2003; Wangdi et al. 2015). The environmental and economic outcomes of scientific forestry schemes in Bhutan have not been well studied.

Of the forest governance categories, most is known about the status, opportunities and challenges of community forestry (Wangdi and Tshering 2006;

Temphele and Beukeboom 2007; Phuntsho et al. 2011; Tarnutzer 2012; Dorji and Schmidt 2014). A review of the program at the behest of the DoFPS revealed that in community forests, sustainable timber harvest, good governance and meeting CFMP objectives are the rule rather than the exception, and that the program “is contributing substantially to the conservation of forests, to bringing more forest area under formal management and to improved rural livelihoods” (Dorji and Schmidt 2014).

3.3 Pressures on forests

While remote sensing analysis of land cover change in Bhutan reveals only very small changes in forest cover (Gilani et al. 2015; Bruggeman et al. 2016), and in fact an overall increase in forest cover of 59 km² per year during 2000–2010 (Gilani et al. 2015), increasing pressure on forests is noted by public officials (NSSC 2014). These pressures range from physiological stressors related to a changing climate to reduction in timber stock, and forest clearing for urban expansion. Key pressures are highlighted here.

The Himalaya is one of the most vulnerable regions to climate change (Shrestha et al. 2012). A clear trend in increasing temperature has been shown for the region overall (Shrestha et al. 2012) and for Bhutan in particular (Hoy et al. 2016). Predictions suggest a temperature increase in some locations at three times the global average (Shrestha et al. 2012), potentially leading to receding glaciers and long-term drying. Although an overall increase in precipitation is likely in the region, rainfall rates are expected to vary greatly in terms of seasonality and location (Shrestha et al. 2012). These factors will affect many economic sectors, including water, forestry, energy and food security in the mountains and downstream.

Forest cover was historically in flux with the dynamics of shifting cultivation and from agriculture and livestock expansion until the late 1980s, when development policy began to reflect conservation goals (Karan 1987). Bruggeman et al. (2016) assessed the proximate causes of recent deforestation events in Bhutan during the 2000s as: infrastructure extension (34%), forest fires (26%), wood extraction (22%), agricultural expansion (14%) and natural causes (5%).

While in rural areas new deforestation is rare, threats do exist that compromise forest quality. A recent assessment of land degradation in Bhutan (NSSC 2014) suggested that among the direct drivers of declining forest quality are excessive forest use, unsustainable agriculture and infrastructure development, in particular roads and electricity transmission lines. Forest degradation in Bhutan is primarily driven by unsustainable extraction of forest products or insufficient silvicultural practices (Covey et al. 2015), removal of forest duff (Roder et al. 2003) and livestock forest grazing (Norbu 2003; Buffum et al. 2009). There is some concern about unsustainable, or at least unplanned, timber harvest in GRFs outside of FMUs to supply the SRTS program (Phuntsho 2015). Degradation of shrub lands at the tree line has occurred in certain parts of the country, particularly of old-growth rhododendron stands, due to pressure by seasonal *Cordyceps* collectors for fuelwood (Wangchuk et al. 2014b; Jamtsho and Sridith 2015).

Forest fires present a serious threat to both forests and people, and fires have been anecdotally linked to soil erosion and road collapse. Surface mining results in the removal of forests and soil (Galay 2008), and hydroelectric stations result in the flooding of limited riparian areas.

At the heart of Bhutan’s modernization process is the improvement and expansion of the country’s road network. Roads have two impacts on forests and their ecosystem services. First is the physical process of road building, where forest is cleared in strips and a road structure is built. The disposal of earth materials from building or clearing the roadway in many cases results in the dumping of soil and rocks down slopes. There it covers existing vegetation, and much of it eventually reaches water channels, potentially causing disruption to the aquatic ecology and sediment load in the streams. Road construction may also destabilize the affected slope and is considered to be at least a partial factor contributing to localized landslides (Cheki and Shibayama 2008; Dunning et al. 2009).

Second, new farm roads provide vehicular access between market hubs (and schools and health posts), farms and forests in the interior of the country. Farm roads have many socioeconomic and cultural benefits, but increasing access to forest interiors can also result in unauthorized extraction of forest resources, as well as creating an incentive

to convert forest land to agricultural use or infrastructure. Rural electrification is almost fully realized in Bhutan, and this process has required clearing of narrow swaths of forest to make way for posts and wires.

Modernization in Bhutan is resulting in a shift in population from rural to urban areas. This shift can adversely affect forests in two ways: expansion of the urban area into forestland, and increasing pressures on forest timber with demand for construction material. That said, urban infrastructure expansion around some cities in Bhutan (Thimphu, Paro, Punakha and Wangdue) has mainly resulted in conversion of agricultural land. At the same time, the allure of the urban modern lifestyle is driving youth from the farm, which reduces rural farm labor availability, and in some cases leads to farm abandonment. This can result in increased forest cover as forests encroach on fallow fields and pastures, as has been shown in Bhutan (Yoder et al. 2017), Nepal (Paudyal et al. 2016) and Australia (Baral et al. 2014a).

Indirectly, climate change may affect the structure, composition and function of Bhutan's forests (Hoy et al. 2016). Some evidence of this can already be seen in western Bhutan, where a change of

temperature and humidity patterns have affected species distribution and resulted in a change of forest composition and structure (Wangda and Ohsawa 2006a).

Extreme weather events related to climate change may have an impact on forests in Bhutan, particularly due to monsoon events that supersaturate soil, resulting in land slips, and overwhelm river courses, causing flooding. Excessive glacier melt threatens to result in glacial lake outburst floods, which may scour a river valley of its vegetation, build infrastructure and crops.

Incidences of mega-drought, erratic rainfall patterns and frequent monsoon failures have been observed in the Himalaya and are attributed to climate change (Cook et al. 2010; Schewe and Levermann 2012; Menon et al. 2013). Tree responses to drought and the adaptive capacity of major species are under study by an international research team (Wangdi 2016). Forest fire incidences have also increased in the region. From 2010 to 2014, the DoFPS recorded an average of 45 forest fire incidents damaging about 80.3 km² of forest annually (DoFPS 2017). Forest fires are currently viewed as the most immediate threat to forests and their continued provision of ecosystem services.

4 Policy imperatives linking forests and human well-being

The RGoB recognizes the multiple critical functions that forests play in securing both goods and services for its people. Thus, the government has developed an array of strong policy imperatives to protect and manage the nation's forests.

At the highest level, the imperative for forest conservation comes under the Constitution of the Kingdom of Bhutan, which stipulates that a minimum of 60% of Bhutan's total land area is maintained under forest cover for all time. To carry out this mandate, protection of FES and sustainable management for forest goods are central objectives throughout the forest and land regulatory frameworks and development strategies.

4.1 The development imperative

The concept of GNH underpins the RGoB development goals and strategy, with concern for balancing material, psychosocial and spiritual development. It is a development philosophy that describes the multidimensionality of happiness, specifically under four broad pillars: equitable and sustainable socioeconomic development, cultural preservation and promotion, environmental conservation and good governance. It is presented as an alternative to the material focus of the gross domestic product (GDP) or even the human development index. GNH is assessed by the GNH Commission through an index measure of human well-being based on Bhutanese values that are grouped into nine domains and comprise 124 indicators.

The goal of development based on GNH is to take the middle path, recognizing that some trade-offs must be made, and the environment is no exception (Rapten 2008). For example, rural livelihood (sustainable socioeconomic development pillar) in Bhutan has historically been highly dependent on natural forest resources,

such as timber and NWFPs, but even more so on arable land for agriculture, which replaces forest. Despite a long tradition of shifting cultivation in Bhutan, this practice was banned outright in 1995 as a response to international pressure to halt so-called 'destructive' agricultural practices (Wangchuk and Siebert 2013). The move may have stabilized forest cover dynamics, particularly in the southern sub-tropical zone, but it was a trade-off for rural livelihood and cultural practice. National economic development today depends on rivers for hydroelectricity generation. Agriculture and livestock practices necessarily compete with forest cover, and timber extraction, while generating revenue, can impact forest quality.

The RGoB prioritizes development goals in successive five year plans, where budgets are set. All policy, plans and program proposals are subject to a screening conducted by the GNH Commission for alignment with the GNH framework. Key objectives in the 11th Five Year Plan (2013–2018) related to the environmental sustainability pillar are (1) to ensure carbon-neutral and climate-resilient development and (2) to pursue the sustainable utilization and management of natural resources (GNHC 2013). Specifically, enhancing water security, improving forest management and increasing efficiencies and income in forest-based industry are priority Sector Key Result Areas (SKRA) (Table 5).

In addition to these national imperatives for environmental sustainability, Bhutan is party to many multilateral environmental agreements, including the Paris Agreement under the United Nations Framework Convention on Climate Change and the SDGs, which offer guidance on achieving equitable and sustainable development. Two of the SDGs are particularly relevant to Bhutan's forests and their role in meeting these development goals. SDG 15 is to "sustainably manage forests, combat desertification, and halt

Table 5. Sector Key Result Areas under the pillar of environmental sustainability related to forest ecosystem services in the 11th Five Year Plan (2013–2018)

| 11th Five Year Plan – Environment Sector Key Results Area | Forest related key performance indicator and target | Target change |
|--|---|--|
| Negative impacts on environment from development activities minimized or avoided | GHG emissions controlled | No change |
| | Ecological footprint | Baseline established and target defined |
| Opportunities for livelihood strengthened | Annual income from sale of forest products from community forests and NWFP groups | Increase from USD32 to USD64 per household |
| Sustainable production and efficient utilization of timber enhanced | Percentage recovery rate of wood from upgraded technology | Increase from 64% to 70% |
| | Forest area brought under SFM | 6.6% to >12% (184,611 ha to 218,542 ha) |
| Water security enhanced | Integrated Water Resource Management Plan | Develop a national plan |

GHG = greenhouse gas; NWFP = non-wood forest product; SFM = sustainable forest management.
Source: GNHC (2013).

and reverse land degradation and halt biodiversity loss.” Specifically, target 15.4 suggests that by 2030 mountainous countries should “ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development.” Bhutan is already on track to meet SDG 13, “to take urgent action to combat climate change and its impacts,” largely because of its high forest cover, low agricultural area and lack of deforestation. It is a carbon-negative country.

4.2 Forest and land policy imperative

Given the multiple sources of pressure on the forests of Bhutan, conserving forest cover and affecting sustainable management of forest resources requires a multisectoral approach. Regulations in forestry, conservation, agriculture and livestock, rural infrastructure development, and energy, among other sectors, are relevant. Successive iterations of key policies are converging on a watershed management approach to promoting the harmonization among sectors. The critical importance of watershed management has been recognized in Bhutan for quite some time, culminating in the establishment of the Watershed Management Division under the DoFPS in 2009. The 2011 *Roadmap for Watershed Management*

recognizes that effective watershed management is a long-term goal requiring multi-level stakeholder engagement at all stages of planning and implementation (Tsering 2011).

Efforts have been made to assess the status of specific watersheds and prioritize needs (Chhetri et al. 2007; GEF-SGP/COMDEKS 2013), but work remains to be done. The development of an Integrated Water Resources Management Plan is a Sector Key Results Area in the 11th Five Year Plan.

The National Forest Policy suggests that watersheds with “effective vegetation cover” are critical for “variations in water flows and to minimize erosion” (RGoB 2011a, 11). The forest policy recognizes that poor watershed management can result in *in situ* reduction of site productivity, reduced life of reservoirs, and hydropower infrastructure maintenance issues as a result of excessive siltation and sedimentation. The policy clearly articulates the linkages between upstream and downstream stakeholders:

“Downstream water users depend on good stewardship of the natural resource base by upstream residents and land managers. Equity considerations suggest that the upstream stewards should receive some recompense for the costs involved in their good stewardship. As well as the role that upstream watersheds

play in water production, they also play an important role in sustaining the livelihoods of upland farmers and graziers. In this regard, the maintenance and improvement of watersheds is critical to the sustainability of rural livelihoods by improving the quality of agricultural and pasture land.” (p. 11).

Finally, specifically related to degraded forest areas, the National Forest Policy 2011 states that investments in planting forest where natural regeneration is inadequate should be made by the beneficiaries of the forest services.

“In areas where natural regeneration is inadequate to ensure a future well stocked forest of desirable commercial species, forest plantation of appropriate vegetation composition should be pursued. Such investments should be realized from beneficiaries of watershed and ecosystem services (e.g. revenue from lease of GRF land, tourism, hydropower and wood and non-wood based industries as also watershed management).” (p. 10)

The Forest and Nature Conservation Act of 1995 established the legal basis for community forestry,

through the Social Forestry Program (RGoB 1995). The Act originally stipulated that the community forest area had to cover at least 50% degraded forestland. The Forest and Nature Conservation Rules of 2006 relaxed this rule, allowing community forest to encompass any type of forest in and around the village or settlement area. However, if degraded or deforested areas fall within community forest area, the CFMG must “afforest degraded or barren area with CF [community forest] and reforest areas that are damaged or destroyed by fire or from natural disasters” (RGoB 2006; Ch. III, 31.2.d). Water source protection is also often included in the management plans for community forests.

The current regulatory framework governing forests and their services includes the following policies, among others: GNH and Bhutan 2020 Vision, the National Environment Strategy, the National Forest Policy 2011, the National Strategy for Community Forestry 2010; and laws: the Forest and Nature Conservation Act 1995, the Forest and Nature Conservation Rules 2017, the Land Act 2007, the Water Act 2014, and the National Environment Protection Act 2007. The Land Act 2007 also has some implications for ownership of trees (Kinga 2010; Wangdi et al. 2013).

5 Evidence for forest contribution to GNH in Bhutan

Few papers specifically address the links between elements of GNH and the status of the environment (e.g. Zurick 2006). Some attention is given to the perceptions of the links between nature conservation and human well-being (Rinzin et al. 2009), and medicinal plant biodiversity and GNH (Wangchuk and Tobgay 2015). The literature on forests is dominated by research on forest ecology and management. Efforts are underway to estimate the value of forests in Bhutan (Kubiszewski et al. 2013; WWF 2017), but very little quantitative data on FES exists.

Under each service, we provide specific evidence by way of published literature that it is tied to Bhutan's development goals. In some cases, we expand on this evidence with personal observations.

5.1 Provisioning ecosystem services

Forests clearly provide subsistence goods and income opportunities to different actors in Bhutan through the provision of forest products, nutrients for agriculture and fodder for grazing domestic animals. These provisions serve to sustain rural families by providing materials for the four basic needs: food, water, energy and shelter. Another critical outcome of forest provisioning services is rural income, and increased production can result in growth in local and national economies. We include rural income here as an outcome of the provisioning services of forests.

5.1.1 Food security

Fully 60% of Bhutan's population is rural, and 69% of households are reportedly dependent on an agrarian lifestyle. The food security of rural households depends on forests in several ways. First, forest grazing is an essential source of fodder for cattle (Roder et al. 2003; Darabant et al. 2007),

and the cattle provide milk for cheese, a mainstay of the Bhutanese diet. Herders are granted grazing rights (*tsamdrog*) to certain areas of forest, but cattle grazing is not confined to these areas (Roder et al. 2003). Forest grazing has been estimated to provide around a quarter of the total dry matter requirement of Bhutan's livestock and also much needed phosphorous for agricultural soil from the cattle manure (Roder et al. 2002), although with the introduction of improved breeds and cultivated pasture, this practice is changing (Wangchuk et al. 2014a). Cattle feed primarily on the young sprouts of forest bamboo and the saplings of broadleaf trees, in many cases hindering the regeneration of broadleaf species (Wangda and Ohsawa 2006b; Buffum et al. 2009) but facilitating the regeneration of conifer species (Darabant et al. 2007).

Second, the traditional practice of *sokshing*, or the collection of leaf litter (duff) from the forest floor, is an essential practice for enhancing the fertility of agricultural soils, particularly by contributing phosphorous (Roder et al. 2003). *Sokshing* areas are now under state control, but prior to the 2007 Land Act, they were included in private and community land records (Kinga 2010) and the *de facto* practices of local people tended to result in effective forest management (Dorji et al. 2006).

On the other hand, forests indirectly challenge food security through harboring wildlife that prey on livestock and raid crops. Human-wildlife interactions in this way pose a serious threat to rural livelihoods, food security and personal safety throughout the country (Wang et al. 2006). In this way, forests are also a "disservice" to society. New restrictions on clearing brush and burning, coupled with loss of labor to urban migration, take land out of production, resulting in forest encroachment on grazing land and agricultural fields (Namgay et al. 2014) and bringing wildlife habitat yet closer to the farm.

5.1.2 Fresh water

The Greater Himalaya is a critical regional landscape and, with its glacial mountains, serves as the water tower for much of Asia (Xu et al. 2009). The provision of fresh water as a resource is critical to human well-being across sectors. Streams and springs supply water for drinking, bathing and irrigation, while rivers feed the many hydroelectricity generators across the country, large and small. Fresh water in water bodies and wetlands also serves as a regulating service, providing habitat for aquatic, wetland and riparian flora and fauna. Forests may also play a role in the provision of fresh water for local and downstream uses.

Public belief that the removal of forest cover causes a reduction in the volume of water in streams and springs is widespread (Gilmour 2014). This belief has been revealed in Bhutan in public forums and meetings where concern is expressed about decreasing water supply from springs. Evidence from elsewhere suggests that the opposite is true, that removal of trees increases water yield in the catchment due to the reduction in evapotranspiration by trees (Likens and Bormann 1974), particularly in low-flow periods (Gilmour 2014), though no research on water balance has been published for watersheds in Bhutan.

5.1.3 Energy

Forests contribute to Bhutan's energy sector in two ways, directly through the provision of fuelwood and indirectly through the maintenance of water catchment areas for hydroelectricity generation plants (Uddin et al. 2007).

Fuelwood comprises about 70% of Bhutan's total energy consumption (Wangchuk et al. 2014b). In 2012, 47% of the country's general population was estimated to rely on fuelwood, down from 55% in 2003 (Rahut et al. 2016). Overharvesting of fuelwood has resulted in shortages in some areas (Moktan 2014). Rural electrification has been shown to reduce fuelwood use (Uddin et al. 2007). Efficient wood-burning stoves and alternative energy appliances are being introduced to reduce pressure on forest resources and to alleviate the public health problems associated with indoor air pollution from burning wood.

Charcoal is not currently a forest product in Bhutan, but some argue for its production, since it is a major import item used in the metallurgical industries (Feuerbacher et al. 2016).

Bhutan derives almost all of its electricity from its own hydroelectric generators, from pico-scale to mega-scale plants. Furthermore, the sale of hydropower electricity to India accounts for about 14% of the nation's GDP (NSB 2016). High sediment load in rivers accounts for about 60% of the repair costs in hydroelectric plants, making an economic case for watershed management (Nkonya et al. 2014). The team estimated that sustainable land management resulting in increasing forest cover and density, along with terracing and contouring, can reduce sediment loading to rivers by 50%.

5.1.4 Shelter

Wood is the traditional material for rural construction and furniture, and most of this is from conifer species, given its easy workability. Timber for house construction and renovation in rural areas is provided at highly subsidized rates by the government. Through the Subsidized Rural Timber Supply program each household is allotted a certain volume of lumber from state forests every certain number of years to either renovate or renew their dwellings (RGoB 2011b). Urban and peri-urban growth in the nation's capital and other urban centers is creating new demand for Bhutan's pine lumber and putting stress on the program (Phuntsho 2015) and on the forest management units.

5.1.5 Rural income

For natural resource-dependent communities, rural income is an outcome of ecosystem services. In a public perception survey on the effectiveness of GNH, Rinzin et al. (2007) found that 71% of respondents affirmed that the environment provides a basis for socioeconomic development. While export of lumber has been banned in Bhutan since 1999 (DoFPS 1999), timber serves to generate income for local people and the government through sale in the domestic market. Forest products – timber and paper – reportedly provided 7.0% of GDP in 2011, excluding the informal sale of many NWFPs (Nkonya et al. 2014), and 6.6% in 1984 (Karan 1987). The RGoB reports

that the share of real GDP from forestry and logging dropped from 6.1% in 2001 to 3.0% in 2012 (GNHC 2013), and to 2.6% in 2015 (NSB 2016).

The primary goal of the community forestry scheme is for CFMG members to meet subsistence needs, mainly for timber, fuelwood, and NWFPs for food, medicine and household and farm items. A secondary goal, introduced in 2006, is to contribute to rural poverty alleviation by allowing CFMGs to sell forest products, both timber and non-timber (Temphel and Beukeboom 2007; Phuntsho et al. 2011). The precipitous growth of the community forestry program in the last decade has made it difficult to track the effectiveness of the program in achieving its poverty reduction goals, but case studies suggest that CFMGs are gaining income from the sale of community forestry products (Temphel and Beukeboom 2006 case studies herein; Dorji and Phuntsho 2007; Namgay et al. 2007; Buffum et al. 2010; Phuntsho et al. 2011 and case studies herein; Dorji and Schmidt 2014; Rahut et al. 2015; Moktan et al. 2016).

There is some concern about the equity of benefits derived from community forests, both for subsistence and income (Buffum et al. 2010; Moktan et al. 2016). In one case, Moktan et al. (2016) found that forest products did generate considerable income for two communities, accounting for 12% and 3% of the village incomes. In this case, in descending order of importance, communities benefited from the sale of mushrooms, leaf litter, fuelwood and large-diameter timber. The study did find income disparity between the rich and poor households in each village, with wealthier households capturing more of the income, mainly from mushrooms.

Rural residents can also derive income from selling NWFPs harvested in private forests and GRF. Cane (*Calamus* spp.) and bamboo are important products from forests in the middle-elevations and have been estimated to account for well over half the gross annual household income in some villages (Meijboom et al. 2008; Moktan et al. 2009).

Other important NWFPs are wild edible plants and medicinal plants and fungi. Oil derived from natural lemon grass (*Cymbopogon flexuosus*) is a major NWFP in the drier eastern regions

in the chir pine (*Pinus roxburghii*) forests (Wangchuk 2008).

5.2 Regulating ecosystem services

Forests provide numerous regulating ecosystem services, including soil retention, rainwater absorption, and microclimate regulation. These and other regulating services are linked to two of the Key Result Areas of the 11th Five Year Plan: integrated watershed management and minimizing or avoiding the negative impacts of development activities.

5.2.1 Watersheds

Due to the mountainous landscape of Bhutan, it is not unreasonable to expect that forest cover should play an essential role in regulating the overland movement of water resulting from precipitation and flood events, and that forest cover plays a role in regulating soil erosion and the eventual sedimentation in certain landscape features and water channels. In fact, this thinking, in its most broad form, led to the Theory of Himalayan Environmental Degradation (THED), which suggested that land cover change high in the mountains could have a dramatic impact on the hydrology in the lower reaches of the watershed. The theory has little support, at least at the macro scale (Hamilton 1987; Ives 2006), but evidence of impacts at the meso and micro scale can be found (see references in Gamble and Meentemeyer 1996).

Bhutan is initiating efforts to develop schemes for payment for ecosystem services (PES), especially focusing on water-regulating services (WWF 2017), but quantifying such services is challenging, starting with the absence of ground-based data. One CFMG in Bhutan is benefiting from a PES program: the Yakpugang community forest of Mongar in eastern Bhutan, which is the critical water source for Mongar municipality and several downstream villages.

While we found no studies from Bhutan that provide direct evidence for downstream impacts of upstream forest use, a review by Gilmour (2014) clarifies some key points about the relationships between forests and water. While forest cover does not necessarily reduce flood flows compared to other vegetation types, forest management practices can affect forest water use, and potentially water

yield, at the local level. After harvest events, or large-scale forest disturbance, stream flow might increase due to less evapotranspiration and overland flow (Likens and Bormann 1974), and during small and medium-sized rainfall events peak flows may intensify (Gilmour 2014). The increase in water yield from these areas declines as the forest regrows. Intact understory vegetation in forests helps to stabilize surface soil, and timber harvest operations that disturb the soil surface substantially can result in erosion and reduction in stream water quality. It has been suggested by district officials and residents alike that water supply in urban centers is compromised by timber harvest upstream, but direct links have not been verified. In Bhutan, the Gedu forest development project, a private endeavor in the south-west of the country (Karan 1987), has been cited by land management officials we interviewed as a clear case of the impacts of upstream forestry on the downstream environment.

One study on landslides in Bhutan found that landslide occurrence can be predicted with more certainty on barren land with grasses than on forest land, settled areas or agricultural land (Cheki and Shibayama 2008). We found no published direct evidence for the role of forests in local water regulation and erosion in Bhutan. However, there is anecdotal information and, thus, concern. Rural communities and religious bodies have traditionally protected water sources by fencing or prohibiting entry into forested areas near the source. *Bhutan 2020: A Vision for Peace, Prosperity and Happiness* states: “The progressive removal of vegetation cover, especially in critical watershed areas, is beginning to affect the hydrological balance, leading to the localized drying up of perennial streams and flash flooding. In some cases, this has been aggravated by poorly conceived new road construction and irrigation systems” (RGoB 1999, 37).

Problems related to water regulation in Bhutan, including scarcity and flooding, are rather attributed to extreme weather events overwhelming the natural and built

infrastructure, with consequences to human lives attributed to inappropriate siting of infrastructure or poor quality of construction.

5.2.2 Mitigating natural disasters

The public perception of the relationship between land management and natural disasters is shown to be strong in Bhutan (Karan 1987). A public perception survey on the effectiveness of GNH showed that 52% of respondents affirmed that environmental management, in general, results in the prevention of natural disasters (Rinzin et al. 2007). Forests can buffer natural disasters caused by extreme rain events only up to a point where the strength of the event surpasses the ability of the ecosystem to absorb the energy of the storm. Beyond that point, forests are prone to the impacts of extreme events. No direct evidence of forest mitigation of extreme weather events was found in the literature on Bhutan; however, information from Nepal suggests that expanding forest cover in community forests has reduced the incidence of flash floods in some areas (Niraula et al. 2013). Gilmour (2014) cites evidence that forests on hillsides contribute to the prevention of small shallow landslides, but not large ones.

5.2.3 Climate

Weather and hydrological variability in the Himalaya, which is exacerbated by global climate change, are of concern in Bhutan. Precipitation in the whole Himalaya appears to have risen during the past 25 years, but there is high variability among Himalayan regions (Shrestha et al. 2012) and within Bhutan (Dorji et al. 2016a). Farmers, among others, have perceived changes in local precipitation and have been taking adaptive measures to try to ensure continued crop production (Kusters and Wangdi 2013), but the role of forests in mitigating problems related to precipitation is not evident for the region. Changes in temperature and rainfall will affect forest productivity, in turn affecting evapotranspiration rates, which in turn may affect local weather. Basistha et al. (2009) explored the relationship between deforestation

and rainfall in the Indian Himalaya and found that the evidence for a direct cause and effect is inconclusive.

5.2.4 Supporting services

Forests contribute to the supporting services of soil formation, biodiversity habitat and water cycling. Forests pump water from the soil into the atmosphere through evapotranspiration, they provide a local cooling effect by deflecting and absorbing sunlight and providing shade, they promote rainfall through release of volatile organic compounds around which raindrops may form, their above-ground structure slows overland flow of water, and their root structure improves infiltration of water through the soil (Ellison et al. 2017). The removal of forest cover, then, can impact these services. No study on these services in Bhutan was found in this search, though one does estimate the water balance across Bhutan, finding that its variation is mainly due to an interaction between vegetation type and precipitation (Dorji et al. 2016b).

There is a growing literature on the wildlife of Bhutan, some of which is by nature related to

forests as habitat. Strictly ecological studies were not included in this review.

5.3 Cultural services

With dramatic elevational gradients in seven major valley systems, Bhutan's forests harbor high biodiversity (RGoB 2009). This biodiversity is recognized as a source of cultural pride and spiritual strength (RSPN 2006), and its protection is tied to the kingdom's constitution. Research evidence suggests that tourists with an interest in the natural beauty of Bhutan stay longer than those who come to experience its culture (Gurung and Seeland 2008).

Protection of certain landscapes and forests is provided by social restrictions based on religious beliefs and traditions (RSPN 2006; Wangdi et al. 2015). A recent study on this in Bhutan indicates that enforcement of these social restrictions "was primarily driven by a need to pacify local deities and thereby avoid natural disasters" (Wangdi et al. 2015, 113). The modern emphasis on scientific forestry and regulatory prohibition of customary rights and practices has challenged the cultural connection to forests and may threaten the very health of the forest.

6 Discussion

Bhutan's commitment to environmental sustainability is engraved in the nation's constitution and its GNH development framework, defined in its policies across sectors, and evident in the landscape. Just over 70% of the land area is under forest cover, and 51% of it is under some form of protection. This commitment is supported by both logic and the research literature, which suggest strong links between the environment and human well-being.

This small nation has committed to construct energy infrastructure, transport networks and community assets in a manner that does not compromise the integrity of the natural infrastructure and capital. The high forest cover in Bhutan is impressive, and the protections afforded by both *de jure* and *de facto* rules are strong. The GNH framework provides guidelines for vetting the benefits and trade-offs of all development proposals according to the four pillars of GNH: environmental sustainability, cultural preservation, good governance and equitable socioeconomic development. Forests figure strongly in the equation.

Our hypothesis was that forests directly contribute to Bhutan's development goals as defined in the GNH framework, through providing a specific suite of ecosystem services, or causal pathways between the environment – specifically forests – and Bhutan's development goals. We suggested that cultural preservation provides a medium for the social relationship to the environment. This is most evident in the literature on sacred groves and to some extent on the collection of NWFPs. We suggested that cultural preservation also underpins good governance, which in turn drives environmental conservation, through well-informed and enforced policies and the respect for customary social norms. This aspect is critical in efforts to turn forest governance over to villagers in the community forestry program.

Social relationships rooted in strong cultural ties are essential for effective governance, particularly at the village level. We further hypothesized that environmental conservation results in the sustained provision of FES, which supports socioeconomic development: both directly, through the provision of goods and regulation of water services (e.g. to support hydroelectric operations), and indirectly, through providing regulating services of soil and slope stability, water regulation (and mitigation of local flooding) and carbon sequestration.

Some published studies drew links among three and even all four pillars. For example, the strongest, most direct evidence for the causal connections between forests and human well-being in Bhutan comes from village-scale studies on income and subsistence benefits from forest products in community forests, and particularly with NWFPs. This touches on culture, where knowledge and use of NWFPs follows a long tradition; environment, where the sustainable management of the resource requires ecological knowledge and results in the maintenance of intact ecosystems; governance, since the community forest is a result of devolution of control over the forest area to local the community; and socioeconomic development, from the income generated by the sale of the products or handicrafts produced from the resource (see, for example, cases in Temphel and Beukeboom 2006; Meijboom et al. 2008; Phuntsho et al. 2011).

We found limited evidence in the literature for causal connections between upstream forest condition and land use activities and downstream implications. In one case, the downstream impacts were only estimated using models and proxy datasets (Nkonya et al. 2014; WWF 2017). The case of the Yakpugang community forest in central Bhutan, in which the community is paid for water protection for downstream users is encouraging, but to be truly effective as a land management tool,

the watershed dynamics in the system should be quantified. While the institutional arrangement for this is still being worked out, exploring such micro-scale PES schemes is essential not only for the benefit of local communities, but also for recognizing their conservation efforts to encourage local people's participation in natural resource management in the long run.

Priorities for forest conservation, management and restoration, as they relate to the many aspects of human well-being, or GNH, can be identified through assessing FES. Beginning with qualitative assessments of forest services through participatory research methods (Paudyal et al. 2015), priority

areas can be identified for further study through quantitative assessments of the possible causal connections between forest condition and outcomes on human well-being (Bhatta et al. 2016). For example, to assess the pathways between forest condition in the upper watershed and the downstream manifestation of FES, measurements can be made of forest cover, bare soil and area under cultivation and compared to flood events, river sediment loads and water provision in the lower watershed. A quantification of ecosystem services can then inform management strategies and appropriate forestry and land use policies and practices that optimize outcome for the overall goals of GNH.

7 Conclusion

While the links between forests and human well-being in Bhutan, as defined by the GNH framework, are conceptually robust, the literature falls short on providing direct empirical evidence for many of the causal relationships, particularly between upstream land use and downstream conditions. Lack of evidence leaves gaps in our knowledge and even perpetuates myths and misconceptions about the role that forests play in Bhutan. It is becoming more urgent to understand these relationships given the mounting uncertainty about how forests are responding to changing precipitation patterns and temperature due to global climate change.

To develop incentive programs for forest conservation and restoration, such as PES and pay-for-performance donor funding, the evidence base needs to be expanded for causal pathways between upstream forest condition and downstream security, particularly for services such as water regulation. In the sloping landscapes of the eastern Himalaya, concerted efforts should be made to conduct research at multiple scales and using mixed methods (Baral et al. 2014b) on the linkages between forests and human well-being. This will help provide evidence to support policy direction and management decisions. Furthermore, incentives and support must be provided to forest stakeholders to ensure that appropriate measures are carried out and sustained.

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In the eastern Himalayan Kingdom of Bhutan, culture, society, economy and environment are linked in the development framework of Gross National Happiness (GNH). In this literature review, we highlight the relationships between forests and Bhutan's development framework and current priorities, identifying plausible causal pathways. Due to the mountainous nature of this country, our particular interest is in the impacts of upstream forest activity on downstream stakeholders. Our hypothetical framework identifies specific causal pathways between forests and the four pillars of GNH (environmental conservation, cultural preservation, equitable socioeconomic development and good governance), and evidence was sought in the published literature to test the hypothesis. While conceptual support for many linkages between forests and each of the pillars was found in the literature, evidential support specifically for Bhutan is limited. The strongest evidence is found for the role of forests in socioeconomic development and good governance, particularly through the community forestry program. To develop incentive programs for forest conservation and restoration, such as payment for ecosystem services and pay-for-performance donor funding, the evidence base needs to be expanded for causal pathways between upstream forest condition and downstream security, particularly for services such as water regulation. The evidence should inform public policy and forest management strategies and practices.



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