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Short communication

Managed fuelwood harvesting for energy, income and conservation: An opportunity for Bhutan



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ABSTRACT

Fuelwood is the primary energy source for most Bhutanese and comprises 70% of national energy consumption. Nevertheless, forest cover and fuelwood supplies have increased in recent decades. The Government of Bhutan is committed to renewable energy development, reduced fossil fuel use, and sustainable forest management, but has not developed its wood biomass potential. We suggest that promoting research and policies to increase managed fuelwood harvesting could help meet national energy independence, rural income and employment, forest management and biodiversity conservation objectives. Managed fuelwood harvesting will require site-specific assessments of resource availability, local needs and market demands, and rigorous monitoring and enforcement.

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1. Introduction

Fuelwood is the principal energy resource for over 2 billion people worldwide and consumption is increasing due to domestic use [1] and renewable energy development [2]. Researchers and policy makers are concerned about potential adverse environmental effects associated with fuelwood harvesting, particularly in developing countries [3]. Nevertheless, forest cover has expanded in much of the world, including densely populated, fuelwood-dependent countries such as India [4].

The Himalayan nation of Bhutan illustrates the opportunities and challenges associated with fuelwood use and management. The Royal Government of Bhutan (RGoB) is committed to forest conservation and has pledged to become carbon neutral by 2020. Towards this latter goal, and to generate revenue and foreign exchange, Bhutan is rapidly developing hydroelectric production and initiated a program to convert government vehicles from fossil fuels to electricity [5]. The objective of this commentary is to evaluate potential social, economic and environmental implications associated with managed fuelwood harvesting in Bhutan.

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2. Materials and methods

We evaluate fuelwood policies, use and management in Bhutan utilizing newspaper and journal articles, published RGoB data and online sources. This is supplemented by personal observations acquired through studies of fuelwood consumption and management, community forestry, protected area management, and swidden agriculture in Bhutan between 2006 and 2014.

3. Results and discussion

3.1. Fuelwood use and availability

Fuelwood is the primary energy source for the majority of rural and urban Bhutanese where it accounts for 70% of total energy use and per capita consumption is among the highest in the world [6–8]. Nevertheless, forest cover increased in Bhutan from 72% in 1995 to 81% in 2010 [9] primarily due to natural secondary forest regrowth following the cessation of swidden farming and other historic land uses [10]. Swidden was widely practiced throughout Bhutan for centuries, but was banned by the RGoB in 1969 when forests were nationalized and the practice largely ceased by the mid-1990s [11].

At present, fuelwood harvesting occurs primarily in government reserve forests and is regulated by the Forest and Nature Conservation Rules of Bhutan [12]. These rules specify that fuelwood can be harvested in designated forest management units or community forests, and that local household and community forestry management group needs must be met before wood can be harvested for industrial or commercial purposes. Households are allowed up to 16 m³ of fuelwood year⁻¹ from forest management units if they lack electricity or 8 m³ year⁻¹ if they have electricity [12]. The amount harvested from community forests depends on site-specific management plans based on local inventories.

Total fuelwood consumption is likely to be greater than that permitted by the harvesting rules. A detailed study in one village in Bumthang District found that consumption averaged 54 m³ household⁻¹ year⁻¹ or almost three times the permitted amount [13]. However, this same study found that local timber and fuelwood supplies were increasing and that 52 ha could sustainably meet all household heating and cooking needs at current consumption rates based on standing biomass and growth and yield measurements. Furthermore, over 54 ha of pine (*Pinus wallichiana*, the principal fuelwood species) had established naturally (i.e., without planting) on former swidden lands within 2.5 km of this village between 1989 and 2010 [10]. Natural succession of former swidden fields to dense forests has also been observed in Zhemgang District [10], Jigme Singye Wangchuck National Park [14] and many other areas of Bhutan where swidden was formerly practiced [9].

3.2. Potential fuelwood effects

Managed fuelwood harvesting offers the potential to: 1) maintain household energy independence, 2) reduce

government expenditures to provide alternative energy, 3) generate rural income and employment opportunities, 4) provide an incentive to manage forests for timber, esthetic and other values, and 5) address national conservation and forest fire concerns.

3.2.1. Energy independence

Most rural Bhutanese households currently obtain fuelwood from forest management units and that requires purchasing a permit from the Forestry Department. Alternatively, some residents have joined community forest management groups to avoid having to purchase permits and harvest fuelwood from community forests [15]; the number of community forests increased from 8 in 1990 to over 500 in 2013 [16]. Fuelwood use is also increasing in urban areas as residents prefer to heat with wood heat rather than electricity and often obtain supplies illegally in nearby forests [6]. If regulated and well-managed, fuelwood could potentially maintain domestic household energy independence and reduce national electricity production needs.

3.2.2. Government expenditures

The RGoB government proposed providing free electricity and electric cookers to rural households to meet basic energy needs and reduce fuelwood use in 2013 [6,17]. While these provisions could be useful in areas with limited fuelwood supplies, they will be costly and contradict the government's commitment to reduce national expenditures, devolve power to local governments, and encourage private entrepreneurial activity to meet development objectives [17]. Despite hydropower development, Bhutan imports electricity from India during the dry season when low flows limit production capacity [18]. Given electricity generation and transmission costs, and concerns about government expenditures, it is uncertain whether the RGoB can afford to provide free electricity even to a small number of rural households.

3.2.3. Income and employment

Managed fuelwood harvesting, sale and use represent a potentially significant source of rural income and employment which the RGoB acknowledges is desperately needed [17]. While it is unknown how many jobs or how much income could be generated by sustainable fuelwood harvesting, increased forest cover and density throughout much of the country suggests there is potential to increase fuelwood harvesting and sales.

3.2.4. Forest management

Promoting sustainable fuelwood harvesting could provide incentives to manage forests for timber, wildlife, aesthetics and ecological services. Managed fuelwood harvesting could include selective cutting of individual trees to improve the growth, vigor and value of residual forest stands for timber or group selection or clear felling to create open habitat and encourage the growth of early successional vegetation of importance to wild ungulates and their predators (see 3.2.5).

3.2.5. Conservation

While increasing forest cover is widely considered to promote conservation in Bhutan [6,7], it may adversely affect some

plant and animals species. Bhutan is currently more heavily forested than it has been for centuries, while open and disturbed habitats have declined [9]. Research in nearby India and Nepal has found that populations of tigers, the species of greatest conservation concern in Bhutan, are most strongly correlated with the availability of prey (e.g., wild ungulates and pigs) which prefer open and disturbed habitats where forage and browse are abundant [19]. Increased forest cover and density may compromise efforts to conserve tigers, and other flora and fauna that favor open or disturbed environments [20]. RGoB officials have also recently concluded that forest fires are becoming larger, more frequent, and more intense throughout the country, and that accumulating biomass is exacerbating the problem [21].

3.3. Managed fuelwood harvesting

Sustainable fuelwood harvesting requires site-specific assessments of biophysical and socioeconomic conditions, as well as the capacity to monitor impacts and enforce management plans [22]. Methods to assess fuelwood consumption, standing biomass, and annual growth and yield have been developed for Bhutan and could be utilized throughout the country [13]. The increasing forest cover, density, and concern about forest fires suggest that more fuelwood could be harvested in many areas and help reduce the risks and severity of forest fires.

Given the widespread, historic use of swidden throughout Bhutan, we recommend the RGoB establish fuelwood harvesting trials on government forest lands to evaluate and monitor the viability of replicating the size and landscape patterns associated with previous swidden practices. This could include group selection or clear-felling of small stands of timber (i.e., 1–3 ha size), followed by low-intensity burning of slash (i.e., tops, small branches and leaves) in both pine and broadleaf forests where swidden was formerly practiced [20]. Increased harvesting around villages and residences should also be explored as means to reduce wildfire risks and fuelwood transport costs. Commercial fuelwood harvesting and sale by private individuals or community forest management groups could complement government efforts to encourage market activities, generate employment, and reduce rural poverty, particularly in community forests with significant fuelwood supplies [15,20]. The current RGoB requirement to fulfill rural household and community forestry management group fuelwood needs before commercial sales is an important safeguard against excessive cutting and should be maintained. However, it may be challenging to enforce forest management plans as is evident in the recent RGoB decision to suspend designating new community forests due to concerns over inadequate monitoring and excessive tree harvesting [23].

3.4. Developing biomass energy

If the RGoB elects to pursue managed fuelwood harvesting and develop biomass energy, Switzerland illustrates the potential benefits and could serve as a source of expertise and assistance. Switzerland is approximately the size as Bhutan, but has ten times the population, fewer forest resources, and

slower forest growth and biomass accumulation rates. Nevertheless, fuelwood is widely used for residential heating throughout Switzerland, and the government has supported development of advanced wood biomass facilities to generate heat and/or electricity in hundreds of villages [24]. Fuelwood consumption has increased significantly in Switzerland over the past 20 years, yet forest cover has increased as well [24]. The Swiss are committed to sustainable natural forest management, environmental conservation, and have provided development assistance to Bhutan for five decades. For example, the Swiss Agency for Development and Cooperation was instrumental in the development of Bhutan's community forestry program.

4. Conclusions

The RGoB is committed to developing renewable energy, reducing fossil fuel use and environmental conservation. If well regulated and managed, fuelwood harvesting from Bhutan's abundant and increasing forest resources could continue to meet residential cooking and heating needs, generate employment and income for rural communities, provide additional incentives to manage forests, and compliment national environmental conservation objectives. Switzerland demonstrates the potential compatibility of wood biomass energy use and rural income generation with national energy, forest management, and conservation interests.

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