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Research

Fuelwood resources and their use pattern by Bhotia community in Niti valley, Western Himalaya

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Abstract

The local communities of the Himalaya have been using fuelwood as one of the major sources of energy since millennia. Their dependency on these resources as primary source of fuelwood has resulted in unsustainable pressures on the forests. The present communication aims to access the fuelwood resource and consumption pattern of Bhotia, an ethnic community in a cold arid and buffer zone of Nanda Devi Biosphere Reserve, i.e. Niti valley in the Western Himalaya. Within the Niti valley, 87 households in six villages were surveyed using open and close-ended structured questionnaire. Use Index (I%) of each fuelwood species was calculated to evaluate the key species used by the inhabitants and their preferences. The study revealed use of 10 species for fuelwood (five species each of tree and shrub) by the Bhotias. *Pinus wallichiana* (I = 96.6%) followed by *Cedrus deodara* (93.1%) were the preferred tree species for fuelwood, while among shrubs, *Juniperus indica* and *J. communis* were extensively used. Fuelwood consumption in the Niti valley was much lower (1.6±0.2 kg household^{-1} day^{-1}) than other villages in the Greater Himalaya (4.9±0.4 kg household^{-1} day^{-1}). The seasonally employed which formed 23% of the surveyed households, collected almost twice as much fuelwood than the employed households (9.2±0.4 and 5.2±0.4 quintals season^{-1}, respectively). As the area is characterized by sparse vegetation cover, low primary productivity and short growing season, and is thus highly susceptible to irreversible changes of natural habitats. The study suggests that providing alternate and non-conventional energy sources such as solar cookers and fuel efficient portable ovens to the inhabitants at subsidized rates could reduce the pressure on nearby forests.

Key-words: Bhotia community, Nanda Devi National Park, Trans-Himalaya, Use Index.

Introduction

Leach (1992) explained that household fuel choice is mostly determined by income and passes through a linear 3-stage switching process that initially involves solid biomass fuels, but with increased economic prosperity finally leads to liquefied petroleum gas (LPG) and electricity, usually via a transition phase involving kerosene, coal and charcoal. Household behaviour can be explained in terms of wealth and substitution effects of increases in household income (Bardhan *et al.* 2001). Current empirical evidence suggests a more complicated process at work than the simple linearized version of the energy ladder model. First, the phenomenon of 'fuel stacking' suggests that richer rural households opt for a mix of modern and traditional fuel types to meet larger energy requirements (UNDP/ESMAP 2003). Similar evidences are recorded from all across the globe (Heltberg 2005; Masera *et al.* 2000).

According to the 55th Round National Sample Survey (NSSO 2001), from a country wide sample of 71,385 rural households, 75% of households used firewood and wood chips as a primary energy source for cooking and lighting, and close to 90% of households used one or the other form of solid biomass-based fuels for meeting their domestic energy needs. Degradation of forests in the Indian mid-Himalaya is reported to be primarily due to collection of fuelwood and fodder by residents of neighboring villages (Baland *et al*. 2006-07). Several parameters, *viz.* socio-economic, demographic, geographic and dwelling characteristics of the inhabitants determine villagers' energy requirements (Pachauri 2004; Rao and Reddy 2007). According to Rai and Chakrabarty (1996), the per capita fuelwood consumption in India ranged between 423–1320 kg. In various parts of the Himalaya, the fuelwood consumption is reported to be between 4.55–23.88 kg person^{-1} day^{-1} (Khuman *et al.* 2011; Dhanai *et al.* 2014; Dhanai *et al.* 2015).

In the Indian Himalayan region, a major part of the total household energy demand is met through non-commercial energy (98.6%), while commercial components such as domestic LPG and kerosene form only 1.4% of the total energy demand (Kumar 2005). By all accounts, the energy transition from biomass to clean fuel types (kerosene, electricity and LPG) has been extremely slow in rural India (Pachauri and Jiang 2008; TERI 2008). The village population in these areas are totally dependent on wood resources as a non-commercial energy source (Bhatt and Sachan 2004).

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Forest resources form an integral part of the social and cultural lives of the Bhotia community inhabiting Niti valley in the Indian Trans-Himalaya. They are highly dependent on the surrounding forests for their fuelwood and fodder requirements (Kumar *et al.* 2015a). In the Trans-Himalayan regions, anthropogenic pressure along with climatic constraints like low precipitation, low temperature and short growing season adversely affects the growth and regeneration of plants (Murti 2001). The present study was undertaken to understand the fuelwood diversity and consumption pattern of the Bhotia community in the Trans-Himalayan region of Nanda Devi Biosphere Reserve to provide a basis for developing conservation strategies in the region where there is scarcity of forest resources.

Materials and Methods

STUDY AREA

Nanda Devi Biosphere Reserve (hereafter referred as NDBR), located in the northern part of the Western Himalaya, has two core zones *viz.*, Nanda Devi National Park (NDNP, 630 km^2) and Valley of Flowers National Park (VoFNP, 87.5 km^2), which were inscribed a 'World Heritage Site' in the year 1988 by UNESCO (http://whc.unesco.org/en/list/335/). The study was conducted in Niti valley, a buffer zone of NDBR (Figure 1). The valley, with elevations ranging from 3500 m amsl to 5000 m amsl is spread over an area of *ca.* 727.7 km^2. The picturesque valley falls under the Trans-Himalayan region in Uttarakhand state of India. The valley is also known as Upper Dhauli valley and is named after the river Dhauli Ganga that forms one of the major catchments of Alaknanda river (a sub-catchment of the river Ganga). It has three sub-watersheds namely, Amrit Ganga, Satyagad and Ganesh Ganga, which are used for transhumant pastoralism (Rawat 2005; Mitra *et al.* 2013).

The valley has seven migratory villages namely, Kailashpur, Mahergaon, Gurgutti, Farkia, Bampa, Gamshali and Niti, which are mainly inhabited seasonally by the 'Bhotia', an ethnic community of Indo-Mongoloid origin. These migratory villagers have two settlements - winter settlement in the lower elevation of Chamoli district, and summer settlement in the higher elevation in Niti valley. The total number of households in the valley was 292 with a population of 864 individuals (47.5% males and 52.5% females) and family size ranges between 4-5 persons (Census India 2011).

This area is situated in the rain-shadow zone of NDBR and dryness increases towards the upper reaches of the valley, which remain snow bound for more than six months in a year. Growing season is very short and generally lasts from June to August. The region receives low amount of precipitation and remains dry and dusty above 3200 mamsl. The vegetation of

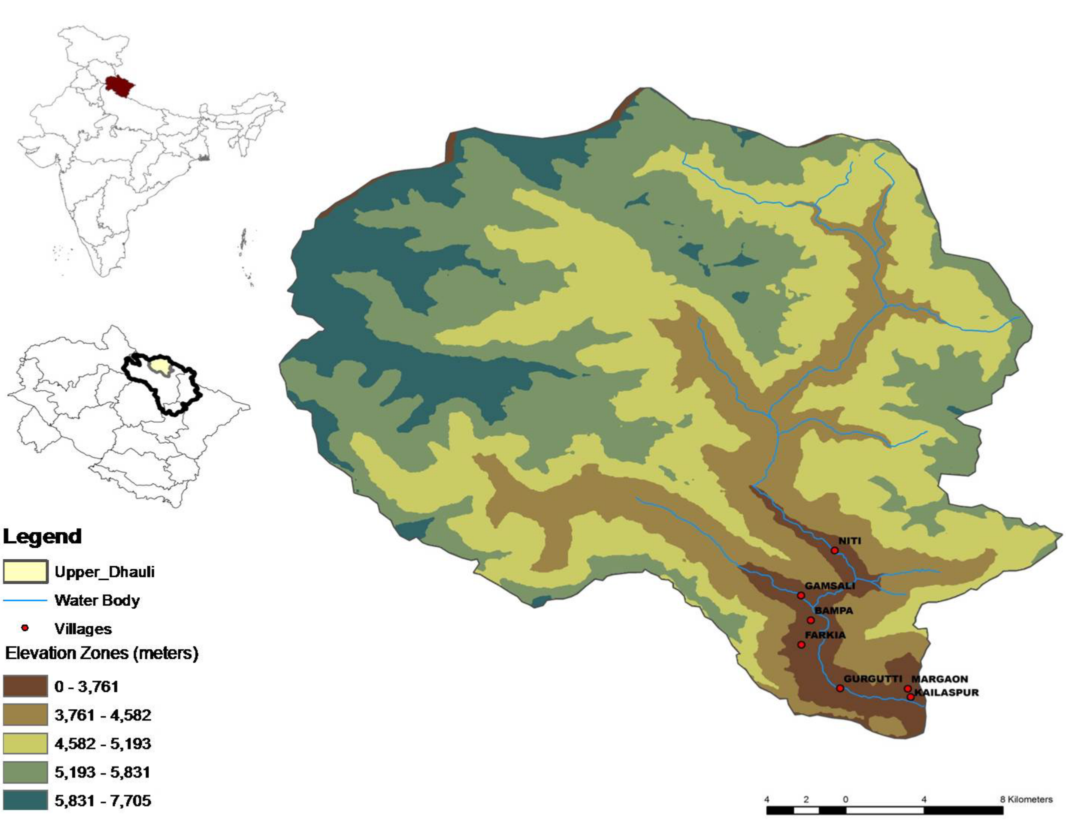

Figure 1. Map showing location of villages in Niti valley, Western Himalaya.

the study area is broadly divisible into the following classes: (i) dry temperate forests, (ii) sub-alpine forests, (iii) riverine scrub, (iv) alpine dry scrub, and (v) alpine mixed herbaceous formations. The alpine dry scrub and alpine mixed herbaceous formations cover >70% of the study area (Kumar *et al.* 2015b, 2016).

DATA COLLECTION AND ANALYSIS

In this study, 87 households representing 30% of total household were surveyed from six villages in Niti valley- Niti, Gamshali, Bampa, Farkia, Mahergaon and Kailashpur, which were located between 3200 to 3600m amsl (Figure 2). Information was gathered through semi-structured questionnaire surveys with open and close-ended questions following Bernard (2006) during June to October 2012. Use of major fuelwood species and their preference by the local inhabitants along with their relationship between employment and fuelwood consumption was studied. To evaluate the major fuelwood species used by the villagers and their preference, Use Index (I%) of each species was calculated following Lance *et al.* (1994):

$$I\% = n/N \times 100$$

Where, I% represents percentage index of use, n represents the number of people citing the use of the tree species, and N represents the total number of people surveyed. If the value of I% is between 60 and 100%, the species is widely used; if I% is between 30 and 60%, the species is moderately used; if I% is less than 30%, the species is not used or minimally used.

Results

SPECIES USED AND THEIR PREFERENCE

A detailed phytosociological investigation was conducted in the study area for the assessment and availability of fuelwood species. A total of 495 species of vascular plants (angiosperms, gymnosperms and pteridophytes) belonging to 267 genera and 73 families have been recorded from the study area (Kumar *et al.* 2016). *Pinus wallichiana* (806 trees ha^{-1}) followed by *Cedrus deodara* (389 trees ha^{-1}) were dominant tree species in the valley and forms the forest.

Among the surveyed villages, a total of 10 species (five species each of tree and shrub) belonging to eight families were primarily used as fuelwood by the Bhotia community. The use of fuelwood species depended on their quality, availability and accessibility in the area. Inhabitants, mostly women, collected fuelwood between 3000-4000 m, which is mainly used for cooking, boiling water and lighting, as well as space heating. The use value ranged from 2.3 to 96.6%, which was highest for *Pinus wallichiana* (96.6%) followed by *Cedrus deodara* (93.10%) indicates their great acceptability as fuelwood and high anthropogenic pressure on the species. The remaining species such as *Viburnum cotinifolium, Rosa sericea, Fraxinus xanthoxyloides, Prunus cornuta* and *Picea smithiana* showed <20% use value, reflected their low availability or low preference. Use of species such as, *Fraxinus xanthoxyloides* and *Picea smithiana* were reported from Kailashpur and Mahargaon villages. *Fraxinus* was distributed along steep riverside slopes of Dhauli Ganga while *Picea smithiana* was the co-dominant species in *Pinus-Cedrus* forest. Species of *Rosa* and *Viburnum* were also collected along roadside and nearby forested areas, while *Betula* was collected in three villages namely, Farkia, Bampa and Niti by the locals. Among the shrub species, *Rhododendron campanulatum, Juniperus indica* and *J. communis* were used extensively by the villagers of Gamshali and Niti. The major fuelwood species used and their preference by Bhotias in the valley is shown in Table 1.

EMPLOYMENT, LPG AND FUELWOOD EXTRACTION

The employment status of villagers and the availability of domestic LPG (each cylinder of 14.8 kg) in the study area play important roles in determining their dependency on forests for fuelwood. The employed strata have an option of buying domestic LPG, thus decreasing their requirement for fuelwood.

Table 1. Major fuelwood species and their use in Niti valley, NDBR.

Species	Niti	Gamshali	Bampa	Farkia	Mahergaon	Kailashpur
Pinus wallichiana[a]	√	√	√	√	√	√
Cedrus deodara[a]	√	√	√	√	√	√
Picea smithiana[a]	×	×	×	×	√	√
Betula utilis[a]	√	×	√	√	×	×
Fraxinus xanthoxyloides[a]	×	×	×	×	√	√
Prunus cornuta[a]	×	×	×	×	√	√
Rhododedron campanulatum[b]	√	√	×	×	×	×
Viburnum cotinifolium[b]	×	×	×	×	√	√
Juniperus spp.[b *]	√	√	√	√	√	√
Rosa sericea[b]	√	√	√	×	×	√

Symbols used: a = tree, b = shrub; √ = species is commonly used; × = species not used or not found in the area; * villagers refer both species of *Juniperus* by the same name, *Bitaru*.

Table 2. Fuelwood species with their Use Value (UV) based on quality, characteristics and availability in Niti valley, NDBR.

Species	Family	Density (individuals ha^{-1})	Availability*	Use Value (%)
Pinus wallichiana[a]	Pinaceae	805.7	Very high	96.6
Cedrus deodara[a]	Pinaceae	388.6	High	93.1
Picea smithiana[a]	Pinaceae	108.57	Low	2.30
Betula utilis[a]	Betulaceae	95.7	Very low	26.4
Fraxinus xanthoxyloides[a]	Oleaceae	Sparse distribution	Very low	5.8
Prunus cornuta[a]	Rosaceae	Sparse distribution	-	3.45
Rosa sericea[b]	Rosaceae	191.4	Low	13.8
Juniperus spp.[b]	Cupressaceae	281.2	Medium	47.1
Rhododendron campanulatum[b]	Ericaceae	134.2	Low	20.7
Viburnum cotinifolium[b]	Caprifoliaceae	Sparse distribution	Very low	14.9

*Availability (individuals ha^{-1}): Very low = <100, Low = 100-200, Medium = 200-300, High = 300-400, and Very high = >400. Species: a = tree, b = shrub.

The category of seasonally employed people consists of daily labourers, porters and people rearing domestic livestock for commercial purposes. 77% of households, which has atleast one member employed is considered as employed, of which 44% use domestic LPG as well as fuelwood, while 56% are totally dependent on fuelwood for energy. The maximum fuelwood was extracted by the seasonally employed category i.e. 23% of the total sampled population. The fuelwood collected by the employed and unemployed category was 5.2±0.4 and 9.2±0.44 quintals season^{-1}, respectively. Likewise, in villages of Kailashpur and Mahergaon, where the percentage of employed people exceeds the percentage of unemployed, the fuelwood extracted was reported less (1.8±0.2 kg household^{-1} day^{-1} and 1.6±0.2 kg household^{-1} day^{-1}, respectively) as compared to Farkia and Bampa villages (4.5±0.3 kg household^{-1} day^{-1} and 4.9± 0.4 household^{-1} day^{-1}, respectively). The fuelwood consumption pattern with respect to employment status across different villages is shown in Figure 2.

Discussion

The villagers used blue pine (*Pinus wallichiana*) and deodar (*Cedrus deodara*) more (use value 96.6 and 93.1, respectively) than *Betula* (use value 26.4) because the lower reaches of the valley and the area adjoining villages are dominated bydry temperate forest of blue pine (*Pinus wallichiana*) and deodar (*Cedrus deodara*). The local inhabitants prefer to use these species compared to dry sub-alpine forests predominately of Birch (*Betula utilis*, remnant patches), because the former species are easily available. Although, when asked which species they considered as better fuelwood, *Betula* was considered a better fuelwood species by the villagers. The low use value of a potentially good fuelwood species is chiefly attributed due to its inaccessibility, as *Betula* grows alongside steep ridges protruding towards hill tops. The villages such as Niti, Bampa and Farkia which have *Betula* forests close by reported extensive use of it along with *Pinus* and *Cedrus*.

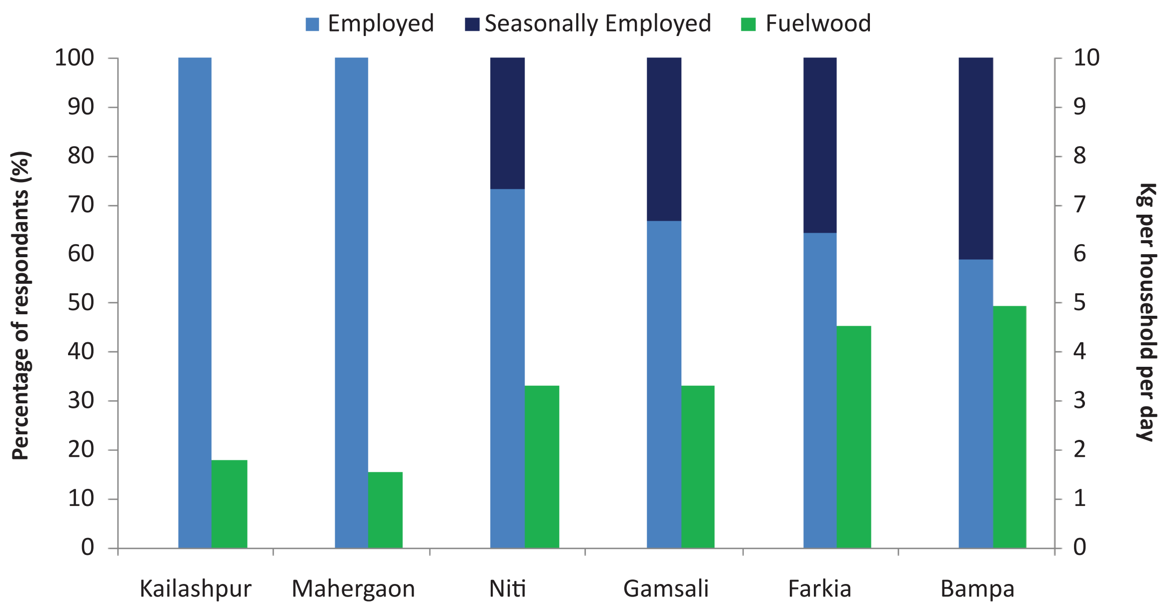

Figure 2. Fuelwood consumption and employment status across different villages in Niti valley, Nanda Devi Biosphere Reserve.

The fuelwood consumption in cold arid region of Niti valley was recorded to be much lower (1.6±0.2 kg household^{-1} day^{-1}) compared to villages of the Greater Himalaya (4.9±0.4 kg household^{-1} day^{-1}) (Samant *et al.* 2000; Awasthi *et al.* 2003; Bhatt and Sachan 2004; Singh *et al.* 2010; Dhanai *et al.* 2015). This is mainly attributed to sparse vegetation cover, fewer species and migratory settlements of the villagers in the Trans-Himalayan regions such as Niti valley. These regions are floristically impoverished as compared to adjacent high altitude areas of Greater Himalaya (Mani 1978; Schweinfurth 1984).

Fuelwood consumption is affected by the employment status and availability of alternative fuel to the villagers. Employment provides people with financial means to purchase alternative energy such as LPG and kerosene. This not only relieves them of the labour required in obtaining wood from forests, but also provides health benefits through the absence of smoke and ease of their use. Employed households in most cases also have better access to education and towns/cities, and they tend to minimize their stay in the remote valleys. They are likely to spend more time in towns where they are employed, hence, decreasing the demand for wood for cooking and heating. Likewise, if alternative energy is available for cooking, the amount of wood consumed will decrease. Therefore, providing alternative fuel options such as, LPG, solar cookers and fuel efficient portable ovens to the local and pastoral communities in such remote regions of the Himalaya would not only reduce the dependency on the forests for fuelwood, but also in turn save the forests from degradation.

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