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A study on fuelwood consumption in two villages of Bhaderwah forest division (J&K), India

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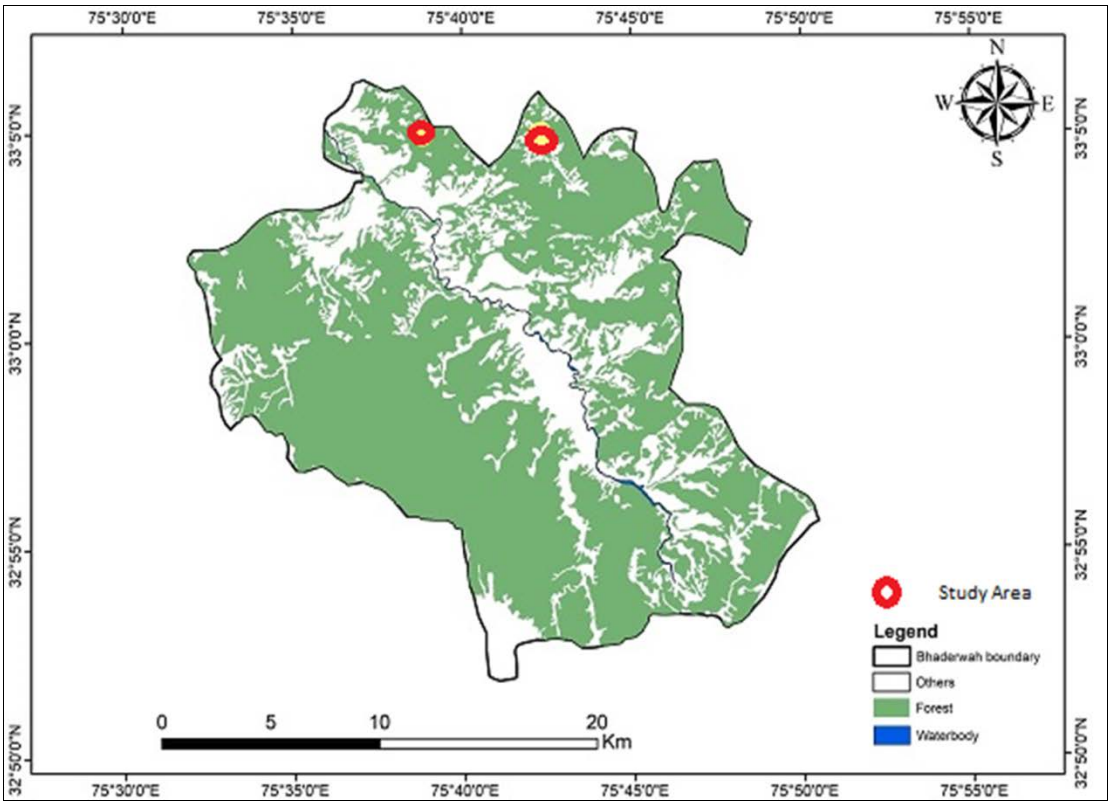
Abstract
Forest being the most important resource for the welfare of humankind, provide many tangible and intangible benefits to human beings. In many countries, people are dependent on forests for various produces of which fuelwood is the main component. Fuelwood is the principal energy service provider to about 70% of the Indian population as it is extensively used for cooking and heating purposes. Lack of alternative sources of fuelwood makes the rural population mostly dependent on adjoining forest resources which ultimately results in the depletion of forest resources. The aim of present study was to examine the patterns of fuelwood consumption and their ecological implications in two villages namely village Chhani and village Lanchan of Bhaderwah forest division (J&K). The study was based on general survey and interview and it was observed that 12 plant species such as *Pinus wallichiana, Pinus roxburgii, Cedrus deodara, Quercus floribunda, Quercus leucotrichophora, Quercus semicarpifolia, Lyonia ovalifolia, Aesculus indica, Pyrus pashia, Indigofera species, Alnus nitida and Abies pindraw* were utilized as source of fuel wood in the study area. However, *C. deodara, Q. floribunda* and *P. wallichiana* were the most exploited fuel wood plant species. The preference for these species were due to ease of their availability and better fuel quality. Increase in fuel wood harvest caused intense forest degradation and biodiversity loss. The forests of the study area demand immediate attention in order to conserve the depleting forest structure. The policy makers must provide a sustainable solution to reduce the overexploitation of forest resources.

Keywords: Chhani, consumption, fuel-wood, households, Lanchaan

1. Introduction
Biomass is the main source of fuel both in the rural and urban areas within countries like India, China, Nepal, and Bangladesh. Biomass is available in two forms Charcoal and fuel wood (Food and Agriculture Organisation, 2012, Moreno *et al.* 2019) [17]. In the past few decades, increase in the consumption of fuelwood have led to more pressure on natural resources worldwide (Tilman *et al.* 2001; Arrow *et al.* 2004, Liu *et al*. 2010 and Velho *et al.* 2018) [27, 1, 29]. The demand for energy is partly met by firewood which is the important source of domestic energy for the developing world (Heltberg *et al.* 2000) [11]. This is particularly important to the areas where limited energy sources lead to high pressure on scarce natural resources. For example, the dependency on forest biomass as primary source of energy was up to 87% in India, (Madhu 2009, and Bhatt *et al.* 2016) [15, 5], 77% in Nepal (Benato *et al.* 2016) [3], 78% in Bhutan (Rana *et al.* 2016) [23], 73% in Bangladesh (Huda *et al.* 2014) [12] and 38.82% in Myanmar (Wen *et al*., 2017) [30].
In the study area, the high energy requirement is believed to be one of the main reasons for natural resource degradation. In this region, winter lasts for five months (October to February) during which local people heat their homes throughout the day because of very low temperature. The present study was undertaken to investigate the availability of fuelwood, pattern of fuel wood collection and its impact on forest ecosystem.

2. Material and Methods
The present study was conducted in two villages namely village Chhani and Village Lanchaan of Chinta block of Bhaderwah forest situated between 32.98 North latitude to 75.71 East longitude of Bhaderwah forest division (J&K). The objective of the study was to collect the reliable data on fuel wood consumption of the area and also to evaluate the impact of fuel wood collection on forest ecosystem.

Fuel wood refers to the woody material collected from trees, such as stems and large branches collected from exclusively for fuel wood, or small branches collected as by product of fodder collection.



Source: Working plan JK Forest

Fig 1: Forest map of Bhaderwah Forest Division showing study area marked with rugged topography comprising high ranges, steep slopes, deep valleys and sloping meadows.

The study was conducted during 2019 and 2020 and the data for fuel wood consumption was recorded during different months of the year. Two methods were used for the collection of data related to the fuelwood consumption that is general survey and interview. The information regarding fuelwood species and the quantities of wood consumed was collected during spring (March-May), summer (June to September) and winter seasons (October to February). Also the fuel wood was weighed for 50 households and families were requested to use fuelwood from already weighed. After 24 hours remaining fuelwood was weighed again thus obtaining a clear picture of how much fuel was consumed during 24 hr. The plants used as fuelwood in the area were collected and identified with the help of Taxonomic experts in the field. The information regarding other parameters like name of the village, number of households, average family size, income, distance from forest, consumption of LPG and kerosene were also collected through interview.

3. Results and Discussion

Due to ever increasing population, fuelwood consumption is increasing rapidly. For developing countries like India, fuelwood is a major energy source for people surviving at the subsistence level (Sharma,*et al.*, 2009; Negi and Maikhuri 2016) [25]. Lack of the alternative fuelwood sources makes the rural population entirely dependent on wood sources (Bhatt and Sachan, 2004) [5] and they mostly meet their demand solely from the adjoining forests (Hussain *et al.* 2017) [13]. Thus, the intense use of forest resources has put woody species in different regions of the world at risk (Dahdouh Guebas *et al*.2002 and Mushtaq *et al.* 2010) [6, 18].

Due to ever increasing population, fuelwood consumption is increasing rapidly in the Bhaderwah forest division. In both the villages of the study area (Bhaderwah Forest Division, J&K) about 90% of the people are totally dependent on forests. According to respondents, each day they travel a long distance (1-5 kms) to collect fuel wood. Fuel wood collected from the nearby forest is the only source of energy in this region. Commercial fuel is beyond the reach of most of the inhabitants due to poor socioeconomic conditions, inaccessibility, and limited supply of these resources.

Table 1: Major fuelwood species used in the villages, of Bhaderwah Forest division, J&K

S. No	Botanical Name	Family	Altitude	Category	Uses	Calorific value(kj/g)
1	*Pinus wallichiana*	Pinaceae	1800-4300m	Tree	FW, T,BL,AI, HA	20.89 (usaid.gov)
2	*Pinus roxburgii*	Pinaceae	900-1950m	Tree	FW, T,BL,AI, HA	23.23 (Thakur *et al.*,2016) [28]
3	*Quercus leucotrichophora*	Fagaceae	1500-2400	Tree	FW,F,HA,AI	23.52(Thakur *et al.*,2016) [28]
4	*Cedrus deodara*	Pinaceae	1800-2300m	Tree	FW, HA,AI,BL	21.75 (usaid.gov)
5	*Quercus floribunda*	Fagaceae	2100-2700	Tree	FW,F,HA,AI	22.92(Dhanai *et al.*,2015) [8]
6	*Quercus semicarpifolia*	Fagaceae	1700-3800m	Tree	FW,HA,AI	23.82(Dhanai *et al.*,2015) [8]
7	*Lyonia ovalifolia*	Ericaceae	1200-2400	Tree	FW	18.05(Dhanai *et al.*,2015) [8]

8.	*Aesculus indica*	Hippocastanaceae	900-3000m	Tree	FW,M	18.60(Sharma *et al*.,2009) [25]
9.	*Pyrus pashia*	Rosaceae	750-1500m	Tree	FW, FR, F	19.50(Dhanai *et al*.,2015) [8]
10	*Indigifera Species*	Fabaceae	900-2500m	Shrub	FW, F	16.40 (indiaeng.com)
11	*Alnus nitida*	Betulaceae	1800-2800m	Tree	FW, F, T	19.22 (Thakur *et al*, 2016) [28]
12	*Abies pindraw*	Pinaceae	2400-3700m	Tree	FW, T, AI, HA	19.17(Sharma *et al*.,2009) [25]

F,Fodder; FW-Fuelwood; T-Timber; AI –Agricultural Implements; HA-Household articles; M-Medicine; BM-Bedding material for livestock; FR-Fruit.

The current study showed that different plant species were used for fueling households in the villages, as the major fuel species include *P.wallichiana, P. roxburgii, C. deodara, Q.floribunda, Q. leucotrichophora, Q. semicarpifolia, Lyonia ovalifolia, Aesculus indica, Pyrus pashia, Indigofera species, Alnus nitida and Abies pindraw* were utilized as fuel wood in the study area. *However, P. wallichiana, C. deodara and Q. floribunda* were under the immense fuel wood pressure as these three plants are mostly collected from forests and used as fuel wood (Table1).

The preference of these species could be due to availability and better fuel quality. In summer the pressure on the forests for fuel collection was comparatively lesser because people did not need wood for heating purposes.

According to the forest department locals use much more wood than estimated by the department as they depend upon forests for variety of forest products like, food, fodder, agriculture, housing and variety of various minor marketable produces which can potentially degrade the forests if harvest unsustainably. The villager's dependency on forest resources subjected to severe deforestation which is the main cause of forest degradation. Baland *et al*.(2010) [2] while studying environmental impact of Rural poverty in Rural Nepal analysed that the main cause of forest degradation is fuelwood collection. Demurger and Fournier, (2011) [7] carried out study in the Nothern China and reported the loss of forest structure due to fuelwood collection. Specht *et al.*,(2015) [26] while studying Brazilian Atlantic Forest also analysed that collection of fuelwood was the main cause of forest degradation.

During the present study it has been observed that on an average about 5021.21 tons of valuable fuel wood was used for cooking and warming houses annually. In summer season on an average each person consumed about 26kg of fuelwood per month, during spring about 35 kg and in winter about 43 kg per person was utilized. (Fig.2)

Maihkuri (1991) [16] carried out fuelwood consumption study in Arunachal Pradesh and recorded relatively high fuelwood consumption values of 90 kg/ capita/ month whereas Bhat and Sachin (2004) observed fuelwood consumption values of 58.8Kg/ Capita/ Month in Garhwal Himalaya. Bhatt *et al*. (2016) [5] observed the change in fuelwood consumption during different seasons in eastern Himalayas.

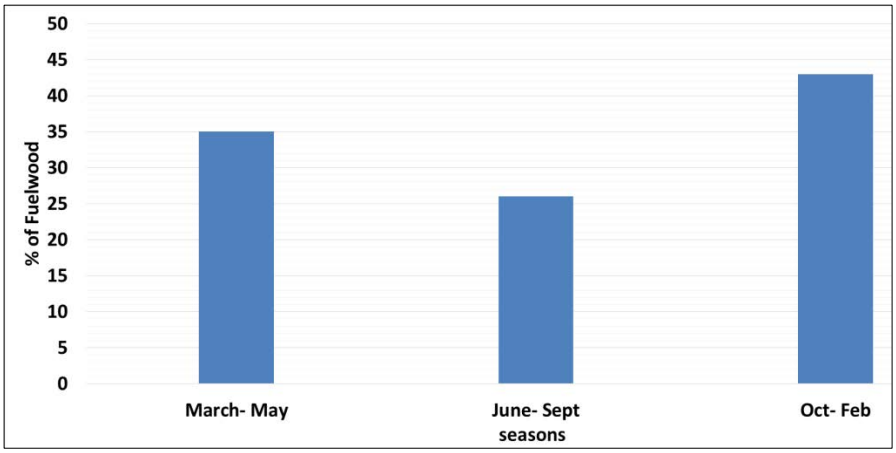


Fig 2: Average seasonal fuelwood consumption/ person (kg) in Village Chhani and Village Lanchaan of Bhaderwah forest Division (J&K)

The present study revealed that the region is suffering from constant deforestation and soil erosion which is threatening the regions biodiversity. The use of fuel wood as the primary source of energy is the main cause of severe deforestation in the region. In village Lanchaan it was observed that 96% of the respondents were using fuelwood for cooking purposes, 84% of the respondents used forests for their timber about 42% of the respondents were collected medicinal plants from forests for domestic use and about 20 % of the villagers sell the wood for the income. Whereas in village Chhani the percentage use of fuel wood was 80 %, timber 35 % and medicinal plants 35 % only 12% of the villagers sell wood for cash income. Negi *et al*. (2018) [21] also have similar findings while studying fuelwood diversity and consumption patterns in cold desert (Kailash Sacred Landscape) part of Indian Himalaya.

The study indicated that dependency on forests was more in village Lanchaan as compared to village Chhani. Due to high literacy rate and high living standard of most of the households of village Chhani, the individuals are using other sources of energy like electricity and LPG for cooking and heating. Whereas in village Lanchaan, it was observed that firewood was mainly used for cooking and heating and electricity was mostly used for lightening and sometime for cooking and heating water. Heating devices in 97 % of the households were the same (Table 2.) Ouedraogo (2006) [22] investigated on household energy preferences for cooking in urban Burkina Fasom, Nigeria, and observed that the domestic demand and choice for energy resources were strongly related to their household income.

Table 2: A general profile of the villages of Bhaderwah Forest Division (J&K).

Parameter	Villages of the study area		
Name of Village	Village A (Lanchaan)		Village B(Chhani)
Number of households	167		244
Average Family Size	5 to 6 (Min-1; Max. 8)		5 to 6 (Min-1; Max. 8)
Average Income /household/ month	6544 (min 500; Max 35000)		20,511(min.1500; Max, 60,000)
Name of Nearby Forests	Jai Forest and Lanchaan Forests		Trabi forest and Thridal Forest
Average Distance of households from the forets(Kms)	3.07 (Min:0.2; Max.:5)		2.11 (Min: 0; Max. 4)
Fuelwood Extracted from the forests	96%		84%
Amount of Average fuel wood consumption per day(Kg)/household	summer	8.7 kg (Min :5; Max.: 12)	6.3(Min; 2; Max. 12)
	winter	13.2Kg (Min:7; Max. 15)	9.1 (Min. 5 and max. 15)
Average LPG consumed per household/ year(L)	31.2		68.6
Average Kerosene consumed/ household /month(L)	4.3		6.5

Fuelwood collection is important for local people of the Bhaderwah Forest division (J&K). as the other resources are insufficient and forest degradation is happening at a faster rate. Gera *et al.* (2017) [10] at Dehradun (Utrrakhand) and Sassein and Sheil, (2013) [24] at Uganda also observed insufficient forest resources and environmental degradation. This in turn affects the forest functioning and its ability to provide important resources for local population in the long run. As the population increases, demand for fuelwood is likely to grow that may lead to further forest degradation both in intensity and extent. In the study area (Bhaderwah Forest Division), roads and new buildings are also being constructed, the villages are expanding which will certainly be an addition leading to the degradation of forest ecosystem.

4. Conclusion: It was analysed that due to poor availability of other alternatives to fuelwood, the dependency on forests was more in village Lanchaan as compared to Village Chhani of Bhaderwah forest division(J&K). Due high literacy rate and high living standard of most of the households of village Chhani, the individuals used other sources of energy like electricity and LPG for cooking and heating. Though the energy consumption differed in these two villages but some general patterns can be observed. It was also observed that to save energy, all the household members lived in the same room during winter. Also these villages had weak infrastructure and because of harsh climatic conditions there is dependency on forests. As the pressure on forests are increasing for fuelwood and other developmental activities, incentives for sustainable forest use that build on local people's perception for cost and benefit are urgently required.

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