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# Forest resource use pattern in Kedarnath wildlife sanctuary and its fringe areas (a case study from Western Himalaya, India)

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## HIGHLIGHTS

- We studied energy consumption at different altitudes in Western Himalaya of India.
- On an average, fuelwood and fodder consumption is 2.42 kg/capita/day and 43.96 kg/household/day respectively.
- Maximum fuelwood (3.24 kg/capita/day) at higher and fodder consumption (1800 kg/household/day) at middle altitudes was recorded.
- *Dhabas* (roadside refreshment establishments) consume much more fuelwood as compared to the permanent villagers ($P < 0.000$, *t*-test).
- Fuelwood consumption showed significant negative relationship with LPG (−0.87) and kerosene oil (−0.89).

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## ABSTRACT

The rural population of Himalaya has been strongly dependent on the forest resources for their livelihood for generations. The present study, carried out at three different altitudes of Kedarnath Wildlife Sanctuary (KWLS), explored forest resource-use patterns to understand rural peoples' dependency on the adjacent forests. A total of six forests were selected and the seven dependent villages were surveyed for the study of forest resource use patterns in relation to their socioeconomic status. Average fuelwood and fodder consumption were found to be 2.42 kg/capita/day and 43.96 kg/household/day respectively which was higher than the earlier reported values. Average fuelwood consumption by temporary *dhaba* (roadside refreshment establishments) owners (52.5 kg/dhaba/day) is much higher than the permanent villagers. Average cultivated land per family was less than 1 ha (0.56 ha). Inaccessibility of the area and deprived socio-economic status of the locals are largely responsible for the total dependency of the local inhabitants on nearby forests for fuelwood, fodder and other life supporting demands. Extensive farming of fuelwood trees on less used, barren land and establishment of fodder banks could be the alternative to bridge the gap between the demand and supply. Active participation of local people is mandatory for the conservation of these forests.



## 1. Introduction

The Indian Himalayan Region (IHR) occupies a special place in the mountain ecosystems of the world. These geo-dynamically young mountains are not only important from the standpoint of climate and as a provider of life, giving water to a large part of the Indian subcontinent, but they also harbour a rich variety of flora, fauna, human communities and cultural diversity. Despite the abundance of natural resources, most of its people are marginalized and still live on subsistence level (Singh, 2006). The Himalayan mountain system covers only 18% of the geographical area of India, but accounts for more than 50% of India's forest cover and for 40% of the species endemic to the Indian subcontinent (Gairola et al., 2009). The Garhwal Himalaya, that is an expansion of the western part of Central Himalaya, lies between Latitudes 29°26′–31°28′N and Longitudes 77°49′–80°06′E, with altitude ranging from 250 to 7800 m amsl, and is well known for its panoramic views, diverse land forms, green valleys and floristic diversity. Besides a wide range of geographical features such as snow-capped peaks, deep gorges, glacial moraines and perennial water streams further add to its attractive and serene beauty. Dispersed small settlements and terraced agricultural fields carved out of the hill slopes for raising crops, with numerous multipurpose tree species growing, particularly on the boundaries of rainfed terraces, are typical features in the temperate area of Garhwal Himalaya.

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Forests have provided a livelihood for rural populations in India over the ages and the same is true for Garhwal Himalaya. People of this region are dependent on the forests for their basic requirements, such as fuelwood, fodder, timber, raw material for forest based industries, small timber for agricultural implements and other non timber forest products (NTFPs). Because of the limited employment opportunities, the forest is the important source of income for the rural people in Garhwal Himalaya. Agriculture is the main occupation of about 80% people of western and central Himalaya (Sharma et al., 1999). Average cultivated land per farmer in the central Himalaya is 0.5 ha, but its production is supplemented from the adjacent forest ecosystem (Tewari et al., 2003). Forests are used extensively for grazing, fuelwood collection and numerous other subsistence needs by rural peoples (Rahmani, 2003). In fact, biomass extraction, in the form of grazing, fuelwood collection and non-timber forest product (NTFPs) extraction, may be the most widespread pressure on forests in the rural areas, where people depend significantly on these activities for household and livelihood needs (Pattanayak et al., 2003). The dependency of the continually growing population on finite resources and lack of viable technologies to mitigate mountain specificities and enhance production to meet demand are depleting resources. Along with the increasing marginality of farmers, this ultimately causes poverty (Samal et al., 2003). Depletion of forest cover, biodiversity and terrestrial carbon stocks, declining farm productivity, increasing hydrological imbalance, and soil erosion are interconnected problems and therefore root causes of the poor economic status of the hill people (Chipika and Kowero, 2000). In Garhwal Himalaya, traditionally, agricultural activities are concentrated at elevations between 1000 to 2000 m amsl, often called the agricultural or populated zone; pressure on forests is at a maximum in this range.

This paper presents a case study of seven villages from three altitudes of Kedarnath Wildlife Sanctuary (KWLS) in Garhwal Himalayas and the main focus of the study was to understand how much biomass in the various forms especially fuel and fodder is extracted from the selected forests of KWLS. The information would be beneficial in drawing a picture of the links between the socioeconomic status of people and forest resource-use patterns.

The holy shrines located at the higher reaches of the study area (KWLS) are of great cultural value. These attract thousands of pilgrims and tourists every year and because of which extensive collection of fuelwood is made by the small *dhabas* (roadside refreshment establishments) in these high altitude regions during summer/tourist season (May–November). Hence these *dhabas* were also included in the survey programme and an attempt was made to correlate the fuelwood consumption by villagers and *dhaba* owners. Some of the studies in the parts of Himalaya on this subject are: Bhatt et al., 1994; Bhatt and Sachan, 2004; Sharma et al., 2009; Singh et al., 2010; Shaheen et al., 2011.

## 2. Materials and methods

### 2.1. Study area

The study area lies in the sub-montane, montane and subalpine zones of Garhwal Himalaya in Uttarakhand state of India. The Kedarnath Wildlife Sanctuary (KWLS) is one of the largest protected areas (975 $km^2$) in districts Chamoli and Rudraprayag of Uttarakhand between the coordinates 30°25′–30°41′N, 78°55′–79°22′E in the Garhwal region of Greater Himalayas and falls under the IUCN management category IV (Managed Nature Reserve). It is bordered by high mountain peaks viz., Kedarnath (6940 m), Mandani (6193 m), Chaukhamba (7068 m) and extensive alpine meadows in the north and several dense broad leave oak mixed forests in the south (Bhat et al., 2013). The present study was carried out at three different altitudes of KWLS. A total of six forests were selected from three different altitudes, two from each, for the study of 'forest resource use patterns in relation to socioeconomic status of the dependent population' in this part of Western Himalaya. Seven villages were selected for survey that depend on the selected forests for catering basic needs of fodder, fuel, litter, medicinal plants and other non-wood forest products (NWFPs). Three villages were selected from each of the lower and middle altitudes but in case of the higher altitude, only one village was available for study (Table 1 and Fig. 1). Different altitudes were selected for comparison of results regarding dependency of people on the forests.

The climate in the study area can be divided into four distinct seasons, viz., summer (May–July), rainy (mid July–September), winter (October–January) and spring (February–April). The rainfall pattern in the region is largely governed by the monsoon rains (July–September), which account for about 60–80% of the total annual rainfall. However, at higher altitudes, raining is almost a daily routine. The details of vegetation of the selected forests are given in Table 2.

### 2.2. Methodology

Research was conducted by means of community-based questionnaire survey. Surveys were conducted during the year 2012. Structured questionnaires were used to interview approximately 30% of the total households in each village (a total of 244 in 7 villages; Table 3). The families surveyed were chosen to include equal representation from all economic classes and family sizes. Selection of the interviewed families was done on the basis of their socio-economic status. The heads of the families were interviewed to determine their economic status in terms of land holdings, number and variety of animals owned by them and the status of their employment. Usage of alternative fuel like LPG and type of houses (whether of modern type, made up of bricks and cement or of traditional type, made of stones and mud) was also taken into consideration for selection of interviewed families. To understand the pressure on individual forest tree species, the villagers were asked to specify their preferences for various purposes such as fuelwood, fodder, agricultural implements, household articles, and other uses; a maximum of 10 points was given for each use. This information was further verified by personal observations. All points were combined to give a final ranking for each tree species. We also used different ways of collecting precise, quantitative data on income and income sources i.e. questionnaires, personal observation, and discussions with *gram pradhans* (heads of village legislative councils). The data collected for the study included general information about each

**Table 1**
Selected sites, villages and forests for study.

| Sites | Altitude (range) | Selected villages | Selected forests |
|---|---|---|---|
| Kund | Lower (900–1200 m amsl) | Barmadi, Pathali and Lamgondi | Barmadi **(BR)** and Pathali **(PT)** forests |
| Phata | Middle (1500–1900 m amsl) | Jamu, Rail and Dhar Gaon | Jamu **(JM)** and Kukrani Band **(KB)** forests |
| Triyuginarayan | Higher (2200–2600 m amsl) | Triyuginarayan | Two Triyuginarayan **(TN1 & TN2)** forests |