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# Fuelwood Consumption by Semi-Nomadic Communities of Sakteng Wildlife Sanctuary in Bhutan

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**Abstract:** ***Fuelwood is essential for the survival of rural households in Bhutan as almost 94% of rural household energy consumption is met by fuelwood. This study examined the consumption of fuelwood by a semi-nomadic community residing in Sakteng Wildlife Sanctuary. Data was collected from 173 households using semi structured interviews, Participatory Rural Appraisal techniques, a structured survey questionnaire and fuelwood allotment data from Sakteng Wildlife Sanctuary, park office. The results indicate that on an average one household in Merak and Sakteng consume 335 Cubic feet of fuelwood in a year which is equivalent to 4.7 standing trees. Despite connectivity of road and electricity in these villages, the pressure on fuelwood persists due to its use for heating purposes owing to harsh weather conditions. Change in constructional design of the house which conserves heat energy while still maintaining the traditional outlook and exploring the use of alternative source of energy such as solar energy and biogas wherever feasible can help in reducing the use of fuelwood in Sakteng Wildlife sanctuary.***

**Keywords:** Fuelwood, Consumption, Sakteng Wildlife Sanctuary (SWS), Bhutan, Brokpa herders,

## 1. Introduction

Approximately 40-50% of the world's total population depends on fuelwood for warmth and food preparation [4]. Fuelwood gathered from forested areas is the most important source of domestic energy for the developing world [5]. Around 80% of the wood produced for energy is used by the developing countries compared to only 30% by the developed countries [12]. Wood fuels are also an important form of non-fossil and renewable energy [13].

Fuel is an essential source of energy needed for rural households to survive in many developing countries [6]. It is commonly utilized for cooking, heating and lighting purposes.

The rural population of the Himalayas has been using firewood as the only source of energy for generation [2]. Bhutan, a mountainous developing country in the eastern Himalayas with altitude ranging from 100 masl [Meter above sea level] in the south and 7500 masl in the north is still highly dependent on fuelwood consumption.

Bhutan has a constitutional mandate of maintaining 60% of the total land under forest cover in perpetuity and has been successful in maintaining cover at 71% [3]. Several large protected areas and biological corridors have been established. Among all the natural resources such as timber, Non wood forest products (NWFP) and ecosystem services provided by the forest, fuelwood plays a vital role in the rural household. Fuelwood accounts for 21% of total household energy consumption at national level and 94% of rural household energy consumption with only 6% in urban areas [7].

In Bhutan households which have access to electricity are entitled to $8m^3$/yr equivalent to one truck load of firewood and the households which do not have access to electricity are entitled to $16m^3$/yr equivalent to two truckloads of fire wood [8].

Fuelwood is used to carry out all domestic chores in the rural household. Fuelwood is preferred from other sources of energy by the people mainly due to its proximity to the household and also because it is comparatively cheaper to other energy sources such as kerosene, wind, solar and electricity also utilized in Bhutan.

However with 69% of the population residing in the rural areas depending mostly on the natural resources, there is increasing pressure on the forests of the country. The protected areas (PAs) in Bhutan are also very unique in term of having communities residing in them which further add to the pressure on the natural resources. The population is expected to grow at an estimated average annual increase of 1.4% as per the population and housing census of Bhutan, 2005.

Bhutan as of 2015 has an estimated population on 757,042 which is quite high considering the rugged topography, vast expanse of snow and rocky areas and forests which limit the land available for agriculture and settlement [9]. Hence, with increase in population the pressure on natural resources will increase unless alternative energy sources are provided.

There has been limited research on fuelwood use in Bhutan. This study aimed to fill the lacuna of information by studying the fuelwood consumption and sustainability of semi-nomadic communities in Merak and Sakteng located in the Sakteng Wildlife Sanctuary (SWS). We explored the difference in fuelwood consumption before and after the introduction of road access and electricity to both villages from the fuelwood allotment data in SWS from 2007-2016. The paper firstly describes the different sources of energy utilized by people, then aspects of fuelwood consumption


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and conclude with suggestions for management intervention to reduce the consumption of fuel wood.

## 2. Study Area

Merak and Sakteng are two *gewogs* (sub-districts) under Trashigang *dzongkhag* (district) located in the easternmost part of Bhutan at $27^0$18'06.8''N $91^0$51'20.8''E and $27^0$24'14.1''N and $91^0$55'20.4''E (**Figure 1**). They border the Indian state of Arunachal Pradesh in the north and east. Merak is located at slightly in higher altitude of 3500 masl compared to Sakteng which is at 2900 masl. Located in the eastern Himalayas, Merak and Sakteng experiences temperate climatic conditions characterized by long cold winters and short summers with occasional heavy rainfall. The villages under these *gewogs* receive snowfalls from mid October till early April.

Studies have shown that villages situated in higher elevation consume more wood than the villages situated in lower elevations [1].

Merak and Sakteng are located in SWS which was established in 2003 to represent the easternmost temperate and alpine ecosystems of Bhutan. The vegetation is broadly classified into eight different types; Dry Alpine Scrub, Rhododendron Scrub, Fir Forest, Hemlock Forest, Cool Broadleaved Forest, Bhutan Pine Forest, Chir Pine Forest and Warm Broadleaved Forest [10].

There are around 770 households in Merak and Sakteng, comprising almost 5000 people mostly dependent on the natural resources from the forest for their daily uses. There are 10 villages namely *Borangmang*, *Borangtse*, *Sakteng*,*Tengma*, *Pusa*, *Thrakthri*, *Joenkhar*, *Dak*, *Murphee* and *Tholong* under *Sakteng gewog* and 4 villages viz *Merak*, *Gyengo*, *Kheliphu* and *Khashiteng* under Merak *gewog*.

The people of these villages are known as "*Brokpa*" and most of them are semi-nomadic herders raising yak, cattle and yak/cattle cross. A few households reside in the low land and practice subsistence agriculture. Most herders practice vertical "Transhumance"- moving livestock from one grazing ground to another according to seasonal change. The survey sample mostly concentrated on Sakteng *gewog* covering all the villages and two villages from Merak *gewog* taking in consideration the density of population occupying the villages and remoteness of the area

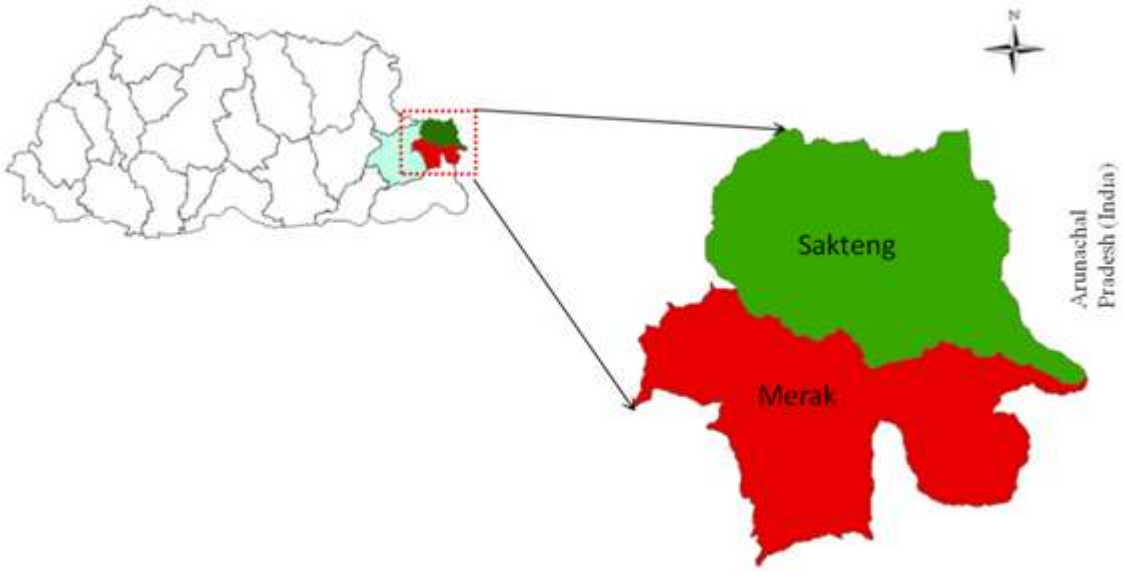


**Figure 1:** Study Area

## 3. Methodology

Two sets of interviews: semi structured interview and structured survey were used. The semi structured interview included all the Participatory Rural Appraisal (PRA) tools used and the structured survey included questionnaires.

Two sets of questionnaires, one for household information and other for village information were prepared to collect data from individual household and at the village level.

The questionnaires were used to collect quantitative data at each household and village level whereas the PRA tools were used to collect descriptive data, conduct meetings and discussions, built a rapport with the people and more importantly to involve people in the process by conducting small exercises in groups.

The sampling size used for the household survey was 25% of the total households which accounts to 173 households (72 from Merak *gewog* and 101 from Sakteng *gewog*) and total of 11 villages were surveyed from Merak and Sakteng. From surveyed households, 52% of the respondents were female and 48% of them were male respondents. The data of fuelwood allotted to the people of Merak and Sakteng for last 10 years were also collected from the SWS's park office to study the trend in the fuelwood consumed by the people. The data was analyzed using MS-Excel 2007. The study was undertaken from the year 2016-17 and the data was analyzed using MS-Excel 2007.


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## 4. Results and Discussion

### 4.1 Energy Sources

Sources of energy used in Merak and Sakteng were kerosene, electricity, solar, fuel wood and liquid petroleum gas (LPG). In the past, people of Merak and Sakteng were solely dependent on wood for cooking, lighting and heating. Today, not much has changed in the cooking and heating processes, as the majority still use wood for the same purpose.

However with the arrival of electricity the pressure on wood for lighting purposes has decreased significantly (**Figure 2** and **Figure 3).** It is evident that electricity is used by the majority of households in both *gewogs* for lighting followed by cooking. Kerosene and solar energy were also used for lighting in both the *gewogs* but in very few households.
The majority of households use wood for cooking and heating. Households in Sakteng *gewog* use more wood for heating compared to cooking in comparison with the households in Merak *gewog* who use wood for heating and cooking almost equally. This is because transportation of fuelwood for the people of Merak is easier compared to Sakteng due to road connectivity whereas people of Sakteng do not have road to their village yet which makes the transportation of fuelwood difficult. Merak is slightly at higher altitude compared to that of Sakteng resulting into a longer cold season in Merak comparatively.

From the figures it can also be concluded that although electricity has lessened the pressure on wood consumption, in places like Merak and Sakteng people are still dependent on wood due to harsh weather conditions and remoteness of the place.

### 4.2 Fuelwood Collection Locations and Types

In rural Bhutan the consumption of fuelwood is more than any other resource from the forests. The centralized program of electrification of whole rural part of Bhutan has reduced the pressure on fuelwood but in villages of Merak and Sakteng the dependence of people on fuelwood persists. People usually collect fuelwood from Government reserve forest (GRF), *Tsamdro* (grazing land), *Sokshing* (land for leaf litter collection), Community forest (CF) and drift wood. **Figure 4** shows that most of the people collect fuelwood from GRF followed by collection from their *Tsamdros*.

The fuelwood in rural areas of Bhutan are mostly allotted from GRF in the given specified time of the year, October to March during the G2C (the government-to- citizen) services based on their entitlements [8].

The most preferred species of fuel was *Quercus* sp. followed by Juniper based on the discussions held with the people during PRA sessions. They also prefer species like Fir, *Rhododendron* sp., *Betula* sp., *Alnus* sp. and *Lyonia* sp. Despite the availability of only few tree species in highlands, people prefer these species owing to their high calorific value [11].

### 4.3 Fuelwood Consumption

From the data collected from the SWS park office for the allotment of fuel wood in 2016 (**Table 2**), one household in Merak on average consumes 1.14 truckload of fuelwood annually whereas one household in Sakeng on average consumes 1.23 truckload of fuelwood annually.

Therefore one household in Merak on average consumes 322 Cft of fuelwood equivalent to 4.5 trees in a year and one household in Sakteng consumes 347.5 Cft of fuelwood equivalent to 4.9 trees in a year.

It has also been found that fuelwood is also being transported in the form of head loads and animal loads apart from the transportation by vehicle such as tractor and bolero with the recent arrival of farm road to Merak village.
Fire wood unit conversion factor used for conversion:
1 Tree= 70.62 Cft
1 TL= $8m^3$
1 $m^3$= 35.315 Cft

Apart from the villagers, other institutions such as Schools, Monasteries, Basic health Unit, and Extension offices in and around SWS also contribute to the consumption of firewood in the area. Among these, the Schools having boarding facilities contribute the most since firewood is used to prepare meals for the students. **Table 1** shows the Schools within SWS which contribute towards fuel wood consumption.

From the figure, it can be concluded that 493 students consume 20,621Cft of fuel wood annually. With the increase in enrolment of students every year, the fuelwood consumption is expected to increase accordingly, if alternative energy sources for cooking are not provided to the schools. **Table 1** show only schools residing within SWS but there are also other schools outside SWS who are dependent for fuel wood on the forests in SWS.

### 4.4 Fuelwood Consumption Trends

The fuelwood allocation data for the span of 10 years (**Figure 5)** indicates that the consumption of fuelwood has increased from 2007 to 2009 and there is a sharp decrease in 2010 and 2011.

The high consumption of fuel wood before 2010 can be attributed to the absence of electricity when each household was entitled two truckloads of fuelwood annually. The sharp decrease in the fuel wood allocation after 2010 can be attributed to connection of electricity in villages of Merak and Sakteng which was completed within 2010-2012 reducing the fuelwood entitlement of the household from two truckloads to just one truckload. The number of applicants for fuel wood has also decreased in these years compared to previous years which show that electricity has lessened the burden on fuel wood (**Figure6**).

However, the arrival of electricity has only lessened the burden but not completely removed the burden on fuel wood owing to unavoidable use of fuel wood for space heating given the harsh weather conditions. From the figure it is


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evident that the consumption of fuel wood and number of applicants has started increasing gradually from 2011 onwards owing to increase in the population.

The consumption of the fuel wood is expected to increase with increasing population every year and the arrival of motorable roads in these villages will also be an advantage. Merak has been connected with motorable road since 2015 and construction of the road to Sakteng is in process and expected to be completed within few years. Therefore, the pressure on fuelwood is going to increase with arrival of roads in these villages since the transportation of fuel wood will be made much easier.

## 5. Conclusion

Fuel wood plays very important role in running the household especially in rural areas where other source of energy is not usually opted by the people. Therefore, it is an indispensible source of energy in rural areas for now which needs to be strengthened and supplemented with alternative source of energy.

Villages in Merak and Sakteng are located in protected area which further makes the responsibility towards conservation of the forest and improvement of the livelihood of the people residing within the sanctuary more vigilant. Some of the measures which can be taken to conserve the forest without hampering the needs of the people are to provide some alternative measures for sustainable consumption of fuel wood.

It has been observed that fuel wood is mostly used for heating purposes in these villages, the change in constructional design of the house which conserves heat energy while still maintaining the traditional outlook of the house can also be explored. As of now most of the houses are made from local raw materials in traditional way entertaining large unwanted gaps for cold air to enter and heat to exit making it extremely cold without a *Bukhari* (local space heater which uses fuel wood).

*Quercus* sp. Juniper sp. and *Rhododendron* sp. are some of the most preferred fuel wood species by the people. There are high chances that in near future, the preferred tree species will face more pressure compared to other trees which might result into loss of the species from the area. Therefore strategies to increase the growth and production of these species need to be formulated and planting of other tree species with high calorific value can also help in addressing the issue.

Schools and other institutions also immensely contribute towards fuel wood consumption. Alternative energy sources for cooking such as electric rice cookers and pressure cookers can be provided to the schools and institutions to minimize the fuel wood consumption.

Encouraging use of electricity and gas for cooking and heating where ever feasible in villages of Merak and Sakteng will also help in lessening the burden on fuelwood. Other potential options such as use of biogas and solar energy for cooking and lighting can also be explored.

The fuel wood consumption trend shows that the consumption is expected to increase with increase in population and arrival of motorable road. Therefore some sustainable measures such as local forest management plan (LFMP) need to be in place for SWS.

The LFMP will not only help in sustainable extraction of timber and fuelwood from the allocated area but also help in regeneration of rest of the areas where the allocation is not done. This way the people will not be deprived of their fuel needs and the conservation of the biodiversity will also not be at stake.

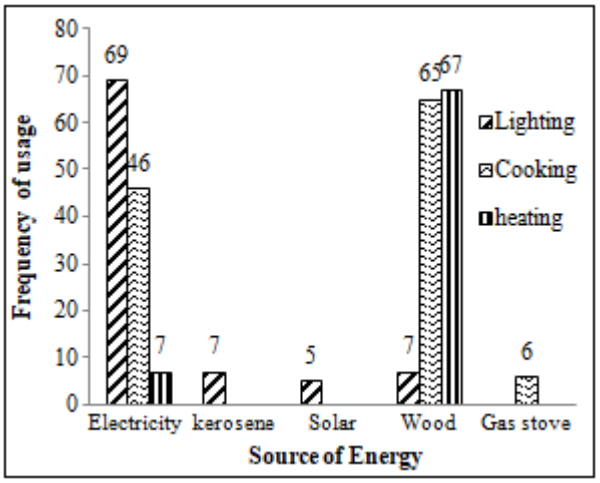


**Figure 2:** Energy Consumption in the surveyed households in Merak*Gewog* (N=173)

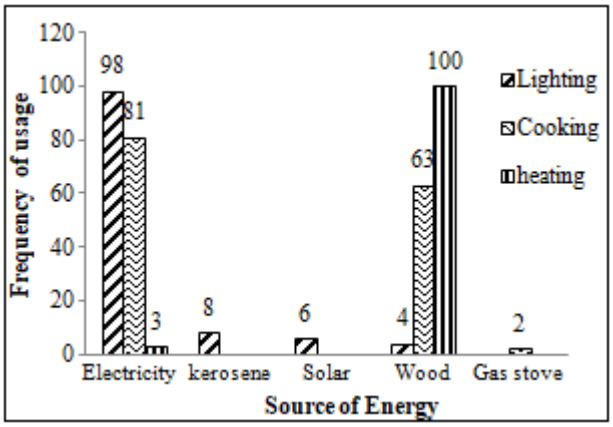


**Figure 3:** Energy Consumption in the surveyed households in Sakteng *Gewog* (N=173)


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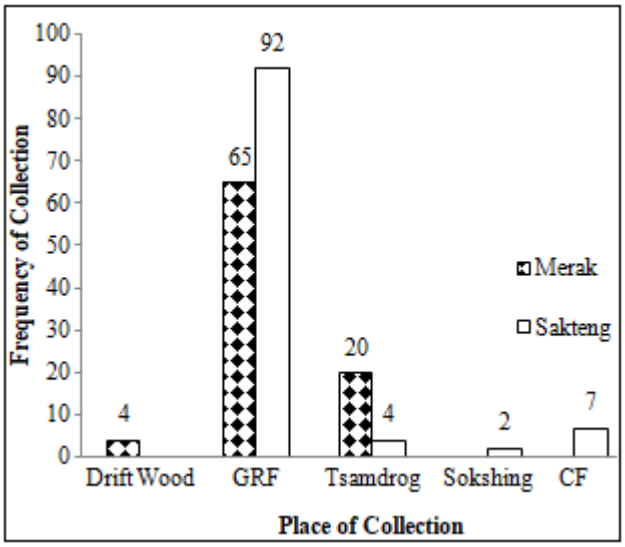


**Figure 4:** Sources of Fuel Wood collection in the surveyed household (N=173)

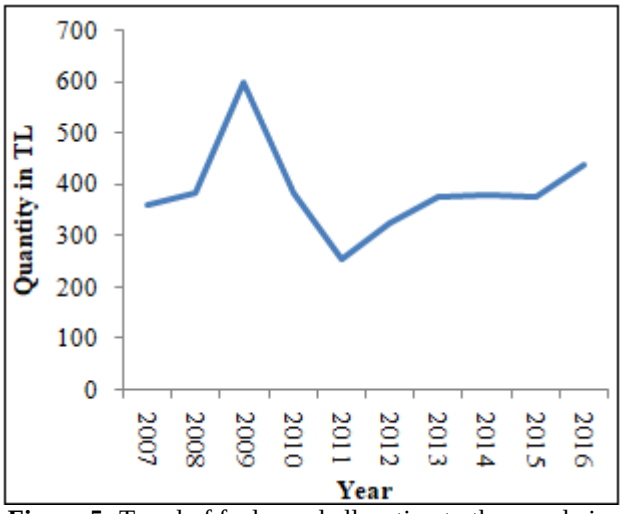


**Figure 5:** Trend of fuel wood allocation to the people in Merak and Sakteng from SWS (2007-2016)

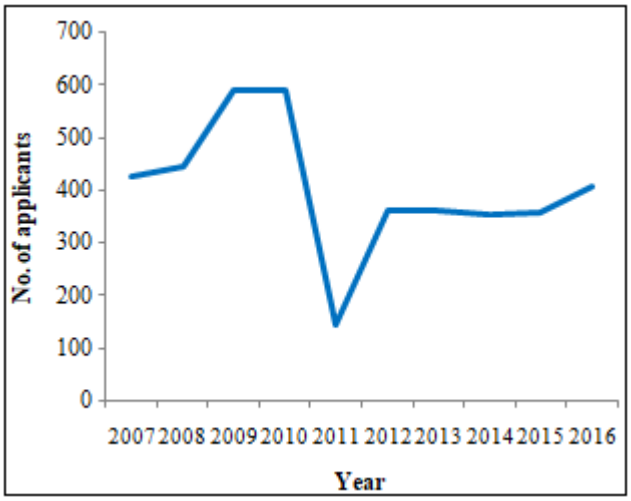


**Figure 6:** Trend in number of applicants applying for fuel wood in SWS (2007-2016)

**Table 1:** Consumption of fuel wood by schools having boarding facilities in different villages (Cft)

| | Merak | Sakteng | Joenkhar | Total |
|---|---|---|---|---|
| Students | 144 | 288 | 61 | 493 |
| Fuel Wood Consumption (in Cft) | 11449 | 6912 | 2260 | 20621 |

**Table 2:** Allotment of fuelwood from SWS office to people in Merak and Sakteng in 2016

| | Truckload | No. of applicant |
|---|---|---|
| Merak | 44.625 | 39 |
| Sakteng | 208.37 | 170 |

## 6. Acknowledgements

This study would not be possible without the cooperation and guidance from the management and staff of Sakteng Wildlife Sanctuary. The authors are thankful to Mr. Thinley Wangdi, Chief Forestry Officer of Sakteng Wildlife Sanctuary for his unwaivering guidance and encouragement.

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