FUELWOOD COLLECTION AND CONSUMPTION PATTERN IN THE BUFFER ZONE OF NANDA DEVI BIOSPHERE RESERVE, WESTERN HIMALAYA, INDIA

C.S. SILORI*

Wildlife Institute of India,
Chandrabani, Dehra Dun (Uttaranchal).

Introduction

Fuelwood is the most common energy source in rural Third world population (Allen *et al.*, 1988). In India, where almost 75% of the total population lives in rural areas, dependency on natural resources is common since varied biomass needs are met from surrounding vegetation (Ranjithsingh, 1979; Bowonder *et al.*, 1987; Kothari *et al.*, 1989). The easy availability of wood makes it one of the most popular sources of fuel for cooking, as well as other household and non-agriculture needs in the rural areas (Chakravarti, 1985; Monga and Lakhanpal, 1988; Rawat and Nautiyal, 1988). Moreover, due to ever increasing human population, commercial demand on wood resources also has increased manifold. A substantial part of this demand is from urban centres, leading to the rapid destruction of country wide forest resources (Leach, 1987; Rangnathan *et al.*, 1993). A huge gap in supply and demand has put enormous pressure on the country's forest resources, leading to their rapid depletion. In the Garhwal and Kumaon regions of North-Western Himalayas, however, the demand for fuelwood is well within the supply limit. It was estimated in 1989 that fuelwood demand was 1.8 million tonnes while 20.3 million tonnes were available as fuel from the forests and wastelands. Fuelwood demand has been projected to increase to 2.1 million tonnes in 2001 (Gadgil *et al.*, 1989).

Traditionally, rural energy demands and economics have been calculated multiplying the total population by a constant value of per capita consumption. There are many errors associated with this approach. First, estimates of fuelwood use or fuel use in general for that matter, are generally obtained through questionnaire-based surveys and, therefore, likely to be inaccurate (Saksena *et al.*, 1995). Additionally, these questionnaire-based surveys do not address the variation in the fuelwood consumption patterns due to several factors such as difference in family size, season, altitude, accessibility to the surrounding forests and availability of alternate fuel sources. The present paper is an attempt to address some of these factors, which influence the consumption pattern and generate a comprehensive understanding of patterns of fuelwood collection and consumption in the buffer zone of Nanda Devi Biosphere Reserve in the Western Himalayas. The objectives of this study were to :

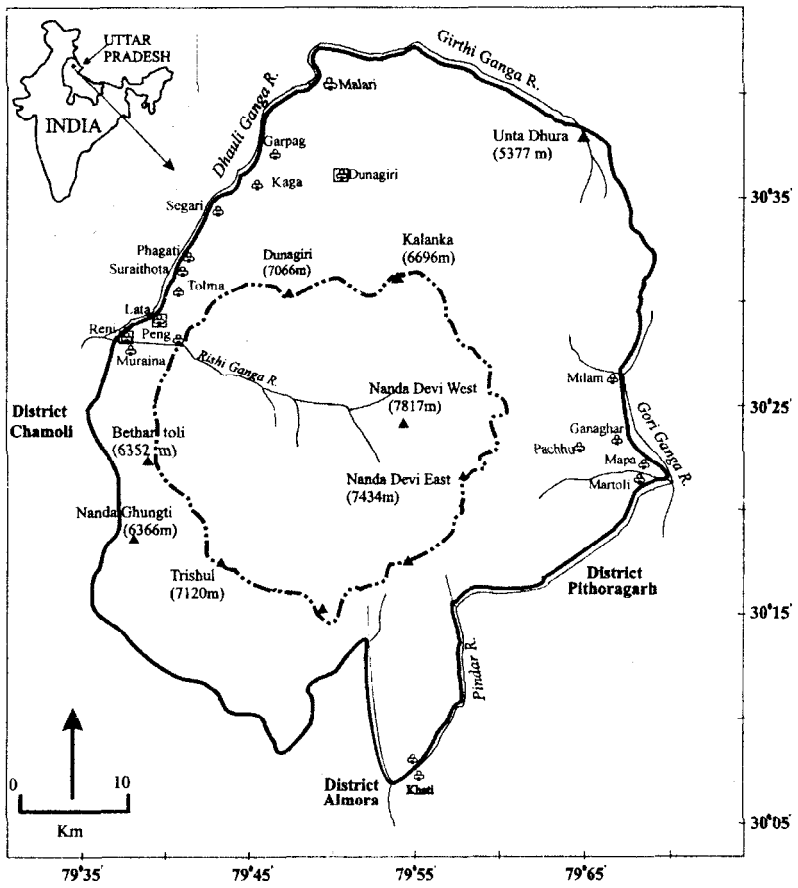
* Presently at : Gujarat Institute of Desert Ecology, Bhuj - Kachchh (Gujarat)

(i) understand the patterns of resource dependency of the local people with respect to fuel usage;
(ii) estimate per capita daily consumption of fuelwood, and
(iii) study seasonal and altitudinal variation in fuelwood use patterns.

Study Area

Geographical location and climate : The Nanda Devi Biosphere Reserve (NDBR) (70°40' E and 80°5' E latitude and 30°17' N and 30°41' N longitude) covers an area of 2236.74 km^2 in the Garhwal and Kumaon regions of Western Himalayas in the State of Uttaranchal (Fig. 1). The core zone (624.12 km^2) of the reserve, also designated as Nanda Devi National Park, is encircled by 1612.62 km^2 of the buffer zone. The altitudinal variation within the reserve ranges from 1,800 m above mean sea level (msl) to 7,817 m above msl, the height of the second highest peak of the country, Nanda Devi West Peak, is located within the core zone.

Fig. 1



Nanda Devi Biosphere Reserve in the Western Himalaya, showing location of villages in the buffer zone

Being an inner Himalayan valley, with a vast range of altitudinal variation, the NDBR experiences distinctive micro-climates. Heavy rainfall is recorded during monsoon, from late June until August. The approximate variation in rainfall is between 750 mm and 2,000 mm per annum and decreases from South to North. The maximum temperature in the NDBR reaches to almost 35°C in July while the minimum temperature goes well below 0°C with January being the coldest month (Silori and Badola, 1999). The winters are generally long, starting as early as mid October and continue until end March or early April. The higher elevations of NDBR (above 4,500 m) remain under perpetual snow while the lower altitudes remain under snow for more than six months of a year. Thus, about 66% of total area of the reserve remains snow bound or covered by glaciers throughout the year (Sahai and Kimothi, 1996).

Human habitation : Human habitation is restricted to the buffer zone of NDBR and are distributed among 19 villages (n=1856 persons) throughout the Chamoli, Bageshwar and Pithoragarh districts (Fig. 1). A tribal community, known as Bhotiya, dominates the human population. Majority of the inhabitants have two settlements - winter and summer, which are use to cope the harsh climatic conditions of the region. The villagers practice seasonal and altitudinal migration between these settlements and spend about 6 months. During the summer and rainy season (May until October) the inhabitants occupy settlements located inside the buffer zone. With the onset of winter, beginning in October, the inhabitants begin to migrate to winter settlements in the lower altitudes. The villages which are located at lower altitudes (below 2,500 m) in the buffer zone migrate within a range of 5 km (local migration) while most of the higher altitude villages migrate much greater distances ranging from 15 km to 125 km away from the buffer zone (distant migration).

The dependency of the villagers on the biomass resources of the buffer zone varied according to their degree of seasonal and altitudinal migration. Of the total human population, 55% depend on the natural resources of the buffer zone for six months of the year (May until October), while the remaining population depend throughout the year. Similarly of the total livestock (n=7885), only 36% graze round the year while the remaining graze for a maximum of six months from May until October in the buffer zone forest.

Methodology

One of the objectives of this study was to quantify variations in per capita daily consumption of fuelwood across the seasons and altitudes, therefore, three villages viz., Reni, Lata and Dunagiri, located at an altitude of 2,000 m, 2,400 m and 3,600 m above msl respectively, were selected. The selected villages also represented different lifestyle modes, viz., sedentary (Reni), locally migrating (Lata) and distantly migrating (Dunagiri). The villagers of Lata migrate from 2,000 m about 1.5 km down to winter settlement within the buffer zone, at an elevation of around 1,800 m while that of Dunagiri migrate about 125 km from the buffer zone in mid October to the lower altitudes (1,200-1,500 m) and return to their summer settlements in early May of the following year. Thus, the villagers of Reni and Lata use the natural resources of the buffer zone throughout the year while that

Dunagiri use the resources of the buffer zone for six months of the year. Demographic and socio-economic details of the sampled villages are presented in Table 1. The data on two major parameters (i) fuelwood collection, and (ii) consumption patterns, were collected in two phases. Fuelwood collection patterns were studied for one complete year during 1994-1995 in the study villages, while data collection on consumption patterns was carried out during 1995-1996.

Fuelwood Collection Pattern : Study on fuelwood collection pattern was started with a rapid survey in the three study villages in order to identify the areas of surrounding forest in which wood is being collected. The entry/exit points for wood collection on the village boundaries were also identified in order to monitor the patterns of fuelwood collection and quantify the off take and observe the time allocation for such activity. The number of entry/exit points was limited to 2-3 around study villages, probably due to limited accessibility to the hilly terrain. Since Reni and Lata villages are located close to each, monitoring of entry/exit points at the village boundaries was carried out for 10 days each in the first fortnight of every month for one year between May 1994 and April 1995. In Dunagiri village however, it was done for 10 days in the second fortnight of every month during May till October during 1995.

Table 1

Demographic and socio-economic details of the study villages in the buffer zone of Nanda Devi Biosphere Reserve

Socio-economic parameter	Reni	Lata	Dunagiri
No. of families	50	70	37
Human population	210	319	125
Av. family size	4.20	4.56	3.38
Proportion (%) of land owning families	92	97	100
Av. land ownership (ha)	1.25	1.25	1.02
Total livestock population	501	853	472
Proportion (%) of livestock owning families	76	76	86
Av. livestock holding per family	13	17	15

Based on the rapid survey, the monitoring of entry points was done twice in a day, when villagers start entering into the forest between 6 and 8 hrs and while coming out of the forest in the afternoon between 12 and 13 hrs. At these times, number of persons visiting the forest for wood collection and number of wood loads being brought out of the forest were recorded. The woodcutters were interviewed randomly at both the times of monitoring regarding the distance they walk inside the forest, time spent by them and the tree/shrub species they cut for fuelwood. The woodcutters were occasionally followed into the forest in order to cross check the validity of the information provided during interview. The selection of woodcutters for validation was done randomly across various groups, irrespective of age and sex, at different entry points. Regarding quantification of extracted wood, initially an attempt was made to weigh all the wood loads brought out of the forest, but due to lack of cooperation and opposition from some of the woodcutters, the sample size was restricted to 20. The weight of wood bundle was taken by weighing the cut stems of

different species and summing up these values. The variation in the seasonal collection of fuelwood was captured by broadly dividing the collection period into three major seasons *i.e.*, summer (April to June), rainy (July to September) and winter season (October to March).

Fuelwood Consumption Pattern : To study per capita daily consumption of fuelwood, 20% families were randomly selected from each of the three study villages. Thus a total of 35 families, 10 each from Reni and Dunagiri and 15 from Lata, were monitored for one year during 1995-1996. Monitoring in Reni and Lata villages was carried out from October 1995 until September 1996, while in Dunagiri it was carried out from May 1996 till October 1996, coinciding with their stay in summer settlements. Since there were 10 families each in Reni and Dunagiri village, each was visited at least three days in a month, while that of Lata villages was visited twice in a month.

Regarding per capita daily fuelwood consumption, methods adopted by Bartwal (1987), Allen *et al.* (1988), Osei (1993) and Saksena *et al.* (1995) were followed in the present study. Each selected family was asked about their daily requirement of wood (in kg) for cooking three meals in one day, as well as, for room heating (during winter). Based on this each family was given a slight excess quantity of pre-weighed wood from their own wood stock on the previous evening of monitoring day, using the spring balance (accurate up to 50 g). The excess wood was given to them in order to meet their unforeseen additional demand, which could be because of visits of guests. The same family was visited the next day morning to weigh the left over quantity after consumption, if any, using a spring balance. On each monitoring day the record of number of family members was also kept for each monitoring day for one year.

To check the significance in the variation in the fuelwood collection and per capita consumption pattern across altitudes and seasons, test of analysis of variance (ANOVA) was used with alpha level at 0.05 using statistical package SPSS/PC+4.2. The mean values are presented with standard error of mean (±SEM). The correlation between family size and per capita fuelwood consumption is also checked.

Results

Fuel use pattern : In all the study villages, 100% of the families use wood as the chief source of fuel for cooking and room heating. Though, kerosene and liquid petroleum gas (LPG) also contributed marginally (1-4% families) for cooking in Reni and Lata villages, fuelwood remained chief source of energy for room heating. Despite having electricity connection, none of the families in these two villages used electricity for cooking due to low voltage and irregular power supply. On the other hand in Dunagiri village, kerosene was use to light the lamps and not for cooking. Other fuel devices, such as dung cakes and crop residues were not used in any of the study villages.

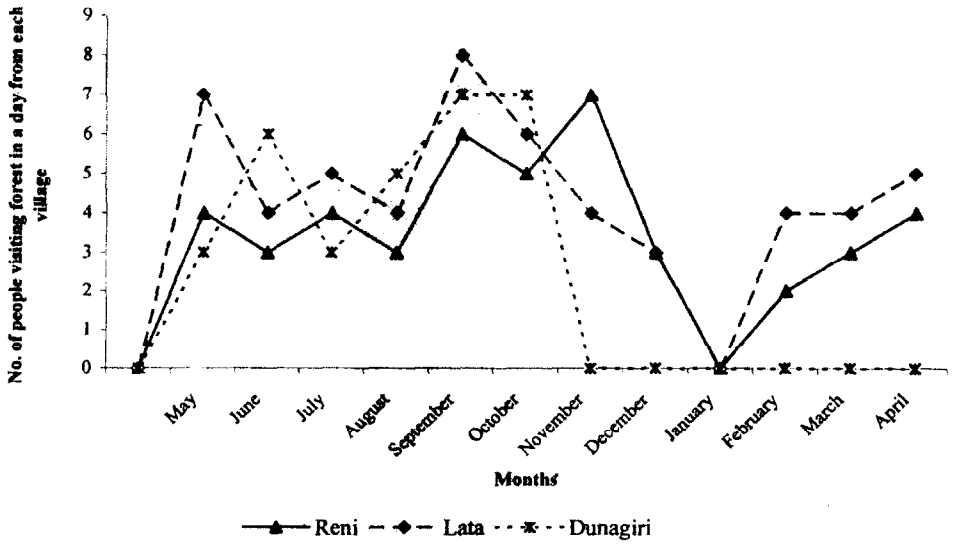
Fuelwood collection pattern : The villagers of Reni and Lata collect fuelwood for almost 10 months of a year from the buffer zone forest, excluding second fortnight of December, whole of January and first fortnight of February, when the surrounding forests remain inaccessible

due to heavy snow fall. On the other hand in Dunagiri, fuelwood collection was recorded for about 5 months between mid May and mid October from the buffer zone forest. In each of the study villages, the people venture about 2-3 km inside the forest and spend about 5-6 hours collecting fuelwood. Fuelwood collectors bring wood loads on their back. Besides collecting from forests, the villagers of the Reni and Lata also collect flowing wood logs in the Rishi Ganga and Dhauli Ganga Rivers during rainy season.

The wood loads brought by the villagers of Reni and Lata, generally consisted of (in terms of weight) dry cut branches of *Pinus wallichiana* (35%), *Cedrus deodara* (45%), *Cotoneaster* spp (10%), *Cupressus torulosa* (5%) and others (5%). In Dunagiri village, woodloads consisted of *Betula utilis* (55%), *Rhododendron campanulatum* (35%) *Juniperus* spp. (5%) and *R. arboreum* (5%). It is important to mention here that in Dunagiri village, villagers rarely cut the branches/trees for fuelwood because useable fallen wood remains available in the forest after heavy snowfall and glacial movements. Such a practice of wood collection keeps a check on the cutting pressure on the trees, which is otherwise a common practice in other parts of the reserve.

The monitoring of entry/exit points at village boundary revealed that the number of people visiting forest for fuelwood collection increased just before the onset of winter in all the study villages (Fig. 2). In Reni and Lata, villagers store the fuelwood for 2-3 months of winter to meet the additional energy demand for keeping their houses warm. On the other hand in

Fig. 2



Monthly patterns of fuelwood collection in the study villages in the buffer zone of Nanda Devi Biosphere Reserve (1994-1995)

the Dunagiri, villagers store wood for next season to last for initial 15-20 days, because the forests around their summer settlements still remain inaccessible due to heavy snow.

The average weight of per load of fuelwood varied significantly among the three study villages. It was calculated to 31.50±0.94 kg per load (n=20) for Reni village, 29.70±0.69 kg (n=20) for Lata and 25.40±0.72 kg (n=20) for Dunagiri village (p=0.0001). The variation in the average weight of fuelwood load was attributed to the terrain and nearness to the surrounding forest. In the Reni and Lata, villagers need to walk downhill with wood loads, therefore, they could bring heavier load to avoid the frequent visits to the surrounding uphill forests. On the other hand in the Dunagiri, due to nearness of *Betula utilis* and *Rhododendron* forest (1-1.5km) on a relatively easy terrain, villagers could visit the forests more frequently and bring comparatively less heavy loads.

The proportion of total annual collection did not vary significantly across seasons in the three study villages (Table 2). In Reni, the proportion of summer collection (25%) and rainy collection (30%) was relatively less as compared to winter collection (45%). In Lata village, the proportion of summer and rainy collection did not vary much (30% and 32% respectively) while the winter collection was slightly high (38%). Interestingly, in Dunagiri village, the proportion of rainy season collection was higher (48%) than summer (29%) and winter collection (23%) but statistically there was no significant variation. Due to location at higher altitude, the temperature inherently remains low and with the onset of monsoon it drops further, incurring higher consumption of wood for room heating. However, the proportion of winter collection was low because of the short stay of the villagers during few days of October, after which they migrate to the lower altitude outside the buffer zone.

Per capita fuelwood consumption : The results of average per capita daily consumption revealed a declining trend

Table 2

Seasonal collection of fuelwood in the study villages in the buffer zone of Nanda Devi Biosphere Reserve during 1994-1995

Season	Quantity (tonnes) collected			Total	P value across seasons within village
	Summer	Rainy	Winter		
Reni	10.52 (25)	12.51 (30)	19.12 (45)	42.15	0.765
Lata	14.46 (30)	15.41 (32)	18.86 (38)	48.74	0.234
Dunagiri	6.93 (29)	11.63 (48)	5.51 (23)	24.08	0.589
P value within season across village	0.239	0.611	0.144		

Values in parentheses refer to per cent of total wood collection

Table 3

Per capita daily consumption of fuelwood in the study villages in the buffer zone of Nanda Devi Biosphere Reserve during 1995-1996

Village	Per capita av. daily fuelwood consumption (kg±SEM)	Per capita daily consumption of fuelwood (kg±SEM)			P value across seasons within village
		Summer	Rainy	Winter	
Reni	3.43 ± 0.46	2.62 ± 0.36	3.91 ± 0.52	3.68 ± 0.61	0.166
Lata	3.75 ± 0.53	2.96 ± 0.39	2.86 ± 0.40	4.60 ± 0.67	0.050
Dunagiri	4.59 ± 0.72	3.82 ± 0.66	4.72 ± 0.74	5.75 ± 0.79	0.226
P values across altitude and within season	0.092	0.115	0.251	0.107	

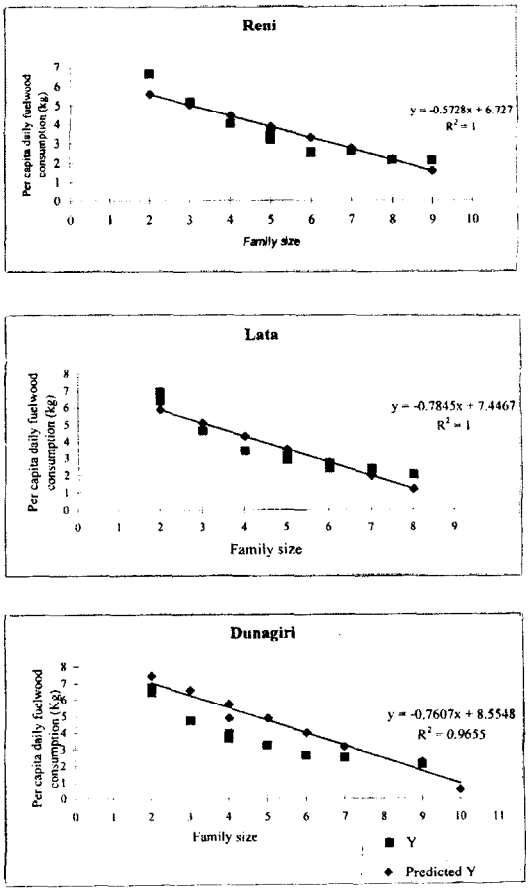
with the declining altitude, but the decline in the fuelwood consumption was not very significant (Table 3). Irrespective of seasons, per capita daily consumption of fuelwood was recorded maximum in Dunagiri village (5.75±0.79 kg) while the minimum was recorded for Reni village (2.62±0.36 kg). While analysing the variance in the consumption pattern across seasons in the study villages, no significant difference was observed. Similar results were obtained while checking the variance within a particular season across altitudes.

Variation in the fuelwood consumption pattern due to difference in family size revealed that per capita daily consumption was high in smaller families and this reduced with increasing family size. In a two member family, per capita daily consumption ranged between 6.65 and 6.93 kg while in a larger family of 8-9 members the daily consumption ranged between 2.02 and 2.11 kg. Thus, in case of all the three study villages, a strong negative correlation (R^2=1) was achieved between family size and per capita daily fuelwood consumption (Fig. 3).

Discussion

Lack of alternate fuel devices, cold climatic conditions and the easy accessibility of wood in surrounding forests together make wood the most popular and chief source of fuel in the study villages on which almost entire population depend for cooking and room heating. Other fuel devices such as dung cakes, agriculture residues, and biogas have never been used in these villages, which are otherwise quite popular in the lower plains of Northern India (Bernard, 1985). The improved hearth was never used to reduce the consumption rates in any of the study villages. Gupta *et al.* (1999) in a study conducted in the high altitude region of Jammu and Kashmir have revealed that the consumption rates of fuelwood can be brought down by 8% to 18% by using improved hearth. Due to easy availability of wood in the surrounding forests within

Fig. 3



Correlation between family size and per capita daily consumption of fuelwood

a range of 2-3 km, unlike other parts of country (Silori, 1996), villagers do not store wood for longer period except for 2-3 months of winter, when due to heavy snow fall the surrounding forests remain inaccessible and additional wood is required for room heating. Use of modern fuel devices such as LPG, solar cookers and biogas is either recorded infrequently or totally absent, mainly because of lack of proper extension work by the government agencies towards popularising and promoting these devices. Although few families of Reni and Lata had started using LPG, but irregular supply hampers its role in minimising the dependency of local people on the wood for fuel.

In the present study, per capita daily consumption of fuelwood for cooking and room heating was found to decline with altitude, without yielding statistically significant variance. Nevertheless, it was much higher, when compared to other similar studies in different parts of the Himalayas ranging from lower to higher altitudes and other parts of Northern India (*e.g.*, Chandola *et al.*, 1985; Bartwal, 1987; Mishra *et al.*, 1988; Singh and Singh, 1989; Saksena *et al.*, 1995; Sundriyal and Sharma, 1996; Gupta *et al.*, 1999) (Table 4). The winter consumption recorded by Moench (1989) (3.6 kg day^{-1} capita^{-1}) is comparable with overall per capita daily consumption of Reni (3.43 kg) and Lata (3.75 kg) village. Similarly per capita daily consumption of fuelwood (2.95 kg) recorded by Mishra *et al.* (1988) is comparable with the summer and rainy consumption of Reni and Lata villages. However, Gupta *et al.* (1999) recorded low consumption rates of fuelwood for some of the high altitude villages in Jammu and Kashmir region of North India, ranging between 1.49 kg (summer) and 1.95 kg (winter) per day per capita across seasons, mainly because of the use of other sources such as dung cakes and kerosene oil, which contributed about 16% to the total fuel consumption. Per capita daily consumption of fuelwood in the present study was also compared with the similar studies conducted abroad. Soussan *et al.* (1991) recorded much lower consumption rates for Dhanusha District (0.86 kg capita^{-1}) in the Nepal Himalaya. Allen *et al.* (1988), while studying the two rural communities in Swaziland, recorded

Table 4

Comparative account of fuelwood consumption pattern in different study sites

Area	Altitude (m)	Climate	Comman fuelwood species	Per capita consumption (kg day^{-1} capita^{-1})	Source
1	2	3	4	5	6
Garhwal Himalaya	1200-1300	Sub-tropical to temperate	*Pinus roxburghii, Celtis australis, Anogeissus latifolia, Bauhinia parviflora*	1.53	Bartwal, 1987
Garhwal Himalaya	1200-1500	Sub-tropical to temperate	*Pinus ruxburghii, Eucalyptus* sp.	1.26-1.95	Mishra *et al.*, 1988
Garhwal Himalaya	1800-3000	Sub-tropical to temperate	*Quercus leucotrichophora, Q. dilatata, Pinus roxburghii, Rhododendron* sp.	1.9-3.6	Moench, 1989
Vindhyan range, North India	140-150	Sub-tropical monsoon	*Anogeissus latifolia, Lagerstroemia parviflora, Hardwickia binata*	0.78-0.80	Singh and Singh, 1989
Garhwal Himalaya	2000-2480	Sub-temperate to temperate	*Pinus roxburghii, Celtis australis, Quercus leucotrichophora, Rhododendron arboreum*	0.76-1.21	Saksena *et al.*, 1995
Sikkim, Eastern Himalayas	400-2350	Sub-tropical to temperate	*Shorea robusta, Quercus lamellose, Symplocos theaefolia, Albizia* sp.	2.5-3.5	Sundriyal and Sharma, 1996
Jammu region of Western Himalaya	Not mentioned	Temperate	Not listed	1.46-1.95	Gupta *et al.*, 1999

Contd...

1	2	3	4	5	6
District Dhanusha, Nepal	Not mentioned	Sub-tropical (Tarai region of Gangetic plains)	Not listed	0.86	Soussan *et al.*, 1991
Rural Swaziland, Africa	600-800	Not mentioned	*Acacia karrooa, A. tortilis, Rhus pyriodes, Dichrostachys cinerea*	1.72-2.11	Allen *et al.*, 1988
Ghana, Africa	Not mentioned	Moist to semi-deciduous	*Oxytenanthera abyssinia, Manihot asculenta, Zea mays*	1.54-1.72	Osei, 1993

per capita daily consumption rates of fuelwood ranging between 1.72 kg and 2.11 kg. Osei (1993) also recorded low per capita daily consumption rates (ranging between 1.54 and 1.97 kg) for the rural areas of Ghana.

In the studies stated above, the major reason of lower rates of wood consumption as compared to the present study was the use of other sources such as dung cakes and agriculture residues, which were not used in the present study villages. In addition, the prolonged cold climatic conditions and easy availability of the wood from the surrounding forests also caused higher consumption of fuelwood. Due to prolonged winter season, especially at higher altitudes, daily consumption is increased because of additional use of wood for room heating. Moench (1989) and Allen *et al.* (1988) recorded similar trends for a high altitude village in Garhwal Himalaya and for rural Swaziland in South Africa respectively while Mishra *et al.*, (1988) recorded nearness to the forest as one of the major reasons of higher consumption rates (2.95 day^{-1} capita^{-1}) as compared to the villages located far away from the forest in Garhwal Himalayas (1.26kg day^{-1} capita^{-1}).

Measurements made in this study indicate that per capita daily consumption of fuelwood increased with the decreasing family size, a finding similar to that recorded by Saksena *et al.* (1995) for three villages in Garhwal Himalaya. Located between and altitude of 2000 and 2480 m. The authors also recorded that beyond a certain size of family (6-9), the per capita consumption increased. However, during this study the largest family size was 9, therefore it is difficult to support this fact through the present study.

Conclusion

In the present study, from a management point of view, the consumption of fuelwood needs to be brought down to stop the cutting of trees/ shrubs for fuel and better regeneration of surrounding forests. Silori (2000) has recorded that in District Chamoli sector of the buffer zone of the biosphere reserve, the proportion of cut trees to the total trees was maximum (26%) as compared to

Table 5

Proportion of cut stems and regeneration pattern of major tree species in District Chamoli sector of the buffer zone of NDBR

Tree species	Total trees	Cut trees	Percentage of cut	Density of seedlings (no. ha^{-1})	Density of saplings (no. ha^{-1})
Abies pindrow	60	13	22	23	8
Butula utilis	73	26	36	17	7
Cedrus deodara	235	74	31	24	14
Cotoneaster lindleyi	14	1	7	4	2
Cupressus indicum	24	19	79	5	1
Cupressus torulosa	115	76	66	16	10
Fraxinus xanthoxyloides	52	45	87	2	3
Juniperus communis	152	50	33	7	4
Pinus wallichiana	482	118	24	83	36
Rhododendron campanulatum	163	41	25	31	13
Viburnum cotanifolium	29	10	34	15	11

District Bageshwar (18%) and Pithoragarh (5%). Author further recorded that substantial proportion of cut stems (29%) fall under 23-40 cm GBH class, indicating damage to the recruitment class, which in the long run would have negative impact on the health of the buffer zone forest. Although, of the total 32 tree species listed by author in District Chamoli sector, 81% showed signs of regeneration, the density of regeneration and recruitment of majority of these species (Table 5) can not be rated as good for the long term establishment of the forest.

Although distribution of wood cutting in the study region was limited to the surroundings of the human settlements, it needs to be brought down further in order to ensure the biodiversity values of NDBR, for which it is known in the entire Himalayan region (Green, 1993). Imposing a ban of the fuelwood collection would be an impractical alternate in view of the harsh climatic conditions of the region, especially in the high altitude villages. Therefore, phase-wise introduction of alternate fuel devices would help in bringing down the dependency of local villagers on biomass resources. In this regard ensuring the proper supply of LPG in road side villages would help in minimizing the dependency of local people on the buffer zone forest. In higher altitude villages, where supply of LPG is difficult, and a large chunk of the population has agriculture-based economy, the use of dung cakes, agriculture residues and biogas can be promoted. In addition, the plantation of fuelwood species in the wasteland surrounding to the villages and on the bunds of agriculture fields (agro-

forestry) would help in meeting the fuelwood demand of the families who cannot afford the cost of LPG or biogas. Awareness programmes can also be taken up in these villages towards the sustainable use of existing and introduced conventional and non-conventional energy sources.

Acknowledgements

Ministry of Environment and Forests, Govt. of India is sincerely thanked for financial support to a larger project under which the present study was conducted. Director, Wildlife Institute of India, Dehra Dun is thanked for providing logistics for field studies. Field assistants Mr. Prem Singh and Roop Chand and the villagers of the study villages are thanked for their co-operation during household sampling.

SUMMARY

The article describes patterns of fuelwood collection and per capita daily consumption across seasons and altitudes in the buffer zone of Nanda Devi Biosphere Reserve, Western Himalayas. Three villages, located at different altitudes were monitored during 1994-1995 in order to identify fuelwood collection pattern during 1995-1996 to quantify fuelwood consumption patterns. *Rate of fuelwood collection was found to be highest just before the onset of winter* during September-October. With declining altitude, per capita daily and seasonal consumption of fuelwood also declined. Average per capita daily consumption was, however, substantially higher in the study villages when compared to other studies. At the household level there was a negative correlation between family size and per capita daily consumption of wood. Easy accessibility to fuelwood in the surrounding forests, cold climatic conditions and the lack of alternatives resources have been identified as the major factors for the higher consumption rates of fuelwood, *especially in the higher altitude villages.* The findings of the study have been concluded in the light of the sustainable use of wood fuel for the long-term conservation of the buffer zone forest.

नन्दादेवी जीवमण्डल संरक्षित क्षेत्र, पश्चिमी हिमालय, के प्रत्यारोध क्षेत्र में ईधनकाष्ठ एकत्रीकरण और उपभोग की रूपसज्जा

सी०एस० सिलोरी

सारांश

इस अभिपत्र में नन्दादेवी जीवमण्डल संरक्षित क्षेत्र, पश्चिमी हिमालय के प्रत्यारोध क्षेत्र में विभिन्न मौसमों और विभिन्न ऊंचाईयों पर ईधनकाष्ठ एकत्रीकरण और प्रतिव्यक्ति उसके उपभोग की रूपसज्जाओं का वर्णन किया गया है । भिन्न-भिन्न ऊंचाईयों पर अवस्थित तीन गांवों की 1994-95 में जांच पड़ताल करके उनके ईधनकाष्ठ एकत्रीकरण की सज्जा का पता लगाया गया तथा 1995-96 में उनके ईधनकाष्ठ उपभोग को मात्रांकित किया गया । ईधनकाष्ठ संग्रह करने की दर शीतऋतु आरम्भ होने से ठीक पूर्व सितम्बर-अक्टूबर में सर्वाधिक रहती पाई गई । जैसे-जैसे ऊंचाई घटती गई ईधनकाष्ठ का प्रतिव्यक्ति दैनिक और मौसमी उपभोग भी घटता गया । तथापि, औसत प्रति व्यक्ति दैनिक उपभोग अध्ययन किए गए गांवों में अन्य अध्ययनों की तुलना में काफी अधिक पाया गया । परिवार स्तर पर, परिवार के आकार और काष्ठ के प्रतिव्यक्ति दैनिक उपभोग मे नकारात्मक सहसंबध रहता देखा गया । आसपास के जंगलों में ईधनकाष्ठ की सुगमता से उपलभ्यता, ठंडी जलवायु दशाएं और वैकल्पिक संसाधनों का अभाव ईधनकाष्ठ की अधिक ज्यादा दरों के विशेषत: अधिक ऊंचाई पर अवस्थित गांवों में, मुख्य कारण रहते पाए गए हैं । इस अध्ययन से मिली जानकारियों का समापन, ईधनकाष्ठ के दीर्घकाल तक चलते रहने वाले उपभोग के प्रकाश में प्रत्यारोध क्षेत्र के वनों की लम्बे समयतक संरक्षित रखने से किया गया है ।

References

Allen, J.A., D.P. Piemental and J.P. Lasoie (1988). Fuelwood production and use in rural Swaziland: A case study of two communities, *For. Ecol. Manage.*, **25** : 239-54.

Bartwal, P.S. (1987). Fuelwood Consumption Pattern in Rural Areas - A Case Study. *J. Trop. For.*, **3** : 136-141.

Bernard, G.W. (1985). The Use of Agriculture Residues as Fuel. *Ambio,* **14** : 259-265.

Bowonder, B., S.S.R. Prasad, and N.V..M. Unni (1998). Deforestation Around Urban Centres in India. *Environmental Conservation* **14**,23-28.

Chakravarti, R. (1985). Some Observation on Fuelwood Forestry in India. *J. Trop. For.,* **1** : 3-17.

Chandola, L.P., A.K. Mahendra and M.Y. Ansari (1985). Pilot Survey of Fuel Consumption in Rural Areas - III. *Indian Forester* **111** (4) : 208-214.

F.S.I. (1987). *State of the Forest Report,* Forest Survey of India, Dehra Dun.

Gadgil, M., M. Sinha and J. Pillai (1989). *India: A Biomass Budget.* Final Report of the Study Group on Fuelwood and Fodder. Planning Commission, Government of India, New Delhi. 33 p.

Green, M.J.B. (1993). *Nature Reserves of the Himalayas and the mountains of Central Asia.* International Union for Conservation of Nature and Natural Resources (IUCN), Gland. p. 471.

Gupta, T., P.S. Kaushal, U. Rana, R.K. Gupta and M.S. Pathania (1999). A study on fuel consumption pattern in Jammu Region of Jammu & Kashmir. *Range Mgmt. and Agrofor.,* **20** : 177-183.

Kothari, A., P. Pande, S. Singh and D. Variava (1989). *Management of National Parks and Wildlife Sanctuaries in India: A Status Report.* Indian Institute of Public Administration, New Delhi. p. 298.

Leach, G. (1987). Household Energy in South India. *Biomass*, **12** : 155-184

Mishra, N. M., A.K. Mahendra and M.Y. Ansari (1988). Pilot Survey of Fuel Consumption in Rural Areas V. *Indian Forester,* **114** (1) : 57-62.

Moench, M. (1989). Forest Degradation and the Structure of Biomass Utilization in a Himalayan Foothills Village. *Environmental Conservation,* **16** : 132-147.

Monga, P. and T.N. Lakhanpal (1988). *Rural Energy Alternatives in the Hilly Areas.* Today and Tomorrow's Printers and Publishers, New Delhi. p. 213.

Osei, W. Y. (1993). Woodfuel and Deforestation - Answers for Sustainable Envirnonment. *J. Env. Mgmt.,* **37** : 57-62.

Prasad, R.R. (1989). *Bhotia Tribals of India: Dynamics of Economic Transformation.* Gian Publishing House, New Delhi. p. 206.

Rangnathan, V., S.S. Rao and G.S. Prabhu (1993). *Demand and Supply of Fuelwood in Karnataka.* India Institute of Management, Bangalore.

Ranjitsinh, M.K. (1979). Forest Destruction in Asia and South Pacific. *Ambio* **8** : 192-201.

Rawat, J.K. and J.C. Nautiyal (1988). Forest Biomass - A Source for Fodder, Feed and Fuel. *Indian Forester,* **114** (6) : 429-439.

Sahai, B. and M.M. Kimothi (1996). Remote Sensing for Surveying, Mapping and monitoring of Conservation Areas in Himalaya. *Conservation and Management of Biological Resources in Himalaya* (P.S. Ramakrishnan, A.N. Purohit, K.G. Saxena, K.S. Rao and R.K. Maikhuri, eds.). Oxford & IBH Publishing Co. New Delhi, India. pp. 235-258.

Saksena, S., R. Prasad and V. Joshi (1995). Time Allocation and Fuel Usage in Three Villages of the Garhwal Himalaya, India. *Mountain Research and Development,* **15** : 57-67.

Silori, C. S. (1996). Study of Pressure and Dependency of Local People on the Natural Resources of Mudumalai wildlife Sanctuary with a view to Devision Compatible Management Strategies. *Ph.D. Thesis.* Saurashtra University, Rajkot, Gujarat. pp. 211.

Silori, C.S. and R. Badola (1999). Nanda Devi Biosphere Reserve : A study of socio-economic aspects for sustainable development of dependent population. *Final Report*, Wildlife Institute of India, Dehra Dun. p. 133.

Silori, C.S. (2000). Status and Distribution of Anthropogenic Pressure in the Buffer Zone of Nanda Devi Biosphere Reserve in Western Himalaya, India. *Biodiversity and Conservation*, **10** : 1113-1130

Singh, V.P. and J.S. Singh (1989). Man and Forest : A case study from the Dry Tropics of India. *Environmental Conservation,* **16** : 129-136.

Soussan, J., E. Gevers and P. O'Keefe (1991). Planning for Sustainability: Access of Fuelwood in Dhanusha District, Nepal. *World Development,* **19** : 1299-1314.

Sundriyal, R.C. and E. Sharma (1996). Anthropogenic Pressure on Tree Structure and Biomass in the Temperate Forest of Mamlay Watershed in Sikkim. *For. Ecol. & Manag.*, **81** : 113-114.