Examining the socioeconomic drivers of fuelwood dependence in villages on the Northern boundary of Bandipur National Park

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By
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Declaration

I declare that the thesis entitled "Examining the socioeconomic drivers of fuelwood and fodder dependence in villages on the Northern boundary of Bandipur National Park" comprises research work done by me under the guidance of Dr. M.D. Madhusudan and co-guidance of Dr. Mahesh Rangarajan and Ms. Krithi K. Karanth. The work is original and has not been done earlier by anyone else. Part of this work, which is related to or similar to work done by other researchers, has been referred to in this thesis at appropriate places. The results presented in this thesis have not been submitted previously to this or any other University for an M.Sc. or any other degree.

Signature of the Guide
(Dr. M.D. Madhusudan)

Signature of the Candidate
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Certificate

I declare that this thesis entitled "Examining the socioeconomic drivers of fuelwood and fodder dependence in villages on the Northern boundary of Bandipur National Park" comprises research work carried out by V. Sumati at the Centre for Wildlife Studies under my guidance and the co-guidance of Dr. Mahesh Rangarajan and Ms. Krithi K. Karanth during the period 2005-2006 for the Degree of Master of Science in Wildlife Biology & Conservation of the Manipal Academy of Higher Education (MAHE). The results presented in this thesis have not been submitted previously to this or any other University for M.Sc. or any other degree.

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Summary

This study examines the socioeconomic processes that affect fuelwood dependence in 32 villages along the north eastern boundary of Bandipur National Park. The socioeconomic aspects of fuelwood dependence on the national park are studied with the specific objective of providing information that is useful in designing conservation initiatives to mitigate the impacts of fuelwood dependence on the Bandipur National Park.

Dependence is studied both at the level of the household as well as at the level of the village by means of household questionnaire surveys. A dependence index is not defined; instead the various aspects of dependence including use of alternatives and effort invested in obtaining wood from the forest are looked at separately in order to obtain an understanding of how interactions work.

At the village level, influence of caste and social structure of a village, location and economic structure of a village on dependence on the national park for fuelwood are explored. At the level of the household, the role of primary income source and landholding in influencing various aspects of fuelwood dependence are examined. Patterns at the household level indicate that landless households are the most dependent on the forests as a source of fuelwood, as these households often do not have access to farm residue as an alternative source of fuel. Households that rely on wage labour as a primary source of income are found to be the most dependent on forests when compared to other groups both in terms of use of alternative fuels, as well as in terms of effort spent in extracting forest resources. At the level of the village, location does not play an important role in proportion of households the using of LPG, indicating perhaps, that it is not the availability of commercial fuels that restricts its

use. However, villages that are closer to the forest have a greater proportion of households dependent on the forests as a source of fuelwood. This shows that the use of fuelwood from the forest is influenced by the location of a village and indicates that the effect of distance operates at a scale which maybe captured by studying villages within five kilometres from the forest edge. Villages are seen to be differentiated on the basis of caste into three types, single caste villages, multi caste villages and tribal villages. They are also differentiated on the basis of economic structure and preliminary analyses reveal that these are important determinants of forest dependence. This study indicates that landless households and households that rely on wage labour are the groups that must be target of conservation intervention.

Further analysis and study are likely to improve understanding of relationships and processes in the region and help provide a clearer picture of relationships between socioeconomic variables such as caste and economic status on forest dependence at both the household level as well as at the village level.

CONTENTS

Introduction

Loss and degradation of natural habitat is widely reported to be one of the most important reasons for the extinction of wild species (IUCN 2004; Novecek and Cleland 2001). The extraction of biomass in the form of forest products like fuelwood and fodder alters wildlife habitat and constitutes one of the most important threats to forests and wildlife (Shaanker et. al. 2003). The pressures of human dependence on forest resources threaten most protected areas in India (Kothari 1989). Increasing demand for forest products, driven by demographic and market pressures, often leads to accelerated extraction of forest resources that in turn drives habitat degradation (Shylajan & Mythili 2003; Madhusudan 2000; Robinson 1993; Reid at al. 1990).

It is difficult to design conservation initiatives that deal with habitat destruction on a global scale as the forces governing it are often complex and intractable. If practical strategies to mitigate habitat degradation are to be designed, it is more relevant to look at drivers for habitat loss at a local scale.

The primary cause for habitat degradation in the Bandipur National Park is the extraction of fodder and fuelwood form the park by the villagers living along the north-eastern boundary of the park (Madhusudan 2000).

While the immediate physical cause of degradation is apparent, the drivers that result in illegal extraction from a protected area, inspite of the costs flouting enforcement and of harvesting resources from potentially dangerous wild animal habitat are not immediately obvious.

To be able to design and implement long term conservation initiatives in the region, it is necessary to understand the social and economic drivers of extraction of forest resources (Bawa et. al 2004). There is a need to understand this extraction from the perspective of the people who are using the forest resources to design a solution that is appropriate and effective, and so that we may be able to present that solution in a way that is acceptable to them (Martin & Lemon 2001).

Understanding the social and economic drivers of forest resource use will help actively identify market and governance mechanisms by which dependence on the forest might be reduced (Wells & Shane 2000). Identifying the drivers of forest resource use will help determine how policy must change or what market mechanisms might be used in order to maximize biodiversity conservation (Heltberg et. al. 2000). Conservationists can then focus on lobbying for these specific changes, aiming ultimately for a biodiversity friendly culture and society.

Generalization of findings

It has often been established that no one solution yields satisfactory conservation results across diverse ground situations. Thus it is required to study particular regions in order to understand the mechanisms that might result in conservation under a particular set of ecological, sociological, economic and political conditions (Madhusudan & Shankar Raman 2003). Therefore it is required to look at forest extraction in different landscapes without necessarily being able to extrapolate or generalize the findings from a single region to a national or global context. Indeed designing and implementing conservation strategies without a clear understanding of the local context may lead to contrary results that counter the intended impacts of conservation interventions (Martin and Lemon 2001)

Looking outside for the answer

Protected areas in India are often the last remaining habitats for endangered species (Madhusudan & Shankar Raman 2003). However, the majority of protected areas in India are located right in the midst of densely populated agricultural landscapes (Kothari et. al. 1989). The Bandipur National Park is flanked on its north-eastern boundary by numerous villages that depend on the park for fuelwood resources. Extraction of fuelwood by people living adjacent to the park has inflicted severe damage on the park (Madhusudan 2000). This is borne out by satellite imagery that shows increasing loss of tree cover spreading inwards from the boundary of the park *(Madhusudan and Krishnaswami, pers comm)*. There is little doubt that the daily entry of close to one thousand five hundred people *(worked out by assuming that one member of a household enters the park every once in two days)* through a 20 km zone of the park to collect fuel wood causes immense disturbance to the park and its wildlife *(Madhusudan unpublished).* The villages that exert this pressure on the park are characterized by poverty and an acute fuelwood shortage inspite of the National Park being a primary source for fuelwood in the region.

Decisions about pattern and extent of resource extraction from the forest are made at a household level, and hence the household is an appropriate unit to understand socioeconomic factors that influence dependence on the forest. There are several complex factors that affect dependence and use of fuelwood from the forest at the household level (Heltberg et. al. 2000). To be able to design conservation initiatives it is imperative to have a clear description of the region in order to understand the various socioeconomic covariates of forest resource use and dependence. This sort of an understanding is necessarily region specific and is frequently missing in many conservation initiatives. In order to effectively alter systems, it is first required that they are understood in a specific context. While several sociological and

economic studies look at issues of fuelwood use in rural areas, this study focuses on understanding fuelwood consumption in a conservation specific context.

The villages studied obtain a substantial proportion of fuelwood resources from the adjacent national park, thereby causing significant damage to the park and undermining its function as undisturbed wildlife habitat (Madhusudan 2000).

It is important to look at conservation at the scale of the village for several reasons. Firstly conservation interventions are frequently targeted at the village level. For instance eco-development programs and many types of community based conservation initiatives both state controlled (example JFM) and civil society initiated are frequently designed to be implemented in selected villages. Some social institutions may also operate at the level of a village, such as informal institutions that regulate the sale of cattle dung in a village or use of trees on village temple grounds. The effect of displacement and geographical location of a village with respect to forest resources can only be understood if viewed at a larger grain.

Forest Dependence

In order to find conservation solutions in situations where people rely on forest resources for subsistence needs, it is important to understand both the impact of human dependence on forests as well the socio-economic context of people's reliance that results in particular type and extent of dependence on forests and forest products. Conservation strategies that do not take into account both these aspects often fail in achieving their objective, or at least achieve only partial success (Agarwal & Ostrom 1999). Forest resources provide crucial livelihood economic and inputs in rural societies living adjacent to forests (Byron and Arnold 1997).

Rural communities living adjacent to protected areas are directly dependent on the protected area for subsistence resources such as fuelwood (Byron & Arnold 1997; Bahuguna 2000).

Defining dependence: It is difficult to define dependence in objective terms as dependence is often justified based on a definition of "need" which is necessarily subjective. One option to define dependence on the forest in absolute terms is to find the difference between the actual cost of obtaining resources from the forest and the cost of obtaining alternate resources at the household level. The greater the difference between the cost of obtaining forest resource and the cost of obtaining an alternative resource, the higher the dependence. This definition is likely to be useful to conservation in many ways as the greater the "dependence" as defined above, the greater the cost people are likely to bear when denied access to forest resources, which would also reflect on the cost of enforcing forest protection (Gunatilake, 1998). This definition may also help identify appropriate governance or market methods to reduce dependence, or discover technological solutions to provide alternatives that are of lower cost than obtaining resources from the forest. However, understanding the actual cost of obtaining various fuels in a rural economy is very complex as a large proportion of fuel resources are gathered rather than bought and cost of fuel is incurred as opportunity cost in terms of labour invested (Natarajan, 1995, *cf in Heltberg et. al. 2000)*. The actual cost of obtaining fuel from various sources is extremely variable and shadow prices of obtaining non commercial fuel can be estimated for each household only approximately at best *(*Shylajan and Mythli 2003*).* Factors that affect the extent to which a household relies on the forest for are complex and are measured in different units. For instance, the effort a household invests in fuelwood collection from the forest is measured in terms of labour, the number of months fuel from commons is available to a household is measured in terms of months per year and the access to various fuel alternatives is measured binomially. Thus the various aspects of forest

dependence are not combined into a “dependence index” but instead are analysed separately and so allow a better understanding of interactions.

The study site

The Bandipur National Park, part of the Nilgiri Biosphere Reserve, is located in the southernmost district of Karnataka. The park is characterized by dry deciduous forests and is habitat to several large and charismatic fauna, including the tiger. Bandipur was declared a National Park in (1974), and is also managed as a Tiger Reserve under Project Tiger. The villages studied abut a region of the park that encompasses seasonal grasslands along the Kabini reservoir that are grazed by large numbers of wild ungulates and attract huge congregations of Asian elephants during the dry season

The villages along the northern boundary of Bandipur are characterized by a dry land agro-pastoral farming community. There are three main caste groups in the region, General castes, Scheduled castes and Scheduled Tribes. The main tribes are the Soliga’s the Jenu Kuruba’s and the Betta Kuruba’s.

Although there are no people living inside Bandipur National Park, the villages on the northern boundary of the park use the park to graze cattle and collect forest produce, primarily fuelwood (Madhusudan, 2000).

GIS images of the park show significant degradation along the eastern boundary and disturbance studies indicate that signs of disturbance such as lopping and presence of cattle are high in the regions of the park adjacent to the study villages (Madhusudan *unpublished*).

Villagers in the region report an increase in the distance they must venture into the park in order to obtain fuelwood over that past decade due to increased numbers of people collecting fuelwood from the forest indicating that degradation due to fuelwood collection is spreading inwards from the boundary and increasingly undermining the effectiveness of park protection.

The region has a large number of families that rely on wage work. Due to the cropping cycle in the study region as described earlier, agricultural wage labour within the study is available for only part of the year. Even when the crop is in the field (May to January), wage labour is usually required only during certain times of the cropping cycle, during sowing, for two cycles of weeding and during the harvest of the crop. Thus households often rely on wage work outside the region usually in Kerala, Chikmagalur and Kodagu in plantations where wage labour is required through out the year and in urban centers like Bangalore and Mysore. The study was carried out in the months form January to May, which included the winter months and the beginning of the sowing season in April-May. The study concluded before the onset of the monsoon.

Most of the villages in the region were displaced from their original locations in the early 1970's due to the almost simultaneous creation of the Bandipur National Park and submergence of large tracts of land at the completion of the Kabini reservoir. Large tracts of forested land outside the National Park were cleared in order to facilitate resettlement of the villages displaced by the creation of the Kabini reservoir. Resultant changes in economic structure have created a large number of labour families (as a result of labour brought in for dam construction, as well as by establishing dam-displaced families who served as wage labour during the construction of the dam).

Landholding patterns were disrupted which in turn, is likely to have had significant impact on patterns of forest resource utilization. Land was allocated to displaced villagers in "blocks" of three acres each. During this re-mapping of the landscape, traditional "*maala*" or common grazing lands were lost and not accounted for during resettlement. As a result there is very little land that is not under private ownership and the commons (as a source of fuelwood) are represented primarily by roadside trees and shrubs and trees around shrines. During the creation of new blocks of agricultural land, no trees were left standing along the boundaries of fields, as was the case before clearing of the land as a result, the number of trees on private lands or in copses which provided fuelwood were reduced greatly (interviews with villagers). During the creation of the Bandipur National Park and subsequently, tribal villages located inside the park were resettled on the boundary of the park.

The Karnataka Forest Department has implemented conservation intervention targeted at addressing fuel needs under the Eco-development program in the region. This is likely to have significantly increased the availability of LPG in the region.

Methods

Data on socioeconomic variables and reliance on forests for fuelwood and fodder were collected from 23 villages in two Village Panchayats using household questionnaire surveys. A preliminary survey was carried out in order to pilot test questionnaires and to obtain an initial understanding of the region. Qualitative data on household level resource use and variables were collected by means of structured interviews, focus group discussions, key informant interviews and participant observation. These data helped to determine important issues in the region as well as indicate socioeconomic factors that might be relevant in determining reliance on the forest for fuelwood and fodder. In addition, quantitative data on

general socioeconomic variable and on forest resource use were collected by means of questionnaire surveys carried out in two phases. Questionnaire surveys were administered in face to face interviews with villagers at a household level. A total of 517 out of 2702 (census of India) households were covered in 23 out of 32 villages.

The questionnaires administered collected information on:

1. General household characteristics: Information on household size, age and sex composition, caste and education level.
2. Information on socioeconomic variables such as land ownership, cropping pattern, agricultural yields, occupation and income sources and livestock holding and composition were collected.
3. Forest resource use: information on types of domestic fuel used, cost of each type of fuel used, labour invested in gathering fuelwood from the forest.
4. Information on fuelwood buying and sales.

Phase one: In the first phase, 15 of a total of 32 villages in the study region were surveyed (survey design is shown in Table 1). Data on socio economic variables and forest resource use was gathered from a sample (around 10%) of the total number of households in each of the 15 villages by using questionnaire surveys and structured interviews. Sampling procedure attempted that 10% of households from each caste group in a village were covered. Information on caste composition of villages was obtained from census information. Information on caste composition of the village was obtained from the census of India data available at the village Panchayats. 147 households out of a total of 1539 households were sampled during the first part of the study. Detailed information on household size and composition, income sources, landholding and cropping pattern, livestock holding and

grazing pattern, sources of domestic fuel and fuelwood dependence on the forest were collected. In addition information about history of the household, attitudes towards the national park and experience of conflict was collected informally.

Villages sampled in Survey 1	Households (census of India)				Households surveyed			
	Total	SC	ST	GC	Total	SC	ST	GC
Thittu	52	16	7	29	10		5	5
Jakkahalli Colony	53	3	0	50	6		3	3
N. Begur	238	69	61	108	28	18		10
Brahmagiri	78	0	78	0	17	0	17	
Gandattur	122	0	117	5	12		12	
Dyavana Haadi	19	0	19	0	5		5	
Kanakanahalli	91	33	5	53	10	3		7
DonnemaadanaHaadi	12	1	9	2	2		2	
Biramballi	184	68	15	101	15	5	1	9
Boredevara Munti	109	43	18	48	12	7	2	3
Nanjanathapura	100	90	0	10	6	5		1
Hosakere Sunda	63	*unknown*	*unknown*	*unknown*	4	2	2	
Kalasur	146	59	48	39	18	8	8	2
Somedevarahundi	17	1	0	16	3	2		1
Therani Munti	401	60	9	331	17	1	15	1
Total	**1685**	**443**	**386**	**792**	**165**	**51**	**72**	**42**

Table 1: The table above shows the caste wise break up of households in each village according to the census of India data and the caste wise break up of households surveyed. The first survey covered 15 villages out of a total of 32 villages in the study region. An attempt was made to cover all caste groups in a village.

Phase two: In the second phase data on the same parameters were gathered from using questionnaire surveys in all the households in a sample of 9 villages out of 32 villages (survey design is shown in Table 2). The 9 villages were chosen using stratified random sampling with villages being stratified according to social structure and distance from the forest. In the second phase of the study 9 out of the 32 villages were chosen using stratified random sampling (as outlined in Figure 2). Villages were stratified on the basis of social structure and distance from the forest. About 50% of the households in each of the 9 villages were surveyed using questionnaire surveys to attempt to uncover a village level profile of dependence.

Caste groups	Village name	Distance from forest	Households (census of India)	Households surveyed
Betta Kuruba's	Kempanahaadi	Close to forest	46	23
Jenu Kuruba's	Maaladahaadi	Close to forest	47	27
Betta Kuruba's	Jaaganakote	Close to forest	46	35
Naika's	Basaapura	Close to forest	247	81
Muslims	Murband	Medium distance from forest	66	41
SC	Uyyamballi	Far from forest	122	29
Multi-caste	Kenchanahalli	Close to forest	200	54
Multi-caste	Mosarahalla	Medium distance from forest	203	22
Multi-caste	Bidarahalli	Far from forest	200	40

Table 2: In the second phase of the study 9 villages were chose using stratified random sampling, where villages were stratified on the basis of social structure (caste composition) and distance from the forest. About 50% of the households in the sample villages were surveyed.

In addition, secondary data from census information for total population, and distance to the nearest town was used in the village level analysis. Village level data were also collected by group discussions and from key informants in each of the studied villages.

Analysis

The data gathered was analyzed using descriptive statistical tools and graphical representations of data in order to elucidate various patterns. Relationships between various aspects of dependence on the forest such as availability of various alternatives to forest resources, cost of obtaining alternative resources, effort expended in procuring forest resources, landholding, cattle holding and income source were explored.

Results

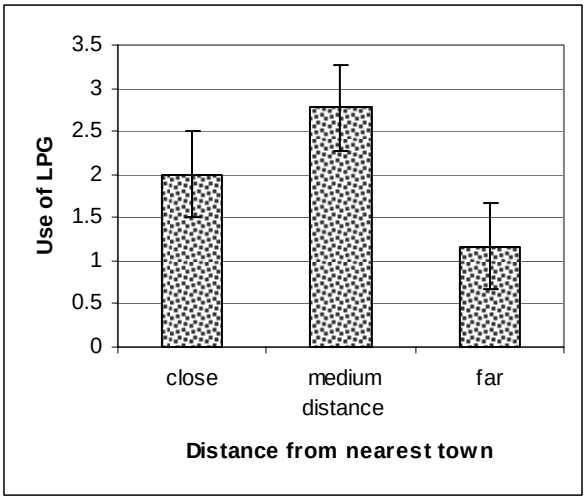
Due to high variability in costs of labour and non commercial sources of fuelwood in rural economies as described earlier, the assumptions required to calculate a dependence index are

avoided and instead variables that contribute to determining dependence are examined separately as well as using multidimensional analysis. One of the key indicators of dependence that was used was defined as “resilience.” Resilience of a household is defined simply as the sum of the various fuel alternatives a household uses in a year. It indicates the range of fuel options available to, and utilized by a household. For instance if a household used three types of domestic fuel, say kerosene, fuelwood from the forest and crop residue, it would have a resilience score of 3. A household that has access wide variety of alternative fuel sources is likely to be more ‘resilient’ or less impacted if denied access to fuel from the national park. In contrast, households that derive all their fuel from the park are likely to be the most negatively impacted by lack of access to the park as a source of fuelwood. A household with a resilience score of 0 is completely dependent on the park to meet domestic fuel needs. The maximum number of alternatives available to forest fuel in the region is seven. Thus the maximum possible resilience score is seven, though of the households sampled none obtained this score. The alternatives to forest fuel are a) crop residue from private lands b) crop residue that is bought as fuel c) wood that is gathered from trees on private lands d) wood that is bought as fuel e) fuelwood gathered from trees on common lands f) LPG (gas) (g) kerosene (h) cattle dung.

The analysis is presented in two sections. Village level analysis which looks at the relationship of various aspects of dependence and village level attributes such as location, social structure (caste composition) and economic structure. The second section looks at dependence at a household level, exploring various aspects of dependence in relation to primary income source of households and landholding.

Village level analysis

Location and availability of various types of fuel at a village level



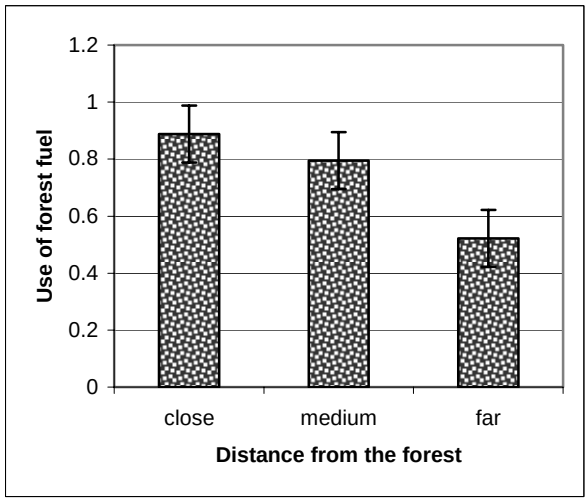


Figure 1: The graph on the left shows the proportion of people using LPG in villages at various distances from the nearest town. It is noticed that distance from the town seems to have no effect on use of LPG. The graph on the right proportion of households in villages at various distances from the forest that use forest fuel. The graph seems to indicate that a higher proportion of people in villages closer to the forest use fuelwood from the forest, indicating the effect of distance. In the study, the furthest villages were 5 km from the forest, while the closest were right at the edge of the forest.

Villages that are less than five kilometers away from the nearest town are classed as “close” villages that are between 5 and 10 kilometers away from the nearest town are classed as “medium” and villages that are more than 10 kilometers away from the nearest town are classed as “far”. The use of LPG does not seem to be affected greatly by distance form nearest town market (Figure 1), and hence it maybe inferred that it is readily available in all villages.

The proportion of people using fuelwood in villages that are closer to the national park seem to be higher than the proportion of people using forests as a source of fuel in villages that are further from the park (Figure 1) indicating some effect of location of the village on dependence. The effect of location is seen to influence dependence at the level of the village and the scale at which the effect of distance from the forest operates may also be inferred as

being within the scale of the study. That is within a distance of five kilometers from the edge of the forest, villages show a decrease in use of forest fuel as distance from the forest edge increases.

Social structure and forest dependence

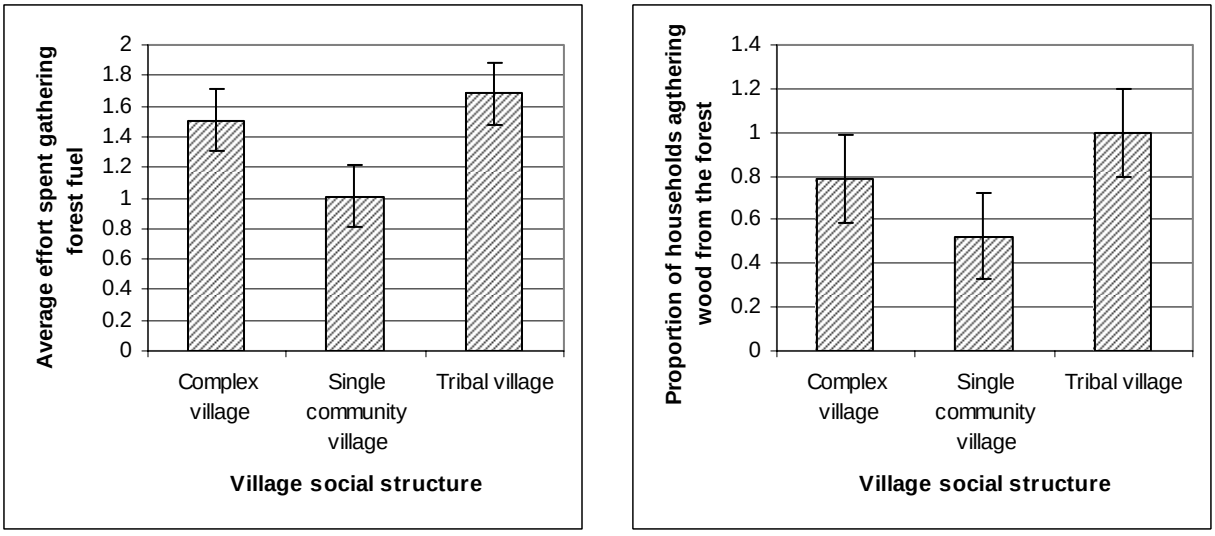


Figure 2: Villages maybe classified based on social structure into three types. Single community villages comprise of majority of households belonging to only one caste, Complex villages have a mixture of different castes and Tribal villages. Effort spent gathering fuelwood from the forest is measured in man-hours per day, i.e. (time taken to bring one load of wood from the forest) X (frequency of trips to the forest). In each village some households gather wood from the forest and some households do not. The graph on the right shows the proportion of households in the each village averaged over villages having the same type of social structure that gather wood from the forest.

Three types of villages based on social structure are described previously and illustrated further below. Figure 2 shows the proportion of households using forest fuel and fuel from the commons averaged across the villages in each social class.

On the whole tribal villages have a slightly larger proportion of people who use some fuelwood from the forests and there does not seem to be significant difference in the proportion people who gather fuelwood from the commons in the

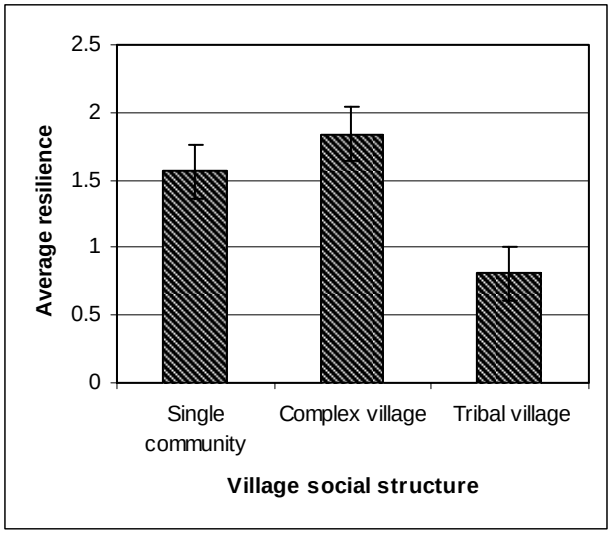


Figure 3: The graph above shows the average resilience of households in villages with different social structure. It can be seen that tribal villages have the lowest average resilience and hence utilize on average the least number of alternatives to forest fuel.

While complex villages seem more resilient on average than the other types of villages (Figure 3), tribal villages are the least resilient indicating highest dependence on the forest and lowest use of alternative types of fuel.

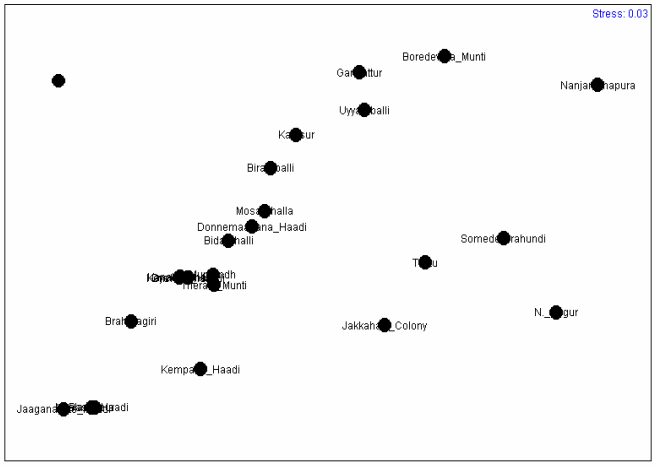


Figure 4: Multi-dimensional scaling graph using proportion of houses with land, proportion of households relying on wage labour as a primary source of income and proportion of households relying on agriculture as a primary source of income for each village as variables for each of the villages. Clustering of villages indicates that they separate based on economic structure.

Multi dimensional scaling using the economic variables proportion of households with land, proportion of households dependent on wage labour and proportion of households dependent on agricultural income for each village results in a separation of villages that presumably have similar economic structure (Figure 4). Similarly social composition of villages in terms of proportion of various caste groups in the population also results in a separation of villages into three clusters (Figure 5), corresponding to the description in the previous section. Tribal villages are most separated, while there is separation between single caste villages and complex villages. When resilience and proportion of population deriving fuel from the forest are added to the social variables villages distinctly cluster into three groups indicating that social composition of a village is related to dependence.

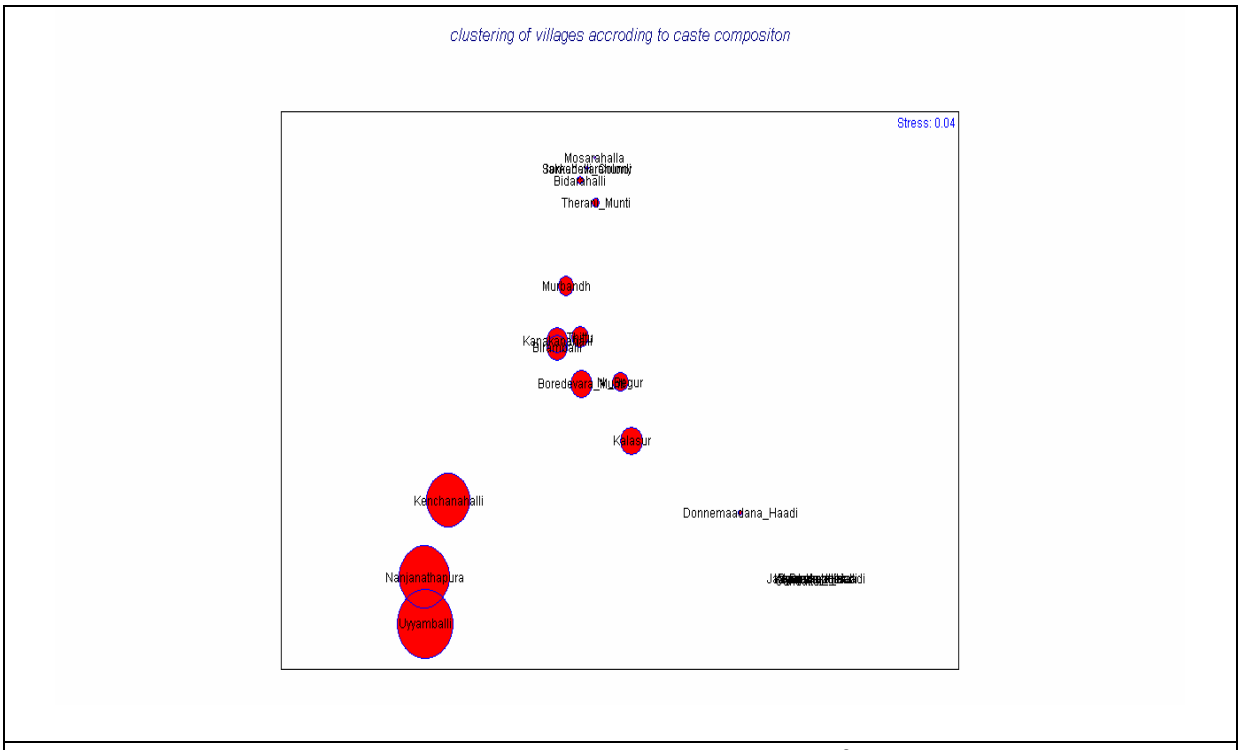


Figure 5: A multi-dimensional scaling graph using proportion of scheduled castes, proportion of scheduled tribes and proportion of general caste households in a village. The larger circles indicate Scheduled Caste majority villages. Again tribal villages cluster in a corner on the top of the chart. In the centre are “complex” villages with a mix of caste groups.

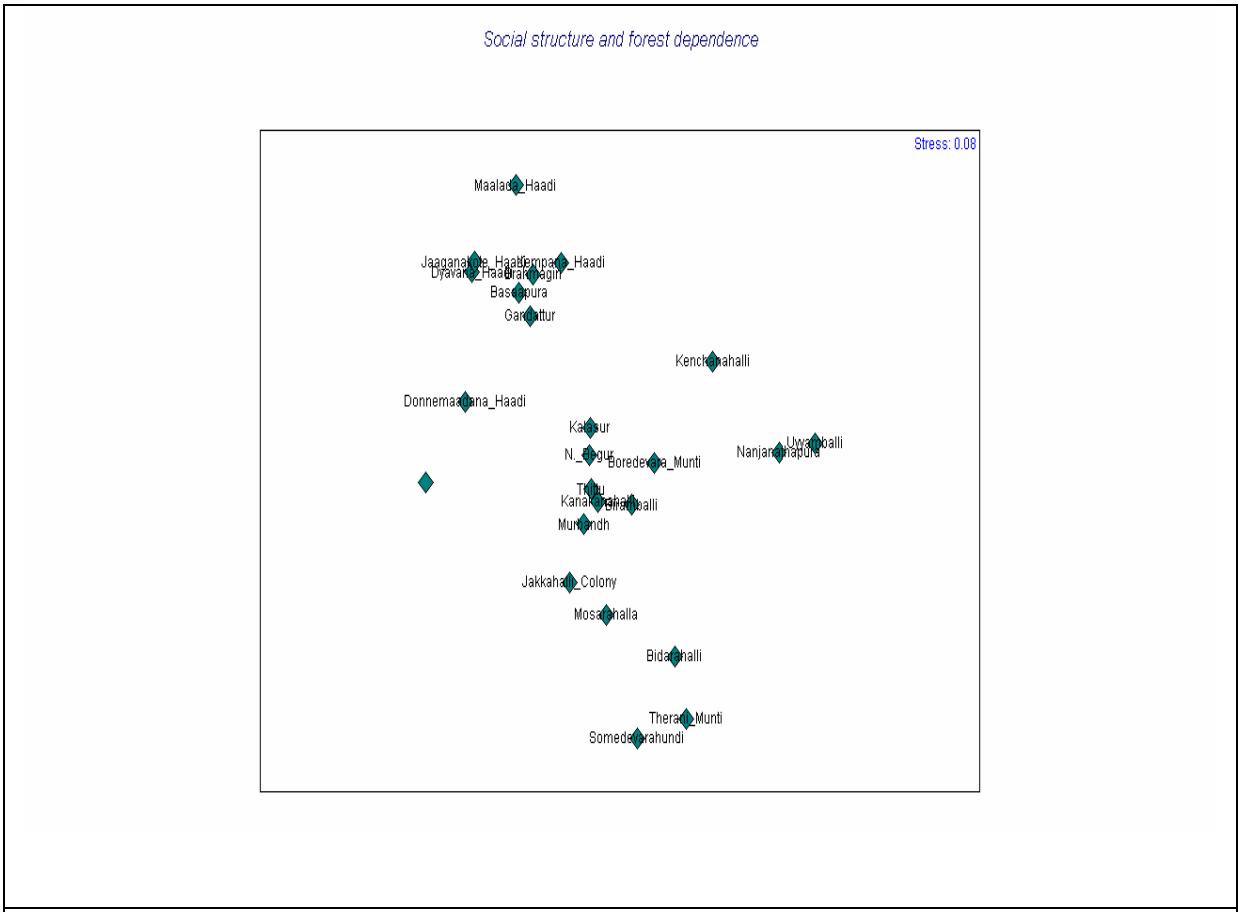


Figure 6: Multidimensional scaling graph using proportion of scheduled castes, proportion of scheduled tribes, proportion of general caste households, proportion of households using fuelwood from the forest, average effort to collect wood in each household and average resilience score. Villages seem to cluster into at least two groups indicating social structure has some effect on dependence.

Villages at the top of the chart (Figure 6) are tribal villages; tribal villages separate very clearly from other villages indicating that they are likely to have patterns of fuel use and extractions that are significantly different from other villages.

The multidimensional plot using only dependence variables (Figure 7) also seems to differentiate villages into three clusters separating Tribal villages into a very tight cluster indicating that they have a very similar dependence profile.

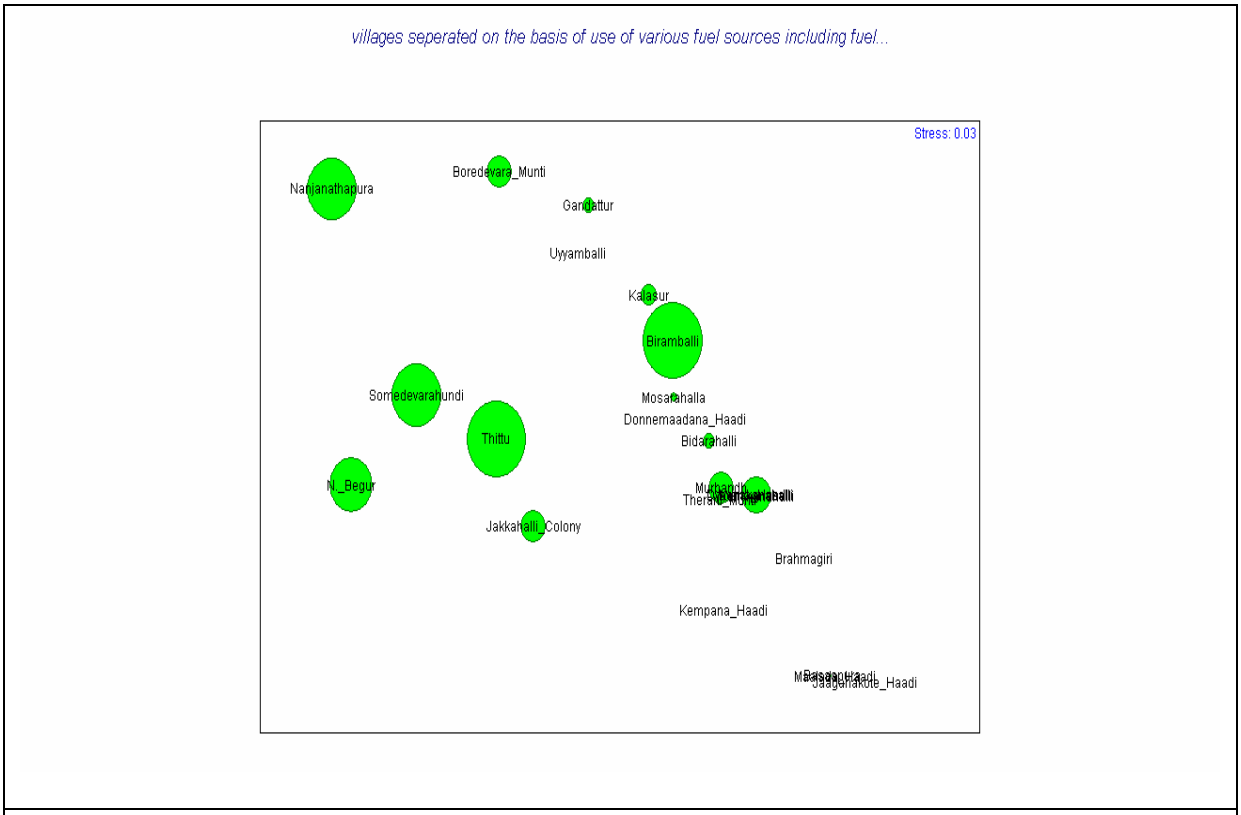


Figure 7: A multidimensional plot using the various dependence variables resilience, proportion of the population using forests, dung and commercial fuel shows a distinct separation between villages in terms of dependence on the forest. Here again we see tribal villages (all at the bottom right hand corner) separating very clearly from other villages.

Household level analysis

Of the households in the region, those that are landless and depend on wage labour as a primary source of income are the households that are likely to have the highest dependence on fuelwood gathered from the national park. Households that rely on wage work are the least 'resilient' i.e., they access only a small number of alternative fuels, and hence are likely to rely on forest fuel more. They are also likely to be the most impacted by effective forest protection. On an average, households that rely on wage labour also spend much more effort (calculated in terms of labour) than agricultural or other households, and are also the gathering forest fuel indicating that they may also be the group that has the greatest impact on the national park.

The effect of primary income source on the number of fuel options availed by households.

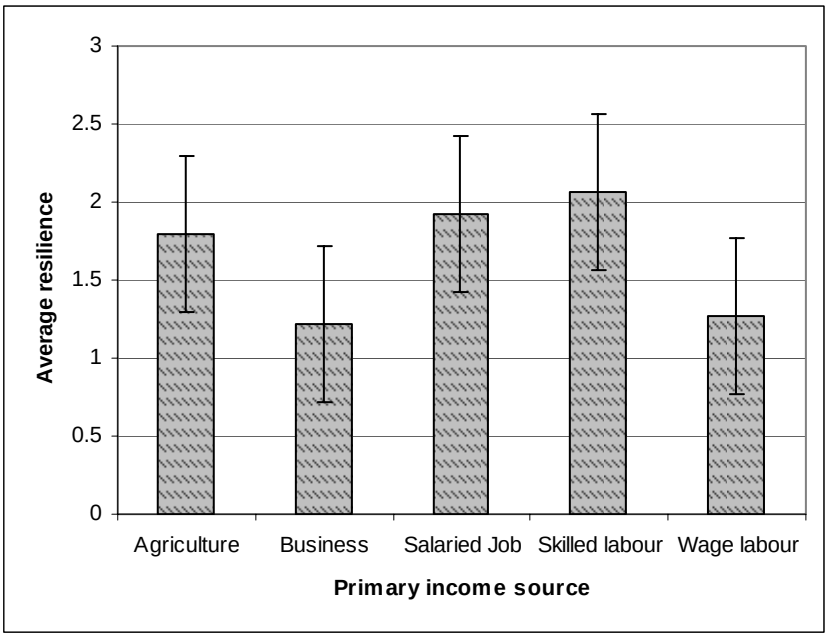


Figure 8: The graph above shows the average resilience (as described in the text) of households relying on wage labour, agriculture, regular employment, skilled labour and business as their primary income source.

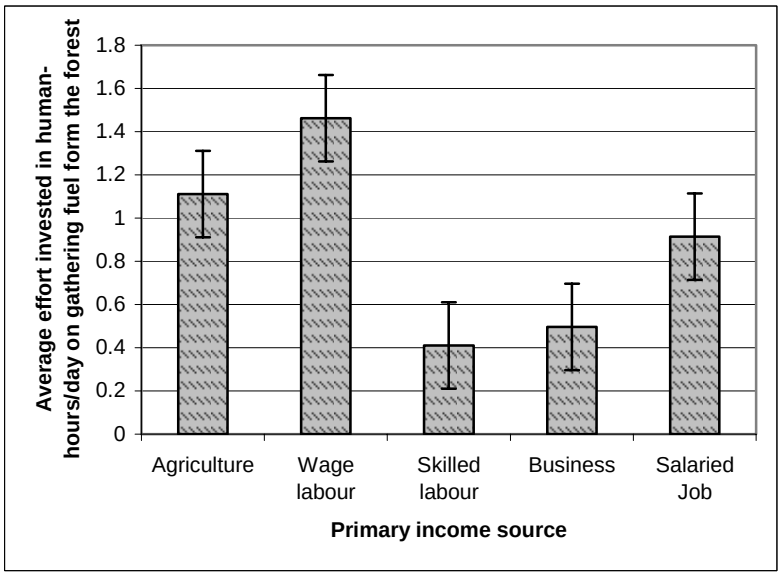


Figure 9: The above graph shows the average effort in human-hours invested by households in each of the income categories. It can be seen that households relying on wage labour spend the most number of hours on average gathering fuelwood from the forest

In terms of both the number of different types of fuel used by households (Figure 8) as well as the effort spent in obtaining fuelwood from the forest (Figure 9), households that rely on

wage labour are the most dependent on forests. The households are also often the poorest households who rely to a large extent on the wage work of one or more members outside the region. Because of high variability in monthly income, low over all economic status and lack of access to crop residue as an alternative fuel, these households are the most dependent on forests as a source of fuelwood.

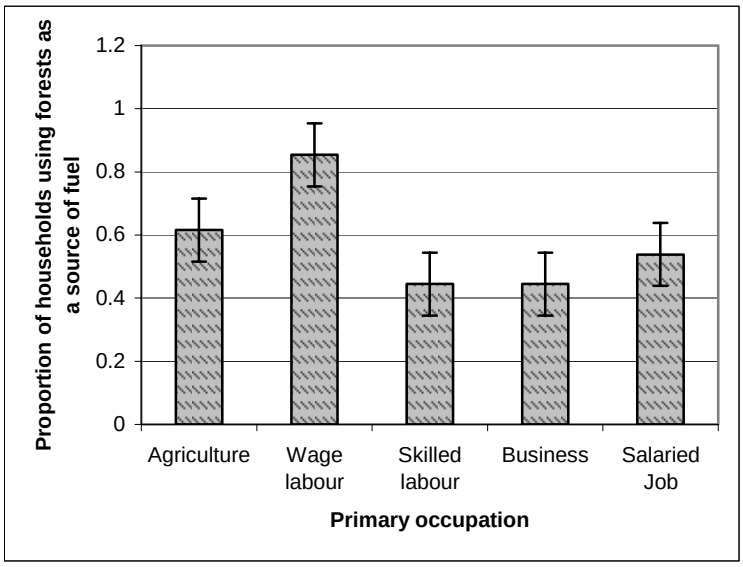


Figure 11: The above graph shows the proportion of total households that rely on wage labour who gather wood from the forest. Although some proportion of all types of households rely on the forest, the highest proportion (85%) of wage labour reliant households dependent on the forest for fuel.

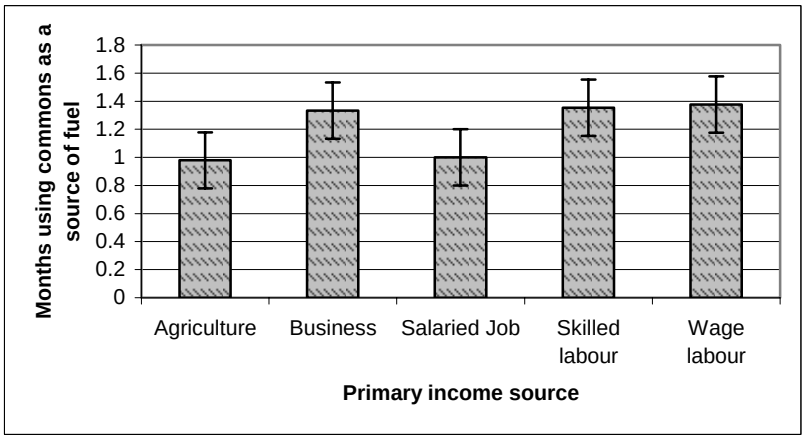


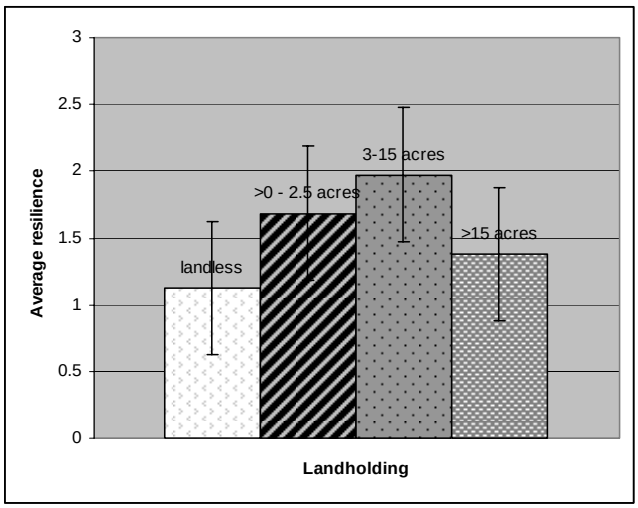
Figure 12: This graph shows the average number of months that fuel from the commons is used in households differentiated by income type. It can be seen that wage labour households on average use fuel from the commons for the most number of months.

As can be seen in Figure 11, 85% of households that rely on wage labour gather wood from the forest. Considering that they access few other alternatives and spend more effort gathering forest fuel, labour households are the most dependent on forests as a source of fuel. Households relying on wage labour are also depend for the most number of months on the commons as a source of fuel (Figure 12) this is consistent with the fact that these households do not utilize commercial fuels or farm residue and hence depend primarily on ‘free’ fuel gathered from the forest and commons outside the forest.

Relationship between land holding and forest dependence:

Four categories of households based on landownership are defined: landless households, households with less than 3 acres of land (small), households with 3 to 15 acres of land (medium) and households with landholding greater than 15 acres (large).

Households with less than three acres of land are frequently subsistence or marginal farmers who primarily grow a single food crop ragi. These households rely on wage labour or other sources for cash income, and are often not food sufficient. Households with 3 to 15 acres of land usually grow a cash crop such as ground nut or cotton in addition to the food crop. Households with greater than 15 acres of land form a very small proportion of the population (8 households) and have high economic and social status. Land less households are the least resilient having on average only one other alternative to forests as a source of fuelwood.



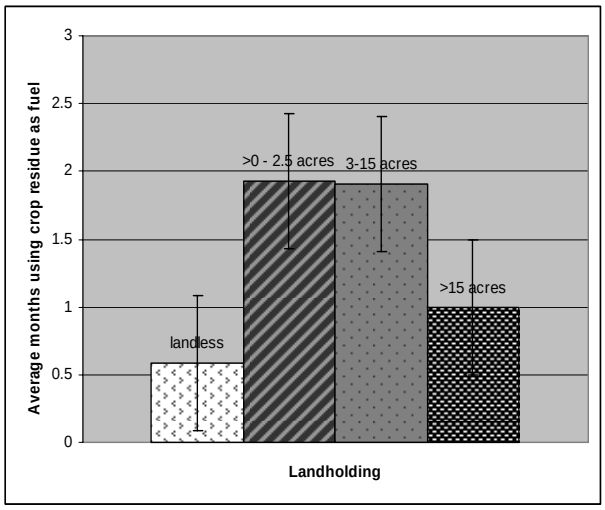


Figure 13: The first graph shows average 'resilience' (as described in the text) for the households in each of four landholding classes. The first class is landless households, the second class includes households with a landholding of less than 3 acres, the third class includes households with 3 to 15 acres of land, and the fourth bar shows the average resilience of households with more than 15 acres of land.

Landless households are the least resilient; even households with small landholdings are significantly more resilient than landless households (Figure 13). This does not seem to be a surprising pattern as landed households are likely to have access to farm fuel in the form of crop residue and therefore they are likely to be less dependent on fuel from the forest. Households with 3 to 15 acres of land are more resilient than households with marginal landholdings. It may be speculated that this is due to an increased availability of crop residue as fuel, however, the next graph indicates that both small and medium farmers use farm residue to the same extent (Figure 13). This is contrary to expectation, as one would expect larger landholdings to yield more crop residue and hence to address fuelwood needs for more number of months, however this would be affected by crop choice as not all crops yield fuelwood. However it maybe inferred that increased availability of crop residue is not the reason for decreased dependence of households with medium landholdings. Since landholding is likely to be closely related to economic status, increased resilience households with 3 to 15 acres of land might indicate a greater proportion of such households using

commercial fuels. The households with large landholdings (over 15 acres) are also the wealthiest households and all of them afford LPG every month. Further examination reveals the process that causes increased resilience and also describes the pattern of availability and use of alternative fuel resources across various landholding groups.

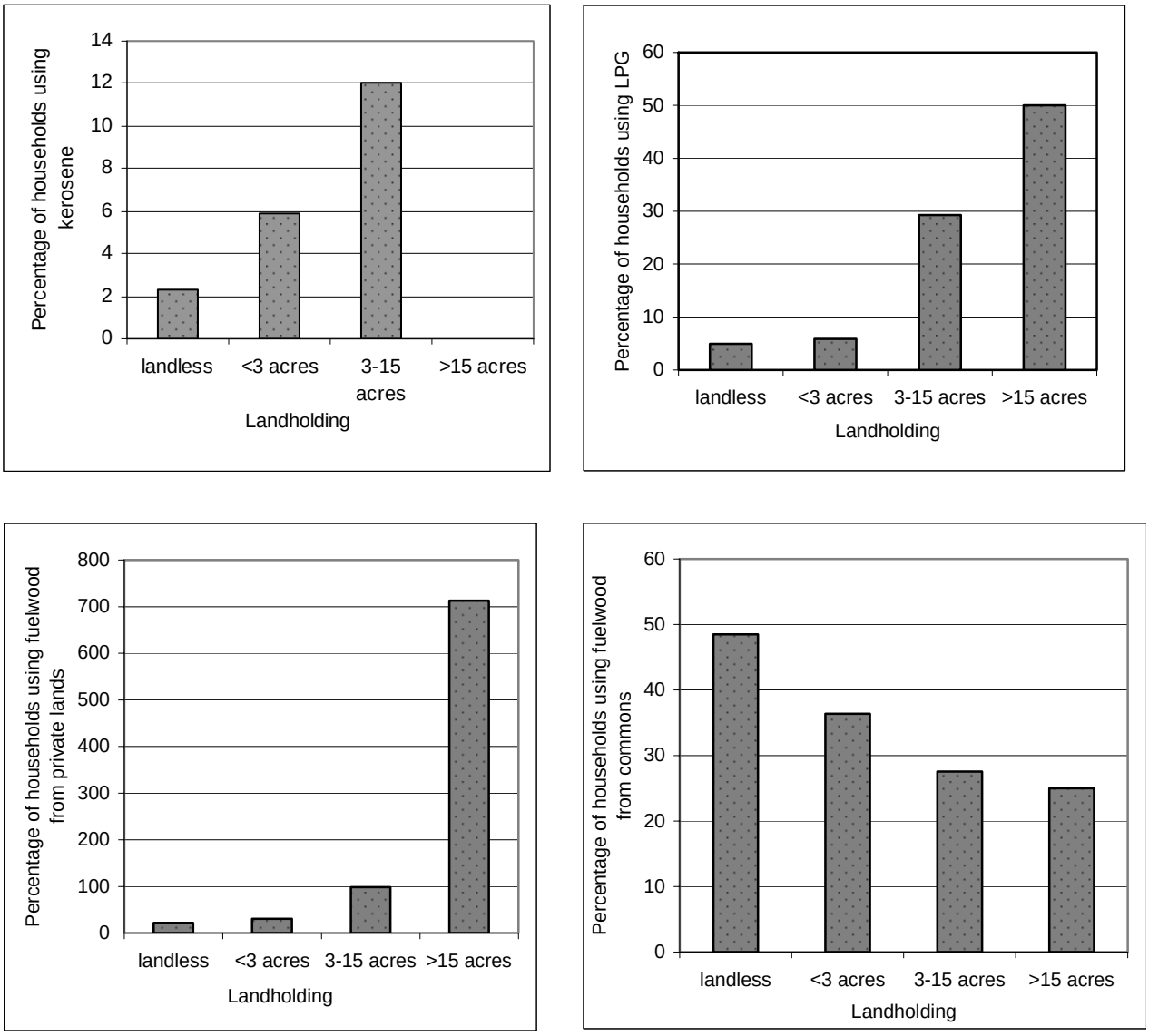


Figure 14: Percentage of households out of 517 in four landholding classes that use kerosene, LPG, fuelwood from private lands and fuelwood from the commons as domestic fuel. The first class is landless households, the second is households with less than three acres of land, the third class includes households with 3 to 15 acres of land and the last class has households with very large landholding of above 15 acres.

The pattern revealed in this series of graphs (Figure 14) elucidates clearly the relationship between use of various types of fuel and landholding. The graphs indicate a separation of the

types of fuel that people with various land holdings use. While households with very large landholding use LPG exclusively, households with 3 to 15 acres of land use commercial fuels much more than households with marginal landholdings. It is also seen that landless people are the most dependent on the commons (and forests) for fuel. This separation in the types of fuel used by various groups based on land holding is a very interesting pattern and provides an insight into the socioeconomic processes that govern forest fuel use. The fact that medium and large households have an increasing preference for LPG as a cooking fuel clearly indicates that forest fuelwood is a poor option and one that people will attempt to move away from provided that they are able to afford the alternative. This trend probably reflects the fact that landholding is closely related to economic status. The trend to move away from using fuels from the commons and to move towards using commercial fuel with increased landholding (or economic status) seems to reveal that use of fuel from commons and the forest is a poor option and one that is abandoned as soon alternative fuels become affordable. Both LPG and kerosene are available locally, kerosene is available through the PDS system and LPG is reported by people to have been made increasingly available by interventions of the forest department in the region.

Discussion

Not all households extract the same amount of resources from the park, and not households are equally dependent on the forest as a source of domestic fuel. Determining the attributes of a household that are related to dependence on the forest will help predict which households are likely targets for conservation. Landholding is an important factor that influences the extent to which a household relies on the forest for fuelwood. This is because agricultural byproducts are an important substitute to forest resources in this landscape. The residual

twigs from the cash crop cotton provide domestic fuel to households and are an important alternative to wood from the forest in the region. Crop residue from cotton, that supplements fuel wood from the forest to various degrees is usually available exclusively to landed households. Larger land holdings are likely to be able to yield enough agricultural byproducts to serve the household's fuel wood and fodder needs year-round, whereas smaller landholdings may only be able to take care of part of a year's supply.

On an average households relying on wage labour as a primary source of income utilize far fewer fuel types than households relying on any other income source. Since wage labour in the region is rarely available continuously for a number of days at a stretch, it makes more sense for a household relying on labour to gather fuelwood from either the commons or the forest on days when no work is available and save the price of fuel than to invest in commercial fuels. Commercial fuels as opposed to wood fuels require monthly cash commitments that households relying on wage labour cannot make. High seasonal and annual variation in amount of labour available in the region means that households depending on wage labour cannot afford to rely on commercial fuel as cash income is unreliable. Households with very small landholdings too cannot afford to invest in commercial fuel. Households with marginal land holdings and households which share crop land, frequently depend on wage labour as an important secondary source of cash income along with a single food crop on their land that provides some food security. Capital earned through the wage labour of one or more members of the household during the fallow season is often a crucial input into the following season's agriculture in these households. As these households rarely crop cotton, crop residue is unavailable to them as an alternative to fuel gathered. Agricultural households that crop cotton however usually substitute crop residue for fuel from the forest for at least part of the year. Smaller landholdings are frequently unable yield

sufficient crop residue to last the year round. In households where there are enough “forest going” members (labour), crop residue is sometimes burned in the fields as manure. This is likely to indicate that the cost of obtaining fuel from the forest is lower than the benefit derived from burning cotton sticks in the field. Alternatively, it might indicate that the value of crop residue as fuel is lower than the cost incurred to transport the crop residue from the fields. In female headed households that are frequently landless and hence dependent on wage labour, fuelwood is sometimes bought, as women in some households especially higher caste households do not go into the forests to gather wood. Other groups that might buy fuelwood rather than gather from the forests or commons are immigrants into the region, carpenters, smiths and other skilled workers.

Over all households dependent on wage labour for income seem to have less number of alternative fuels and spend more effort in collecting wood from the forest indicating a higher dependence on forests.

While the above two measure do not act as an index of dependence they do indicate important aspects of dependence including the access to alternatives and the effort invested in gathering fuelwood from the forest. When combined these two indicators reveal dependence trends in the population. Households dependent on wage labour have access to fewer alternatives and spend more effort gathering fuel from the forest indicating that they are the most dependent section of the population, both in terms of impact on the forest as well as in terms of vulnerability to removal of access to forests. Conservation intervention that is effective must focus on interventions that target this group. For instance, interventions proposed must take into account high variation in monthly income and changes in lifestyle of households due to members working for several months outside the region.

Landholding clearly affects access to alternatives over all and indicates that use of forests as a source of fuel is poor option, and that with increased landholding (or income) households switch to commercial fuels. Thus the most dependent group is the landless households that depend on wage labour. While these two groups overlap significantly they are not the same, households that do not have land may rely on business or skilled labour, or have a salaried profession.

The differences in the dependence of a village on the national park for fuelwood maybe explained by looking at relationships with respect to village level characteristics. Processes that are likely to affect extraction at the village level are:

Location

Location of a village determines the access a village has to various alternative fuel sources. Distance from forest will affect access to the forest for getting forest resources and will be reflected in increasing costs in terms of time in order to gather fuelwood resources at village level. This might result in a smaller proportion of the population of a village using fuelwood from the forest or in a reduction in the importance of forest as a fuelwood source overall. Location also will determine access to markets, and hence influence the availability of commercial fuels. Villages that are close to markets but far away from the forest might have a larger proportion of people using commercial fuel. Observing patterns in use of alternatives at the village level will describe the trade off's people are making in terms of choice of fuel and indirectly indicate relative costs of various sources of fuel.

Demography

The size and population of a village may reflect on its absolute footprint on the forest. A smaller village with a greater proportion of its population dependent on forests may in absolute terms have lower impact on the forest.

Economic structure

Villages in this region also lend them selves to being grouped under different *economic categories*. For instance, some villages have complex economies based on a system dominated by agriculture. Bidarahalli is one such village where there are a large number of farmers with medium landholdings, a proportion of the households that are dependent on agricultural wage labour, which is usually available within the village itself. The region also has several large “labour colonies” established in the 1960’s during the construction of the Kabini reservoir. Majority of the population in the labour colonies do not own land and are reliant primarily on wage labour in the region as well as outside for a livelihood, Terani Munti is one such village. The economic structure of a village can influence the use and extraction of forest resources in several ways. Institutions that regulate the collection and sale of dung in a village for instance exist in agricultural villages. For instance, landed member of the village may restrict the number of dung lorries that come into the village or specify a season in which they are allowed into a village. Village economic structure may also play be reflected in economic dependence of a village on forest resources. For instance, a larger number of people in labour villages may also be economically dependent on the sale of fuelwood from the forest as availability of cotton sticks would be very low. This study however does not attempt quantitatively measure economic dependence on forest resources

as sale of fuelwood from the forest is an illegal activity and response to questions on sale of fuelwood from the forest was very likely to have been inaccurate (Subsequent observation of some of the households that had been surveyed using questionnaires revealed that several households that had responded in the negative to questions on fuelwood sales were actually selling fuelwood.).

Social structure

In addition to being differentiated on the basis of location and economic structure villages in the region are clearly differentiated on the basis of social structure. Villages in the region maybe recognized as being one of three main types:

“Complete” villages are villages that have a relatively mixed composition of castes including scheduled castes, scheduled tribes and general caste sections. Examples from the villages in my study are N.Begur, and Bidarahalli. In contrast, there are single caste villages, which have a large proportion of the population belonging to one caste. Although there maybe other caste groups present in a single caste village, they make up a very small proportion of the population. An example from my study region is Uyyamballi which is composed almost entirely of a scheduled caste population.

Finally there are tribal villages which have completely different cultural and social structures from other villages and contain households of a single tribal community. There are commonly, either Betta Kuruba villages or Jenu Kuruba villages in the study region.

Social composition and caste dynamics have complex and over arching effects on the socioeconomic context of forest resource use. Preliminary analyses show that caste is likely to have a strong relationship with economic status and landholding and thus is likely to influence dependence both directly and indirectly.

History

Displacement has been a major factor affecting the region. Almost all villages in my study area have been displaced from their original location exactly thirty years ago. This has affected landholding patterns (as reported by villagers), which in turn, is likely to have affected forest resource gathering greatly. The creation of 'labour colonies' resulting from dam construction is also likely to have affected patterns of forest dependence. Data indicates that households relying in wage labour are the most dependent. One of the stated reasons for people continuing to use fuelwood is their inability to afford LPG, due to their inability to find sufficient wage labour in the region. A history of relocation also has disrupted existing social structure and perhaps institutions that deal with common property resources. Forest areas that were not part of the national park were cleared to re-settle the people displaced by the dam leading to increasing pressures on the smaller region of remaining forest land to provide fuelwood and fodder resources.

Examining the various direct and indirect village level processes that are likely to impact forest resource extraction and dependence on forest resource will contribute to a more comprehensive understanding of dependence.

Understanding dependence at two scales will reveal patterns that operate at both scales and as well as those that operate only on either one of the two scales. Thus it is important to look at dependence at both the level of the village as well as at the level of the household in order to provide a useful understanding of reliance on forest in a given landscape. Intervention can then chose to target villages that are most reliant and within those villages, to focus the type of intervention in order to address the dependence of the most reliant households.

There is a lot of further scope for analysis and discussion of the issue. The village level analysis reveals fascinating patterns while looking at caste, economic status and dependence that require further exploration and study. Even though the work is preliminary, it still identifies the various groups in the landscape and indicates which groups are likely to be most dependent on forests and why. Knowing this will help appropriate design of effective intervention programs that reduce the negative impacts of dependence on the forest. For example, the reason for the limited popularity of LPG as domestic fuel in the region is explored, and patterns revealed guide the development of technology, policy or market based intervention that is appropriate to the region and context.

Further work

There is immense scope for further work that addresses dependence more completely and develops a deeper understanding of long term issues that affect forest resource use in the landscape. This work sets the back ground to ask many more questions on dependence in specific and conservation in general in the landscape. For instance looking at dependence in conjunction with impact on forest resources rather than looking at one or the other in isolation. Looking at the role gender and caste dynamics play in determining extent of forest

dependence. Variation of dependence over time across seasons and years is another fascinating question to explore where an understanding of longer term processes and change of time in the ecological and sociopolitical.

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