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Forest resources and rural livelihoods in the north-central regions of Namibia

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Abstract

This paper contributes to the literature on forest resource use in the north-central regions of Namibia (NCR) and the findings are also relevant for northern Namibia and communal lands throughout southern Africa. Our findings concur with those from South Asia on the impact of collection time on fuelwood use and add to the small amount of literature on the substitution of animal dung for fuel. We report results from a household survey of forest resources use in the NCR, which finds that utilisation is within sustainable limits for forest growth. Households consume an estimated one tonne of firewood annually and one tonne of poles. Markets are weak and very little is sold. Forest resources contribute significantly to rural livelihoods for some of the continent's poorest people. The population of the NCR rely on forest resources for their energy supplies and shelter as well as providing shelter and grazing for livestock. These resources provide almost one quarter of household income and form the basis of an active but apparently weak and inefficient informal economy. Opportunities to upgrade livelihoods (i.e. increase efficiency, productivity, income, etc) through use of forest resources currently seem limited without external intervention. However, with the NCR's economic development gathering pace, the potential for increased trade in NTFPs and other forest-based products will grow. The question we are unable to answer here is what impact this will have on current rates of forest product utilisation.

To this end, any policy to be developed on forest resources must take into consideration the impact on the rural population if it is not to exacerbate existing poverty. Forest resources, while providing a safety net, could also provide a launch pad for innovation, economic development and poverty alleviation, as they have elsewhere. The development of policies that offer conspicuous incentives to promote both poverty alleviation and forest conservation must become the goal for all stakeholders. The structure of opportunities facing individuals and the private sector in the NCR is not currently generating industry supplied by or involving over-exploitation of forest resources. Indeed, these natural resources are economically under-utilised at present. We find every reason for these forests to become economically sustainable through locally managed and enforced sustainable harvesting and it seems clear that greater intra-region efficiency upgrading would further develop the region and spread market benefits. Key steps to take include the need: to continue monitoring trends in firewood use and forest exploitation; to expand analysis and monitoring of the rural economy and rural livelihoods; and to develop solutions to ensure future expansion is sustainable.

1. Introduction

Objective

The objective of this paper is to understand the current levels of utilisation of forest resources at a household level and to apply a dynamic modelling approach to develop policy pointers that can maximise poverty alleviation and conservation benefits as Namibia develops. We use a combination of descriptive statistics, econometric modelling and data from local sources (official and independent) to analyse the significance of forest resources to rural livelihoods in northern Namibia. Our methodology is to analyse survey data on woodland use, collected by the Ministry of Environment and Tourism in 2004 in order to establish better the linkages between livelihoods and forest conservation through analysing the current utilisation rates and associated values and investigating the dynamics of household forest use.

The study is focused on the North Central (NC) region of the country, and embraces four relatively densely settled rural areas, which also include several small rapidly developing urban nodes. In the context of Namibia's dual economy the area falls outside the modern sector, but infrastructure in the NC region is being upgraded and links with the rest of the economy are growing. Land use is primarily small-scale traditional agro-pastoralism in a semi-arid setting. Uses of forest resources form part of households' livelihood strategies. Most forest products are consumed locally, but there is some development of forest-related industries. For instance, baskets made in NC region from palms and grasses are currently sold globally, but this is virtually a lone example.

This economic dichotomy creates dual linked concerns, that:

- Poverty is increasing and driving over-utilisation of forest resources.
- Economic development is increasing and driving over-utilisation of forest resources

This paper is focused on addressing these concerns. We analyse data from a survey analysing the household dynamics of forest resource use in northern Namibia. These data collected through a household survey were used to construct preliminary forest resource accounts for Namibia (Barnes *et al*, 2005).

Background

Namibia is a land of contrasts. Economic indicators, in turn, point to its position as a middle-income country (GDP: $7,400 [2006 estimate[1]]), yet also to the world's highest Gini coefficient of 74.3. It is home to widespread poverty with an estimated 90% of the population living on less than $2 per day[2]. The country has a generally good record on environmental protection – it was the first country in the world to incorporate the protection of the environment into its constitution – yet, in large areas of the country – particularly the NC region focused on in this paper – detailed knowledge of the state of the natural resources, the rates and ranges of utilisation, and the significance these play for poverty alleviation is poor.

Namibia does not possess true forest. In this study *forest resources* are defined as all woody plants that occur in the woodlands and shrublands (savannas) of the country, and *forest*, as

[1] www.cia.gov
[2] United Nations (2006). *Human Development Report 2006*. United Nations Development Programme.

used here, refers to woodland or shrubland. The country covers an area of some 824,000 km^2 on the south-western coast of Africa, and has a human population of 1.8 million. Some 70% of the population is rural and most of the rural population is founjd in communal land in the north and north east of the country. Namibia's climate ranges from extremely arid in the west and south, to semi-arid in the north-east. Woody resources are extremely sparse in the arid desert environment, but increase in density toward the north-east, through shrubland and savanna habitats to woodland.

The study area occupies some 30,000 km^2 on the northern border of the country. It is semi-arid with mean annual rainfall ranging between 350mm and 550mm. The area is flat and soils are sandy, derived from recent Kalahari beds. About half of the country's population is concentrated in this area, which contains an ephemeral wetland, the Cuvelai drainage system, where edaphic conditions allow low value rainfed crop production and extensive livestock grazing. The Cuvelai contains a complex mosaic of shrublands woodlands, relict open woodlands, grasslands and cultivation variants. Dominant trees include *Colophospermum mopane*, *Hyphaene petersiana*, *Sclerocarya birrea, Terminalia sericea* and *Acacia* spp.

Land surrounding the Cuvelai embraces the transition between drier shrubland, dominated by *Colophospermum mopane*, and more mesic Kalahari sand woodland, dominated by *Burkea africana*, *Combretum* spp., *Baikiaea plurijuga* and *Terminalia sericea*. Outside the Cuvelai, conditions are unsuitable for crop production, and the woodlands and shrublands are used primarily for extensive livestock grazing. Forest resource use takes place throughout but mainly in woodland areas. The NC region can be divided into nine ecological regions, listed in Table 3 below. Households surveyed fell into five of these.

Natural resources have several types of economic value, and in resource economics these values are commonly classified in the framework of "total economic value". *Total economic value* embraces direct use values, indirect use values, and non-use values. Direct use values derive from the direct use of the resource, i.e. in production of tangible goods, usually with market value. Indirect use values derive from the resource's value in ensuring ecological function, such as watershed conservation. Non-use values derive from the value of preservation of the resource either for future use (*option value*), for its mere existence (*existence value*), or to bequeath to future generations (*bequest value)*. The results presented here deal exclusively with direct use values.

The direct use values derived from the use of the natural woodland resources in the north-central region come from harvesting firewood and poles for the construction of houses and fences. The wood harvested is mostly consumed directly by rural households, but limited amounts are also for sale in urban areas. Forest use value also comes from other plant products, the vast majority of which are harvested for home consumption by rural households. These non-timber forest products (NTFPs) include plant products for craft production (carving, basket-making); plant products for food, medicine and cosmetics; and grass for thatching. In addition, there are limited small-scale commercial activities reliant on certain species, particularly for the manufacture of household items.

2. Methods

The surveys and datasets

The datasets were constructed through a survey focusing on livelihoods, characterising the rural economy and forest utilisation during 2004 in the NCR of Namibia. Analysis aimed to ascertain the significance of woody resource utilisation in the NCR for rural livelihoods, forest cover and the regional and national economies. It is anticipated that a robust analytical framework for this dataset will enable clear-cut policy implications.

A specific household and focus group survey was conducted to obtain data on the use of forest resources (specifically fuelwood, poles and NTFPs) among rural residents. This provided information associated with resource use and sales, which, combined with other parameters extracted from the literature, enabled computation of the accounts.

A stratified sample of 182 households in the Ohangwena, Omusati, Oshana and Oshikoto regions of the NCR was targeted. The sample was designed to cover residents in all of the biomes present in the regions. Household sampling within biomes was randomised. The questionnaire was aimed at obtaining quantitative information on: a basic household profile; volumes of forest products harvested, consumed and sold; prices; harvesting costs; and the relative importance of forest income to household livelihoods. Two pilot surveys, each of which involved ten respondents, informed the final survey tool. Two graduate economists and four undergraduate enumerators, who were trained prior to the survey, were deployed. Household heads were interviewed in the Oshiwambo language for approximately one hour.

A complementary sample of 25 forest product traders and trader groups in the NCR were targeted by means of a similar survey designed to solicit information on volumes, prices and costs for trading in fuelwood, poles and NFTPs. The sampled entrepreneurs were from both rural and urban locations, and were both full-time and part-time traders. They provided additional information on the size and characteristics of product market chains. Traders concentrate at open markets in Ondangwa and Oshakati and on public roads across the survey area. The field survey also involved collecting qualitative information from local forestry experts, regional councillors and regional development planners to obtain an overall picture of the use and potential of the forest sector in the study area.

All households were sampled on the basis of their dependence on forest resources for their livelihoods. The survey was randomised but representation was controlled when choosing sites and households for the survey – politically (see Table 1), ecologically (see Table 3) and occupationally (see Table 4). Evidence from a 2001 survey of households in the NCR enables us to analyse the representativeness of the sample. However, in view of this paper’s focus on environmental factors, some aspects remain inadequately covered. For instance, the NCR covers nine biomes, yet the population is centred in only five of these, reflected in the survey sites (see Table 3). Precise proportions of population by biome do not exist.

Case studies inevitably raise the issue of representativeness. Our dataset has similar characteristics to the entire population of the NCR – although it over-samples the Ohangwena region – and by education level with an earlier survey (see Table 1and Table 2). Furthermore, our point of departure is that the NCR shares a number of characteristics with other regions in northern Namibia and hence the findings here have a wider relevance.

Table 1: Comparison of representation of political regions in our 2004 survey and the 2001 Census (north-central regions)

Political Region	Census (2001)		Our survey (2004)	
	Population	% total	No. of respondents	% total
Oshikoto	28,419	22%	30	16%
Ohangwena	35,958	27%	78	43%
Oshana	29,557	22%	20	11%
Omusati	38,202	29%	54	30%
Total	**132,136**		**182**	

Table 2: Educational attainment comparison with earlier study

Education level	Our study (2004)	Tvedten and Nangula (1999)
None	17%	16%
Grade 1-5	34%	24%
Grade 6-7	17%	26%
Grade 8-10	23%	25%
Grade 11-12	8%	7%
Tertiary	2%	2%

Table 3: Households surveyed by ecological region (north-central regions, 2004)

Ecological region	Number of households surveyed	Percentage of sample
Acacia trees & scrub savannah	0	
Western Kalahari	29	16%
Mopane scrubland	15	8%
Cuvelai drainage	52	29%
Karstveld	0	
Lakes and pans	0	
Broad leaved trees	0	
North eastern Kalahari woodland	50	27%
Mopane woodland	36	20%
Total	**182**	

The rural economy in the NCR

In general, rural life in the NCR is largely based on subsistence. Reflecting this, we expect the reliance on woody resources and other open-access or common-property natural resources to be higher for the rural population than the urban population.

Table 4 shows how our survey sample differs from the averages provided by the census (from 2001). These differences are what we might expect from rural respondents: lower formal employment, higher unemployment and fewer self-employed.

Table 4: Comparisons of occupation of household head between our survey and census data (north-central regions, 2004)

Occupation	Our survey (2004)		Census (2001)
	Frequency	% sample	% population*
Subsistence farmer	78	43%	47%
Formal employment only	6	3%	20%
Self employed	7	4%	8%
Pensioner	11	6%	17%
Unemployed / student	80	44%	8%

Our sample showed the following household characteristics:

- The average household comprises 7.5 persons.
- The gender of the head of household is a key definer of total household income, with male-headed households earning 50 per cent more per annum than female-headed ones; although most other characteristics are common across gender.
- Access to a car is limited to less than 10 per cent of households, spread roughly evenly among political regions and ecological regions excepting Mopane shrubland. Bicycles and carts are more widely used by households – with 17 per cent and 14 per cent respectively reporting access.
- Over half of the sample is unaware of official restrictions on the use of forest resources.
- Hired labour was not used by any households in the sample.

Table 5: Gender of household head and income group (north-central regions, 2004)

Gender	Income group (N$)								Average income (N$)
	0	>500	>1,500	>3,000	>5,000	>10,000	10,000+	Total	
Male	18	22	15	35	9	7	14	120	2,204
[proportion of male]	*15%*	*18%*	*13%*	*29%*	*8%*	*6%*	*12%*		
Female	12	18	4	22	3	2	1	62	1,585
[proportion of female]	*19%*	*29%*	*6%*	*35%*	*5%*	*3%*	*2%*		
Total	30	40	19	57	12	9	15	182	1,993

Table 6: Educational attainment of head of household and distribution of annual household income by income group (north-central regions, 2004)

Education	Income group(N$)								Average income (N$)
	0	>500	>1,500	>3,000	>5,000	>10,000	10,000+	Total	
None	7	7	4	7	3	1	2	31	1,613
Grade 1-5	7	9	7	30	3	4	1	61	1,734
Grade 6-7	8	8	3	7		2	3	31	2,266
Grade 8-10	5	12	4	6	4	2	8	41	2,226
Grade 11-12	3	3	1	6			1	14	1,821
Tertiary		1		1	2			4	5,000
Total	30	40	19	57	12	9	15	182	1,993

Table 7: Occupation of head of household and annual household income by income group (north-central regions, 2004)

Occupation	Income group								Average income (N$)
	0	>500	>1,500	>3,000	>5,000	>10,000	10,000+	Total	
Subsistence farmer	10	22	8	24	8	2	4	**78**	1,494
Formal employment				1		1	4	**6**	8,667
Self-employed	3		1	2	1			**7**	1,250
Unemployed	15	16	7	20	3	6	6	**73**	1,973
Pensioner	1	1	2	7				**11**	2,045
Student	1	1	1	3			1	**7**	2,714
Total	**30**	**40**	**19**	**57**	**12**	**9**	**15**	**182**	**1,993**

Table 8: Aggregate household income (north-central regions, 2004)

Factor	Proportion
Formal sector activity:	
Pensions	23%
Employment	42%
Informal economic activity:	
NTFP sale	22%
Cuca retail/meat cooking	8%
Livestock and chicken sale	4%

The economic activity of the households is predominately farming for home consumption. Yet, there are indications that the informal economy is significant, and this might not be revealed here owing to cashless transactions, intra-community reciprocity and low prevailing rates of exchange. Only a small proportion is formally employed (3 per cent), far lower than the census data indicates with a regional average of 20 per cent. The majority of household heads (83 per cent) reported that they were subsistence farmers or unemployed (see Table 5, Table 6 and 7).

Households with a formally employed head have by far the highest total incomes. Income is mostly from paid employment, local informal economic activity and pensions (Table 8). Although no households sell poles or firewood, a significant part of household income (22 per cent) comes directly from forest resources. It is certain that opportunistic sale of firewood from the roadside to passing vehicles does occur, but it is likely to be sporadic and does not constitute a large trade. Eighty-one per cent of households sampled receive some income from woody resources, with 40 per cent of households having more than two forms of income from woody resources.

Forest utilisation

Availability of environmental resources is a key indicator of household reliance on woody resources. The main woody resources used by households in the NCR are fuelwood, poles and NTFPs. Different species used for each with differentiated final uses, including: energy, food, shelter and retail. The 2001 census and our survey data corroborate this for cooking, heating and building materials (Table 9 and Table 10) but political regions are not differentiated by biome.

Table 9: Significance of woody resources for cooking, heating and building materials in the NCR, 2001

Region	Energy for cooking	Energy for heating	Building materials
Ohangwena	94%	69%	37%
Omusati	94%	70%	46%
Oshana	66%	42%	36%
Oshikoto	85%	66%	61%
Total NCR	**86%**	**62%**	**44%**

Table 10: Household characteristics of forest and woody resource use by political region (north-central regions, 2004)

Use	Factor	Political region				Total
		Oshikoto	Ohangwena	Oshana	Omusati	
	Income (N$)	1,567	1,574	2,675	2,583	1,993
	Respondents (n)	30	78	20	54	182
Fuelwood	**Household (t)**	3.99	7.48	0.54	5.41	5.53
	Per capita (t)	0.66	1.20	0.14	0.91	0.91
	Distance (km/t)	54	56	211	55	58
	Time (hrs/t)	22	38	94	29	33
Poles	**Household (t)**	9.98	7.65	1.64	3.42	6.12
	Per capita (t)	1.79	1.23	0.35	0.78	1.09
	Distance (km/t)	5	2	1	2	3
	Time (hrs/t)	17	13	11	15	14
Livestock ownership	**No. cattle (n)**	2.53	1.03	2.50	2.09	1.75
	Cattle forest grazing (%)	57%	41%	68%	40%	49%
	No. goats (n)	3.47	1.69	1.85	3.50	2.54
	Goat forest grazing (%)	57%	47%	34%	42%	46%
	No. donkey (n)	0.90	0.09	1.25	0.41	0.45
	Donkey forest grazing (%)	96%	64%	70%	55%	74%

Key characteristics of use in our survey dataset confirm this reliance on wood and provide an initial quantification of the use of woody resources by households:

- The average household uses 11.67 tonnes of wood for energy and shelter annually: 5.53 tonnes of firewood and 6.12 tonnes of poles (see Table 10).
- The average *per capita* consumption of firewood is 913 kg (see Table 10), but ranges from 119kg in western Kalahari to 1,183kg in north-eastern Kalahari woodland; and from 144kg in Oshana region to 1,202kg in Ohangwena region.
- The highest total use of woody resources is in Mopane woodland biome at 7.59t of firewood and 11.21t of poles per annum per household.

The chief characteristics defining household use of woody resources are:

- *Availability*: differences in use among households and particularly biomes (see Table 10 and Table 11), reflecting availability of woody resources and the nature of livelihoods. For instance, those living in Western Kalahari owing to the low availability of firewood, supplement their low per capita consumption of firewood with dung, whereas biomes with greater firewood availability use little dung.
- *Effort*: the greater the total distance and the total time required to travel to collect firewood and poles the less is collected (Table 12).

Table 11: Average resources used for heating and light per household per annum by ecological region (north-central regions, 2004)

Data	Western Kalahari	Mopane shrubland	Cuvelai drainage	North-eastern Kalahari	Mopane woodland	Total
Dung use (kg)	736	104	-	70	22	149
Candles (n)	128	111	120	134	189	138
Paraffin (ltr)	50	13	39	34	38	37
Firewood (kg)	568	4,953	5,298	7,327	7,595	5,529
Income (N$)	2,172	500	2,375	1,735	2,278	1,993
No. respondents	29	15	52	50	36	182

Table 12: Summary information for selected ecological regions on costs (distance and time) associated with firewood use (north-central regions, 2004)

Ecological region	Distance (km) / tonne	Time (hr) / tonne	Average tonnes per household
Western Kalahari	233	67	4.05
Mopane shrubland	44	46	2.68
Cuvelai drainage	62	32	3.30
Kalahari mosaic	48	32	7.62
Mopane woodland	38	26	11.21
Average	**58**	**33**	**6.12**

Benefits from woody resources

There was very little reported sale of fuelwood or poles – 0.5 per cent and 1 per cent of reported harvest respectively. But the case is different for NTFPs. In our survey, 22 per cent of household income comes from the collection and sale of NTFPs (Table 8). There is a great variety of NTFPs. Table 12 breaks them down into their broad species.

Table 13: Proportion of households receiving financial income from forest products (north-central regions, 2004)

Factor	Proportion of sample obtaining income from forest resource
Palm – Cucashop, Traditional gin	32%
Grasses – sale and baskets	22%
Livestock – cattle sales	16%
Woodcarving and fuelwood sales	13%
Marula nuts	6%
Berchemia fruits	4%
Eemheke	2%
Mahangu sale	2%
Marula juice	2%
Kalahari seed melon	1%
Sale of huts	1%

In addition to the private financial benefits that rural residents receive from forest utilisation, there are also considerable indirect and non-financial benefits (such as spiritual and cultural values, shelter and some inter-cropping). These are not quantified here, and would require separate projects to ascertain their significance. Yet, the existence of an important informal economy and the evident reciprocity (of goods and labour) alerts us to the limitations of focusing solely on monetary measures.

The quantifiable *indirect* benefits that households receive from woody resources in the NCR are those pertaining to the use of forests for grazing and shelter of livestock. Significant tracts of open-access grazing land are available throughout the NCR, and ownership of livestock is widespread (Table 10) although in small numbers per household. Indeed, it is significant that no respondents note buying any fodder for their cattle, donkeys or goats – rather cattle make use of the open-access vegetation in the NCR, and for this the forested areas are key. Table 10 illustrates the significance of forests for almost half of the grazing of goats and cattle and three-quarters of the grazing of donkeys.

There is a range of other non-financial benefits from woody resources including spiritual and cultural values, shelter and some inter-cropping.

This section has characterised forest utilisation in an under-studied area of Namibia. It is clear that rural livelihoods depend on the sustainable utilisation of forest resources throughout the NCR. Specifically, averages coupled with per-capita and per-household data provide a quick illustration of the significance of woody resources in rural livelihoods. However, we need to understand more about the correlations between these factors (inputs and outputs) to expand our understanding of the linkages, and hence develop more specific policy messages. In the following section these robust data are used to develop a dynamic understanding of the significance of forest resources by submitted our dataset to regression analysis and further econometric modelling.

3. The model

In order to understand the nature of decision-making over forest resources by rural population in the NCR, a dynamic model was developed focusing on all forest resources. The aim is to test policy outcomes to ascertain how to deliver simultaneous conservation and livelihood security through interventions. The collection of fuelwood has been studied by a number of researchers in various developing countries via the case study approach. This analysis builds on these studies and takes a novel approach in order to develop policy strategies.

This study does not seek to develop a theoretical model for describing household behaviour regarding use of forest resources in Namibia. Instead, the following approach has been chosen to illustrate interesting research questions that also appear to apply datasets that are most similar to our dataset. It is envisaged that any model used will simply be adapted for our purposes in order to help construct hypotheses, which could be tested in a robust empirical analysis.

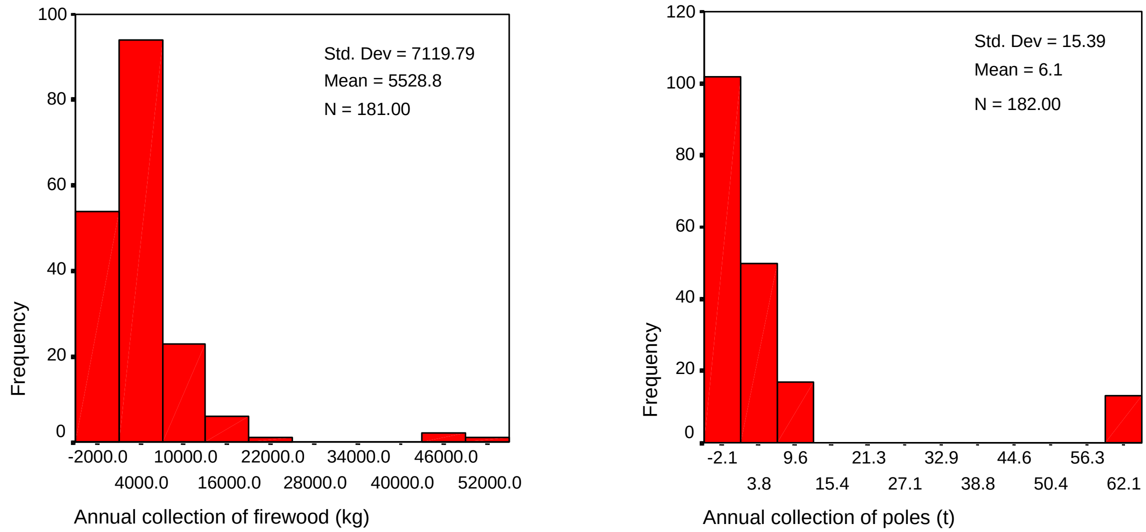
In this attempt to apply our dataset to a regression analysis, the more quantitative studies that develop household production-consumption models for analysing household decision-making with respect to forest resource use are of particular interest. These models and analyses focus primarily on fuelwood collection because of concerns about its widespread impacts on the forest resource base in the developing world. The use of wood for poles and other building materials has been much less researched in the literature, although given the existence of alternatives to wood in buildings, an approach similar to that of household choice over energy sources is discussed here for pole consumption.

Two studies of fuelwood collection in Nepal were undertaken – one by Amacher, Hyde and Joshee (1993), and one by Amacher, Hyde and Kanel (1999). The first paper measures household production of and demand for fuelwood and fuel substitutes, with a focus on women's' roles in fuelwood collection. It also measures demand elasticities for fuelwood, combustible residues and improved stoves (a technological substitute) by household income group. The second Nepalese paper also considers fuelwood consumption and production, but the household analysis includes production consumed in the producing household. The household regressions yield coefficients and elasticities that are very different to and more reliable than a comparable assessment of market demand and supply model. The consumption-production household model used in Amacher *et al*. (1999) is also used in a study by Heltberg, Channing and Sekhar (2000), which investigates domestic energy supply and demand in rural India. Links between forest scarcity and household fuel collection are analysed in a non-separable household model, focusing on substitution of non-commercial fuels from forests and non-forest fuels. The authors found that households respond to forest scarcity and increased fuelwood collection time by substituting household labour for fuelwood. The idea underlying the models in both Amacher *et al*. (1999) and Heltberg *et al*. (200) is that fuelwood collection is subject to the same labour, land and natural resource constraints as other household activities including agricultural production, and therefore cannot be analysed in isolation.

Proposed analysis

It is proposed that our dataset be applied to an adaptation of the models used in Amacher et al. (1999) and Heltberg et al. (2000). Specifically, the analysis will focus on the elasticities of demand for fuelwood with respect to energy alternatives (candles, paraffin and dung). Data for the annual consumption of fuelwood contains enough variation for the analysis to be both viable and interesting, although it appears to follow a Poisson distribution (see Figure 1). Data for energy alternatives also appear to be sufficient for such an analysis and can be converted to the same units as fuelwood following Heltberg et al. (2000).

Figure 1: Variation in annual collection of fuelwood and poles (north-central regions, 2004, kg)



Data on pole and fuelwood consumption cannot be combined into a single figure for consumption. This is because poles and firewood consumption have different determining factors. There is little evidence for a correlation between firewood and pole collection (correlation coefficient = 0.034). Although the data for pole consumption is not as variable as that for fuelwood (see Figure 1), the analysis could still attempt to investigate the elasticities of demand for poles with respect to building material alternatives such as bricks, iron sheeting, mud and dung. However, our dataset does not track the consumption of material alternatives apart from some NTFPs, such as grass. Nevertheless, wood for building construction (poles) is collected for household consumption by 133 households in the sample, with none selling any on the open market.

The model

The proposed model captures the situation of a household engaged in crop and livestock production, off-farm work and energy collection. To emphasise, as most rural domestic fuels are not traded but produced and consumed by the household itself, the model used is a non-separable (or non-recursive) household model. This implies that allocation of the various household resources (including energy supply, energy demand, farm and off-farm labour supply) is decided simultaneously. This also means that each household determines energy production and consumption by maximising its utility subject to a shadow price of energy, which is unobserved and known only to the household itself.

The main focus is on the choice between gathering fuelwood from the forest, producing fuels using private farm resources (dung) and the purchase of energy sources from the market (paraffin, candles). The main hypothesis to be tested is that fuelwood from forests, private fuels from the farm and energy sources from the market are substitutes in the consumption of domestic rural energy.

First, the household maximises utility defined as:

$$MaxU = U(C_H, C_M, C_L; Z^C) \quad (1)$$

where C_H denotes consumption of household goods that require energy inputs such as cooked food and heating; C_M are other consumption goods; C_L is leisure for working household members[3]; and Z^C is a vector of household characteristics pertaining to consumption such as wealth, family size and size of house.

Household goods are produced with fuel inputs from woody sources and non-forest sources:

$$C_H = \Gamma(C_{FW}, C_D, C_P, C_C) \quad (2)$$

The major energy sources (for heating and light) are wood, paraffin, candles and dung. Consumption of fuelwood is denoted C_{FW} (85 per cent of the sample consumed firewood), while C_D denotes dung from the farm (consumed by 13 per cent). C_P denotes paraffin (43 per cent) and C_C denotes candles (74 per cent).

A concave production function describes fuelwood collection:

$$Q_{FW} = g_{FW}(L_{FW}, A_{FW}; Z^V) \quad (3)$$

where L_{FW} is household labour time spent collecting fuelwood, A_{FW} are household fixed factors of production (harvesting equipment such as panga), and Z^V is a vector of characteristics describing forest stock and access conditions, including population density, management institutions and distance from the household to the wood resources. Hired labour was not used by any households in the sample.

The agricultural production function can be written as:

$$Q_{AG} = g_{AG}(L_{AG}, inp; Z^K) \quad (4)$$

where L_{AG} is household farm labour, *inp* denotes the use of dung as a farm input, and Z^K is a vector of household endowments pertaining to farming (land, livestock, family workforce). The total amount of dung is modelled as a fixed proportion of agricultural output αQ_{AG}. There is a trade-off between using dung as a farm input and burning it for fuel. Thus, dung supply is the residual of farm biomass not used as inputs:

$$Q_D = \alpha Q_{AG} - inp \quad (5)$$

The budget constraint is:

$$P_{FW}(Q_{FW} - C_{FW}) + P_{AG}Q_{AG} + wL_{OUT} = P_M C_M + P_P C_P + P_C C_C \quad (6)$$

[3] Note in Heltberg et al. (2000), a distinction is made between time allocation for male and female household members, which is not possible with our dataset.

$P_{AG}Q_{AG}$ is restricted farm profits (gross of own labour), w is the exogenous wage rate, and L_{OUT} is household labour time in off-farm work. The variables P_{FW}, P_{AG}, P_M, P_P, and P_C refer to the market prices of fuelwood, agricultural goods, other goods, paraffin and candles, respectively. Q_{FW} - C_{FW} is the net marketed amount of fuelwood.
Total household leisure is given as:

$$C_L = T - L_{AG} - L_{OUT} - L_{FW}$$

where T is the endowment of household labour.

Driven by the dataset, it is assumed that households procure all fuels themselves through collection in forests (fuelwood and dung) and may only purchase paraffin and/or candles. Although two households in the sample are observed to sell fuelwood, it is proposed to drop this relatively insignificant proportion (approximately 1 per cent) of the sample and concentrate on those that collect and consume fuelwood only. Hence, for these areas, households' extraction of fuelwood, fodder and grazing resources from the forest for use in their own household appears to be a more important factor behind forest degradation than fuelwood markets. This will simplify the model and the empirical analysis. Econometrically, dropping these two households from the model avoids a censored dependent variable problem, thus reducing the sample size to 180. We can assume that for these 'non-sellers' of fuelwood, the reservation price of fuelwood exceeds the market sales price and they therefore opt for self-sufficiency. Thus we hold that fuelwood is non-traded, that is, supply is equal to consumption ($Q_{FW} = C_{FW}$). Hence, the first term on the right-hand side of equation (6) can be set to zero. Similarly, dung is not traded and again supply is equal to household consumption (Q_D - C_D). In addition the following non-negative constraints apply:

$$\begin{aligned} &Q_i \geq 0; C_j \geq 0; L_K \geq 0 \\ &i = FW, AG, D; \\ &j = L, FW, D, C, P, M, H; \\ &k = FW, AG, OUT \end{aligned} \qquad (7)$$

The Lagrangian for an internal solution to the problem consisting of (1) – (7) can be written as:

$$\begin{aligned} &\ell = U\left[C_M, \Gamma\left(Q_{FW}, Q_D, C_P, C_C\right), T - L_{AG} - L_{OUT} - L_{FW}; Z^C\right] - \\ &\lambda\left[P_M C_M + P_P C_P + P_C C_C - P_{AG} Q_{AG} - wL_{OUT}\right] - \\ &\eta_{AG}\left[Q_{AG} - g_{AG}\left(L_{AG}, A_{AG}, \alpha Q_{AG} - Q_D; Z^K\right)\right] - \\ &\eta_{FW}\left[Q_{FW} - g_{FW}\left(L_{FW}; Z^V\right)\right] \end{aligned} \qquad (8)$$

Taking first-order conditions for this problem and rearranging them gives some insight into what might drive household decision-making. First:

$$\frac{\partial U}{\partial C_L} = \eta_{AG} \frac{\partial g_{AG}}{\partial L_{AG}} = \eta_{FW} \frac{\partial g_{FW}}{\partial L_{FW}} = \lambda w \qquad (9)$$

This states that households collect fuelwood until the point where the marginal value product of household labour in fuelwood collection is equal to the opportunity costs of household labour in agriculture. The allocation of household labour time between fuelwood collection, agriculture and leisure is however, dependent on the off-farm wage rate.

With respect to dung:

$$\frac{\partial U \partial \Gamma}{\partial \Gamma \partial Q_D} = \frac{\lambda P_{AG} \frac{\partial g_{AG}}{\partial inp}}{1 - \frac{\alpha P_{AG}}{\partial inp}} \qquad (10)$$

This implies that dung use is determined by the opportunity cost of dung as a farm input. The denominator on the right-hand side shows that using dung as a farm input not only increases agricultural output directly but also indirectly through the generation of more by-products allowing yet higher levels of input use, which may further increase output and so on.

With respect to paraffin (and similarly for candles though not shown here):

$$\frac{\partial U \partial \Gamma}{\partial \Gamma \partial C_P} = \lambda P_p \qquad (11)$$

As expected, the consumption of paraffin (and candles) is determined by its market price.

To summarise, the model shows under certain assumptions that fuelwood collection is determined by the households' opportunity costs of time, as predominantly influenced by farming. Dung use is determined by the opportunity costs of dung as farm inputs. In our model we assume that male and female labour in agriculture are perfect substitutes and hence, the opportunity costs of both female and male time is driven by the wage. An increase in the wage draws labour away from agriculture, and also from fuelwood collection.

From the first-order conditions, a set of reduced form equations are derived, showing fuelwood collection, amount of time spent collecting and dung production as functions of all the exogenous variables:

$$\left.\begin{matrix} Q_{FW} \\ L_{FW} \\ Q_D \\ B_{FW} \end{matrix}\right\} = f(Z^H, Z^V, Z^C, T, P_{AG}, P_M, w, P_{FW}) \qquad (12)$$

Now included is B_{FW}, fuelwood bought on the market, since a significant proportion of households in the sample purchase fuelwood. These equations form the basis of the empirical work. The lack of markets for some goods and the recursive nature of this theoretical model dictates that household fuelwood demand and supply decisions cannot be separated. All exogenous variables remain as explanatory variables in all equations, irrespective of whether they pertain to consumption decisions or production decisions. The equations are independent and it is not necessary to estimate the full system of all endogenous variables. Estimation is therefore confined to three reduced-form equations: amount of fuelwood collected (kg/yr), labour input for fuelwood collected (hours/yr), amount of dung consumed (kg/yr) and amount of fuelwood bought (kg/yr). These are the endogenous variables of interest for the analysis of fuelwood collection and energy substitution, and are listed in Table 14 along with the exogenous variables.

Table 14: Exogenous and endogenous variables

Variable	Definition
Exogenous (independent) variables	
Density of forest biomass	Relative abundance of woody resources in the region, in m^3 per hectare
Distance to source of firewood	Household forest access, in metres
Collection time of firewood	Collection time in hours per kg of firewood collected
Access to car or motorbike (discrete)	Ease of market access
Household income	N$ per household
Livestock	Number of goats, cows and donkeys owned by the household
Household size	Number of people living in the immediate household
Education	Number of years household head and spent in education system
Gender	Gender of household head (1 codes for male)
Endogenous (dependent) variables	
Fuelwood collection time	Total collection time for fuelwood in hours per year
Fuelwood collected	Fuelwood collected by the household in one year in kg
Fuelwood purchased on the market	Fuelwood purchased by the household in one year in kg
Dung consumed	Dung consumed by the household in one year in kg

Paraffin consumption has been dropped from the analysis due to its different uses such as lighting, in addition to cooking and heating of space and water. This variety of uses means that paraffin cannot be considered as a perfect substitute for fuelwood and dung.

The presence of multiple regimes (buyers, sellers, non-buyers and non-sellers and a few that buy and sell) complicates the analysis. There are two sellers and 180 non-sellers, and 30 buyers and 152 non-buyers in the sample. As noted previously, the small size of the seller sub-sample precludes it from further analysis thus reducing the overall household sample to 180. From the first-order conditions, it is clear that the market price of fuelwood is relevant only to the buyers. Non-buyers are guided by unobservable reservation prices.

Accounting for market and reservation prices across multiple regimes is a complex task. Thus simply splitting the sample into buyers and non-buyers and running OLS regressions on the separate sub-samples is not appropriate. It introduces selectivity bias because households are distributed in a non-random manner. The method used here to address this problem is that of Heckman’s (1979) and Lee’s (1982) two-step estimator. It should be noted, however, that while the two-stage approach is consistent it lacks efficiency. Zuehlke and Zeman (1991), for example, demonstrate that the imprecision of the two-step estimator is greatest for small sub-samples. Furthermore, fuel markets in the study areas appear to be highly localized. Fuelwood market prices are therefore unlikely to be exogenous and will not be included among the regressors, unless an instrumental variable is constructed in order to correct for this. In this study, prices will be proxied by other independent variables such as collection time per kg of fuelwood collected.

The independent variables used for estimation are listed in Table 14. These are household capital, forest resource availability, household income and various demographic indicators of household behaviour. The expected directions of effect of these variables on the dependent variables can be seen in the results tables below.

In the absence of market prices, household responses to fuelwood scarcity can be assessed through the impact of non-price variables on fuel consumption. Collection time is expected to have a negative impact on fuelwood consumption and a positive impact on use of dung. Family size is expected to influence fuelwood collection positively, due to both increased energy demand (e.g. for cooking) and increased labour supply for collection. The expected impact of family size on dung consumption is ambiguous because more household labour means increased demand for energy, but also greater scope for substituting fuelwood, which is relatively labour intensive, for dung.

The prices of agricultural output, P_{AG}, and other goods, P_M, are assumed not to vary across the households in the sample: hence they are not included among the regressors. Also, no data on wage rates are available. Instead, a continuous variable measuring the number of years the household head spent in education is included in the regressors to account for unobserved labour market opportunities.

Livestock will proxy for household capital since they tend to be the household's most valuable form of capital. Moreover, households with more animals also tend to have other forms of capital, which have not been captured in the survey. The relative scarcity of dung can be assessed through the effect on fuel mix of variables such as animal stock. The number of livestock owned is expected to have a positive impact on dung consumption because households with large herds have easy access to animal dung for burning.

The cross-price elasticity of demand is used for determining whether goods are substitutes or complements in consumption. Because of the lack of price data, indirect 'cross-price elasticities' may be used to assess the extent to which households substitute between fuels. Thus, substitutes between dung and fuelwood can be evaluated through the impact of collection time on private energy consumption and through the effect herd size has on dung collection. Higher prices may reduce energy consumption or keep it steady with a greater emphasis on fuelwood collection.

Collected fuelwood has no direct financial cost, but has high labour costs, which vary according to the density, distance and accessibility of woody resources. These are expected to rise with increasing distance from the forest resource. Forest stock is given as cubic metres of available woody resources per hectare in each political region. These stocks are assumed to lie within public forests. Access to woody resources for firewood is given by distance from the household. Shorter distance is expected to lead to fewer market purchases, less dependence on dung and less labour allocated to fuelwood collection. Improved access to the resource or to the market is measured through access to motorised transport. In the absence of data on the nearest road or market, access to a car or motorbike implies the existence of some kind of road nearby. There are data on exogenous market income for almost all households. Wealthier households probably collect less of their own firewood and rely more on market purchases.

In addition, the gender of the household head is given as a household demographic variable. It is not understood how the gender of the household head might affect household fuelwood behaviour.

4. Model findings

In the following regression results (Table 15), there are a number of missing observations for two key regressors, which reduces the size of the sample to 150 households. All four regressions are estimated using the Heckman two-step estimation in which a prediction from one model is used as a covariate in a second model. The binary indicator variable is whether or not households buy firewood. Unfortunately, the use of the Heckman estimator does not make it possible to retain all households with observations on the dependent variable for estimation.

Table 15: Regression results

Explanatory variables		**Dependent variables**											
			Fuelwood collected			*Fuelwood collection time*			*Fuelwood purchased*			*Dung consumed*	
Description	Mean												
Constant			***6618*** (2115)**			***-140.4*** (78.1)*			***1138*** (791)			***-494*** (413)	
Density of forest biomass	12.4	+	70.3 (83.7)	0.13	-	-1.37 (3.09)	-0.04	-	-62.5 (31.9)**	-1.86	-	12.7 (16.5)	0.56
Distance to source of firewood	3106	-	-0.060 (0.056)	-0.03	-	-0.0065 (0.0021)**	-0.05	-	-0.010 (0.022)	-0.08	+	-0.0067 (0.011)	-0.07
Collection time of firewood	0.082	-	-36962 (9791)**	-0.44	+	3728 (361.7)**	0.76	-	-6187 (3610)*	-1.21	+	-157 (1900)	-0.05
Access to car or motorbike	0.087	+	3563 (2119)*		-	53.5 (78.3)		?	-887.9 (807.8)		-	-269 (417)	
Household income	2017	-	-0.11 (0.18)	0.03	?	-0.0063 (0.0066)	-0.03	+	0.254 (0.068)**	1.23	-	-0.035 (0.035)	-0.25
Livestock	4.78	?	-85.8 (133.2)	0.06	?	-0.021 (4.92)	0.00	?	-72.1 (50.8)	-0.82	+	21.1 (26.2)	0.36
Household size	7.73	+	198 (123)*	0.22	+	29.2 (4.55)**	0.56	+	31.6 (39.6)	0.58	+	36.2 (22.7)*	1.00
Education	6.24	+	178 (162)	0.16	-	11.4 (5.99)*	-0.17	+	-51.0 (61.7)	-0.76	+	19.0 (31.9)	0.42
Gender	0.63	?	540 (1222)		?	-30.6 (45.2)		?	229.2 (465.3)		?	189 (240)	
Λ (Lamda)	-0.13		978 (2080)			-30.8 (76.9)			-3428 (597.2)**			-977 (369)**	
Sample size			150			150			150			150	
Log likelihood function			-1536			-1042			-1388			-1293	
Degrees of freedom			139			139			139			139	

Note: For each, the first column gives the expected sign, the second gives the coefficient and standard error and the third gives the elasticity (evaluated at the mean). *significant at the 0.10 level; **significant at the 0.05 level

All regressions perform satisfactorily in terms of overall fit, absence of heteroskedasticity, robustness to minor changes in specification and conformity with prior expectations. However, these model estimations only explained between 20 and 50 per cent of the variation in the dependent variables, which may be due to a lack of variables that proxy for local population pressure on the forest resource, the management of the resource, market access and household landholdings. Also, it should be noted again that the Heckman estimation is less efficient than a normal OLS. Nevertheless, the regression results give some interesting findings that are consistent with those of other researchers.

Table 15 shows the regression estimates for the household's total fuelwood collection, labour input to fuelwood collection, fuelwood purchases and dung consumption. For the majority of regressors in these estimates, the results follow the anticipated signs. In the case of the collection time (the proxy for the price of fuelwood) is significant at the 0.05 level, while market/fuelwood access and household size are both significant at the 0.10 level. Thus, as expected, the less fuelwood collected the higher the fuelwood price. The larger the household, the more fuelwood is collected. Households with access to a motor vehicle collect more fuelwood.

With respect to fuelwood collection time, distance to the resource, collection time and household size are all significant at the 0.05 level. Thus, as expected, total labour input to firewood collection declines the further away firewood is found from the household. There is greater household input into the collecting process in larger households. Higher education levels also seem to significantly (at the 0.10 level) increase household labour efforts in collecting fuelwood.

Fuelwood purchases are significantly impacted by collection time, forest density and household incomes, with all the estimated signs as anticipated. The latter two variables are significant at the 0.05 level, while collection time is significant at the 0.10 level. Thus, more fuelwood is purchased in areas where forest density is lower, where household incomes are higher and where collection times are lower.

Dung consumption only seems to be affected by household size, which is significant at the 0.10 level. Thus, larger households appear to consume more dung than smaller ones. Numbers of livestock and incomes, while having the anticipated sign, appear to have insignificant impacts on household dung consumption.

5. Discussion

In this study, two approaches have been used to develop policy direction for monitoring and potentially enforcing rules on forest resource use. First, the dataset was analysed to comprehend the significance of forest resources for rural livelihoods. We find that over one-third of household income and almost all energy use depends on forest resources. Markets in the north central regions are currently weak or missing – although the existence of sub-household unit trades of labour among economic activities has not been tested.

Secondly, the dataset was analysed to understand better the poverty dimension of rural livelihoods. We find that over 90 per cent of rural population in the NCR survive on less than $2/day – far higher than the official rate of 56 per cent for Namibia as a whole. It is those households with formal employment income that earn the most. Subsistence farming households earn the least – less than $1/day. In addition, there appears to be a low level of soft technological dispersal – with almost no hired labour reported, high unemployment and few apparent opportunities for upgrading incomes through diversification into new markets. The informal sector is far more important for rural livelihoods than the formal sector, yet this sector appears to be weak and inefficient – with low levels of rural business development.

Thirdly, these findings were dually examined through a dynamic modelling exercise to understand how policy could be developed that provides simultaneous poverty alleviation and forest conservation. A household model for domestic energy supply and demand was adapted from Heltberg *et al*. (2000). The model was estimated on primary data from Namibia using the Heckman two stage process. The results support the theoretical model to a limited degree. While the direction of effects are mainly in line with expectations derived from an analysis of the constraints and opportunity costs facing households, it cannot be concluded that forest and non-forest fuels are direct substitutes. Nevertheless, energy consumption responds to forest access, fuelwood collection time and household size. Market participation responds to higher household incomes, lower fuelwood collection times and lower forest density.

Forest resources appear to be significant for incomes and hence poverty alleviation and at current rates, appear sustainable at a regional "landscape" level. . A study by Erkkilä (2001) has shown that forest cover in the study area has declined between 1943 and 1996, most notably in the intensively settled central Cuvelai area. It predicts increasing pressure on the forest resources in the surrounding areas. However, Erkkilä's study and the forest resource accounting study of Barnes et al. (2005) indicate that at regional level in the study area current rates of use are below the sustainable yield.

Fuelwood has the characteristics of a staple fuel. Our finding that higher fuelwood price leads to less fuelwood collected suggests that as forest resources become increasingly scarce (as measured by per-unit collection time) households react by reducing their consumption of forest fuelwood. However, the degree of this response is relatively low: a 10 per cent increase in the time it takes to collect one unit of wood results in a 4.4 per cent reduction in the amount of fuelwood collected. It also results in a 12.1 per cent decline in fuelwood purchased. This implies that households respond to scarcity by increasing labour input to collection rather than by reducing energy consumption or by substituting between fuels. This is consistent with the idea of fuelwood as a basic necessity. These results are similar to those of Heltberg et al. (2000), although the elasticities estimated here are higher.

Furthermore, the results from the dung consumption regression do not suggest that dung is an important substitute for fuelwood. The signs on a number of coefficients are unconvincing. Firstly, higher forest density, increased collection time for fuelwood and a greater distance from the resource all seem to imply that households consume less dung, despite these variables not being significant. The sign on livestock suggests that this acts more as proxy for a source of dung than household wealth. Smaller and wealthier households consume less dung. Overall, dung cannot be considered an important fuelwood substitute.

Many of the key estimated elasticities are low. This implies that increasing forest scarcity (associated with lower stocks and higher collection time) cannot be expected to halt forest degradation. Thus, any interventions that seek to increase forest stock, such as through plantation development may have little or no impact unless the underlying causes of forest degradation are addressed. Furthermore, the lack of evidence for fuel substitution also precludes any sensible policy prescriptions being made with respect to dung.

Finally, the limitations of this analysis should be noted. The survey data was primarily collected for the purpose of developing forest resource accounts, not to analyse household energy consumption. Consequently, a number of variables could not be included that may improve the quality of this analysis, such as those for local management institutions and local population density. Also, there is a lack of variation in some of the variables used that make changes harder to pick up, particularly given the relative inefficiency of the Heckman estimator.

6. Conclusions and policy pointers

This paper contributes to the literature on forest resource use in the NCR and the findings are relevant for northern Namibia and most likely also for communal lands throughout southern Africa. Our findings concur with those from South Asia on the impact of collection time and add to the small amount of literature on the substitution of animal dung for fuelwood.

Forest resources are significant contributors to rural livelihoods for some of the continent's poorest people. The population of the NCR relies on forest resources for their energy supplies and shelter as well as providing shelter and grazing for livestock. These resources provide almost one quarter of household income and form the basis of an active but apparently weak and inefficient informal economy. Opportunities to upgrade livelihoods (i.e. increase efficiency, productivity, income, etc) through use of forest resources currently seem limited without external intervention. However, with the NCR's economic development gathering pace, the potential for increased trade in NTFPs and other forest-based products will grow. The question we are unable to answer here is what impact this will have on current rates of forest product utilisation.

To this end, any policy to be developed on forest resources must take into consideration the impact on the rural population if it is not to exacerbate existing poverty. Forest resources, while providing a safety net, could also provide a launch pad for innovation, economic development and poverty alleviation, as they have elsewhere. The development of policies that offer conspicuous incentives to promote both poverty alleviation and forest conservation must become the goal for all stakeholders.

The structure of opportunities facing individuals and the private sector in the NCR is not currently generating industry supplied by or involving over-exploitation of forest resources. Indeed, these natural resources are economically under-utilised at present at a regional level. However, opportunity vectors for rural populations are apt to rapid change and with the envisaged development of the transport infrastructure (roads, air and rail), global market demands are increasingly influencing activities in the NCR. For instance, baskets woven in the NCR are being sold in 'street markets' throughout South Africa and increasingly in the European Union. Moreover, current increasing global price trends for timber might provide a window of opportunity to develop sustainable forest-based enterprises. Anticipatory policy is needed to ensure that any development hinted at by these trends provides appropriate income and benefits to the NCR regional economy and also alleviates poverty wherever possible. This might include developing measures to ensure that local rather than external traders take advantage of potential income from expanding opportunities through expanded linked-up marketing, production and supply chain governance based around cooperative structures. Here the government has a role to play, alongside relevant local NGOs, providing assistance with marketing, negotiation and other appropriate business skills development.

However, markets distort. The importance of NTFPs and the forest for livelihoods means that unfettered exploitation could prove ruinous to rural communities and their livelihoods. Hence, opportunities for identification of best practice, transfer of skills and benefit sharing should be explored. Again, the government, alongside local NGOs, should provide assistance in building capacity and monitoring industry and market development using socially-focused criteria. Spillovers from other region's demands require constant attention and monitoring.

Equally, the spillovers from other industries and their policies into the NCR forest sector cannot be ignored owing to the potential threat to the margin of the forest.

Greater intra-region efficiency upgrading will further develop the region and spread market benefits. At a regional level, rural livelihood development faces few obvious opportunities for generalised upgrading. Elsewhere in Namibia, successful community-based rural development schemes have leveraged natural resources such as tourism and wildlife to the advantage of the poor and the national environment. Yet, the NCR is different: population is denser and the land has higher value for agriculture and grazing. Significantly, preferential access to Namibia's largest urban markets – Oshakati and Ondangwa – presents considerable opportunities for marketing products. However, there seem to be few market opportunities and the markets themselves are relatively immature. In this regard, fuelwood is exemplary: there is strong urban demand but this is not being answered by the poor rural population of the abundant local forests. Equally, there are evident barriers to the commercial movement of other agricultural and NTFP products from rural to urban areas. There is a role for government and NGOs to extend opportunities for substitution for consumption of forest products, through improved stoves for instance.

Donors and government also need to identify forest areas of significant local social value and external value in order to guide protection efforts where possible, such as through tenurial innovations. . In this regard the approach adopted elsewhere in Namibia through the highly successful community-based natural resource management (CBNRM) programme could have a role to play. In particular, the community forestry initiative could be expanded to embrace the north central regions.

The fundamental role for the government's Forest Departments in the NCR needs to be re-visited and efforts made to shift from a focus on forest protection to one of efficient forest management. There is every reason why sustainable financing for these forests should come from locally managed and enforced sustainable harvesting. Elsewhere, innovative use and dispersal of property rights to local communities combined with judicious capacity-building and monitoring-enforcement efforts has helped to devolve and expand forest protection and management capacity.

We have countered the argument that fuelwood is an unsustainable natural resource and an engine of overexploitation in the NCR. It will be important to replicate such analysis in other regions of southern Africa. One issue that we have been unable to address is the changes in composition of household fuel consumption, and how this changes in the light of greater availability of electricity or access to modern alternatives.

Key next steps should, on the environmental side, involve continued monitoring of trends in fuelwood use and forest exploitation particularly as infrastructure expands and travel times shorten. On the development side, there is a need for further in depth analysis of the rural economy and its shortcomings, threats and requirements for rural livelihoods.

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The Environmental Economics Programme (EEP,) which forms part of IIED's Sustainable Markets Group, seeks to develop and promote the application of economics to environmental issues in developing countries. This is achieved through research and policy analysis on the role of the environment and natural resources in economic development and poverty alleviation, specifically:

- the impact of economic policies and market liberalisation on natural resource management, pollution and environmental quality;
- the economic value of natural resources and environmental services, and the costs of environmental degradation; and
- policy incentives to internalise environmental values in economic decision-making.

A unifying theme in much of the progamme’s work is capacity building through collaborative research. To this end, EEP works with a range of partners around the world, including government and multilateral agencies, private enterprise, academic institutions, research organisations and advocacy groups.

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