Evaluating patterns of wood use for building construction in Maputaland, South Africa

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A questionnaire survey was conducted to evaluate the level of wood utilization for house building in the community of Manqakulane in Maputaland, northern KwaZulu-Natal, South Africa, in 2003. The questionnaire's aims were to evaluate in both a descriptive and quantitative manner the utilization of wood in building construction. House building design in that community has abandoned the traditional round huts with thatched roofs of 20 years ago and now favours square or rectangular houses made with wooden walls covered with mud or cement and with a corrugated iron roof. While wooden houses represented the majority of buildings, houses made of bricks were on the increase. Square or rectangular houses with a corrugated iron roof required significantly less elements for the roof beams than round thatched houses. The wall panels were the most wood-consuming part of a house. It was estimated that the average household would have to source 11 main posts, 10 main beams, 27 roof laths and 277 wall laths annually to replace old buildings. Between 40 and 50% of the material used in house building was obtained from species with an established sustainable harvesting potential. The high preference for *Brachylaena huillensis* as main posts is, however, cause for concern as the current population of this species in the communal land of the Manqakulane people cannot sustain such high levels of harvesting.

Key words: hardwood utilization, rural community, questionnaire survey, Maputaland.

INTRODUCTION

The rural community of Manqakulane live in the heart of the Maputaland Centre of Plant Endemism. This centre of endemism harbours a rich range of rare and endemic plant and animal species, and has a high biodiversity value (Kirkwood & Midgley 1999; Van Wyk & Smith 2001; Mucina & Rutherford 2006). The centre forms part of the Maputaland-Pondoland-Albany region, which has recently been recognized by Conservation International as one of the global hotspots of biodiversity.

A large portion (>65%) of the Manqakulane community's land is still in a natural state and contains large tracts (1050 ha (Gaugris *et al.* 2004), or 21.0% of the community's land area) of the rare forest type, known as Licuati Forest (Myre 1964; Izidine *et al.* 2003) or Sand Forest (Van Rensburg *et al.* 1999; Kirkwood & Midgley 1999; Matthews *et al.* 2001; Van Wyk & Smith 2001; Mucina & Rutherford 2006). The Manqakulane community established the Tshanini Community Conservation Area on their land in 2000 (Gaugris *et al.* 2004), and they envisage the sustainable utilization of the renewable natural resources contained within it. The main forms of utilization in the conservation area will consist of the extraction of wood for the construction of houses by villagers as well as harvesting of medicinal plants by traditional healers.

Rural communities across the developing world make extensive use of natural resources to supply them with an array of environmental goods and services. Several studies have been carried out in savanna regions of South Africa to quantify the consumption and direct-use value of the natural resources harvested by the communities and found that wood use was an important if not essential element of survival in the rural areas (Shackleton *et al.* 2002; Twine *et al.* 2003; Shackleton & Shackleton 2004).

To prevent the degradation of the timber and medicinal resources in the Tshanini Community Conservation Area, and in particular the Sand Forest patches included in the reserve, it is crucial to balance human utilization with conservation. From a scientific viewpoint, sustainable utilization

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should be based on knowledge of a) availability of resources, b) the regeneration potential of the species and c) the rate of resource use (Obiri *et al.* 2002; Lawes & Obiri 2003). However, sustainable conservation requires that biodiversity concerns are incorporated into the behaviour of individuals and this in turn requires an understanding of people's behaviours (Cowling & Wilhelm-Rechmann 2007). The biological assessment should therefore ideally be accompanied by a social assessment, and whenever possible, longitudinal studies in time should be made.

The aims of the present paper are a) to describe and analyse the patterns of wood use in house building in the Manqakulane community; b) to quantify the wood used for construction in the homestead of a standard household; c) to calculate the mean annual wood replacement rate per household; and d) to discuss the sustainability of wood use for building construction and changes observed since a study by Cunningham & Gwala (1986) and one by Tarr (2006) in the same region.

METHODS

Study area

The study area lies in the Maputaland region of northern KwaZulu-Natal, South Africa. At the time of the study, the land of the rural community of Manqakulane covered approximately 5000 ha of which 2420 ha formed the Tshanini Community Conservation Area (Gaugris *et al.* 2004). The area consists mainly of a sandy plain that is interspersed with ancient littoral dunes, and it is covered by an open to closed woodland with patches of Short to Tall Sand Forest. The Muzi Swamp forms the eastern boundary.

Approximately 800 people, forming 110 households, lived in the community at the time of the survey in 2003 (Gaugris 2004). This population was dispersed in the forest around the Muzi Swamp on the eastern portion of the community land where the supply of clean water has recently been installed. Each household has a homestead that is formed by a range of one to 13 structures utilized for different purposes (Gaugris 2004). The community of Manqakulane is ruled by a local iNduna representing the chief (iNkosi) of the Tembe Tribal Area.

Unemployment in the community is high (80.0–90.0% depending on perception of 'work', Peteers 2005), and the income per household is low (R 186.2 per adult per month, Peteers 2005). Subsistence farming is a reality for the community people and reliance upon natural resources that are directly available in the surrounding environment represents the only way to obtain fuel for cooking and heating, or a range of food products. Wood is a main resource that is utilized for fire, the building of houses, and the manufacture of tools for everyday life. Wood is also utilized by local artists to manufacture an assortment of music instruments and curios (Gaugris 2004).

Questionnaire surveys

Traditionally questionnaire surveys were employed to obtain information on the consumption of natural resources, as they are time- and labour-efficient compared to field inventories (Vaughan *et al.* 2003; White *et al.* 2005) and they are a valuable source of information about the targeted species and the interactions between humans and the environment (Lykke 1998; White *et al.* 2001; Bosetti & Pearce 2003). The current study has employed a triangulation approach to describe and quantify the wood use for building construction in the Manqakulane community. The questionnaires were complemented by a partial validation (limited *in situ* inventory conducted by the head of the household) and a full inventory of wood use (carried out by the research team). By synthesizing the data from all three sources, the impact of potential bias could be reduced and confidence in the results increased.

Prior to the current study, a complete census of the households in the Manqakulane community had been conducted for a sociological study (S.M. Ferreira, unpubl. data). For the census, the number of occupants as well as homestead structure in terms of number of buildings, building material and roof material were recorded. These data were used to carefully select 42 households so that the frequency in which a particular homestead structure was represented in the sample was similar to its proportion in the entire community.

These 42 households were selected for conducting full wood use inventories and questionnaire surveys. The inventories were conducted first, and were followed a month later by the questionnaire surveys. The inventories involved physically examining the wood that had been utilized in house building, counting all the structural elements and identifying the species used. For the questionnaire surveys, personal interviews were held and a partial wood use inventory was carried out with the help of the head of the household.

A questionnaire was designed and then refined with the help of the Department of Anthropology and the Department of Statistics of the University of Pretoria, South Africa, to ensure that questions were ethical and understandable as well as within the design criteria for analysis in SAS® (SAS® Version 8.2, SAS Institute, Cary, NC, U.S.A.) thereafter. Both ecological and social information were targeted in the questionnaires. The questionnaire survey evaluated the woody resources used for building construction and queried the opinions of the various households about preferred material, house type, and recent changes in the vegetation. The construction elements evaluated in the questionnaires were the main posts (used to support the house walls and roof), main beams (forming the roof principal support structure), roof laths (supporting the roofing material, either thatch or corrugated plates) and wall laths (mesh of sticks woven between two main posts that form the wall structure, and that may be plastered).

The questionnaires were conducted in the Zulu language by a 24-year-old man from the community of Manqakulane, who received training to conduct such research. The methodology for the questionnaires involved going to the selected households at times when essential activities were low. The head of the household was greeted, the scope of the entire questionnaire was presented and his assistance requested. Each question was fully explained in Zulu before the answer was noted. For the questions of a quantitative nature, the nearest available building made of wood in the homestead was used as an example. The head of the household was asked to identify the wood and to assist the interviewer in counting the elements. Both open ended (OE) and closed format (CF) questions were used. The questionnaire covered the following aspects:

- wood species preferred for construction and the reasons for the choice (OE);
- least preferred wood species for building and the reasons for the choice (OE);
- house shape preference and the reasons for the choice (OE);
- number of people sleeping in the houses (OE);
- number of buildings made of bricks, and type of roof (OE/CF);
- number of buildings of different shapes (square, rectangular or round), wall type, roof type, floor type, window type, number of windows;
- number of buildings to be replaced (OE/CF);
- buildings in construction, shape, wall type, roof type, floor type, window type and number (OE/CF);
- number of kitchens or cooking shelters, the nature of the building and the wood utilized (OE);
- number of maize stores, the nature of the building and the wood utilized (OE);
- who builds a house (OE);
- distance required to gather building material (CF);
- time needed to build a thatched roof house (CF);
- perceived recent environmental changes (CF)
- dream house (OE);
- in the quantitative survey accompanying the questionnaire the number of elements used as main posts, main beams and wall laths were counted in the nearest house and the wood species actually used for each of these elements recorded (OE/CF). Roof laths were not surveyed.

The data were analysed by the Department of Statistics of the University of Pretoria using the SAS®. Unpaired *t*-test with Welch's correction and a *F*-test on the variance were performed to compare the mean number of main poles, beams, roof laths and wall laths used in standard houses with a corrugated iron roof, or with a thatched roof.

RESULTS

Forty-two households participated in the field inventory, but only 33 households (30.0%) were sampled through the questionnaire surveys. This was attributed to the fact that the field inventory had already been completed and most people did not understand the need to repeat the survey in another form. However, questionnaire fatigue may also have played a role as a social study conducted simultaneously had already investigated a range of households for social information. Homesteads ranged in size from one to 13 buildings, and the mean number of buildings per households was 5.3 ± 2.84 (S.D.).

In total, 120 inhabited houses were counted in the questionnaires, with an additional seven in construction. The detail of the house shapes, wall types and roof types is presented in Table 1. Square or rectangular houses made of wood and with a corrugated iron roof formed the bulk of the houses in the community, followed by wooden houses of the same shape but with a thatched roof. Only eight houses in the sample were made of bricks, one of which had a thatched roof. There was a marked preference for walls made of woven wooden sticks thereafter covered in mud to isolate against the wind. Similar walls but covered with cement formed the second most employed wall construction method.

Table 1. Homestead composition by house shape, roof type and wall type in the community of Manqakulane as evaluated during a questionnaire survey conducted in 2003.

		House type			
		Square or rectangular		Round	
Roof type	Wall type	Frequency	%	Frequency	%
Corrugated iron	Bricks	7	5.8	0	0.0
	Wooden posts	4	3.3	0	0.0
	Wood and mud	31	25.8	4	3.3
	Wood and cement	13	10.8	0	0.0
	Wood and stone	9	7.5	0	0.0
	Reeds	5	4.2	0	0.0
Thatched	Bricks	0	0.0	1	0.8
	Wooden posts	0	0.0	1	0.8
	Wood and mud	14	11.7	14	11.7
	Wood and cement	3	2.5	2	1.7
	Wood and stone	4	3.3	0	0.0
	Reeds	8	6.7	0	0.0

Number of buildings in construction = 7.

People preferred square or rectangular houses (69.7% of respondents) because they were easier to build (42.4% of respondents) than round houses (Table 2). Among the respondents preferring round houses (30.3% of respondents) 50% were of the opinion that round houses were easier to organize than square or rectangular ones. Most houses were used by two (30% of respondents) or three people (24.0% of respondents) with the maximum number of occupants being five (4.0% of respondents).

The five most favoured species by order of preference were *Brachylaena huillensis, Ptaeroxylon obliquum, Cleistanthus schlechteri, Newtonia hildebrandtii* and *Hymenocardia ulmoides* (Table 3). The five least favoured species were *Afzelia quanzensis, Elaeodendron aethiopicum, Haplocoelum gallense, Ochna arborea* and *Balanites maughamii.* A 'good' species according to the respondents' standards had a hard wood, provided straight and durable wood that did not rot (Table 4) whereas a bad species rotted easily, and therefore had a short lifespan, as well as a soft wood.

The mean number of elements required to build the houses as well as the mean diameter of these elements, as measured by the head of the household himself are listed in Table 5. The number of main posts required did not differ significantly between different house shapes. However, square or rectangular houses with a corrugated iron roof required significantly less elements for the roof

Table 2. The preferred house shape and the reasons motivating the choice in the Manqakulane community as evaluated during a questionnaire survey conducted in 2003.

	Response frequency	%
Choice of house shape		
Square or rectangular	23	69.7
Round	10	30.3
Reason for choice		
Square houses		
Easier to build	14	42.4
Looks beautiful	3	9.1
Easier to thatch	3	9.1
Easy to furnish	2	6.1
Easy to organize	2	6.1
Short construction time	2	6.1
Cool in summer/warm in winter	2	6.1
Easy to thatch	1	3.0
Better when hot	1	3.0
Big inside	1	3.0
Easy to divide into rooms	1	3.0
For the ancestors	1	3.0
Round houses		
Easy to organize	4	50
Easier to build	1	12.5
Short construction time	1	12.5
More comfortable	1	12.5
No gaps when thatched	1	12.5

Table 3. The most desirable and least desirable species for house building according to the people of the Manqakulane community in 2003.

Good to worse ranking	Favoured species	(%)	Worse to better ranking	Less favoured species	(%)
1	*Brachylaena huillensis*	34.7	1	*Afzelia quanzensis*	0.3
2	*Ptaeroxylon obliquum*	26.2	2	*Elaeodendron aethiopicum*	0.9
3	*Cleistanthus schlechteri*	11.4	3	*Haplocoelum gallense*	1.2
4	*Newtonia hildebrandtii*	10.1	4	*Ochna arborea*	1.2
5	*Hymenocardia ulmoides*	4.4	5	*Balanites maughamii*	2.1
6	*Terminalia sericea*	2.6	6	*Drypetes arguta*	2.1
7	*Spirostachys africana*	2.3	7	*Hymenocardia ulmoides*	2.1
8	*Psydrax obovata*	2.1	8	*Euclea natalensis*	2.4
9	*Diospyros inhacaensis*	1.8	9	*Sclerocarya birrea*	2.8
10	*Eucalyptus* post	1.3	10	*Tabenaemontana elegans*	3.1
11	*Drypetes arguta*	1.0	11	*Terminalia sericea*	3.1
12	*Combretum molle*	1.0	12	*Strychnos madagascariensis*	3.7
13	*Croton steenkampianus*	0.8	13	*Psydrax locuples*	4.0
14	*Ochna arborea*	0.3	14	*Strychnos spinosa*	4.3
			15	*Acacia burkei*	4.3
			16	*Spirostachys africana*	4.6
			17	*Cleistanthus schlechteri*	5.2
			18	*Dialium schlechteri*	8.3
			19	*Diospyros inhacaensis*	11.9
			20	*Pteleopsis myrtifolia*	32.4
Total		100.0			100.0

beams than round thatched houses (mean of 6.8 as opposed to 21.7 main beams).

The species used in construction, which were identified by the head of the household for the nearest house, are listed per element type in Table 6 and compared with the preferred species list and the most important species recorded in the full inventory. Except for main posts, the list of species actually employed for house construction clearly differed, either in ranking, or in selection altogether (reflecting a different order, and different choices) from the list of species initially described as preferred by the people. In general, species used as main posts corresponded best with the preferred list of species and included: *Brachylaena huillensis, Ptaeroxylon obliquum, Cleistanthus schlechteri, Hymenocardia ulmoides* and *Psydrax obovata* (the total for these five species represented

Table 4. Desirable and undesirable qualities of local wood influencing the selection of woody species for house building in the Manqakulane community in 2003.

	Good wood			Bad wood	
Reason for the choice	Frequency	(%)	Reason for the choice	Frequency	(%)
Hard wood	166	29.6	Rots easily	137	31.8
Straight poles	138	24.6	Short lifespan (1–3 years)	114	26.5
Does not rot	122	21.8	Soft wood	53	12.3
Provides wood for pole and beam	65	11.6	Affected by sand	50	11.6
Long lifespan (6–10 years)	32	5.7	Not straight poles	39	9.1
Long poles	10	1.8	Lifespan <6 months	13	3.0
Not affected by insects	10	1.8	Affected by insects	9	2.1
Hard wood core	8	1.4	Resprouts easily	5	1.2
Abundant	6	1.1	Straight poles*	5	1.2
Rare	2	0.4	Hard to utilize	4	0.9
Easy to carve	1	0.2	For beams only	2	0.5
Total	560	100.00		431	100.00

*Although this was a quality for most, some respondents considered it a default.

Table 5. Mean number of elements (±S.D.) and mean element diameter (±S.D.) in house building, by house shape and roof type, in the Manqakulane community in 2003.

House shape	Roof type	Element type	Mean number of elements	Mean diameter of elements (cm)
Rectangular/square	Corrugated iron	Main Poles	18.9 ± 6.1	6.7 ± 1.3
	Beams		6.8 ± 2.7	5.9 ± 1.3
	Wall laths (1 panel)		86.0 ± 23.8	2.4 ± 0.7
Rectangular/square	Thatched	Main Poles	18.9 ± 6.1	6.7 ± 1.3
	Beams		21.7 ± 9.8	5.9 ± 1.3
	Wall laths (1 panel)		86.0 ± 23.8	2.4 ± 0.7
Circular	Thatched	Main Poles	16.7 ± 3.6	6.7 ± 1.3
	Beams		21.7 ± 9.8	5.9 ± 1.3
	Wall laths (1 panel)		55.4 ± 11.2	2.1 ± 0.8

77.5% of all posts). Species that were used as main beams included: *Eucalyptus* posts, planks (*Eucalyptus/Pinus*), *Hymenocardia ulmoides, Brachylaena huillensis* and *Cleistanthus schlechteri* (the total for these five species represented 71.2% of all beams). Species that were used as wall laths included: *Catunaregam spinosa, Diospyros inhacaensis, Grewia microthyrsa, Hymenocardia ulmoides* and *Psydrax obovata* (the total for these five species represented 52.7% of all laths).

Households seldom built custom-made kitchens (6.1%), but rather built kitchen shelters (87.8%) to do the cooking, while some households simply cooked in the open (6.1%). Old living quarters that were no longer suitable for that use were also sometimes re-used for cooking purposes. The majority of sampled households (54.5%) had one or more maize stores (1.2 ± 0.7), which were built of similar wood species as the other houses (84.84%). Maize stores had a lifespan of approximately five years (5.2 ± 1.8 years) and were usually replaced when they were too dilapidated (69.7%) although some people replaced them before they collapsed altogether (30.3%) and some households even renewed their maize stores on an annual basis.

A breakdown of the wood contained in the buildings of the average homestead in Manqakulane is provided in Table 7. For this calculation it was assumed that the average homestead was composed of five structures: one kitchen shelter, one maize store and three houses used as living quarters. Of the three houses two were assumed to be square or rectangular, one had a corrugated iron roof and one was thatched and the third house was round with a thatched roof. Calculations were based on the full inventory data because all elements were investigated in that survey. Assuming that the average lifespan of the buildings was eight years (Gaugris *et al.* 2007), the annual replacement rate requirements for each of the building elements were calculated. The unpaired *t*-tests with Welch's correction showed that there were no differences between houses with corrugated iron roofs or thatched roofs in terms of mean number of main poles ($t = 0.1712$, d.f. = 2, $P = 0.89$; variance: $F = 77.07$, $P = 0.02$) and wall laths ($t = 0.4447$, d.f. = 2, $P = 0.70$; variance: $F = 1.189$, $P = 0.77$) needed. However, there was a significant difference between the two roof types in terms of the mean number of beams and ($t = 16$, d.f. = 2, $P < 0.01$; variance: $F = 4.05$, $P = 0.66$) roof laths ($t = 11.65$, d.f. = 2, $P < 0.01$; variance: $F = 116800$, $P < 0.01$) needed, the thatched roofs unsurprisingly demanding many more elements than roofs made with corrugated iron sheets.

House building in the Manqakulane community was a mostly male occupation (60.60%) that was often shared by the children (39.40%). Women were not mentioned as taking part in house building. The men, sometimes assisted by their children, collected the building wood within the community land and usually walked in excess of three km (3.2 ± 0.6 km) for that purpose. The construction of a thatched rectangular or square house took more than a month to complete (36.7 ± 15.6 days).

Respondents found that gathering wood suitable for house building was more difficult compared to when they built their first house (Table 8). In addition, the size of suitable wood had reduced, and necessitated more travelling to harvest them than before. The people had resorted to using new species that were not previously used (pre 2000), but with little satisfaction. In general, houses were now built in a different manner than the way of the

Table 6. Percentage utilization of species for various elements in building construction as recorded in a partial inventory undertaken as part of a questionnaire survey (partial) and a full inventory of homesteads (full).

	Preference list[#]	Main posts		Main beams		Wall laths		Roof laths
		Partial	Full	Partial	Full	Partial	Full	Full
Brachylaena huillensis[†]	34.7	30.0	30.9	9.1	7.4			
Ptaeroxylon obliquum[‡]	26.2	22.5	20.5	3.0	5.9			
Cleistanthus schlechteri[‡]	11.4	12.5	4.4	6.1			0.5	
Newtonia hildebrandtii[‡]	10.1	2.5						
Hymenocardia ulmoides[‡]	4.4	7.5	4.1	10.6	16.0	9.9	6.2	14.2
Terminalia sericea[‡]	2.6	3.8	11.5	1.5	12.0			1.3
Spirostachys africana[†]	2.3	5.0	6.2		2.3		0.3	
Psydrax obovata	2.1	5.0	0.6	1.5		6.6	3.1	1.1
Diospyros inhacaensis	1.8	1.3		3.0	3.1	13.2	0.2	
Eucalyptus posts	1.3	2.5		27.3	7.3			9.0
Drypetes arguta[‡]	1.0			1.5		4.4	4.3	
Combretum molle	1.0							
Haplocoelum gallense[‡]		2.5						
Cola greenwayi		1.3				5.5		
Manilkara concolor		1.3						
Ochna arborea		1.3						
Pteleopsis myrtifolia[‡]		1.3	0.3					
Plank *(Eucalyptus/Pinus)*				18.2	3.5	2.2		17.8
Wrightia natalensis				4.5	2.2	2.2		10.8
Zanthoxylum capensis				3.0		4.4		
Catunaregam spinosa				1.5	2.0	13.2	20.3	7.6
Clausena anisata				1.5		3.3		
Deinbolia oblongifolia				1.5				
Grewia microthyrsa[†]				1.5		9.9	12.3	6.9
Monanthotaxis caffra				1.5				
Psydrax locuples				1.5		3.3		
Ziziphus mucronata				1.5				
Erythroxylum delagoense					4.0	5.5	5.5	5.8
Dichrostachys cinerea						3.3		
Clerodendrum glabrum						2.2		
Rhus gueinzii						2.2		
Brachylaena elliptica						1.1		
Euclea natalensis[‡]						1.1		
Grewia caffra						1.1		
Plectroniella armata						1.1		0.8
Salacia leptoclada						1.1		
Strychnos madagascariensis[‡]						1.1		
Suregada zanzibariensis						1.1		
Toddaliopsis bremekampii						1.1		
All other species that individually contribute <1.0%	1.0		22.5		34.3		48.3	25.7
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total number of species	14	15	50	19	57	24	84	48

Refers to species preference obtained in open ended question in the questionnaire survey.
[†]Species cannot be harvested sustainably.
[‡]Species can be harvested sustainably.

Table 7. Mean number of structural wood elements contained in a theoretical standard homestead representative of homestead constitution in 2003 and an estimated annual replacement rate of structural elements at community level and for the most used species in the community of Manqakulane in 2003, based on a full homestead replacement every eight years.

Household level				
Building type	Number of structural elements per building type (rounded			
	Main poles	Main beams	Roof laths	Wall laths
Kitchen shelter	13	3	3	0
Maize store	17	22	66	364
[1]Rectangular or square corrugated iron	19	7	4	742
[2]Rectangular or square thatched	19	22	66	567
[3]Round thatched	17	22	77	546
Total number (full household)	85	76	216	2219
Total volume 4 (full household in m^3)	0.63	0.29	0.42	0.94
Total number (mean annual figure)	11	10	27	277
ANOVA test results (rows marked as 1, 2, 3): $F = 0.01$, $P = 0.98$, d.f. = 2/9				
Community level (based on a mean figure for 110 households)				
Total number of elements	9350	8360	23760	244090
Total volume of elements (m^3)	69.81	32.13	46.31	102.90
	Annual replacement rate of structural elements (number) based on the community level requirements			
Total number of elements	1169	1045	2970	30511
Estimate of number of elements if all house structures were of one kind across the 110 households				
[1]Rectangular or square corrugated iron	6270	2310	1320	244860
[2]Rectangular or square thatched	6270	7260	21780	187110
[3]Round thatched	5610	7260	25410	180180
Household level				
	Annual replacement rate of structural elements (number) per homestead (rounded) for selected highly desirable species			
	Main poles	Main beams	Roof laths	Wall laths
Brachylaena huillensis	3	1		
Ptaeroxylon obliquum	2	1		
Cleistanthus schlechteri				
Hymenocardia ulmoides		2	4	17
Terminalia sericea	1	1		
Spirostachys africana	1			
Gumpole		1	2	
Plank			5	
Drypetes arguta			1	2
Diospyros inhacaensis				
Psydrax obovata				9
Wrightia natalensis			3	
Catunaregam spinosa			2	56
Grewia microthyrsa			2	34
Erythroxylum delagoense			1	16
Pteleopsis myrtifolia				
Plectroniella armata				2
Dialium schlechteri				
Bridelia cathartica				2

Table 8. General perception on environmental change of the people of Manqakulane community in 2003.

Questions	Answers		
	Yes	No	No answer
It is easier to find good wood for building?	12.1%	84.9%	3.0%
It is more difficult to find good wood for building?	90.9%	3.0%	6.1%
Good wood for building is usually larger than before?	12.1%	81.8%	6.1%
Good wood for building is usually smaller than before?	78.8%	15.2%	6.1%
To find good wood requires more travelling?	90.9%	0.0%	9.1%
To find good wood requires less travelling?	6.1%	87.9%	6.1%
Do you use new wood species?	78.8%	15.2%	6.1%
Are you happy with the new wood species you use?	6.1%	81.8%	12.1%
Are you building your house the same way as your parents?	27.3%	63.6%	9.1%
Are you building your house in a different way from your parents?	81.82%	81.8%	12.1%
Do you prefer having a corrugated iron roof?	78.8%	15.2%	6.1%
Is a corrugated roof warmer in summer than a thatched one?	93.9%	0.0%	6.1%
Is a corrugated roof colder in winter than a thatched one?	93.9%	0.0%	6.1%
Is a corrugated roof more expensive than a thatched roof?	90.9%	3.0%	6.1%
Do you know how to build a thatched roof like your parents?	21.2%	72.7%	6.1%

elders and there was a marked preference for corrugated iron roofs despite the fact that they were more expensive than thatched roofs and that corrugated roofed houses were warmer in summer and colder in winter than thatched roofed ones. A large majority of the people also admitted that they did not have the knowledge to build thatched roofs like their elders.

Should money not be a problem, the Manqakulane people wished for a house with at least 5 bedrooms (5.3 ± 1.8), it should be made of bricks and have a corrugated iron roof (42.1% of respondents), or a thatched roof (31.6% of respondents) or a tiled roof (26.3% of respondents). The floor should be cemented (100%). The house should have a link to the water system (42.4% of respondents); a bathroom with sanitation (39.4% of respondents) as well as a source of electricity (33.3% of respondents) and the property should be fenced off. A kitchen was mentioned by only 6.1% of respondents while a swimming pool was mentioned by 9.1% of respondents.

DISCUSSION

A standard homestead in the community of Manqakulane comprised five structures, mostly of rectangular or square shape, with walls made of wood panels covered by mud, and with a corrugated iron roof. These results indicate a change in building style from the predominantly traditional round thatched huts with reed walls reported by Cunningham & Gwala (1986) two decades ago. While houses with reed walls did still exist (10.8% of sampled houses), they have clearly been replaced by wood as the building material of choice (81.7% of sampled houses). The number of buildings made of bricks was low (6.7%), but the people aspired to build permanent houses with all modern comforts. It therefore appears likely that houses made of bricks should become the standard of living for the majority of rural people in the foreseeable future, as soon as the economic status allows it. A shift towards brick houses and corrugated iron roofs should indeed reduce the impact on the locally available woody resources, if population growth does not lead to increased land clearing for new households (Peteers 2005).

When asked to specify the species preferred for building construction, only 14 species were mentioned. However, the physical examination of the homesteads by the head of the household revealed the use of 38 species, a clearly observable difference. In general, the preferred species agreed well with the species used as main posts in the nearest building as identified by the head of the household. The full inventory also found the most preferred species well represented as main posts. However, *Newtonia hildebrandtii,* one of the rare endemic species of the Sand Forest, was listed as fourth most preferred but was never encountered in the full inventory. The discrepancy between the list of preferred species and those physically identified by the head of the household or in the full inventory became larger when the main beams or wall laths were investigated. The examination performed by the head of the household listed 19 species for main beams and 24 species for wall laths, whereas the full inventory listed 57 and 84 species for the two element types, respectively. It appears that when people were asked about the wood they utilized to build their houses, the species that came to mind first were those used for the main posts, and that the species used for beams or laths were not regarded as equally important. This may in some way reflect the effort required to find suitable main posts of the diameter, length and straightness required, whereas other elements have less stringent requirements. The importance attributed to main posts does, however, not reflect the total volumes required. In terms of volumes of wood utilized, the wall panels are the most resource-consuming part of a house. Taking a mean main post length of 2.2 m and mean wall lath length of 1.0 m (Gaugris 2004), the volume of wood for the main posts is 0.14 m^3, while that for the wall laths for 18 panels of a standard house amounts to 0.72 m^3 (*i.e.* the volume of wood required is 4.9 times greater for the wall panels). The large number of species used for wall laths indicate that the selection criteria are less severe than for the main posts. The results indicate the importance of corroborating people's preferences before planning the sustainable utilization of woody resources.

It was estimated that the average household would have to source 11 main posts, 10 main beams, 27 roof laths and 277 wall laths annually to replace dilapidated buildings. It is encouraging that 40.8% of the main posts were made of species that have been identified as suitable for sustainable harvesting: *Ptaeroxylon obliquum, Cleistanthus schlechteri, Hymenocardia ulmoides,* and *Terminalia sericea* (Gaugris *et al.* 2007). However, Gaugris *et al.* (2007) found that harvesting of *Brachylaena huillensis* (30.9% of posts), the most preferred species, and *Spirostachys africana* (6.2% of posts) could not be done sustainably. It is therefore imperative that alternative species are used in the place of these two species. An alternative could be to investigate the reasons behind the lack of desirability of *Hymenocardia ulmoides.* Indeed, this is an abundant resource, that can be used sustainably, and that has been considered valuable for construction in other parts of KwaZulu-Natal (Pooley 1997) because of its straight and durable wood. In the case of the main beams, 44.7% of them were harvested from species with a sustainable harvesting potential established by Gaugris *et al.* (2007) and only 9.7% from species that could not be harvested sustainably. The sustainable harvesting potential of the remainder of the species used at present had not yet been investigated, but from people's response in the questionnaires on the desirable qualities of harvested material, hard wood species resistant to parasites are favoured. These species are usually slower growing, implying that replacement rates of harvested individuals would probably be low. The sustainability of these species' harvest should therefore be investigated rapidly. In total, 42.2% of the roof laths were obtained from sustainable sources and only 6.9% from species that could not be harvested sustainably. Gumpoles and planks contributed substantially to the high percentage of sustainable use of roof laths. A wide variety of species were used for wall laths but most of these species have not been analysed for the sustainability of their harvesting potential, although harvesting of *Grewia microthyrsa* (12.3% of wall laths) was found to be unsustainable (Gaugris *et al.* 2007).

While no statistically significant difference occurred between building with thatched roofs and building with roofs made of corrugated iron sheets in terms of supporting main poles numbers and wall laths numbers, the latter types proved much more economical in terms of the mean number of beams and roof laths required to hold the roof in place. In biological terms, the harvesting of 3630 elements (beams and roof laths combined) if all buildings were square or rectangular with corrugated iron roofs appears as a much more sustainable position than the harvesting of 29 040 elements (beams and roof laths combined) if those same buildings had thatched roofs instead. One form of construction uses eight times less elements than the other, and fits within a conservative estimate of sustainable utilization of resources established for the region by Gaugris *et al.* (2007), while the other does not.

In general, people found that wood availability for house building was now lower than when they built their first house. In addition, the size and quality of available wood had reduced, which necessitated more travelling than before to harvest suitable trees. Many people now use species unused previously, but with little satisfaction. People admitted that houses are now built differently than their elders built them, and that they preferred corrugated iron roofs despite worse insulation qualities and greater expense. The majority of people also stated that they no longer knew how to build thatched roofs like their elders.

The pattern of wood use for building construction described for the Manqakulane community does, however, not apply for the entire region. A different picture emerged when a similar questionnaire survey was conducted in the nearby Sibonisweni community (5 km further north) also in the year 2003. In this neighbouring community 85.9% of the respondents used reeds to build their houses (Tarr 2005). The land of Sibonisweni borders on the southeastern boundary of Tembe Elephant Park and is traversed by the Muzi Swamp. The community people have rights to harvest the reeds of the Muzi Swamp inside Tembe Elephant Park and these provide building material and a significant source of income (Tarr 2006). In contrast, the Manqakulane people do not have access to an abundant source of reeds. While the Muzi Swamp extends as far south as the Manqakulane community, it only floods intermittently there, and most of it has now been converted to agricultural land because the soil has a higher nutrient content than soil in the adjacent vegetation types (Gaugris *et al.* 2004).

Also noteworthy, was that the harvesting of building material in the Sibonisweni community was done largely by women (87.5%). Reed harvesting was perceived to be an important form of social interaction for the local women (Tarr 2006). Cunningham & Gwala (1986) stated that men were the traditional hut builders while the women 'collect thatch, prepare twine and rope, and thatching mats'. However, in the Manqakulane community, the absence of reeds and the changes in homestead construction appears to have precluded women from the traditional house building activities. Corrugated iron roofs have replaced thatched roofs and nails and nylon ropes have replaced twine and ropes made of natural fibres.

In this impoverished part of South Africa, people used the resources that were in the immediate vicinity before they resorted to other materials. The Sibonisweni community could access an abundant source of reeds, whereas wood resources were freely available to the Manqakulane community. The difference in results between the two communities depicted a much greater reliance on the resources immediately available than anticipated and leads us to conclude that any plan for the sustainable utilization of natural renewable resources should be evaluated at tribal community land level. An evaluation of the use of natural renewable resources evaluated at a wider regional level will most likely overlook some of the local and noteworthy variations. These two rural communities clearly showed that a plan for resource utilization designed for one of them would not work in the other community.

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REFERENCES

BOSETTI, V. & PEARCE, D. 2003. A study of environmental conflict: the economic value of grey seals in southwest England. *Biodivers. Conserv.* 12: 2361–2392.

COWLING, R.M. & WILHELM-RECHMANN, A. 2007. Social assessment as a key to conservation success. *Oryx* 41: 135–136.

CUNNINGHAM, A.B. & GWALA, B.R. 1986. Building methods and plant species used in Tembe-Thonga hut construction. *Ann. Natal Mus.* 27: 491–511.

GAUGRIS, J.Y. 2004. Sustainable utilization of plants in the Manqakulane Conservation area, Maputaland, South Africa. M.Sc. dissertation, University of Pretoria.

GAUGRIS, J.Y., MATTHEWS, W., VAN ROOYEN, M.W. & BOTHMA, J. du P. 2004. The vegetation of Tshanini Game Reserve and a comparison with equivalent units in the Tembe Elephant Park in Maputaland, South Africa. *Koedoe* 47: 9–29.

GAUGRIS, J.Y., VASICEK, C.A. & VAN ROOYEN, M.W. 2007. Selecting tree species for sustainable harvest and calculating their sustainable harvesting quota in Tshanini Conservation Area, Maputaland, South Africa. *Ethnobot. Res. & Applic.* 5: 373–389.

IZIDINE, S., SIEBERT, S. & VAN WYK A.E. 2003. Maputaland's Licuati forest and thicket, botanical exploration of the coastal plain south of Maputo Bay, with an emphasis on the Licuati Forest Reserve. *Veld & Flora* 89: 56–61.

KIRKWOOD, D. & MIDGLEY, J.J. 1999. The floristics of Sand Forest in northern KwaZulu-Natal, South Africa. *Bothalia* 29: 293–304.

LAWES, M. & OBIRI, J. 2003. Using the spatial grain of regeneration to select harvestable tree species in subtropical forest. *Forest Ecol. Manage.* 184: 105–114.

LYKKE, A.M. 1998. Assessment of species composition change in savanna vegetation by means of woody plants' size class distributions and local information. *Biodivers. Conserv.* 7: 1261–1275.

MATTHEWS, W.S., VAN WYK, A.E., VAN ROOYEN, N. & BOTHA, G.A. 2001. Vegetation of the Tembe

Elephant Park, Maputaland, South Africa. *S. Afr. J. Bot.* 67: 573–594.
MUCINA, L. & RUTHERFORD, M.C. 2006. The vegetation of South Africa, Lesotho and Swaziland. South African National Biodiversity Institute, Pretoria.
MYRE, M. 1964. A vegetação do extremo sul da Província de Moçambique. Junta de Investigações do Ultramar. Lisbon.
OBIRI, J., LAWES, M. & MUKOLWE, M. 2002. The dynamics and sustainable use of high value tree species of the coastal Pondoland forests of the Eastern Cape Province, South Africa. *Forest Ecol. Manage.* 166: 131–148.
PETEERS, O. 2005. Poverty alleviation and sustainable development in Manqakulane, northern KwaZulu-Natal, South Africa: a systemic approach using retrospective remote sensing and GIS. M.A. dissertation, Vrije Universiteit Brussel, Brussel, Belgium.
POOLEY, E. 1997. The complete field guide to trees of Natal, Zululand and Transkei. Natal Flora Publication Trust, Durban.
SHACKLETON, C. & SHACKLETON, S. 2004. The importance of non-timber forest products in rural livelihood security and as safety-nets: a review of evidence from South Africa. *S. Afr. J. Sci.* 100: 658–664.
SHACKLETON, S.E., SHACKLETON, C.M., NETSHILUVHI, T.R., GEACH, B.S. BALANCE, A. & FAIRBANKS, D.H.K. 2002. Use patterns and values of savanna resources in three rural villages in South Africa. *Econ. Bot.* 56: 130–146.
TARR, J.A. 2006. The utilization of *Phragmites australis* reeds by communities neighbouring the Tembe Elephant Park, Maputaland, KwaZulu-Natal. M.Sc. dissertation, University of Pretoria.
TWINE, W., MOSHE, D., NETSHILUVHI, T. & SIPHUNGU, V. 2003. Consumption and direct-use values of savanna bio-resources used by rural households in Mametja, a semi-arid area of Limpopo Province, South Africa. *S. Afr. J. Sci.* 99: 467–473.
VAN RENSBURG, B.J., McGEOGH, M.A., CHOWN S.L. & VAN JAARSVELD, A.S. 1999. Conservation of heterogeneity among dung beetles in the Maputaland Centre of Endemism, South Africa. *Biol. Conserv.* 88: 145–153.
VAN WYK, A.E. & SMITH, G.F. 2001. Regions of floristic endemism in southern Africa. A review with emphasis on succulents. Umdaus Press, Pretoria.
VAUGHAN, N., LUCAS, E.A., HARRIS, S. & WHITE, P.C.L. 2003. Habitat association of European hares *Lepus europaeus* in England and Wales: implications for farmland management. *J. Appl. Ecol.* 40: 163–175.
WHITE, P.C.L., BENNETT, A.C. & HAYES, E.J.V. 2001. The use of willingness-to-pay approaches in mammal conservation. *Mammal Rev.* 31: 151–167.
WHITE, P.C.L., VAUGHAN JENNINGS, N., RENWICK, A.R. & BARKER, N.H.L. 2005. Questionnaires in ecology: a review of past use and recommendations for best practice. *J. Appl. Ecol.* 42: 421–430.

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