Hard Wood Utilization in Buildings of Rural Households of the Manqakulane Community, Maputaland, South Africa

Research

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Abstract

An analysis of the structure and composition of household buildings in the rural community of Manqakulane, Maputaland, KwaZulu-Natal, South Africa, is presented. This biodiversity-rich area forms part of the Maputaland Centre of Plant Endemism, currently under threat from land transformation and human utilisation outside conservation areas. The demand for natural resources as building material by people of the community is evaluated through a survey of the structure of 42 randomly selected households. A sample of 226 buildings used for habitation or other purposes was conducted. The results revealed a change in structure types from round reed hut observed in the 1980s towards durable structures made with brick or wooden walls and corrugated iron roofs. Round structures are replaced by square ones, and thatched roofs are no longer the majority. Materials used for construction are identified and quantified, and an attempt is made to plan utilisation for the next eight years.

Introduction

Poverty is considered as the primary enemy of sustainability in the developing world, as it places the emphasis on solving today's problems without any thought for tomorrow's welfare (Kennedy 2001). A widespread and growing environmental degradation usually accompanies poverty, and they both work in a mutually reinforcing spiral. However, it has been shown that economic development cannot occur when the environment is destroyed and quality of human life is neglected (Dernbach 2001). Ruda (1998) argues that for the sustainable development of rural settlements, at least four characteristics should be protected: balance between nature and built-up area, historic traditional entities, local communities, and the countryside as an own culture.

With a human population still predominantly rural and poor, the South African conservation authorities in 1994 endorsed the principle that sustainable utilisation of renewable natural resources was a legitimate form of conservation (Els 2002). This principle forced conservation authorities to manage rural areas for the benefit of the communities with the primary objectives of improving the standard of living (Els 2002). This approach is however faced with the major problem of establishing a sustainable level of utilisation (Borrini-Feyerabend 1997).

Manqakulane in northern Maputaland, KwaZulu-Natal province, South Africa is a poor, rural community with high unemployment levels and a low annual household income. Subsistence farming is a reality for the community people and reliance upon natural resources directly available in the surrounding environment is heavy. Wood is a main resource that is utilized for the building of houses, fuel, and the manufacture of tools for the household. Wood is also utilized by local artists to manufacture an assortment of music instruments, carvings and curios (Els 2000).

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In 2000, this community took the initiative to establish the Tshanini Game Reserve on their land to generate income and to create employment. In the past, this communal land was utilized by the people for a substantial amount of basic resources and they expressed the need to retain access to the natural resources contained within the reserve.

The land of the community of Manqakulane lies in the core of the Maputaland Centre of Endemism (van Wyk 1996) where the rare Licuati Forest (Izidine *et al*. 2003, Myre 1964) or Sand Forest occurs (Kirkwood & Midgley 1999, Matthews *et al*. 2001, Mucina *et al*. 2003, van Rensburg *et al*. 1999, van Wyk 1996, van Wyk & Smith 2001). The Sand Forest is home to many rare and unusual plant and animal species (many of them endemic) and it has a high biodiversity value (Kirkwood & Midgley 1999, van Wyk & Smith 2001). Cattle grazing, firewood demand, elephant (*Loxodonta africana*) utilisation, and fire, are the main identified threats to the Sand Forest (Kyle 2004, van Rensburg *et al*. 1999, van Wyk 1996). The patchy distribution of this rare forest type combined with the fact that few people and organizations have the knowledge and interest to manage it, results in it being subject to uncontrolled utilisation (Izidine *et al*. 2003, Matthews *et al*. 2001).

Little scientific information is available for the KwaZulu-Natal forests in general and sand forests in particular (Everard *et al*. 1995, Kirkwood & Midgley 1999). If the recent increase of the human population in northern Maputaland is taken into consideration (Lewis & Mander 2000), ecologically relevant questions need to be answered soon. One way to evaluate how much the local people utilise the vegetation is to analyze the quantities (Cunningham & Gwala 1986) and size class distributions of the species that have been incorporated into the households (Wall *et al*. 1998). In this manner the targeted species and the total volumes of wood utilized can be estimated. Forest managers can use these estimates of the potential needs to make projections on the future prospects of utilisation with the current demographic increase.

An ecological study was requested by the people from the Manqakulane community to evaluate the potential of the Tshanini Game Reserve for the envisaged sustainable utilisation of its natural renewable resources. The main forms of utilisation are the extraction of posts, beams and laths, for the construction of houses by villagers as well as the harvesting of medicinal plants by traditional healers. To determine the level at which sustainable utilisation can be maintained, the supply and demand of natural resources have to be balanced, we therefore need to know how much do the local people utilise the vegetation? In this paper we present data on the plant species and quantities of wood products utilized for the construction of households. The species are analyzed and classified by order of preference, the quantities of wood elements are estimated, and information is presented on the current choices of the local people to build their households. Basic projections are formulated to evaluate future needs of the local people.

Study area

The land of the rural community of Manqakulane covers a rectangular area approximately 6,000 ha in size (the center of community is at S 27^{0} 07’05.9”, E 032^{0} 24’ 08.6”.) of which 2,420 ha to the west of the land form the Tshanini Game Reserve. The area consists mainly of a sandy plain that is interspersed with three ancient littoral dunes. It is covered by an open to closed woodland with patches of short to tall Sand Forest in the west, and the southern end of the Muzi Swamp in the east (Gaugris *et al*. 2004).

Approximately 800 people lived in the community at the time of the study. This population is spread out in the eastern portion of the communal land where a safe water supply had been installed in 1999. The members of the community live in households that consist of a range of one to thirteen structures utilized for different purposes. The community of Manqakulane is ruled by a local **iNduna** representing the **iNkosi** (king) of the Tembe Tribal Area. The households are dispersed in the forest and woodlands around the Muzi Swamp and follow a broad north - south axis along the water line (Gaugris 2004).

Methods

The present work forms part of an ecological study of the Manqakulane community Tribal ward. The study was seeks to evaluate the potential of the Tshanini Game Reserve in terms of ecological capacity and the possibilities to use the natural renewable resources contained within. The community households needed to be evaluated in order to have a reliable estimate of the natural resources utilisation level. Through a series of meetings with the community’s steering committee and **iNduna**, and then with the whole community, the aims and methods of the study were presented in order to obtain the consent of everyone for conducting research in the households. Once approval for this part of the study was granted by the steering committee, all of the households within the community’s land boundaries were mapped with a Global Positioning System. The general composition and structure of the buildings of each household were recorded. The department of statistics of the University of Pretoria used this initial data to present the researchers with a methodology to sample statistically representative households. A total of 42 households were selected, and these were then intensively sampled by means of field sampling and questionnaires (for details see Gaugris & van Rooyen 2006). A list of alternative and similarly representative households was also presented in case an originally selected household could not be sampled for any reason.

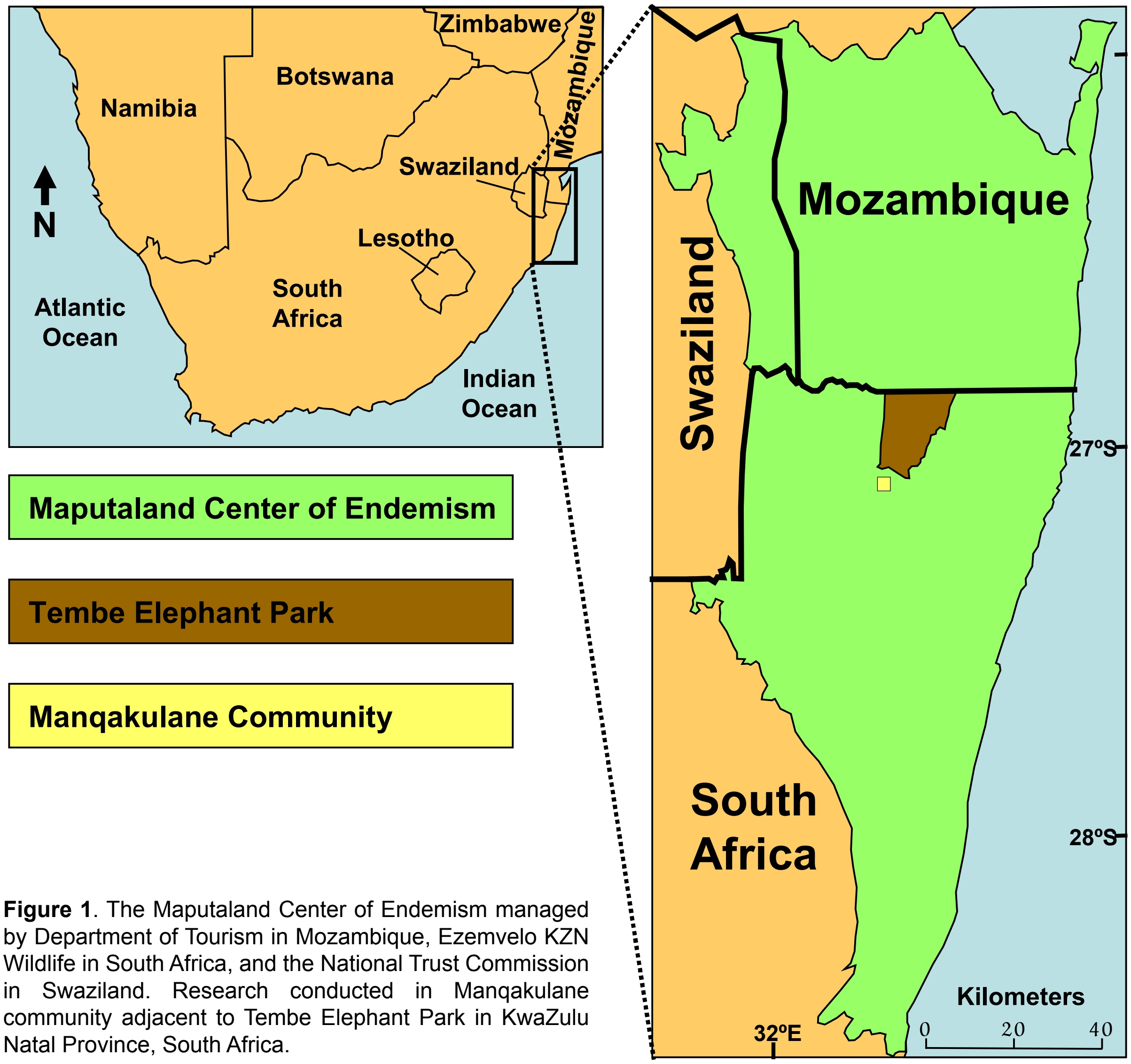

Figure 1. The Maputaland Center of Endemism managed by Department of Tourism in Mozambique, Ezemvelo KZN Wildlife in South Africa, and the National Trust Commission in Swaziland. Research conducted in Manqakulane community adjacent to Tembe Elephant Park in KwaZulu Natal Province, South Africa.

The field methodology 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 survey was presented and his authorisation to proceed with the survey was requested before going ahead. If any reason was presented to oppose the survey, the head of the household was thanked for his attention and an alternative household was selected. If the survey was allowed, the various buildings were assessed from the outside only, and the assistance of the head of the household was requested for some aspects. Once the study was completed, the head of the household was thanked for his help and saluted before leaving.

Field sampling involved a full inventory of all the buildings in a household. The buildings were divided into five basic structural types, depending on the house shape and roofing material. These types were described as: rectangular or square house with either a thatched or corrugated iron roof, and round hut with a thatched roof. The basic measurements of the building were recorded, and for each structural type the number of main posts, main beams, roof laths, and wall laths for a wall-area of four m^2 were determined. For each of these elements, the wood species (scientific names were recorded) that had been used were identified with the help of a trained assistant and the house builder. The diameter and the length of the pieces of wood that had been used were measured and recorded.

Additional information on the basic building specification, such as the number and size of doors and windows, the type of roof and roof material, the age and condition of the construction, were recorded. Questionnaires were used to record social information such as the function of the building, family details, and if applicable the number of people sleeping in each building (Gaugris & van Rooyen 2006).

The data were analyzed per building type, element type and for the tree species and size classes involved by using the SAS® program (SAS® Version 8.2, SAS institute, SAS campus drive, CANY, North Carolina). A model was developed to quantify wood use for the community as a whole, and also to quantify the composition of a standard type of structure in the community. This standard structure of household unit was used as a benchmark to estimate the present need of locally available natural building material.

The mean number of elements per house type and roof type were compared by means of one-way analysis of variance (ANOVA). The number of main poles, main beams and roof laths required if all the planned new rectangular and square houses with corrugated iron roofs were thatched, instead of the suggested assortment of corrugated iron and thatched roofs were compared using a chi-square test.

Results

At the time of the study, the community of Manqakulane was composed of 105 inhabited households from a total of 110 identified house sites. Each household consisted of one to thirteen buildings of various shapes and uses, with a mean of 5.3 ± 0.3 structures per household. In total, 558 buildings were counted within the 110 identified households. A household is a complex unit where each building fulfils a specific function. Each building can therefore be seen as the equivalent of a room of a large house. Each household was inhabited by up to four generations of the same family. The household is extended when children are born, and when older people return to their family as they become unable to live on their own.

From the study of the 42 households selected, only two were alternative households. The bulk of the established buildings in the households were one to four years old with a mean age of 2.8 ± 0.1 years and a mean remaining life expectancy was calculated to be 4.8 ± 1.1 years (range = 0-12 years). The oldest house recorded was 15 years old. The maximum remaining life expectancy recorded for the buildings was 12 years. At the time of the study, 45.9% of the 558 buildings surveyed were not considered to be very good condition. This varied from what could be considered as average (29%) to bad condition (17%) to abandoned (1%). However, 45% of the buildings were identified as being in good to excellent condition, and the remaining 8% of the buildings were in various stages of construction. It therefore appears that the abandoned buildings and those with average to bad condition would have to be replaced within the next three years (Figures 2 and 3). This implies an ongoing replacement rate of 12.5% per year for those of wood construction, translating into 70 buildings that have to be replaced annually.

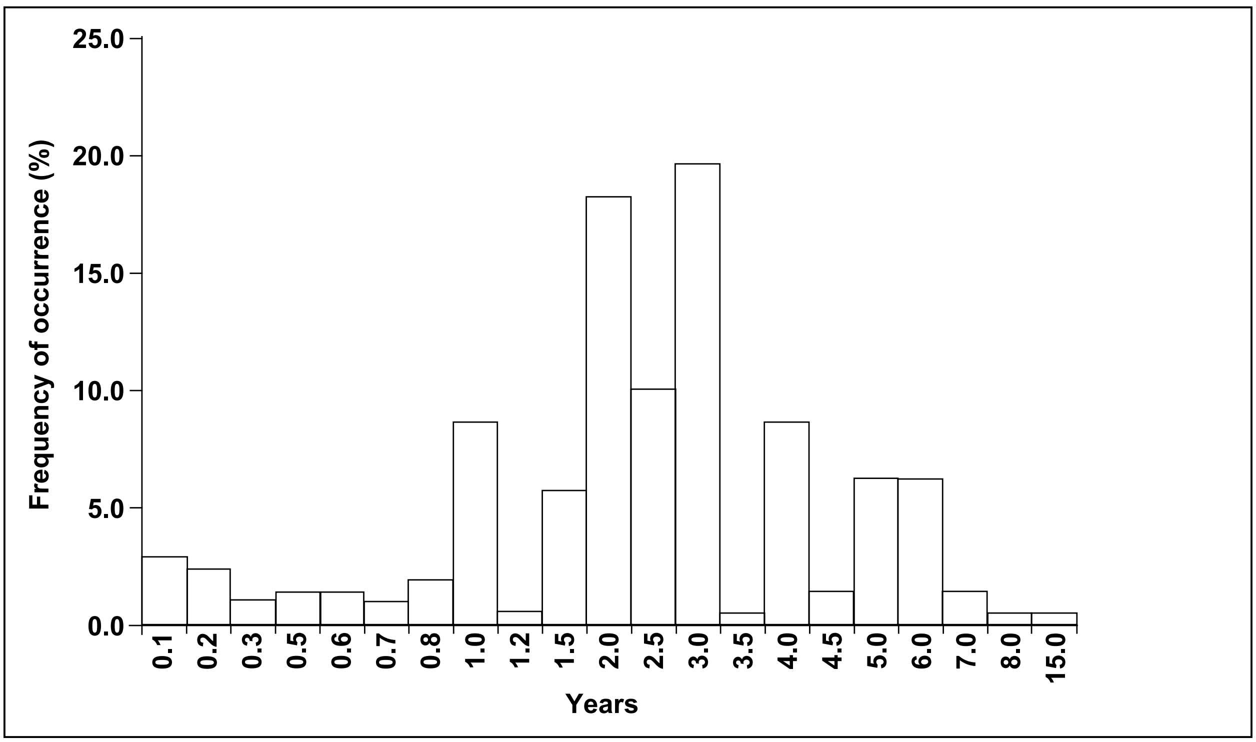

Figure 2. The age distribution of the 558 established buildings in the community of Manqakulane, Maputaland, KwaZulu-Natal province, South Africa, as established by a survey in 2002.

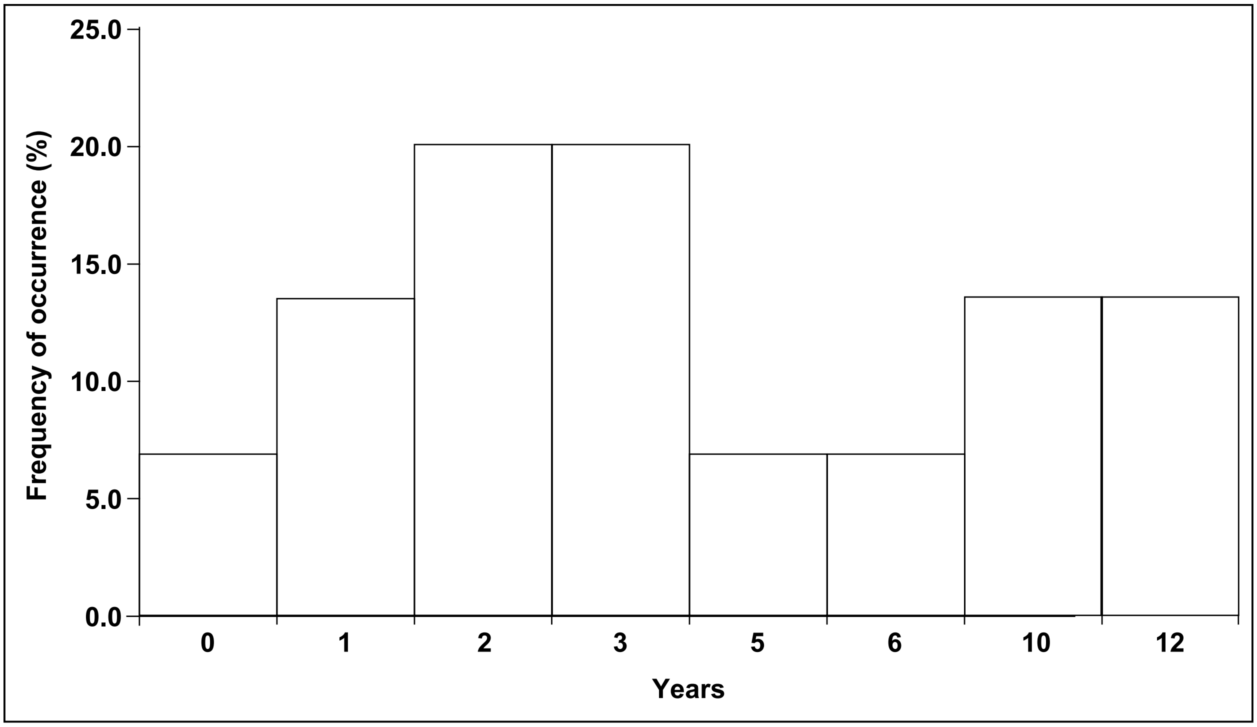

Figure 2. The remaining life expectancy of the 558 established buildings in the community of Manqakulane, Maputaland, KwaZulu-Natal province, South Africa, as established by a survey in 2002.

The buildings that are built with bricks are durable and recent, and were inspired from models seen in the cities. The other buildings were principally made of wood, and were all based on the same design. The main posts support the roof and are also used as wall panel dividers. Irrespective of the roof type, the main beams rest on top of the main posts. For corrugated iron roofs, only a few roof laths are used to support and stabilise the roof plates, but for thatched roofs many roof laths are used. They are spaced evenly at 0.3 m interval to support the thatch.

The wooden and reed walls are the most intricate structures and are built in four different ways. The wall laths may be woven in between the main posts by using thin spacer laths (Figure 4). An alternative way is to have horizontal wall laths that are nailed to at least the top, middle, and lower sections of the main posts, with the space in-between being filled with thick straight vertical laths. This type of wall is referred to as a wooden wall in the present study (Table 1). A wooden wall is often covered in clayish mud to form a solid wall of wood and mud (Table 1). Recently, after the demolition of some old concrete buildings, some of the villagers used the remaining rubble as wall material. In these cases, wall laths were nailed horizontally at regular spaces on either side of the main posts, and the gap between them was filled with the concrete

Table 1. The number of buildings of each shape and material type in the community of Manqakulane, Maputaland, northern KwaZulu-Natal province, South Africa, as established by a survey in 2002.

House Shape	Roof Materials	Wall Materials					Percent of Houses
		brick	wood	wood/mud	wood/stone	reed	
Rectangular or Square	Corrugated iron	28	21	110	22	35	54.4
Rectangular or Square	Thatched	2	5	51	0	2	25.2
Round	Thatched	1	3	60	2	15	20.4
Total		31	25	261	24	52	
Percent of total structures		7.8	7.3	65.7	6.0	13.1	

Figure 4. A typical wooden wall made from interlocked woven wooden laths laced between main support posts in the community of Manqakulane, Maputaland, KwaZulu-Natal province, South Africa, as established by a survey in 2002.

Figure 5. An example of a wood and stone wall, with the space between the horizontal wooden laths filled with old concrete rubble. Community of Manqakulane, Maputaland, KwaZulu-Natal province, South Africa, as established by a survey in 2002.

rubble (Figure 5). This type of wall is described as a wood and stone wall in the present study (Table 1). Once the wall has been filled in, the concrete rubble is often covered with a layer of mud or cement to close the gaps between the concrete pieces. The last type of wall is made of reeds. In this case, at least three rows of horizontal wooden laths are used, being nailed to the top, middle and lower sections of the main posts. The gap in between is densely packed with vertical reeds, and the thickness of the wall varies from 30 to 100 mm. These reed walls sometimes have a thin covering of mud.

Men and children usually build the houses. Once enough main posts and beams have been harvested from the surrounding woody vegetation, the house shape is traced out on the ground, and holes of 0.3 to 0.5 meters deep are dug for the main posts and positioned at approximately 1 meter intervals. After the main posts have been erected, the main beams are positioned to support the roof. Irrespective of the roof type, the roof is usually completed before the walls. Once the roof has been erected and is functional, it allows the workers to complete the walls in shade with protection from rain. It takes from one to two months to complete a house depending on the type of roof. Thatched roofs take longer to complete than corrugated iron ones.

The kitchens and maize stores form a separate category of buildings that do not have the same importance as living quarters. Therefore, kitchens are often old living quarters that are no longer suitable for that use, and would otherwise have been abandoned. The building is used as a kitchen until it collapses. In some instances a shelter is built to protect the area where the cooking is done. In such cases, only the roof is built. It rests on a series of supporting posts and the wall panels that are not completed. Kitchen shelters and maize stores are sometimes combined, with the maize store on stilts forming the roof of the kitchen shelter. This design has the added advantage that the smoke from the kitchen fire keeps seed predators away from the maize store directly overhead. The maize stores are usually built on stilts with the storage platform at a height of 0.5 to 2 meters above the ground. The maize stores are usually thatched. Two main types of maize stores can be distinguished. The first type is a miniature raised thatched house that is built on top of a platform by using the stilts as main posts (Figure 6). The second is a small thatched cupola that rests directly on a raised platform, in some instances it is possible to remove the whole cupola structure and move it onto another platform. Both types have a small access door that is either cut into one of the wall panels, or into the thatching. If a kitchen or a maize store is purposely built, little attention is given to the materials that are used, and the most ac-

Figure 6. A maize store built like a miniature house with a thatched roof in the community of Manqakulane, Maputaland, KwaZulu-Natal province, South Africa, as established by a survey in 2002.

Table 2. Number of buildings that were surveyed per structure shape and function in the community of Manqakulane, Maputaland, KwaZulu-Natal province, South Africa, 2002. Percentages are for the total number of structures studied.

Structure Function	Structure Shape					
	Rectangular		Square		Round	
	Number	Percent	Number	Percent	Number	Percent
Chicken Pen	1	0.4	1	0.4	0	0.0
Fire Shelter	0	0.0	1	0.4	0	0.0
Kitchen	10	4.4	24	10.6	7	3.1
Maize Store	19	8.4	14	6.2	1	0.4
House	12	5.3	99	43.8	26	11.5
Shelter	1	0.4	1	0.4	0	0.0
Storage Room	2	0.9	3	1.3	2	0.9
Store / Shop	1	0.4	0	0.0	0	0.0
Shower	1	0.4	0	0.0	0	0.0
Total	**47**	**20.8**	**143**	**63.3**	**36**	**15.9**

cessible resources are used. Maize stores are renewed frequently, often on a yearly basis. The size of the maize store is usually related to the anticipated crop size.

In Table 1 the composition of the buildings, other than kitchen and maize stores in the community of Manqakulane is summarized. The buildings are presented by house shape, roof type and wall filling. The most abundant category is represented by rectangular or square buildings that have a corrugated iron roof, and their walls are made of wood that is covered with mud. Among wall types, wood and mud walls constitute 65.7% of all building with reed walls second most abundant. It is interesting to note that round houses are least abundant, which indicates a shift from the traditional round huts with reed walls and thatched roofs that were described by Cunningham and Gwala (1986) as the prevalent type of habitation. The switch to corrugated iron roofs improves the longevity of the structures, and favors conservation because fewer natural resources are needed to build such a roof. Moreover, the renewal rate will be less frequent.

Nearly all of the buildings that are made with brick walls are rectangular or square, with a corrugated iron roof. Only one of the buildings with brick walls was round with a thatched roof. This specific building belongs to a former Ezemvelo KwaZulu-Natal Wildlife employee, and the building was based on the standard **rondavel** design of that organization. It has the most professionally made thatched roof in the community and was often admired by other community members as a beautiful construction.

The buildings in Manqakulane have a mean floor area of 7.0 ± 0.4 m^2 for the square buildings, 10.5 ± 2.5 m^2 for the rectangular building and 14.5 ± 5.1 m^2 for the round buildings. Of the buildings that were surveyed in detail during this study, the majority were square and were used as bedrooms or living quarters. The round buildings were nearly always used as living rooms, whereas rectangular buildings were used in a more versatile manner as living quarters, maize stores or kitchens (Table 2).

For practical reasons the construction material were subdivided into four building elements: main posts, main beams, roof laths and wall laths. The thatched roofs require far more beams and laths than roofs made with corrugated iron plates. The latter only require three to four beams and laths, whereas thatched roofs require up to 9 times more beams, and 20 times more roof laths (Table 3). These values translate into a mean number of 2.4 and

Table 3. The mean number of elements per house type and roof type in the community of Manqakulane, Maputaland, KwaZulu-Natal, South Africa, as established by a survey in 2002.

House Shape	Roof Materials	Mean Number of Structural Element		
		Main Posts	Beams	Roof Laths
Rectangular	Corrugated Iron	18.2 ± 0.73	3.7 ± 0.53	3.6 ± 0.22
	Thatched	17.3 ± 0.68	24.9 ± 1.95	78.5 ± 7.71
Square	Corrugated Iron	13.1 ± 1.01	2.5 ± 0.16	2.8 ± 0.12
	Thatched	16.0 ± 1.82	22.0 ± 2.58	65.8 ± 5.51
Round	Thatched	16.8 ± 0.78	21.4 ± 1.63	76.6 ± 6.86

2.6 main beam and lath elements m^{-2} for the rectangular and square houses with a corrugated iron roof respectively, 11.5 and 14.8 elements m^{-2} for the rectangular and square houses with a thatched roof respectively, and 7.9 elements m^{-2} for the round houses with a thatched roof. This suggests that modern, square or rectangular houses with a corrugated iron roof require the fewest main elements, and square or rectangular houses with a thatched roof require the most, using up to six times more elements per surface area. The round lay out, despite being thatched, provides an intermediate value between the square or rectangular houses with either a corrugated iron roof or a thatched roof. However, the young people do not find round buildings practical to fit furniture. They also find that the construction of round buildings is more difficult and requires more time and labour than square or rectangular ones.

The mean number of main posts used does not differ significantly for a house with a corrugated iron roof or one

Table 4. The five tree species most often used for building construction materials by element type, for the houses with a corrugated iron roof in the community of Manqakulane, Maputaland, KwaZulu-Natal, South Africa, as established by a survey in 2002. Percent preference for each species for particular elements actually used.

Species Used	Rectangular House Element Individuals Measured				Square House Element Individuals Measured			
	Main Posts	Main Beams	Roof Laths	Wall Laths	Main Posts	Main Beams	Roof Laths	Wall Laths
Brachylaena huillensis O.Hoffm.	725 44.3%				44 25.9%	1 3.7%		
Catunaregam spinosa (Thunb.) Tirvengadum				97 17.7%				6 9.2%
Cleistanthus schlechteri (Pax) Hutch.	133 8.1%		6 2.0%					
Dialium schlechteri Harms						3 11.1%	1 3.2%	
Diospyros inhacaensis (E. Mey. ex Arn.) Radlk.						2 7.4%	2 6.5%	
Drypetes arguta (Muell. Arg.) Hutch.				44 8.0%				
Erythroxylum delagoense Schinz.								5 7.7%
Grewia microthyrsa K. Schum. ex Burret				70 12.8%				6 9.2%
Hymenocardia ulmoides Oliv.		15 4.5%	17 5.7%	32 5.8%				6 9.2%
Psydrax obovata (Eckl. & Zeyh.) Bridson				30 5.5%				3 4.6%
Ptaeroxylon obliquum (Thunb.) Radlk.	313 19.1%	42 12.5%			31 18.2%			
Pteleopsis myrtifolia (Laws.) Engl. & Diels					9 5.3%			
Spirostachys africana Sond.	85 5.2%		3 1.0%		15 8.8%			
Terminalia sericea Burch. ex DC.	82 5.0%	25 7.4%			41 24.1%		2 6.5%	
Gumpole		143 42.6%	95 32.0%			4 14.8%	3 9.7%	
Plank		83 24.7%	174 58.6%			14 51.9%	21 67.7%	
Total for 5 Preferred Species	1338 81.8%	308 91.7%	295 99.3%	273 49.7%	140 82.4%	24 88.9%	29 93.5%	26 40.0%

Table 5. The five tree species most often used for building construction materials by element type, for the houses with a thatched roof in the community of Manqakulane, Maputaland, KwaZulu-Natal, South Africa, as established by a survey in 2002.

Species Used	Rectangular House Element Individuals Measured				Square House Element Individuals Measured				Round House Element Individuals Measured			
	Main Posts	Main Beams	Roof Laths	Wall Laths	Main Posts	Main Beams	Roof Laths	Wall Laths	Main Posts	Main Beams	Roof Laths	Wall Laths
Brachylaena huillensis O. Huffm.	103 14.5%				74 14.8%				164 27.1%	206 26.6%		
Bridela cathartica Bertol.f.								9 4.3%				
Catunaregam spinosa (Thunb.) Tirvengadum			43 12.5%	77 20.3%		57 8.6%	21 11.2%	62 29.4%			19 7.9%	55 21.2%
Cleistanthus schlechteri (Pax) Hutch.					25 5.0%							
Diospyros inhacaensis (E. Mey. ex Arn.) Radlk.		85 8.5%										
Drypetes arguta (Muell. Arg.) Hutch.												19 7.3%
Erythroxylum delagoense Schinz.		111 11.1%	38 11.0%	39 10.3%			25 13.4%	36 17.1%				
Grewia microthyrsa K. Schum. ex Burret			25 8.4%	51 13.5%				19 5.0%			50 20.7%	34 13.1%
Hymenocardia ulmoides Oliv.	40 5.8%	137 13.7%	53 15.4%	19 5.0%	62 12.4%	133 20.1%	31 16.6%	10 4.7%	44 7.3%	159 20.5%	54 22.3%	23 8.9%
Plectroniella armata (K. Schum.) Robyns				12 3.2%								
Psydrax obovata (Eckl. & Zeyh.) Bridson									23 3.8%		12 5.0%	13 5.0%
Ptaeroxylon obliquum (Thunb.) Radlk.	125 18.6%				106 21.2%	61 9.2%			161 26.6%	62 8.0%		
Spirostachys africana Sond.	73 10.5%	65 6.5%							51 8.4%			
Terminalia sericea Burch. ex DC.	156 22.5%	187 18.8%			134 26.4%	62 9.4%	12 6.4%			59 7.6%		
Wrightia natalensis Stapf.			37 10.8%			60 9.0%	29 15.5%				52 21.5%	
Gumpole										56 7.2%		
Total for 5 Preferred Species	501 72.4%	593 59.5%	200 58.1%	198 52.2%	401 80.4%	373 56.3%	118 63.1%	136 64.5%	443 73.1%	542 70.0%	187 77.3%	144 55.6%

with a thatched roof (F = 1.48, df = 118, P > 0.05). However, houses with a corrugated iron roof require significantly fewer main beams (F = 35.03, df = 117, **P < 0.01) and roof laths (F = 5.45, df = 103, **P < 0.01) than houses with a thatched roof. The reduced number of main beams and roof laths required for a corrugated iron roof has undisputable conservation benefits in the community of Manqakulane. The trend appears to be in favour of corrugated iron roofs.

The five most often used tree species for each of the wooden elements for each building type are presented in tables 4 and 5. For rectangular and square houses with corrugated iron roofs, imported items such as gum poles for the main beams, and sawn planks for the roof laths are used extensively in the roof construction instead of locally harvested wood. For rectangular, square and round houses with thatched roofs, locally available resources are primarily still used. The most commonly used species overall are *Brachylaena huillensis*, *Terminalia sericea* and *Ptaeroxylon obliquum* for the main posts, *Hymenocardia ulmoides*, *Terminalia sericea* and *Ptaeroxylon obliquum* for the beams and *Catunaregam spinosa* and *Grewia microthyrsa* for the walls.

A log diameter class of 60 mm was utilized most often for main posts, with a mean diameter of 62 mm (Tables 6 and 7). This is similar to what has been described by Cunningham and Gwala (1986). The diameter for the main posts in the present study ranged from 30 to 100 mm. The mean diameter of the roof beams was 46 mm, for roof laths it was 34 mm, and for the wall laths it was 26 mm. No significant differences were found among the means of the diameter of the wood used for the different house shapes, type and elements (F3.05 = 0.45, P = 0.76). The same sizes of wood are selected throughout, independently of

Table 6. Log diameters of the five tree species most often used for building houses with a corrugated iron roof, arranged by house shape and element type in the community of Manqakulane, Maputaland, KwaZulu-Natal, South Africa, as established by a survey in 2002. [Note that percentage values do not always add up to 100% because only the five most utilized speciesare illustrated here.]

Diameter Class	Rectangular House Element Individuals Measured				Square House Element Individuals Measured			
	Main Posts	Main Beams	Roof Laths	Wall Laths	Main Posts	Main Beams	Roof Laths	Wall Laths
100		10 4.0%						
90					19 11.2%			
80	243 14.9%	52 20.6%	38 30.4%			3 23.1%		
70			16 12.8%		33 19.4%			
60	498 30.5%	67 26.6%	23 18.4%			2 15.4%		
50	247 15.1%	13 5.2%		144 1.8%	30 17.6%			
40	135 8.3%	88 34.9%	7 5.6%		32 18.8%	2 15.4%	4 40.0%	
30			19 15.2%	482 6.2%		3 23.1%		137 20.4
25				1875 24.0%				85 12.6%
20				3296 42.1%		1 7.7%	3 30.0%	451 67.0%
15				2007 25.7%				
Total Individuals Measured	1353 82.9%	230 91.3%	103 82.4%	7804 99.8%	130 76.5%	11 84.6%	10 100.0%	673 100.0%

Table 7. Log diameters of the five tree species most often used for building construction materials in houses with a thatched roof, by house shape and element type, in the community of Manqakulane, Maputaland, KwaZulu-Natal, South Africa, as established by a survey in 2002. [Note that percentage values do not always add up to 100% because only the five most utilized speciesare illustrated here.]

Diameter Class	Rectangular House Element Individuals Measured				Square House Element Individuals Measured				Round House Element Individuals Measured			
	Main Posts	Main Beam	Roof Laths	Wall Laths	Main Posts	Main Beam	Roof Laths	Wall Laths	Main Posts	Main Beam	Roof Laths	Wall Laths
80	66 9.8%	69 6.9%			30 6.0%				74 12.2%			
70	139 20.6%		12 3.5%		47 9.4%			16 0.5%	72 11.9%		8 3.3%	
60	95 14.1%	62 6.2%			127 25.5%				154 25.5%	71 9.4%		
50	170 25.1%				109 21.8%	86 13.0%			127 21.0%	70 9.3%		224 5.3%
40	95 14.1%	248 24.9%		1 0.0%	91 18.2%	135 20.4%	11 5.9%		60 9.9%	217 28.8%		
30		406 40.7%	47 13.7%	105 2.2%		251 37.9%	18 9.6%	266 8.4%		189 25.1%	35 14.5%	41 1.0%
25			57 16.6%	1023 21.4%		42 6.3%	18 9.6%	338 10.7%			39 16.1%	636 15.0%
20		88 8.8%	189 54.9%	2676 55.9%		71 10.7%	116 62.0%	1498 47.4%		63 8.4%	121 50.0%	2147 50.7%
15			17 4.9%	979 20.5%			17 9.1%	1028 32.5%			32 13.2%	1152 27.2%
Total Individuals Measured	565 83.6%	873 87.6%	322 93.6%	4784 100%	404 81.0%	585 88.4%	180 96.3%	3146 99.6%	487 80.5%	610 81.0%	235 97.1%	4200 99.2%

house type. The mean diameter and length of wood used for the five most favoured species per element, house and roof type appear in Tables 8, 9 and 10. Depending on the house and roof types, the mean length varies from 2 to 2.7 meters for the main posts, from 1.3 to 3.5 meters for the beams, from 1.6 to 4.9 meters for the roof laths, and from 0.7 to 1.5 meters for the wall laths. For the main beams and roof laths, the longest elements are imported gum poles and sawn planks. The dimensions of the elements utilized in the construction of houses represent an array that are easily harvested by the people in the surrounding vegetation. Most of these elements can be transported without mechanized means of transport. As it is not easy work to gather all the necessary woody elements from the vegetation, the people tend to harvest smaller elements, which can be carried easily and in greater number at once by the family.

Discussion

Future needs

An attempt was made to quantify the housing requirements for the near future in the community of Manqakulane. The data in Tables 1 to 3 and Figures 3 and 4 were used to determine the number of structures per type that have to be replaced if a 12.5% renewal rate is used as a guideline. An estimated 70 structures will have to be replaced every year in this community in order to maintain the number and diversity of structures over time. Based on the current composition of the structures, 42 of these buildings will be living quarters (Table 11) and the remaining 28 will be kitchens and maize stores. Of the 42 living quarters units, it is estimated that at least three will be replaced by brick-walled houses with corrugated iron roofs each year, and that a further 20 thatched houses will be replaced by houses with corrugated iron roofs. Conventional thatched houses will replace the remaining 19 units. The composition of the 42 living quarters to be replaced is therefore assumed to be: eight round houses with a thatched roof, three rectangular houses with a corrugated roof, 20 square houses with a corrugated roof, one rect-

Table 8. The mean log diameter and length for the five tree species most often used for building houses with corrugated iron roofs, arranged by house and element type in the community of Manqakulane, Maputaland, KwaZulu-Natal, South Africa, as established by a survey in 2002. Percent preference for each species for particular elements actually used. # = Number of elements measured. Dia = Mean diameter of measured elements in millimeters. Ln = Length of measured elements in meters.

Species Used	Rectangular House Element Individuals Measured												Square House Element Individuals Measured											
	Main Posts			Main Beams			Roof Laths			Wall Laths			Main Posts			Main Beams			Roof Laths			Wall Laths		
	#	Dia	Ln	#	Dia	Ln	#	Dia	Ln	#	Dia	Ln	#	Dia	Ln	#	Dia	Ln	#	Dia	Ln	#	Dia	Ln
Brachylaena huillensis	725	62	2.7										44	46	2.5	1	45	3.2						
Catunaregam spinosa										88	20	1.4										6	24	0.9
Cleistanthus schlechteri	133	73	2.7				6	37	2.0															
Dialium schlechteri																3	43	2.3	1	40	2.6			
Diospyros inhacaensis																2	25	2.0	2	20	1.9			
Drypetes arguta										43	22	1.2												
Erythroxylum delagoense																						5	26	1.1
Grewia microthyrsa										67	21	1.1										6	23	0.9
Hymenocardia ulmoides										30	23	1.2										6	23	1.4
Psydrax obovata										30	24	1.2										3	25	1.2
Ptaeroxylon obliquum	313	68	2.5	42	41	2.5																		
Pteleopsis myrtifolia													9	69	2.4									
Spirostachys africana	85	85	2.4	7	60	2.2	3	43	3.5				15	59	2.3									
Terminalia sericea	82	59	2.2	25	38	1.3							41	65	2.3				2	40	2.6			
Gumpole				143	71	3.1	95	74	4.7							4	75	3.4	3	70	3.0			
Plank							169	n/a	4.9							14	n/a	2.8	21	n/a	2.6			
Mean for 5 Preferred Species		66	2.6		60	2.9		65	4.7		21	1.3		65	2.4		53	2.8		46	2.9		24	1.1

Table 9. The mean diameter and length for the five tee species rmost often used for building construction materials for the rectangular and square thatched roof type, per house and element type in the community of Manqakulane, Maputaland, KwaZulu-Natal, South Africa, as established by a survey in 2002. Percent preference for each species for particular elements actually used. # = Number of elements measured. Dia = Mean diameter of measured elements in millimeters. Ln = Length of measured elements in meters.

Species Used	Rectangular House Element Individuals Measured												Square House Element Individuals Measured											
	Main Posts			Main Beams			Roof Laths			Wall Laths			Main Posts			Main Beams			Roof Laths			Wall Laths		
	#	Dia	Ln	#	Dia	Ln	#	Dia	Ln	#	Dia	Ln	#	Dia	Ln	#	Dia	Ln	#	Dia	Ln	#	Dia	Ln
Brachylaena huillensis	103	59	2.2										74	50	2.2									
Bridelia cathartica																						9	20	0.8
Catunaregam spinosa							43	22	1.8	74	21	1.1				57	30	2.3	21	24	1.8	62	20	0.9
Cleistanthus schlechteri													25	53	2.2									
Diospyros inhacaensis				89	31	2.8																		
Erythroxylum delagoense				111	30	2.4	38	37	1.9	37	20	1.1							25	21	2.0	36	22	1.0
Grewia microthyrsa							29	22	1.8	48	20	0.9										19	22	0.7
Hymenocardia ulmoides				137	36	2.6	53	22	2.2	17	23	1.1	62	53	2.3	133	38	2.8	31	28	2.1	10	22	1.1
Ptaeroxylon obliquum	129	64	2.2										106	59	2.0	61	44	2.5						
Rhus gueinzii										12	22	1.1												
Spirostachys africana	73	74	2.1	69	41	2.6																		
Terminalia sericea	155	60	2.5	187	47	2.7							134	53	2.2	62	35	2.5	12	24	1.9			
Wrightia natalensis							37	23	1.8							60	28	2.4	29	21	1.6			
Mean for 5 Preferred Species		63	2.3		38	2.6		25	1.9		21	1.0		54	2.2		36	2.5		24	1.9		21	0.9

Table 10. The mean diameter and length for the five tree species that are most often used for building construction materials for the round thatched roof type houses in the community of Manqakulane, Maputaland, KwaZulu-Natal, South Africa, as established by a survey in 2002. Percent preference for each species for particular elements actually used. # = Number of elements measured. Dia = Mean diameter of measured elements in millimeters. Ln = Length of measured elements in meters.

Species Used	Round House Element Individuals Measured											
	Main Posts			Main Beams			Roof Laths			Wall Laths		
	#	Dia	Ln	#	Dia	Ln	#	Dia	Ln	#	Dia	Ln
Brachylaena huillensis	164	64	2.2	206	37	3.0						
Catunaregam spinosa							19	19	2.2	55	21	1.0
Drypetes arguta										19	22	1.5
Grewia microthyrsa							50	30	2.1	34	21	1.0
Hymenocardia ulmoides	44	52	2.2	159	46	3.1	54	23	2.2	23	26	1.1
Psydrax obovata	23	62	2.2				12	20	1.9	13	24	1.2
Ptaeroxylon obliquum	161	51	2.2	62	43	3.1						
Spirostachys africana	51	96	2.2									
Terminalia sericea				59	30	2.6						
Wrightia natalensis							52	24	2.0			
Gumpole				56	63	3.5						
Plank												
Mean for 5 Preferred Species		62	2.2		42	3.1		25	2.1		22	1.1

angular house with a thatched roof, and 10 square houses with a thatched roof. At the current estimated mean annual renewal rate, these units will completely renew the community's buildings within the next eight years. This estimate has however not incorporated an increase in human population and number of buildings.

Based on the mean number of elements used in the present buildings, a projection of the future needs of the people in terms of main posts, beams and roof and wall laths is presented in Tables 11 and 12. It is estimated that the community will require 628 main posts, 477 main beams, 1416 roof laths and 28,147 wall laths per year over the next eight years. The number of main beams and roof laths required clearly portrays the transformation that is taking place within the community, where corrugated iron roofs are gradually replacing the traditional thatched roofs. If all the rectangular and square houses with corru-

Table 11. The number of elements planned yearly replacement per house shape, roof and element type in the community of Manqakulane, Maputaland, KwaZulu-Natal, South Africa, as established by a survey in 2002.

House Shape	Roof Materials	Number of Replacement Houses[1]	Mean Number of Structural Element					
			Main Posts		Main Beams		Roof Laths	
			Mean used	Need[2]	Mean used	Need[2]	Mean used	Need[2]
Rectangular	Corrugated Iron	3	18.2 ± 0.73	55	3.7 ± 0.53	11	3.6 ± 0.22	11
	Thatched	1	17.3 ± 0.68	17	24.9 ± 1.95	25	78.5 ± 7.71	79
Square	Corrugated Iron	20	13.1 ± 1.01	262	2.5 ± 0.16	49	2.8 ± 0.12	56
	Thatched	10	16.0 ± 1.82	160	22.0 ± 2.58	220	65.8 ± 5.51	658
Round	Thatched	8	16.8 ± 0.78	135	21.4 ± 1.63	172	76.6 ± 6.86	613
Total Needed / Year		**42**		**628**		**477**		**1416**

1. Number of replacement houses needed per year based upon the number of houses surveyed multiplied by a 12.5% annual replacement rate.
2. Number of replacement elements needed based upon a 12.5% annual replacement rate for the number of houses surveyed.

Table 12. Future wall lath needs based upon the mean number per house type and wall fill type, in the community of Manqakulane, Maputaland, KwaZulu-Natal, South Africa, as established by a survey in 2002.

House Shape	Roof Materials	Wall Fill Materials	Mean Number of Wall Laths	Number of Replacement Houses[1]	Future Wall Laths Needed Annually[2]
Rectangular	Corrugated Iron	Wood / Cement	**1666** ±?	1	1666
		Wood / Stones	**264** ±?	2	528
	Thatched	Wood / Mud	**953** ±?	1	953
Square	Corrugated Iron	Wood / Mud	**649** ±?	14	9086
		Wood / Reeds	**36** ±?	4	144
		Wood	564 ±?	2	1128
	Thatched	Wood / Mud	896 ±?	9	8063
		Wood	480 ±?	1	479
Round	Thatched	Wood / Mud	1001 ±?	6	6008
		Wood / Reeds	46 ±?	2	93
Total Replacements Needed Annually				**42**	**28147**

1. Number of replacement houses needed per year based upon the number of houses surveyed multiplied by a 12.5% annual replacement rate.
2. Number of replacement wall laths needed based upon a 12.5% annual replacement rate for the number of houses surveyed.

gated iron roofs were thatched instead, the total number of these elements would be 683 main posts, 932 main beams, and 2903 roof laths, which is significantly more for each of these elements respectively (main posts: X^2 = 4.61, df = 1, P < 0.05, main beams: X^2 = 293.86, df = 1, P < 0.05, roof laths: X^2 = 1023.93, df = 1, P < 0.05).

If these present estimates are taken into consideration, the best house configuration in terms of sustainable use of the woody plant resources is one of a square or rectangular design with a corrugated iron roof and reed walls. This configuration ensures that the minimum number of main posts, main beams and roof laths are used per surface area unit. The reed walls provide an alternative to wooden walls, and require the least wall laths to secure them. With regard to the present economic development of the northern Maputaland region, if the people cannot afford houses made with brick walls, then the construction of square or rectangular houses with reed walls should be encouraged in the interest of the conservation of the environment and to limit the utilisation of woody plant resources for construction. An economic study is suggested to compare the building costs and the long-term durability of a square or rectangular house with a corrugated iron roof with brick walls, with a similarly sized house with reed walls.

Conclusions

The current evaluation of renewable natural resource needs of the community of Manqakulane is a simple, empirical model that is applicable to this specific community at the time of survey. However, the evaluation of the wood utilisation in the households at the time of the study is accurate, and can be used for any subsequent model refinement. In the present demographic and financial context, it is expected that the evaluation of the future renewable natural resource needs presented in this study are most likely to be liberal. The present intensity of use should remain valid as long as the human population does not suddenly increase massively. Nevertheless the current demographic trend is considered to be fairly stable, and there may even be a gradual decline in the human population in time because of the emigration of young people towards the cities in search of employment, and an AIDS crisis of epidemic proportions in this part of South Africa.

The people of the rural community of Manqakulane utilise the natural resources of the surrounding environment to a great extent to build their households. The projected needs suggest that the utilisation of the renewable natural resources available in the community of Manqakulane should decline over the next eight years. The people of the community are thriving to build better livelihoods for themselves and in so doing regard brick-walled houses with a corrugated iron roof as an ideal home. If the economic empowerment of previously disadvantaged rural communities of South Africa is maintained, the pressure on the environment for building material will decline considerably within the next quarter of a century. However, many obstacles remain before a sufficient level of development is reached and only careful recording and monitoring of the utilisation will establish the trend. From a conservation perspective it is rather encouraging that such a trend can be observed and adds value to the Tshanini conservation area east of the community. It appears possible that the creation of such a reserve will not deprive the local people from a significant building material resource base, and the initiative paves the way forward for the other local communities to join in the conservation initiative.

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