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A study of wood use for fuel and building in an area of Gazankulu

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ABSTRACT

The utilization of wood for fuel and building timber was studied in a 13 000 ha area of Gazankulu, near Giyani. Headloads of firewood brought in by eight of the 978 families present were monitored during six periods in a year.

The two most important sources of firewood are *Colophospermum mopane* and *Combretum apiculatum*. Firewood consumption is estimated at an average of 14,9 kg per family per day. The annual demand for firewood in the whole study area is, therefore, approximately 5 300 tonnes. Living-huts and storage-huts in the process of being built were examined. The mean volumes of wood in living-huts and typical storage-huts are 1,30 m^3 and 1,09 m^3, respectively. 89 living- and 80 storage-huts were built in a year. The demand for finished timber in the study area in that year was approximately 231 tonnes.

Timber use has not yet outstripped production, but it will do so soon if alternative timber sources are not provided.

1 INTRODUCTION

This study was undertaken because of concern at the deforestation taking place in heavily-populated rural areas of the Transvaal. During a preliminary study of plant uses in Gazankulu (Liengme, 1981) the collecting of firewood and building timber was identified as an important contributor to deforestation in Gazankulu, the Tsonga homeland in the north-eastern Transvaal. The use of wood for these purposes is poorly documented (Liengme, 1983).

The present study was undertaken in 1980 and 1981, in order to provide quantitative data on the demand for wood and on selectivity in wood gathering.

1.1 *Literature review*

Investigations into the use of firewood in rural areas and its consequences, have been undertaken in Zimbabwe (Banks, 1980; Furness 1981(a); Johnston, 1980; Whitlow, 1979) and Malawi (Jackson, 1980; Nkaonja, 1981). Proposals for the solution of the problem, including the establishment of woodlots, proper management of existing resources and increasing the efficiency of use of firewood, have been put forward (Banks, 1981; Fuller, 1980, no date; Furness, 1981(b); Jackson, 1980; Nkaonja, 1981). Species trials of both fast-growing exotics (*Eucalyptus* spp. and *Leucaena leucocephala*) and indigenous species (*Acacia* spp.) have been established in Malawi as part of the Rural Fuelwood Research Project (Jackson, 1980). Woodlots have also been established in Lesotho (Baines, 1980). In Botswana, a study of the firewood situation in south-western Kgatleng has recently been undertaken (Jelenic & Van Vegten, 1981). The establishment of woodlots is proposed to counter the total removal of firewood species from natural communities.

Le Roux (1981, p. 27) sums up the situation with regard to rural firewood use in South Africa as being one of '. . . a vast imbalance between supply and demand.' He estimates that 7,23 million m^3 of firewood are required per annum by the rural populations of South Africa, based on a per capita consumption of 0,6 m^3 per annum.

Although there are extensive areas forested under exotic species (1,158 million ha) in South Africa, the main object of these plantations is the production of sawtimber, pulpwood and poles. The area under woodlots for firewood (excluding woodlots on private farms, the extent of which are unknown) is approximately 18 500 ha. Most of this area (12 000 ha) is in northern Natal. The regions in which the firewood problem is critical are those with a rainfall of less than 500 mm. It is in these regions that little attention has been paid to afforestation and the establishment of woodlots. Trials of woodlot species suited to these regions have yet to be undertaken (Le Roux, 1981).

When the present project was conceived no in-depth study of the use of wood in rural areas in South Africa had been completed. Since then Best (1979) has completed a study of the use of fuels of all kinds, including wood, in three villages; Malefiloane in Lesotho, Jozanna's Nek in the Transkei and Mashunka in the Msinga District of KwaZulu. Annual firewood consumption in these villages was calculated at 1,499, 1,705 and 4,824 tonnes per family respectively. The high value for the last village, relative to the other two, reflects the greater availability of firewood in the vicinity of that village.

A second project, a study of wood use and its effects on the environment, is being undertaken in the Mahlabatini District of KwaZulu (Gandar, 1981). The consumption of firewood in a lowland situation in the area is estimated at 21,1 kg per family per day, equivalent to 7,7 tonnes per family per annum. In upland situations, where wood is scarce, consumption is 33% lower.

There is little documented quantitative data on the use of timber for building. Knuffel (1973) studied in detail the construction of a bee-hive grass hut by the amaNgwane of the Upper Tugela Reserve in Natal. He noted that 228 laths and 26 poles were used, but did not estimate their volume. Gandar

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(1981) is investigating the use of wood for building in the Mahlabatini District. He found large differences in the amounts of wood used in upland and lowland situations. The volume of wood in structures standing at any one time was found to be 3,08 m^3 per family for huts and 3,30 m^3 for stores and kraals in lowland situations as opposed to 1,60 m^3 and 1,37 m^3 respectively, in upland situations.

1.2 *The study area*

An area just to the south-east of Giyani was chosen for study (Fig. 1). The area is well-wooded, ensuring that the people are not limited in the amounts of wood they can gather. There is also a wide variety of woody species present (Appendix 1), giving the opportunity for selectivity in wood-gathering.

The study area consists of three settlements, Ka-Homu A and B, and Ka-Mapayeni (Fig. 2). These settlements form a unit, sharing much of the surrounding woodland as a wood resource area. The total area of land allocated to the three settlements is approximately 18 000 ha, of which approximately 5 000 is residential and cultivated land. The actual population of the area is in doubt, but in 1980 there were 978 families living there (Gazankulu Department of Agriculture and Forestry, 1981).

The people are basically subsistence agriculturalists and depend almost entirely on the local vegetation for fuel and building timber. Even in the nearby town of Giyani, where electricity and other forms of energy are available, wood is still used as a fuel by some people. The sale of wood in the town provides some inhabitants of the settlements in the study area with income. (The rate at which the town is supplied with wood from the study area was not investigated during this project.)

According to Acocks (1970), the study area falls across the boundary between Arid Lowveld (veld

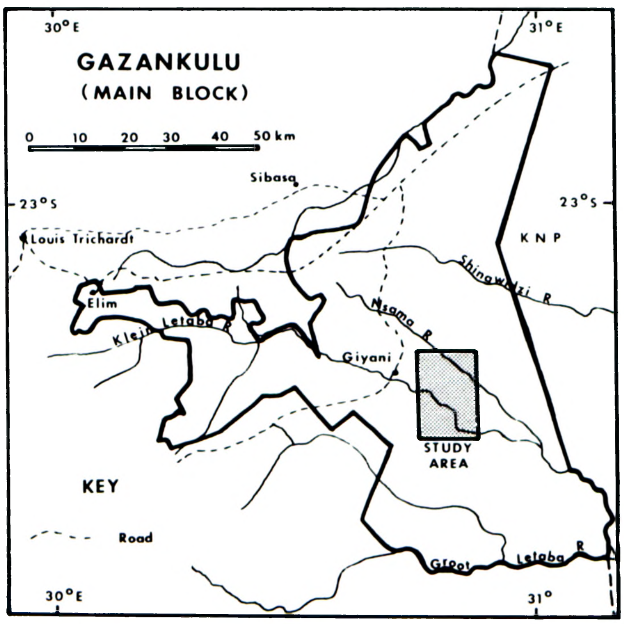

FIG. 1.— Map of Gazankulu, showing the location of the study area.

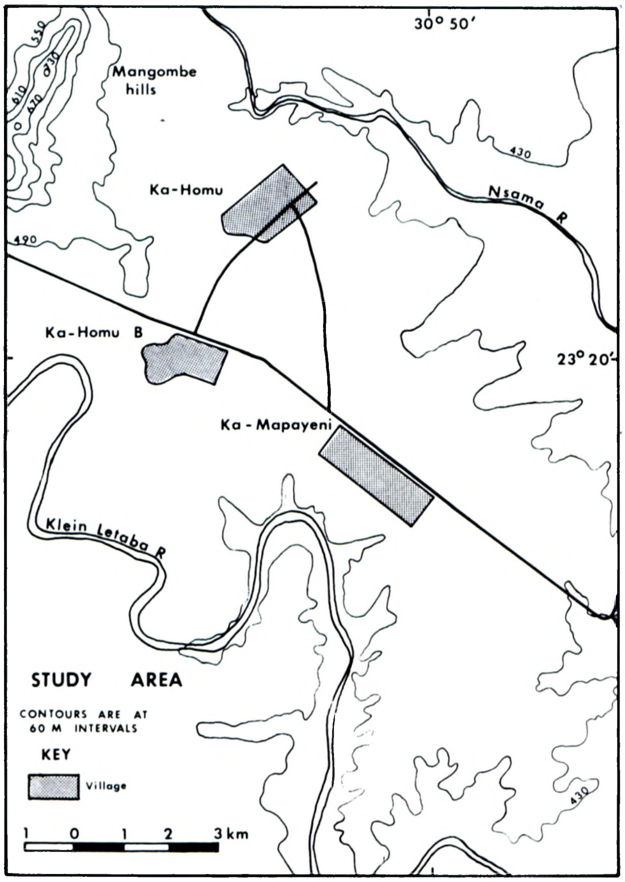

FIG. 2.— Map of the study area.

type 11) and Mopane Veld (veld type 14). A detailed survey of the vegetation in Gazankulu (Loxton, Hunting Assoc., 1972) shows the vegetation of the study area to consist of a mosaic of woodland communities, dominated by *Colophospermum mopane, Combretum apiculatum* and *Combretum collinum* subsp. *suluense,* together with narrow strips of thicket and tall forest fringing the rivers.

2 METHOD

2.1 *Firewood*

Initially nine families were interviewed; three in each of the villages Ka-Homu A (village 1), Ka-Homu B (village 2) and Ka-Mapayeni (village 3). Information on the following aspects of firewood use was obtained:

- family size
- number of fires made per day
- preferred firewood species
- collecting of live or dead wood
- place of collecting
- frequency of collecting
- time spent collecting.

The firewood collecting of these families was monitored at six periods during a year, in June, August, October and November/December 1980 and February and April 1981. During this time the number of families monitored was reduced to eight, since one family either was absent or had brought in cart-loads of wood prior to the monitoring period and were not collecting.

The operative factor limiting the number of families monitored was the number of headloads that could be analysed in one day, should all women of all families collect on the same day.

The time spent studying firewood in each period was not constant. When productive, 12–14 days were spent in the field on each visit, but during the last three visits monitoring was cut to 7 days. The reason for this was that the women were busy ploughing, cultivating and harvesting at these times. Rain also made it difficult to get to the families.

Analysis of the headloads involved:

1. weighing the entire headload, to the nearest 200 g, on a 50 kg spring scale
2. separating the wood in each headload into the various species (familiarity with the wood was achieved by making a reference collection of the woody species of the area prior to starting the project)
3. weighing the wood of each species
4. counting the number of pieces of wood in each of 5 diameter size classes (< 2,5 cm; 2,5–4,9 cm; 5,0–7,4 cm; 7,5–9,9 cm; > 10 cm).

The women were asked how long each headload would last them and any interesting aspects of collecting were noted.

From the above data the following were calculated:

1. mean daily consumption of firewood per family, for each period and overall (firewood consumption was calculated on a family basis rather than on an individual basis because the family is the functional unit consuming the wood)
2. mean headload weight
3. the relative proportions of woody species occurring in headloads, calculated both on a percentage weight basis and a percentage frequency of occurrence basis
4. the diameter size class distribution of pieces of firewood, for each species and overall.

2.2 *Building timber*

The use of timber for building was studied during two winter seasons in 1980 and 1981. It is at this time of the year that most of the building is done. Living-huts and storage-huts (granaries) are the major structures built, fences and cattle stockades contributing only little to the total number of structures erected in one year. These latter two structures are irregular in size and shape, being sometimes solid wooden structures and other times pole and barbed wire structures. For these reasons, it was decided not to include cattle stockades and fences in the study.

The living-huts and storage-huts were examined when the wooden framework of the structure was completed, prior to mud-plastering, bricking-in or thatching.

2.2.1. *Living-huts*

Twenty living-huts were examined. The wooden framework of a living-hut (Fig. 3) comprises the following: (a) wall poles; (b) roof poles; and (c) withes (which are laid across the roof poles and along the top of the wall). The length and average circumference of each pole in the wall were measured (to the nearest centimetre and 0,5 cm, respectively). One quarter of the roof was randomly selected and the length and average circumference of each roof pole in that quarter measured. The length of withes used in a quarter was also measured and a mean withe circumference was calculated from a sample of 20 measured circumferences.

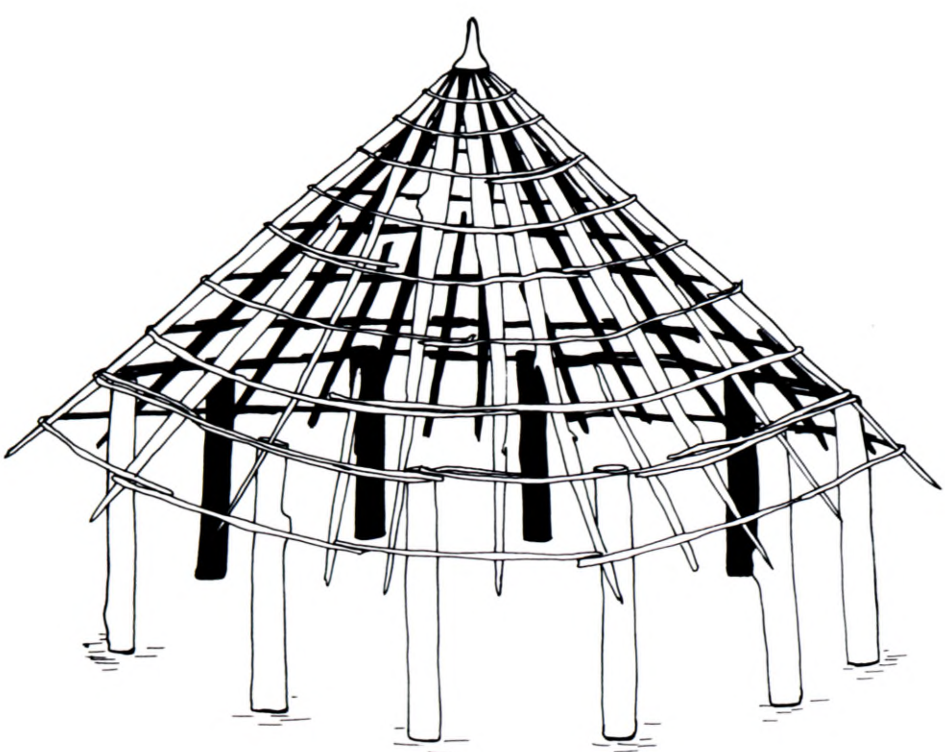

FIG. 3.— The wooden components of a typical round living-hut.

The volume of wood used to build each living-hut was calculated from these measurements, using the following formulae:

volume = (circumference)^2 × length

total volume = (Σ volumes of the wall poles) + [(volumes of the roof poles measured) + (Σ volumes of the withes measured)] × 4

Each piece of wood was identified to species.

2.2.2 *Storage-huts*

15 storage-huts were studied in the same way as the living-huts. A storage-hut consists of the following wooden components: (a) a raised floor, supported on two or three large poles, which are in turn supported on short Y-shaped stumps; (b) a wall made of large and small poles; (c) roof poles; and (d) withes, around the wall (inside and outside) and across the roof poles (Fig. 4).

The floor proved difficult to measure, since there was often maize stored inside the hut and getting in under the floor was sometimes impossible, because it was usually only 30–50 cm off the ground. Therefore, the end circumferences of the floor poles were measured rather than the average circumferences.

One quarter of each storage-hut was selected (again randomly) and the wood used in the wall and roof measured as described for the living-huts. The volume of wood in each storage-hut was calculated as below:

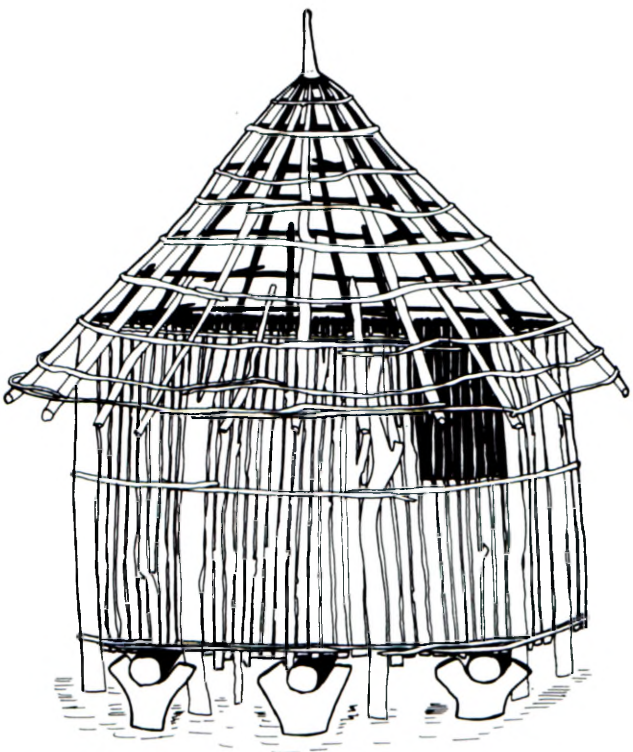

FIG. 4.— The wooden components of a typical storage-hut.

$$\text{volume} = \frac{(\text{circumference})^2}{4} \times \text{length}$$

total volume = [(Σ volumes of the wall poles measured) + (Σ volumes of the roof poles measured) + (Σ volumes of the withes measured)] × 4 + (Σ volumes of the floor poles).

2.2.3 *Statistics on building*

Statistics on the numbers of permits, to cut wood for building, sold in the study area, were obtained from records at the Giyani magistrate's offices. For every structure built, a fee has to be paid and a permit obtained. These permits are sold by the tribal authority for the area, whose local representative is the chief under whom the three study villages fall. Since the people still respect the chief's authority and also because there is a fine for illegally cutting timber, the statistics are assumed to reflect reasonably accurately the actual number of structures built.

2.3 *Overall wood use*

The overall weight of wood used for firewood and building per annum in the study area was estimated, as follows. The total weight of firewood used in a year by the population of the study area was calculated, as was the total volume of building timber cut for living-huts and storage-huts in a year. Timber was converted to approximate weight (air-dried) using wood density data (Van Vuuren, *et al.* 1978).

3 RESULTS

3.1 *Firewood*

3.1.1 *Background information*

The average size of the families whose firewood collecting was monitored was 7,1 persons. This does not include men working away, who are absent most of the year. It is also not a true reflection of real family size since, in some cases, what was taken as a family unit for the purpose of the survey, was an extended family group. The criterion for considering such a group as a single unit was whether or not cooking was usually done on a single fire, in which case if more than one woman collected firewood, this resource was pooled.

All the women interviewed agreed that *Colophospermum mopane* and *Combretum apiculatum* are the best species for firewood. Neither species was given as the single best firewood species; both names were always given in reply to the question. The reason given for this choice was that the wood of these two species produces good coals. Other species also mentioned as producing good firewood were *Combretum imberbe* and *Acacia nigrescens.*

The women said they collected only dead wood — either fallen or standing. It was later found that a little wet wood was collected, that had been cut in the clearing of fields.

FIG. 5.— Women returning from firewood gathering.

One of the families sometimes made use of a 'scotch-cart' for collecting wood; the collector then spent most of the day out collecting. This family also sold wood in the town, Giyani, at R10,00 a load.

Of the remaining seven families only two said they collected relatively near the village. There is, however, little dead wood remaining in the vegetation near the villages and the women of the other five families collected wood as far afield as 4–5 km from home.

Generally, a group of several women goes out collecting together, leaving early in the morning and returning three to six hours later. Firewood is collected three or four times a week in winter and twice a week in spring and summer. Wood is often stockpiled in preparation for the cultivating season since, once that has started, there is little time for collecting firewood, except in small quantities.

Three cooking fires are usually made each day. In winter, cooking fires may be kept going for warmth, especially at night and in the early morning. Fires, specially for warmth, are also made.

3.1.2 *Consumption of firewood*

The overall mean consumption of firewood for the eight families was 14,9 kg per family per day. In terms of annual consumption this represents 5 438,5 kg or 5,4 tonnes per family.

Table 1 gives the weight of firewood used per day by each family during each of the six monitoring periods. Several gaps appear in the table, due to a number of factors. Firstly, the women of families 2, 5 and 7 were harvesting crops throughout period 6, only collecting wood as they walked home in the evenings. This was used up by the following morning. Secondly, the entire family 5 was absent during period 5. Thirdly, the women of family 6 started working in Giyani half-way through the project and despite repeated visits during weekends, no data were obtained for periods 4, 5 and 6.

3.1.3 *Seasonal variation in consumption*

It can be seen from Table 1 that firewood consumption was very variable from one family to another and from one monitoring period to another. There was, however, a general trend to approximately 40 higher consumption in period 2 (August) than at any other time.

3.1.4 *Average weight of headloads*

The mean weight of all the headloads examined (191 headloads) was 29,95 kg (Table 2). The mean weights of headloads in the different families varied from 15,77 kg to 39,31 kg.

TABLE 1. — Firewood consumption (kg per family per day)

Period	Family 1	2	3	4	5	6	7	8	Average
1	22,1	10,0	16,4	14,6	15,9	26,0	9,3	9,9	15,7
2	31,8	28,0	13,3	29,4	18,5	18,8	11,8	14,3	21,6
3	15,5	15,6	12,9	11,2	13,9	6,5	8,6	11,1	12,1
4	17,7	17,5	7,7	10,0	12,1	—	9,0	16,7	13,0
5	9,8	14,6	9,5	15,0	—	—	9,4	14,7	11,8
6	13,6	—	9,9	9,1	—	—	—	11,1	11,4
Overall	21,9	17,4	11,8	18,4	15,1	16,6	10,7	12,3	14,9

TABLE 2. — Mean weight of headloads (kg)

Family	Mean weight of headloads
1	37,28 ± 11,06
2	39,31 ± 12,30
3	15,77 ± 12,71
4	30,00 ± 8,87
5	36,74 ± 9,59
6	24,39 ± 8,53
7	23,38 ± 9,49
8	27,38 ± 7,95
Overall	29,95 ± 12,44
Excl. Fam. 3	31,64 ± 11,39

A second overall mean headload weight was calculated excluding the loads collected by family 3. This family sometimes collected by cart, but when headloads were collected, it was young girls who did the collecting and their bundles were consistently small. This second mean was 31,64 kg.

The heaviest headload weighed was 67,2 kg. Fig. 6 shows the distribution of headloads in weight classes.

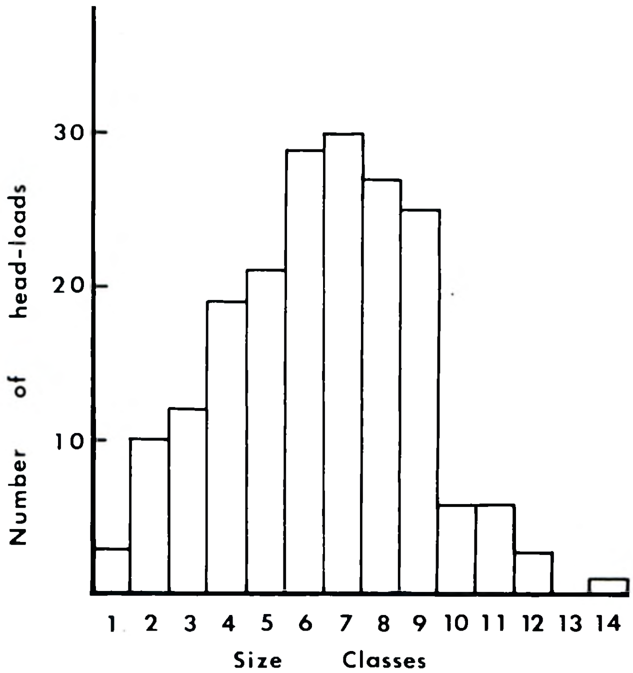

FIG. 6.— The weight-class distribution of the headloads weighed. Weight classes are: 1, < 5,0 kg; 2, 5,2–10,0 kg; 3, 10,2–15,0 kg; 4, 15,2–20,0 kg; 5, 20,2–25,0 kg; 6, 25,2–30,0 kg; 7, 30,2–35,0 kg; 8, 35,2–40,0 kg; 9, 40,2–45,0 kg; 10, 45,2–50,0 kg; 11, 50,2–55,0 kg; 12, 55,2–60,0 kg; 13, 60,2–65,0 kg; 14, > 65,0 kg.

3.1.5 *Species used as firewood*

Altogether, 42 species were found to be used as firewood. These are listed in Appendix 2. The three most commonly collected species, *Colophospermum mopane, Combretum apiculatum* and *Acacia nigrescens,* made up 77,2% by weight of the wood. Table 3 shows the eight most commonly collected firewood species, accounting for over 90% of the wood gathered. The remaining 34 species accounted for only 7,6% of the weight of wood collected. Their contribution is of marginal importance and their collecting is perhaps incidental to the main task.

Of the species most commonly collected by each family, *C. mopane* is the most common in five cases, *C. apiculatum* in two cases and *A. nigrescens* in one case.

Analysis of the firewood species on the basis of the frequency of occurrence in headloads (Table 4) shows the same eight species as being the most frequently collected.

3.1.6 *Size of wood (diameter)*

More than 80% of the pieces of wood collected were less than 5 cm in diameter (Table 5) and more than 50% had a diameter of less than 2,5 cm. The length of pieces was not recorded.

TABLE 3. — Major woody species collected as firewood and their proportionate weights

Species	Family 1	2	3	4	5	6	7	8	Overall
Colophospermum mopane	22,9	57,9	7,6	38,5	16,5	52,3	60,8	54,1	38,7
Combretum apiculatum subsp. apiculatum	27,4	6,1	40,6	25,6	65,6	13,2	15,9	3,7	23,0
Acacia nigrescens	31,1	21,0	5,1	15,6	3,8	9,2	12,0	4,4	15,5
Pterocarpus rotundifolius subsp. rotundifolius	0,5	7,8	—	12,2	8,6	0,2	0,3	5,4	4,6
Combretum collinum subsp. suluense	1,4	1,5	3,3	2,7	3,3	5,7	1,1	14,6	3,8
Combretum imberbe	0,2	0,8	11,2	0,1	—	10,7	3,2	1,3	2,6
Sclerocarya birrea subsp. caffra	3,1	0,1	3,1	1,7	—	0,5	0,1	9,9	2,4
Combretum hereroense	—	1,7	5,1	—	—	4,2	2,8	2,2	1,7
Others**	13,4	3,1	24,0	3,6	2,2	4,0	3,8	4,4	7,6

**See Appendix 2.

TABLE 4. — The percentage frequency of occurrence* of the 8 major firewood species collected

Species	Family 1	2	3	4	5	6	7	8	Overall
Colophospermum mopane	45,1	85,7	40,0	81,5	85,7	89,5	87,0	88,0	74,6
Combretum apiculatum subsp. apiculatum	57,6	25,0	65,0	70,4	100,0	52,6	60,9	28,0	54,4
Acacia nigrescens	48,5	42,9	25,0	37,0	7,1	52,6	39,1	12,0	34,2
Pterocarpus rotundifolius subsp. rotundifolius	15,1	25,0	—	29,6	42,9	15,8	4,3	16,0	18,1
Combretum collinum subsp. suluense	24,2	21,4	35,0	29,6	42,9	57,9	21,7	48,0	32,6
Combretum imberbe	6,1	7,1	35,0	3,7	—	42,1	30,4	8,0	15,0
Sclerocarya birrea subsp. caffra	18,2	3,6	15,0	11,1	—	5,3	4,3	24,0	10,9
Combretum hereroense	—	14,3	30,0	—	—	36,8	8,7	26,0	13,0

*The number of headloads in which a species occurs as a percentage of the total number of headloads.

TABLE 5. — The proportion (as a percentage) of pieces of firewood in various diameter size classes

Family	Diameter 2,5 cm	2,6–5,0 cm	5,0 cm
1	51,6	32,8	25,6
2	53,6	32,2	14,2
3	71,2	19,0	9,8
4	54,2	34,0	11,8
5	51,4	41,0	7,6
6	62,0	29,2	8,8
7	47,8	33,7	18,5
8	53,6	31,2	15,2
Overall	55,8	31,2	13,0

3.2 *Building timber*

3.2.1 *Living-huts*

Of the 20 living-huts examined 4 were square structures, the remainder being round. One of the round huts was atypical in that it had no wooden framework to the wall. It was therefore omitted from the calculations.

The mean timber volumes for the round and square huts are: 1,22 ± 0,44 m^3 and 1,86 ± 0,6 m^3, respectively (Fig. 7).

The mean volume of wood in a living-hut is 1,30 ± 0,57 m^3.

The greater use of wood in square huts is reflected in Tables 6 and 7.

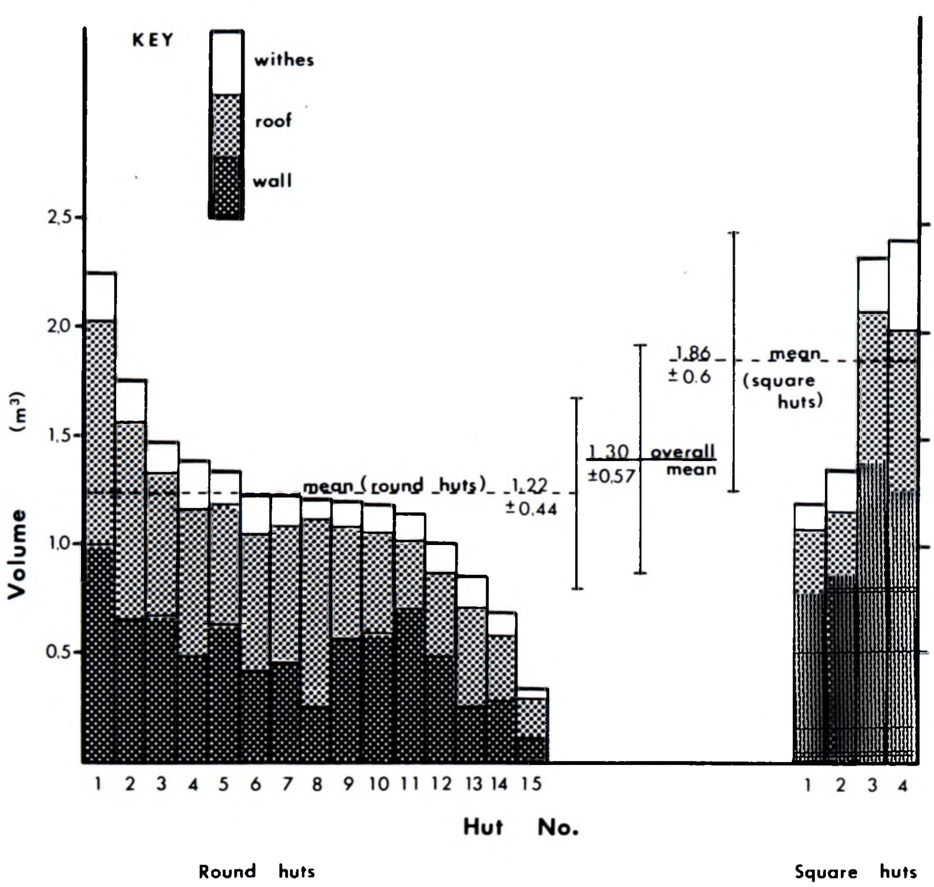

FIG. 7.— The volume of wood in the living-huts examined.

TABLE 6. — The average woody components and dimensions of a round living-hut

Hut circumference	16 m
No. of poles in wall	14
circumference of poles	41,0 cm
length of poles	280,0 cm
No. of primary poles in roof	17
circumference of poles	24,5 cm
length of poles	400,0 cm
No. of secondary poles in roof	14
circumference of poles	18,3 cm
length of poles	247,0 cm
No. of rows of withes in roof	15
circumference of withes	9,7 cm

Square living-huts generally have two rows of poles; one around which the wall is built and an outer row supporting the roof.

TABLE 7. — The average woody components and dimensions of a square living-hut

Hut perimeter	24 m
No. of outer support poles	13
circumference of poles	14,4 cm
length of poles	198,0 cm
No. of poles in wall	16
circumference of poles	47,6 cm
length of poles	263,0 cm
No. of primary roof poles	17
circumference of poles	24,4 cm
length of poles	433,0 cm
No. of secondary roof poles	33
circumference of poles	15,8 cm
length of poles	189,0 cm
No. of rows of withes in roof	20
Circumference of withes	12,4 cm

3.2.2 *Storage-huts*

These are of two types; storage-huts built on a floor raised 30–40 cm off the ground and those built on an elevated platform about 2 m off the ground. Only 3 of the 15 storage-huts examined were of the elevated type. Of the remaining 12, 2 were incomplete, having no roof. These were not included in the calculations.

The mean timber volume in the typical storage-huts was ± 0,3 m^3 (Fig. 8) and that of elevated storage huts was 2,36 ± 1,31 m^3.

The average woody components and dimensions of a typical storage-hut are given in Table 8.

3.2.3 *Numbers of huts built*

The statistics taken from the permit records at the Giyani magistrate's office (Table 9) show that a total of 89 living-huts, 80 typical storage-huts and 4 elevated storage-huts were built in the period April 1980 to March 1981, as well as 5 fences and 7 stockades. The wood used for these last two structures was not studied.

3.2.4 *Species used*

In the living-huts *Colophospermum mopane* accounted for 97,3% of the wood used. Other species are included in Table 10.

In storage-huts 92,2% of the wood used was *C. mopane* (Table 11).

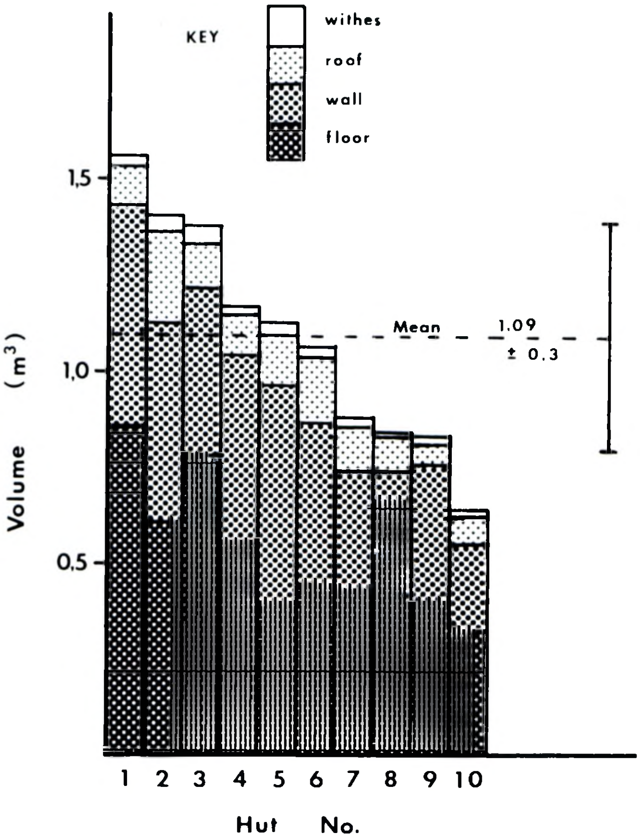

FIG. 8.— The volume of wood in the typical storage-huts examined.

TABLE 8. — The average woody components and dimensions of a typical storage-hut

Hut circumference	8,3 m
No. of support poles	3
circumference of poles	38,8 cm
length of poles	261,0 cm
No. of floor poles	41
circumference of poles	19,3 cm
length of poles	210,0 cm
No. of long wall poles	17
circumference of poles	22,6 cm
length of poles	198,0 cm
No. of short wall poles	109
circumference of poles	16,6 cm
length of poles	144,0 cm
No. of poles in roof	21
circumference of poles	16,7 cm
length of poles	234,0 cm
No. of rows of withes around wall	13
circumference of withes	8,4 cm
No. of rows of withes in roof	9
circumference of withes	7,7 cm

3.3 *Weather during monitoring periods*

Mean daily maximum and minimum temperatures were calculated for the monitoring periods from data obtained at the Giyani weather station (Table 12).

4 DISCUSSION

4.1 *Firewood*

4.1.1 *Consumption*

The number of families monitored was small in relation to the total present (8:978), but the results

TABLE 9. — Permits sold to cut wood for building. 1 April 1980–31 March 1981

Month	Village 1			Village 2			Village 3			Total		
	Living-huts	Storage-huts	Other*	Living-huts	Storage-huts	Other*	Living-huts	Storage-huts	Other*	Living-huts	Storage-huts	Other*
April	—	2	1	6	2	—	1	—	1	7	4	2
May	—	3	—	1	1	—	—	4	—	1	8	—
June	8	5	—	7	15/2**	2	4	2	—	19	22/2**	2
July	12	3	1	3	—	—	6	—	2	21	3	3
August	5	—	—	5	—	1	4	—	—	14	—	1
September	6	—	—	3	—	1	10	1	1	19	1	2
October	2	1	—	2	—	1	2	—	—	6	1	1
November	1	—	—	1	—	—	—	—	—	2	—	—
December	—	—	—	—	—	—	—	—	—	—	—	—
January	—	—	—	—	—	—	—	—	—	—	—	—
February	—	—	—	—	—	—	—	—	—	—	—	—
March	—	5	—	—	9/1**	—	—	31/1**	1	—	45/2**	1
Whole year	34	19	2	28	27/3**	5	27	38/1**	5	89	84/4**	12***

* The number of elevated storage-huts.

** Includes cattle stockades and fences.

*** 7 cattle stockades and 5 fences.

TABLE 10. — Woody species used in the living-huts examined, with their percentages of the total volume of wood used

Species	%
Colophospermum mopane	97,3
Acacia nigrescens	2,5
Combretum apiculatum	0,15
Combretum imberbe	0,05

agree with those by other researchers and probably give a reasonably accurate indication of firewood consumption under the prevailing conditions of almost unlimited availability.

Firewood consumption estimated for other areas of South Africa varies from as low as 1,5 tonnes per family per annum (Best, 1979) to 7,7 tonnes (Gandar, 1981). Consumption is apparently closely linked to availability. For relatively well-wooded areas Best's (1979) and Gandar's (1981) consumption figures are 4,8 tons and 7,7 tonnes per family per annum, respectively. In Zimbabwe, estimated firewood consumption in areas of high availability is approximately 5 tonnes per family per annum (based on the estimate of 8,44 m^3 per family per annum (Furness, 1979)).

The firewood consumption of 5,4 tonnes per family per annum estimated for this study area is comparable to that in other well-wooded areas.

Based on this figure, the total demand for firewood the 978 families in the study area is approximately 5 300 tonnes per annum.

4.1.2 *Seasonal variation in consumption*

The observed general trend to higher consumption in period 2, (August), is not explained by the weather data for the monitoring periods. The coldest weather was in period 1, June.

July/August is a time of initiation for the young girls and considerable quantities of sorghum beer are brewed for the celebrations, requiring additional amounts of firewood to that normally used.

It must be borne in mind that monitoring was discontinous and that peak firewood consumption for the year might have occurred between monitoring periods.

4.1.3 *Average weight of headloads*

The mean weight of headloads encountered during this study (29,95–31,64 kg) is considerably higher than those calculated by Best (1979) for his three villages, these being 21,3; 15,2; and 20,6 kg respectively. Whitlow (1979) gives the average headload in the Tribal Trust Lands of Zimbabwe as weighing from 24–36 kg. Jelenic & Van Vegten (1981), in their study of the firewood situation at Oodi in Botswana, found that headloads generally weighed 20–30 kg. In the present study approximately 60% of the headloads weighed 25–45 kg.

TABLE 11. — Woody species used in the storage-huts examined, with their percentages of the total volume of wood used

Species	%
Colophospermum mopane	92,9
Combretum apiculatum	6,6
Acacia nigrescens	0,5

TABLE 12. — Mean daily maximum and minimum temperatures during the monitoring periods (°C)

Period	Mean daily maximum	Mean daily minimum
1	23	7
2	27	10
3	26	14
4	29	20
5	29	19
6	24	14

4.1.4 *Heaviest headloads*

Few headloads weighed more than 50 kg and the heaviest load encountered (67,2 kg) was exceptional. Note: Bond (1977) refers to a headload weighing about 90 kg, but the heaviest loads recorded by Best (1979) were 32, 34 and 39,5 kg respectively for his three villages.

4.1.5 *Species used*

The two species most commonly collected as firewood, *Colophospermum mopane* and *Combretum apiculatum* are also the two species singled out in the initial interviews as being the best firewoods. This would seem to indicate that the people are selective in their gathering of firewood. These same two species are, however, also very common in the vegetation and their abundance in headloads could, therefore, simply be a result of their availability in the vegetation. An analysis of the vegetation would be necessary to determine whether, and to what extent, selectivity is being practised or not. There is considerable variation from one family to another with respect to what species are collected in quantity (Table 3). Some families (family 1 for example), collect several species in more or less equal proportions, whereas others (family 7 for example), concentrate on a single species. This may be determined by selective collecting as well as by what is available in each of the collecting areas visited by the families.

4.1.6 *Size of wood*

It is obvious that large-diameter firewood is not favoured by the women although it is available. Large wood requires splitting before use — unnecessary hard work if small wood is available. Small wood is also easier to break and to pack into a headload. An implication for woodlot management of this preference for small wood is that short-term coppice rotations would be feasible.

4.2 *Building timber*

The total volume of finished timber required for the 89 living-huts built in the study area in a year (calculated on the basis of a mean wood volume of 1,30 m^3 per hut) was approximately 116 m^3. For the 80 typical storage-huts built in the same period approximately 87 m^3 of finished timber was required and for the 4 elevated storage huts about 9 m^3.

These figures yield an overall estimate of 212 m^3 of finished timber used for building in a year.

From the data in Tables 6 and 8, it is estimated that some 21 000 poles of various lengths and circumferences were used to build the living-huts (assuming these all to be round) and the typical storage-huts.

Most of the wood used (95%) was *Colophospermum mopane*, the density of which (at 10% moisture content) is 1,09 g per cm^3 (Van Vuuren *et al.*, 1978). Using this as a conversion factor for all building wood, the total weight of finished timber used for building in a year was approximately 231 tonnes. This represents an annual timber requirement of approximately 230 kg per family.

There are no strictly comparable data on the use of building timber in rural areas. Gandar (1981) gives data on timber standing in structures in a homestead at any one time. In this study no data were obtained on the average number of living-huts and storage-huts per family but from observation each family appears to have two or three living-huts and a single storage-hut. The timber standing in structures in a homestead is, therefore, in the order of 2,60 to 3,90 m^3 for living-huts and 1,09 m^3 for storage-huts — compared to Gandar's (1981) figures of 3,08 m^3 for stores and kraals in lowland situations.

Few people in the survey area as yet buy *Eucalyptus* poles for building. *Colophospermum mopane* is more durable and insect-resistant than *Eucalyptus*, according to some people questioned. *Eucalyptus* poles are also expensive compared to the small fee payable (R1-00 to R3-00) for a permit to cut indigenous wood. In areas of critical wood scarcity, such as the Bungeni and Mbokota areas some 50 km west of Giyani, *Eucalyptus* poles are commonly used in building. The availability of this timber in nearby plantations in Louis Trichardt obviously influences the choice of building timber. In these areas the style of building is also affected by the shortage of wood. The walls of huts generally contain no poles, being made entirely of mud-bricks.

It is interesting to note that Gandar (1981) found a similar change in building strategy (i.e. from huts with wood in the wall to those without) in areas of low wood availability (upland situations).

4.3 *Demand versus supply of wood*

The annual demand for firewood and finished building timber in the study area as a whole, at the present rates of use, is approximately 5 500 tonnes. Assuming that this is all gathered from the 13 000 ha which are not residential or arable land, the rate of wood gathering is approximately 423 kg ha^{-1} $annum^{-1}$. Rutherford (1978) estimated the radial production of limbs and branches (i.e. wood production) for savannas and woodlands in southern Africa to be 600 kg ha^{-1} $annum^{-1}$, 177 kg higher than the above rate of use.

4.4 *Effects on the vegetation*

Observations on the effect of timber gathering on the vegetation showed the following general trends:

(a) cutting damage to trees, as indicated by stumps (coppicing or dead) and branches or stems cut off trees, decreases as one moves away from the perimeter of a village;

(b) the density of trees increases away from the village;

(c) shrubs tend to be smaller near the villages, usually less than 2 m in height, than they are further away, their height can be up to 3,5 m;

(d) in the highly disturbed areas (i.e. badly cut-out areas) the majority of the remaining trees have stems larger than 30 cm in circumference, whereas in less or little disturbed areas the majority of trees have stems less than 30 cm in circumference — ie. the smaller trees and stems disappear first; and

(e) there is no dead wood on the ground near the villages and very little further away.

These trends are not always equally clearly discernible and where they are present, the sequence or gradation is often disrupted due to clearing of land for cultivation, roads or pipelines. Other than the lack of fallen dead wood, the above effects are due to the cutting of building timber, rather than the collecting of firewood, and are very localized. The picture is accentuated by overgrazing and trampling of the grass and browsing of coppice and shrubs, as can be seen in Fig. 9.

4.5 *Possible role of woodlots*

At the present rate of use, harvesting of wood from the vegetation does not outstrip production, and harvesting on a sustained yield basis is feasible if:

(a) only the inhabitants of the villages utilize the wood resources of the study area, and

(b) If the wood is gathered evenly over the whole area. The people of the town Giyani, however, also make use of this resource at present. To supply these people with firewood and building timber and thus relieve some of the pressure on the vegetation of the study area, woodlots could be established around or near the town. The concentration of wood cutting and gathering in the immediate vicinity of villages is also wasteful as it leads to the elmination rather than the sustained harvesting of timber trees.

For the study area, management of the existing woodlands, together with the planting of trees in the denuded areas around the villages could ensure the continued supply of wood.

Fast-growing exotic species such as *Eucalyptus citriodora* and other drought-resistant eucalypts may be suitable (Wessels *et al.*, 1978). *Leucaena leucocephala* and a number of other leguminous trees also offer possibilities (National Academy of Sciences, 1980).

The introduction of exotics into the area should, however, be carefully considered, bearing in mind the aggressiveness and invasiveness of each candidate species and the threat it could pose to the natural vegetation, particularly along the rivers (Duggan & Henderson, 1982; Wells, Duggan & Henderson, 1980; Talukdar, 1981).

The feasibility of using indigenous species such as *Colophospermum mopane, Combretum apiculatum* or *Acacia* species needs investigating.

Fuel woodlots need only be managed on a short-term coppice rotation basis, since there is a preference for smaller wood for fuel.

5 CONCLUSIONS

Firewood is the major use for wood in the study area. It is estimated that the consumption of firewood is 5,4 tonnes per family per annum, similar to that measured in other parts of southern Africa with comparable availability of wood. Two species emerge as the most important sources of firewood — *Colophospermum mopane* and *Combretum apiculatum.*

The demand for building timber is 0,23 tonnes per family per annum. Almost all of the timber used is *Colophospermum mopane.*

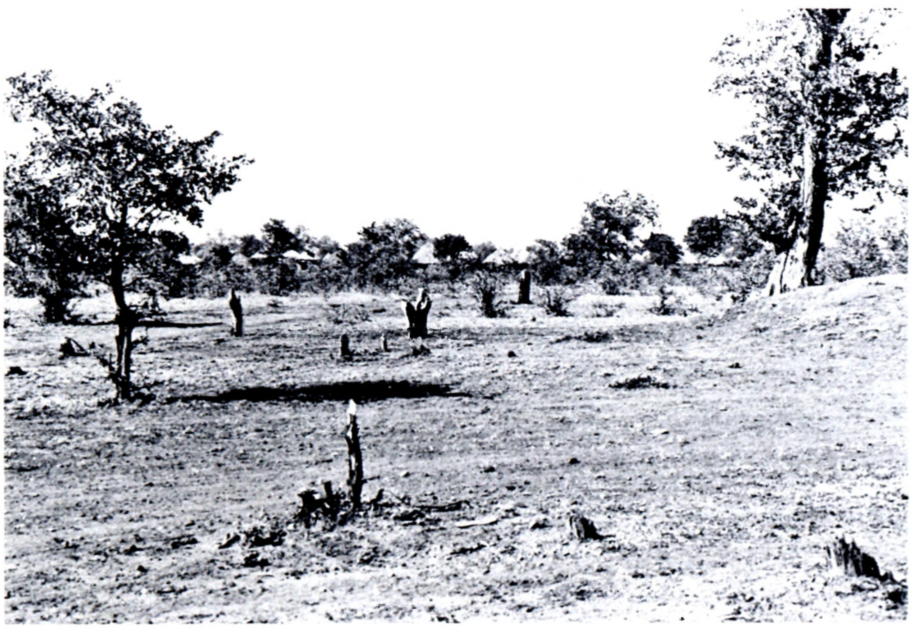

FIG. 9.— Denudation of the environment around a village.

Most of the live wood cut at present is for building: the obvious damage to the woody vegetation near the villages is, therefore, not due to the gathering of firewood but to the cutting of building timber.

Although the wood supply in the study area (and other adjacent areas) is adequate for the present needs of the local population, population increases, fuel gathering for adjacent towns, the escalating demand for agricultural land and wasteful harvesting methods result in the wood supply from indigenous vegetation becoming inadequate. Increased cutting of live wood for firewood will occur.

The establishment of woodlots of suitable exotic or, preferably indigenous species for fuel and building timber is required to prevent the complete destruction of the woodlands. Some parts of Gazankulu are already experiencing a shortage of

FIG. 10.— A part of Gazankulu already experiencing a critical shortage of firewood.

wood (Fig. 10) and small thorny shrubs, poor quality firewood, reeds and dung are burnt as fuel. Here, there is urgent need for the establishment of woodlots.

UITTREKSEL

Die benutting van hout vir brandstof en bouhout is oor 'n gebied van 13 000 ha. in Gazankulu, naby Giyani, bestudeer. Bondels vuurmaakhout wat deur 8 van die 978 families teenwoordig ingebring is, is gedurende 6 periodes in 'n jaar gemonitor.

Die twee belangrikste bronne van vuurmaakhout is Colophospermum mopane *en* Combretum apiculatum. *Die gemiddelde verbruik van vuurmaakhout per gesin per dag word bereken op 14,9 kg. Die jaarlikse aanvraag na vuurmaakhout in die hele studiegebied is gevolglik ongeveer 5 300 metrieke ton. Woonhutte en voorraadhutte is bestudeer terwyl dit in aanbou was. Die gemiddelde volumes hout in woon- en tipiese voorraadhutte is respektiewelik 1,30 m^3 en 1,09 m^3. Nege en tagtig woon- en tagtig voorraadhutte is in een jaar gebou. Die vraag na afgewerkte hout in die studiegebied in daardie jaar was ongeveer 231 metrieke ton.*

Houtverbruik het tot nog toe nie produksie oorskry nie, maar dit sal weldra gebeur indien alternatiewe houtbronne nie verskaf word nie.

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APPENDIX 1

WOODY SPECIES PRESENT IN THE STUDY AREA
(Voucher specimens housed in PRE)

Moraceae
Ficus sansibarica Warb.
F. sonderi Miq.
F. stuhlmannii Warb.
F. sycomorus L.
F. tettensis Hutch.

Urticaceae
Pouzolzia hypoleuca Wedd.

Annonaceae
Hexalobus monopetalus (A. Rich.) Engl. & Diels

Leguminosae
Acacia nigrescens Oliv.
A. permixta Burtt Davy
A. polyacantha Willd. subsp. *campylacantha* (Hochst. ex A. Rich.) Brenan
A. robusta Burch.
A. schweinfurthii Brenan & Exell var. *schweinfurthii*
Dichrostachys cinerae (L.) Wight & Arn. subsp. *africana* Brenan & Brummitt var. *pubescens* Brenan & Brummitt
Colophospermum mopane (Kirk ex Benth.) Kirk ex J. Leonard
Schotia brachypetala Sond.
Cassia abbreviata Oliv. subsp. *beareana* (Holmes) Brenan
Peltophorum africanum Sond.
Mundulea sericea (Willd.) A. Chev.
Ormocarpum trichocarpum (Taub.) Harms ex Burtt Davy
Dalbergia melanoxylon Guill. & Perr.
Pterocarpus rotundifolius (Sond.) Druce subsp. *rotundifolius*
Xanthocercis zambesiaca (Bak.) Dumaz-le-Grand

Balanitaceae
Balanites maughamii Sprague

Simaroubaceae
Kirkia acuminata Oliv.

Burseraceae
Commiphora mollis (Oliv.) Engl.
C. africana (A. Rich.) Engl.

Meliaceae
Turraea obtusifolia Hochst.
Trichilia emetica Vahl

Euphorbiaceae
Securinega virosa (Roxb. ex Willd.) Pax & K. Hoffm.
Pseudolachnostylis maprouneifolia Pax
Bridelia mollis Hutch.
Spirostachys africana Sond.

Anacardiaceae
Sclerocarya caffra Sond.
Lannea stuhlmannii (Eng.) Engl.
Ozoroa paniculosa (Sond.) R. & A. Fernandes
O. reticulata (Bak. f.) R. & A. Fernandes
Rhus gueinzii Sond.
R. leptodictya Diels

Celastraceae
Maytenus heterophylla (Eckl. & Zeyh.) N. Robson
M. senegalensis (Lam.) Exell
Cassine transvaalensis (Burtt Davy) Codd
Hippocratea longipetiolata Oliv.

Icacinaceae
Pyrenacantha grandiflora Baill.

Sapindaceae
Pappea capensis Eckl. & Zeyh.

Rhamnaceae
Ziziphus mucronata Willd. subsp. *mucronata*
Berchemia discolor (Klotzsch) Hemsl.

Tiliaceae
Grewia monticola Sond.
G. flavescens Juss. var. *flavescens*
G. flavescens Juss. var. *olukondoe* (Schinz) Wild

Malvaceae
Gossypium herbaceum L. var. *africanum* (Watt) J. B. Hutch. & Ghose

Sterculiaceae
Dombeya rotundifolia (Hochst.) Planch. var. *rotundifolia*

Flacourtiaceae
Flacourtia indica (Burm. f.) Merr.

Combretaceae
Combretum apiculatum Sond. subsp. *apiculatum*
C. collinum Fresen. subsp. *suluense* (Engl. & Diels) Okafor
C. hereroense Schinz
C. erythrophyllum (Burch.) Sond.
C. imberbe Wawra
C. mossambicense (Klotzsch) Engl.
Terminalia sericea Burch. ex DC.

Ebenaceae
Euclea divinorum Hiern
Diospyros mespiliformis Hochst. ex A. DC.

Loganiaceae
Strychnos madagascariensis Poir
Nuxia oppositifolia (Hochst.) Benth.

Apocynaceae
Carissa edulis Vahl

Boraginaceae
Ehretia amoena Klotzsch

Verbenaceae
Clerodendrum glabrum E. Mey.

Labiatae
Hemizygia elliotii (Bak.) Ashby

Rubiaceae
Breonadia microcephala (Del.) Ridsd.
Gardenia jovis-totantis (Welw.) Hiern
Tricalysia allenii (Stapf) Brenan
T. junodii (Schinz) Brenan var. *kirkii* (Hook.f.) Robbrecht ined.
Vangueria cyanescens Robyns
Pavetta schumanniana F. Hoffn. ex K. Schum.

APPENDIX 2

SPECIES COLLECTED AS FIREWOOD

Acacia nigrescens
Acacia sp.
Albizia harveyi
Berchemia discolor
Bolusanthus speciosus
Carissa edulis
Cassia abbreviata subsp. *beareana*
Cassine transvaalensis
Colophospermum mopane
Combretum apiculatum subsp. *apiculatum*
C. collinum subsp. *suluense*
C. hereroense
C. imberbe
C. paniculatum subsp. *microphyllum*
C. zeyheri
Dalbergia melanoxylon
Dichrostachys cinerea
Diospyros mespiliformis
Dombeya rotundifolia var. *rotundifolia*
Ehretia amoena
Euclea divinorum
Ficus sycomorus
Gardenia spatulifolia
Grewia flavescens
G. monticola
Lannea stuhlmannii
Lonchocarpus capassa
Maerua angolensis
Maytenus sp.
Mundulea sericea
Ozoroa sp.
Peltophorum africanum
Piliostigma thonningii
Pterocarpus rotundifolius subsp. *rotundifolius*
Schotia brachypetala
Sclerocarya birrea subsp. *caffra*
Securinega virosa
Strychnos madagascariensis
Terminalia sericea
Trichilia emetica
Ximenia caffra
Ziziphus mucronata