Wildlife Conservation Society of Tanzania (WCST)

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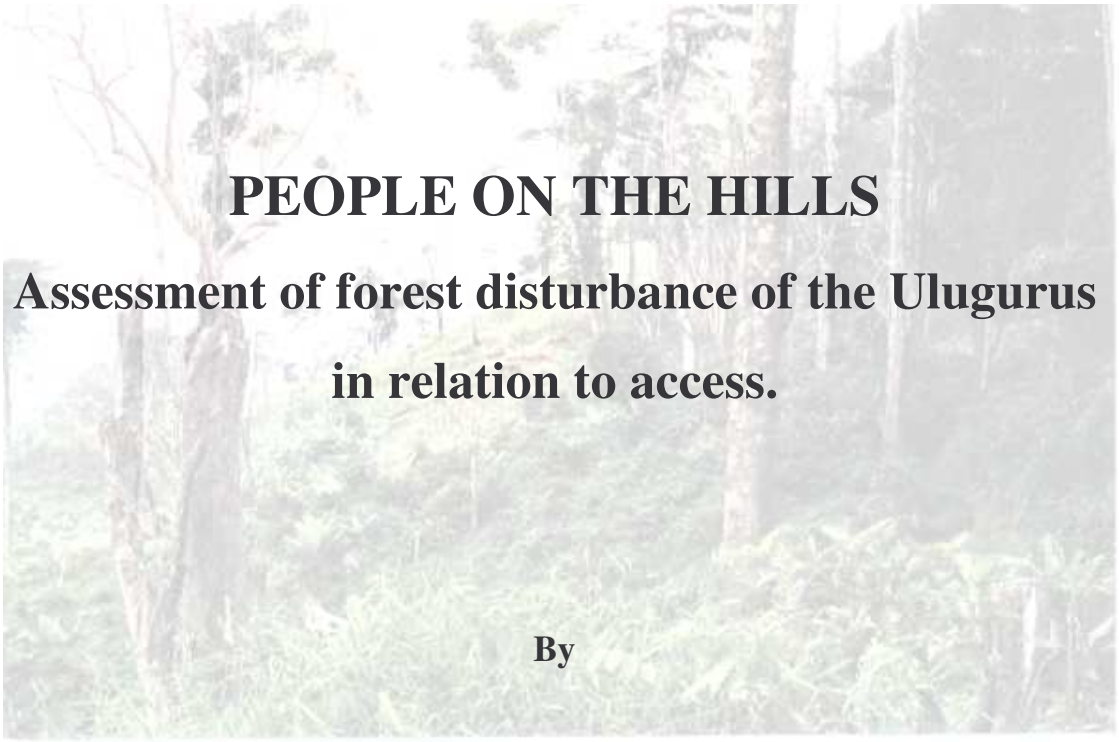

PEOPLE ON THE HILLS

Assessment of forest disturbance of the Ulugurus in relation to access.

By

Olivier Hymas

2001

Acknowledgment

Thanks to John Kilandeka and Amini Mushi two forester willing to walk for many hours day in day out, without out whom this work would not have been possible.

As usual I am indebted to all the people in WCST Morogoro office for allowing me to once again invade their office and for letting me re-use my trusted side kick, the Blue Land Rover, which once more took me far into the mountains on roads more fitting for a Hippo than a vehicle.

I would also like to thank Gitty and Willemijn with whom I spent endless nights at SUA counting the stars while they had to suffer listing to many of my ideas.

And finally to Neil, Rosalyn, Toby, Jessica and Elise whom I am heavily indebted to. Without out them this past year would not have been possible.

A la prochain peut être !

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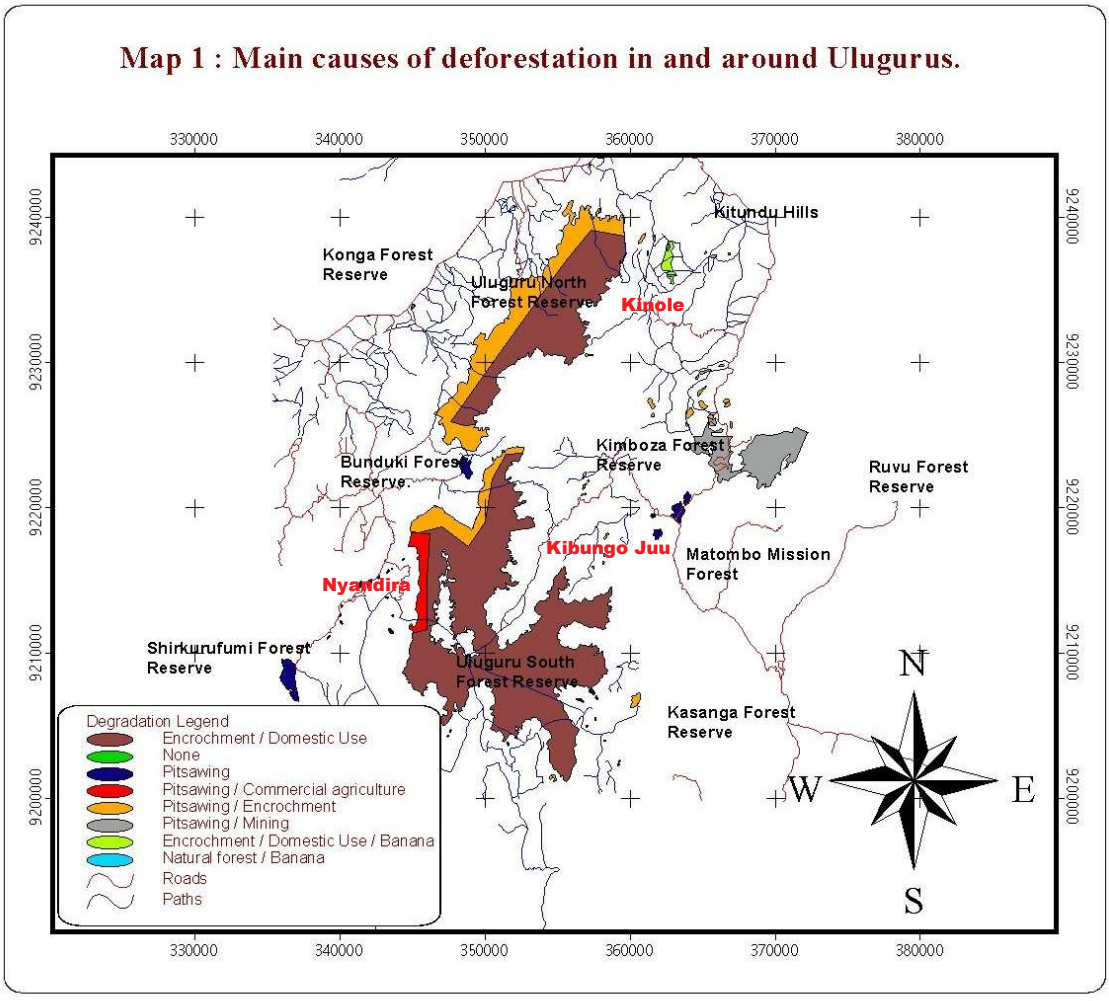
PEOPLE ON THE HILLS.

Introduction

Previous studies in the Uluguru Mountains (Hartley, 2000 and Hymas, 2000b) have suggested a link between access and degradation of the forest reserve. It seems that the areas that are difficult if not impossible to get to by vehicles are also the areas that have the least forest degradation.

This becomes an important issue when development projects such as road improvement or establishment of markets is being planned since if no environmental education is carried out then such projects may have a negative impact on the environment.

The Uluguru Mountains is an area of high biodiversity and economic value but it is also an area with a high rural population, especially where road access is reliable. This rural population relies on agriculture and the environment for their livelihoods. From earlier studies it would seem that this reliance on the environment changes with access (Map 1). All over the mountains people near the forest reserve rely on it for their supply of fuelwood and building materials but, it has been observed by people working in the mountains, that timber becomes an important activity when it can easily be transported out of the area.



Sites

This study has been set up so as to look at the relationship between forest use as observed from degradation in the reserves and the ease of access. Two areas have been chosen that differ in ease access into the areas. The Lanzi, Kibungo and Nyingwa villages in Kibungo Juu (Map 1) is situated at the end of a road, which is impracticable during the rains and is otherwise overgrown. The only regular vehicle to undertake this perilous journey is that of the priest going to his congregation at the weekend. In good condition it is around a 4 hour drive to Kibungo, during the rains it can take all day.

For trade the people of Kibungo Juu ward have to undertake a two hour walk to Tawa market that is also at the end of a road that is cut off during the rains. The other opportunity for villagers to trade is that of Matamba town where there is frequent transport including busses to Morogoro but this walk is longer than that of Tawa.

Access to Nyandira ward is straightforward (Map 1), it takes around 2 hours from Morogoro, though a good vehicle is needed since the section between Langali and Nyandira is a rock field. There is a regular bus service between Morogoro and Langali, with other vehicles frequently going the extra distance to Nyandira village and Tchenzema where vegetables are bought. The junction to Bunduki is in Mgeta village, some difficulties can be encountered directly after it has rained but in general it is easy to get to. This road is being extended to Vinile on the other side of the mountains and to another small village just above Bunduki forest reserve near Hulu falls.

Tandai in Kinole ward (Map 1) is at the end of a road that is maintained by the villagers, this road is usually passable, except in the worst of the rains. During the week trucks regularly take the road to collect bananas in Tandai village. The village is about a 2 hour drive from Morogoro, when the road is impassable it is also possible to get to Morogoro by walking 4 hours across the mountains. It is in this area that forest used to occur on the public land (Hymas, 2000a).

Method

Overview

Methods used through out this study is based on work already done in the Northern parts of the Ulugurus (Hymas, 2000a), so allowing the data of the Uluguru South reserve to be compared with that of the previous data collected in Uluguru North. Both sets of data were entered into a database (Doggart, 2001) as the beginnings of a data set on the state of the forests in the Uluguru North and South reserves.

For this study the sites were chosen so as to allow further analysis of the degradation of the forest reserves in relation to commercial pressure, this is determined through ease of access and population density of the area.

The first of the two study sites chosen was Kibungo Juu ward with transects carried out in the reserve to the West of Lanzi, Nyingwa and Kibungo Juu villages. This ward is in an area where access is along an overgrown road that becomes particularly hard, if not impossible to utilize during the rains. It has a total population of 4037 in 1988 and a population density of 0.000327 people per km2 (3.28 people per Ha).

The second area is in the wards of Bunduki and Nyandira, one set of transect was carried out in the reserve to the South of Bunduki and Kibigili while a second set was carried out in the forests to the East of Tchenzema and Nyandira villages. Into these areas there is frequent flow of traffic with buses frequently going into Langali. This area has a total population of 8589 in 1988 with a population density of 0.001431 people per km2 (14.33 people per Ha).

One of the problems that this study has is that the sites are not topographically the same. They occur at different heights and have different aspects, this will therefore effect the vegetation structure of the site but it should have little effect on the amount of damage occurring in the sites. This makes it difficult to compare the vegetation structure of the sites. An exception to this is the Tandai and Public land site data taken from a previous study, these sites were chosen so as to also look at differences in vegetation structure they were therefore chosen to be as topographically similar as possible (Hymas, 2000a).

Transects

In both of the sample areas nine transect were undertaken, each transect occurring at a random point in one of the nine 1 km grids on the East Africa (Tanzania) 1:50,000 map of Mgeta area (Series Y742, Sheet 201/1, Edition 1-TSD, 1982). Getting to the grid square was done by using a GPS with the co-ordinates of one of the corners of the squares being used. Once inside the grid square paths were taken to enter the forest.

The taking of paths biases the data since it can be assumed that it is around these that the most degradation would occur, but this is the easiest method in entering the reserve since slashing through fields and then into the forest is time consuming and some times rather painful. These paths were only used as long as they kept to the direction of the transect line. In general any bias due to paths would be more towards damage of vegetation with a small DBH since these have a tendency to be slashed if they get in the way of a person.

Direction of the transects was determined by taking an right angle to the general direction in which the reserve border ran on the map ie if the border ran in a South - North direction then the transect would run in a East - West direction, this direction was maintained by the use of a compass. At each of the transects care was taken not to start a line that would run parallel with the border or where difficulties would be run into by topographical features such as cliffs.

Starting at the border of the reserve, the transects ran 1 km into the reserve, with samples points being taken every 50 meters. The interval between samples was measured with a 50 meters tape. At each of these sample points the altitude using a altimeter, the angle and aspect of the slope using a compass with clinometer and where possible the UTM co-ordinates were noted, as well as any topographical features.

At the sample points data was collected in a 10 meter by 60 cm quadrate at right angles to the transect, with the mid point of the quadrate being the transect line. The quadrate was measured using a 10 meter ribbon and a 150 cm tape. Everything that fell into this quadrate either partly of wholly was measured. This data collected was split into two categories a Disturbance survey and a Vegetation survey.

Disturbance survey

The type of disturbance was recorded at every survey point, as with the vegetation categories there are many codes which have not been used, but the structure has been kept the same. The Disturbance types are : Pitsawing, Fire Damage, Cultivation, Settlement, Camp sites, Mining, Cleared, Forest Edge, Wood extraction, Charcoal burning, Traps, Animal remains, Gunfire, Sound of cutting, no damage and Others. The main ones used in this study were Forest Edge, Wood extraction, Pit sawing, Traps and No damage. Forest edge was recorded when the edge of the forest was reached, Wood extraction included any type of wood use, while pitsawing was specifically the pitsawing site, Traps included deadfall traps and pitfalls traps for animals and No damage was used for all quadrate sites where no disturbances was observed.

Quantitative data was collected for all vegetation above 5 cm in circumference found in the quadrates at each sample point. The Diameter at Breast Height (D.B.H.) was calculated for each plant by dividing the circumference by ∏ (Pi), with the circumference itself being measured with the 150 cm tape and sometimes the 50 meter tape. The vegetation was separated into one of three categories : Saplings with a D.B.H. of 1.5 cm to 4.9 cm (circumference of 5 to 15 cm), Poles with a D.B.H. of 5 to 15 cm (circumference of 16 to 48 cm) and Trees with a D.B.H. of grater than 16 cm (circumference greater than 48 cm).

From the D.B.H. the basal area (BA) was calculated for the saplings, poles and trees, by using the following formulae (Muller-Dombois *et al*, 1974) :-

$$B.A. = (\tfrac{1}{2}\, d)^2 * \prod$$

where d is Diameter at Breast Height

As the quadrate size is known (60 cm * 1,000 cm) so the total Basal area for each sample point (60,000 cm^2), for each transect (60 cm * 1,000 cm * 20 samples = 1,200,000 cm^2) and sample site (60 cm * 1000 cm * 20 samples * 9 sites = 10,800,000 cm^2) can be later calculated.

At each quadrate site the number of live, naturally dead, newly cut and old cut saplings, poles and trees were counted. With the distinction between newly and old cut plants being done based on colour, with yellow classified as newly cut and darker colours as plants cut long in the past.

Vegetation Survey

To keep consistency the same codes were used as descriptions of the vegetation type as the previous study (Hymas, 2000a). This was originally based on survey work done in the Segoma Forest Reserve (Doody *et al*, 2000), and expanded then extended to include several other categories. It now contains many redundant codes since the previous survey was also concerned with vegetation in the public lands, but this system has been kept so as to allow a data set to be created of the vegetation cover of the Ulugurus.

The type of vegetation present was split into one or several of the following categories; Grasslands, Cultivated Land, Plantation, Bananas, Bamboo, Thicket / Scrub, Fallow, Disturbed Forest, Forested Land and Other. Grassland, Cultivated Land, Plantation, Bananas and Fallow were categories not used in this survey, descriptions of these can be found in Hymas, 2000a and Doody *et al*, 2000. Bamboo was noted since there are areas where bamboo dominates the vegetation, Thicket / Scrub was taken to be any area where the vegetation was above shoulder height and hard if not impossible to penetrate. Degraded forest was any area where there was evidence of disturbance to the forest. Forested land was taken to be any area where there was no evidence of disturbance to the forest.

The vegetation cover of the sample point was estimated by looking directly up or down at the sample point, it was estimated for three types of vegetation categories, Canopy, Ground and Scrub cover, using one of four percent ranges (Table 1). Scrub cover was taken as anything below the tree canopy and above shoulder level. The canopy height was also estimated into one of five height ranges (Table 2).

Table 1 : Vegetation cover classes.

0%	- The sample has no cover.
1-10 %	- Little evidence of cover in the sample.
11-50%	- Less than half of the sample is covered.
51-100%	- More than half of the sample is covered.

Table 2 : Canopy height categories.

0 meters	- No trees present.
1 to 10 meters	- Tree canopy between 1 and 10 meters.
11 to 20 meters	- Tree canopy between 11 to 20 meters.
21 to 30 meters	- Tree canopy between 21 to 30 meters.
Greater than 31 meters	- Tree canopy greater than 31 meters.

Results

Disturbance Survey

Table 3 : Damage to forest at the different sites with the sites population.

Site	Total live vegetation	Total damaged vegetation	Total vegetation	Percent of vegetation damaged	Total population	Population density / Ha	Population density per km^2
Public (N=176)	204	249	453	54.97	4800	4.36	0.000437
Tandai (N=177)	2047	167	2214	7.54	6490	5.19	0.000519
Lanzi (N=180)	1033	84	1117	7.52	2994	2.28	0.000228
Nyandira (N=180)	1319	170	1489	11.42	10051	14.30	0.001431

With an increase in population density there is also an increase in the percent of damage that is found in the forest reserves (Table 3, Figure 1). This change was tested for significance using the G-Test with the Null Hypothesis being that the sites have the same amount of damage. The test shows no significance between the low population sites of Tandai and Lanzi when tested against with the high population site of Nyandira (Table 4 and 6). On the other hand the two Low population sites of Lanzi and Tandai are significantly the same (Table 5). So the damage occurring in Tandai and Lanzi site is similar, but this is not so when these two sites are compared with Nyandira.

For comparison the percent damage done to the forest in the Public land is shown in Table 3, this is not plotted on Figure 1 since it would be well off the scale, it shows that deforestation is a lot worse on the Public Land.

Figure 1 : % of Vegetation Damaged at Different Population Densities.

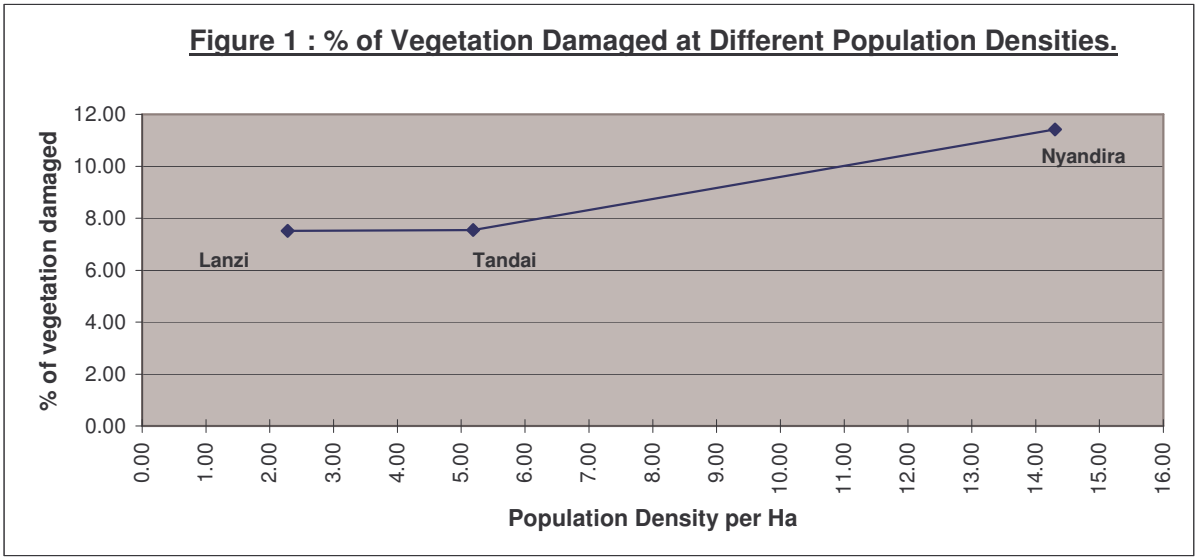


Table 4 : G-test looking for significance difference in damage between the low population site (Lanzi) and the high population site (Nyandira).

Tree State	Total live vegetation	Total damaged vegetation	Totals
Lanzi (N=180)	1033	84	1117
Nyandira (N=180)	1319	170	1489
Totals	2352	254	2606
G-Test	11.28		
Degrees of Freedom	1		
P level at 0.05	3.84		
P level at 0.01	6.63		

Table 5 : G-test looking for significance difference in damage between the two low population sites (Lanzi and Tandai).

Tree State	Total live vegetation	Total damaged vegetation	Totals
Tandai (N=177)	2047	167	2214
Lanzi (N=180)	1033	84	1117
Totals	3080	251	3331
G-Test	0.00055		
Degrees of Freedom	1		
P level at 0.05	3.84		
P level at 0.01	6.63		

Table 6 : G-test looking for significance difference in damage between the low population site (Tandai) and the high population site (Nyandira).

Tree State	Total live vegetation	Total damaged vegetation	Totals
Tandai (N=177)	2047	167	2214
Nyandira (N=180)	1319	170	1489
Totals	3366	337	3703
G-Test	15.86		
Degrees of Freedom	1		
P level at 0.05	3.84		
P level at 0.01	6.63		

Table 7 : Number of quadrates in each sites where no occurrence occurs.

Site	Total occurrence of quadrates with no damage	Average occurrence of quadrates with no damage
Public (N=176)	3	0.017
Tandai (N=177)	113	0.638
Lanzi (N=180)	133	0.739
Nyandira (N=180)	93	0.517

The damage done to the reserves is highest at the very edges of the reserve it then diminishes as one moves further into the reserve (Figures 3 to 5). In comparison damage to the public land can be found in all samples except for three quadrates (Table 7 and Figure 2). Between the three reserve sites it is Lanzi (Table 7 and Figure 4) that has the highest occurrence of no damage while Nyandira has the lowest (Table 7 and Figure 5). This further confirms that population pressure has a negative effect on the reserve.

Figure 6 showing average observations of damage to trees, poles and saplings shows that this is greatest in the Public land with Nyandira and Tandai following. In Nyandira this is expected if population pressure is a contributing factor to forest degradation.

Figure 2 : Total Number of Occurence of No Damage Along the Transects in the Public Land Around Tandai (N=176).

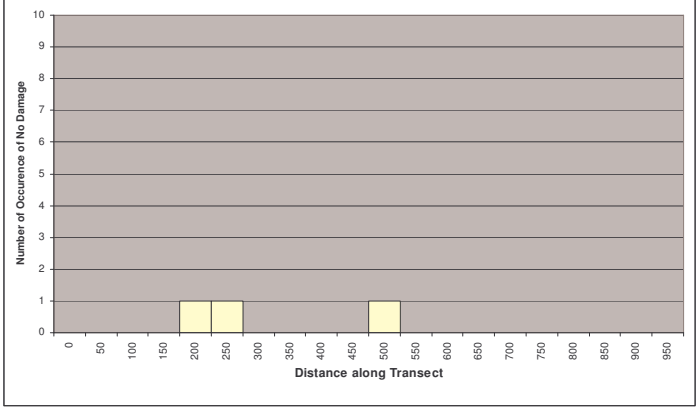


Figure 3 : Total Number of Occurence of No Damage Along the Transects in the Reserve Around Tandai (N=177).

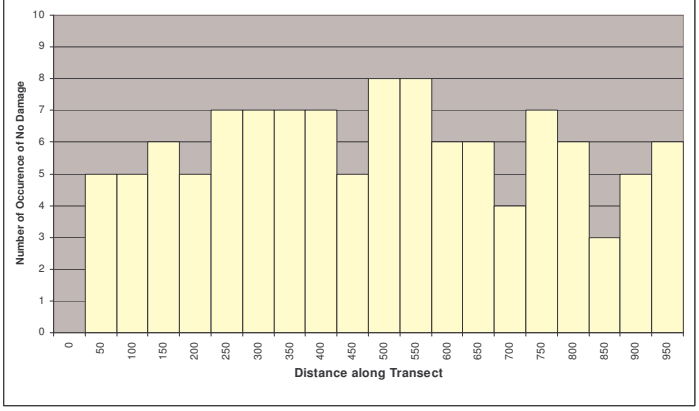


Figure 4 : Total Number of Occurence of No Damage Along the Transects in the Reserve Around Lanzi (N=180).

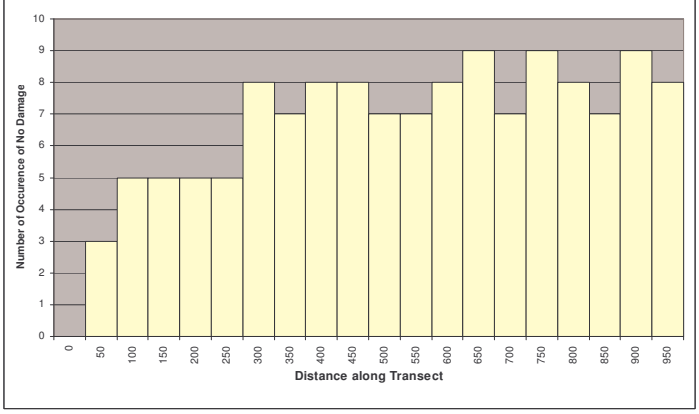


Figure 5 : Total Number of Occurence of No Damage Along the Transects in the Reserve Around Nyandira (N=180).

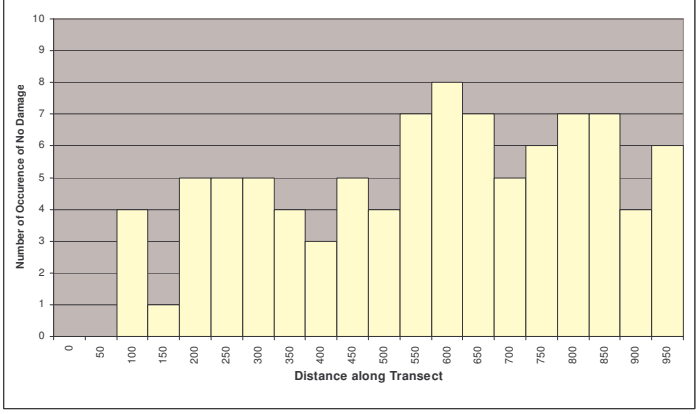


Figure 6 : Average of the Total Damage to Trees, Poles and Saplings at the Different Sites.

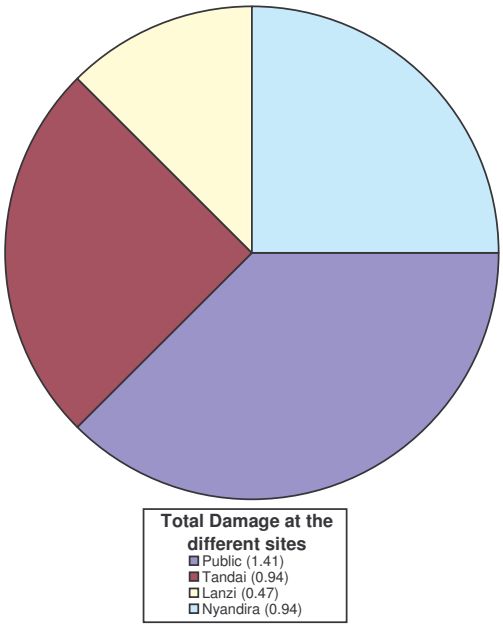


Figure 7 : State of Woody Vegetation in the Public Land Around Tandai (N=176).

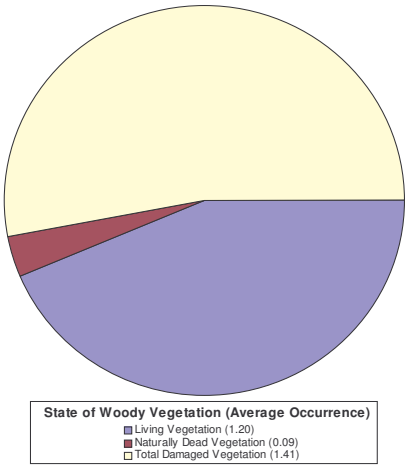


Figure 8 : State of Woody Vegetation in the Reserve Around Tandai (N=177).

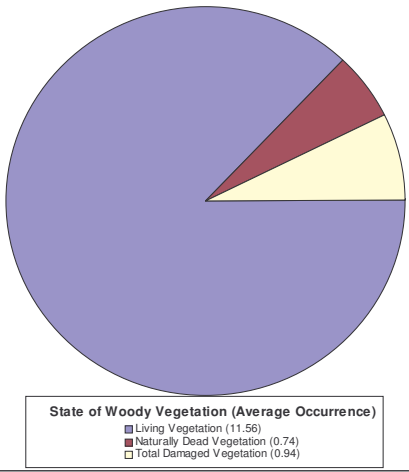


Figure 9 : State of Woody Vegetation in the Reserve Around Lanzi (N=180).

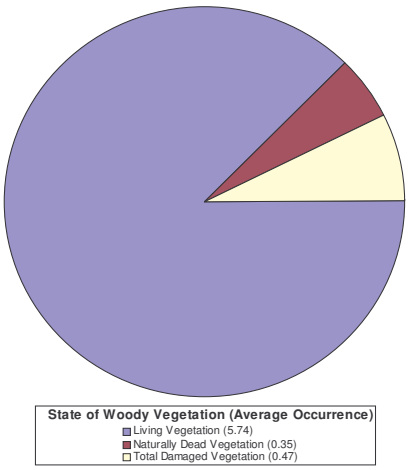


Figure 10 : State of Woody Vegetation in the Reserve Around Nyandira (N=180).

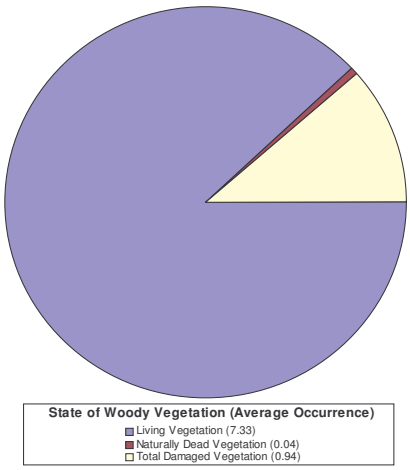


Table 8 : Amount of live, naturally dead and damaged vegetation found at each site.

Sites	Number of samples	Total live vegetation	Average live vegetation	Total naturally dead vegetation	Average naturally dead vegetation	Total damaged vegetation	Average damaged vegetation
Public	176	204	1.16	16	0.09	249	1.41
Tandai	177	2047	11.56	131	0.74	167	0.94
Lanzi	180	1033	5.74	63	0.35	84	0.47
Nyandira	180	1319	7.33	8	0.04	170	0.94

Total damaged vegetation is found highest in the Public land (Table 8 and Figure 7). Out of the three reserves it is in Nyandira and Tandai that the highest total damage to the vegetation (Table 8 and Figures 8 to 10).

Interestingly Nyandira is also the site with the least naturally dead vegetation (Table 8, Figure 10), this may indicate that the people in Nyandira are collecting all the dead vegetation that they can find, while in the other areas there is still dead vegetation that the villagers can collect. This may mean that the extraction of dead vegetation in Nyandira is no longer sustainable while in the other two villages it still is.

The site with the highest amount of live vegetation in the reserves is found in Tandai, with Lanzi being the site with the lowest amount of live vegetation. This is not what would be expected if Nyandira is the site with the highest damage being done to it. This is probably due to the effect of where the three reserve sites occur for they are not at the same altitudes or on the same side of the mountains. The sites in Tandai range from 1050 to 1570 meters and are on East facing slopes, Lanzi's sites range from 1425 to 2140 meters also on east facing slopes, while Nyandira sites range from 1660 to 2335 meters

but it is on west facing slopes. Not only this but the site of Lanzi finishes just before the Lukwenge plateau where the vegetation is grassland.

The difference in topography of the sites is reflected in the vegetation with Lanzi having the site with the greatest amount of moss and epiphytes on the trees this reflects the wetness of the site, which is mirrored in its frogs that can be heard constantly. In the other reserve sites moss is only really found higher up in the transect and frogs are only usually heard when it rains. Above about 1900 meters to the end of the transect in Lanzi the vegetation is dominated by bamboo while the canopy gradually opens up. This also occurs in Nyandira where large clearing can be found near the end of the transects.

Figure 11 : Influence of People in the Public Land Around Tandai (N=176).

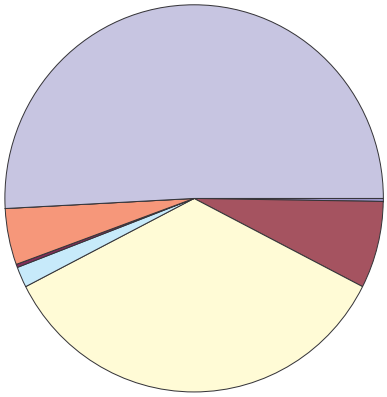


Figure 12 : Influence of People in the Reserve Around Tandai (N=177).

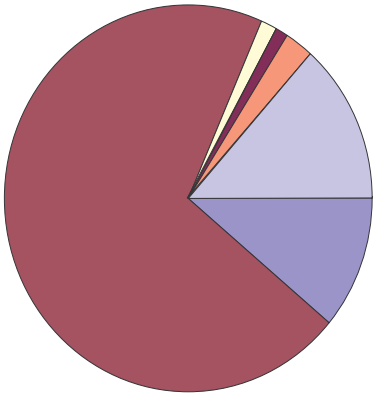


Figure 13 : Influence of People in the Reserve Around Lanzi (N=180).

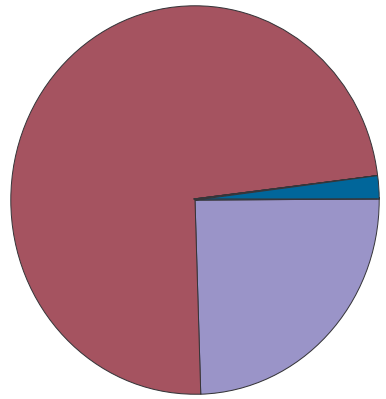
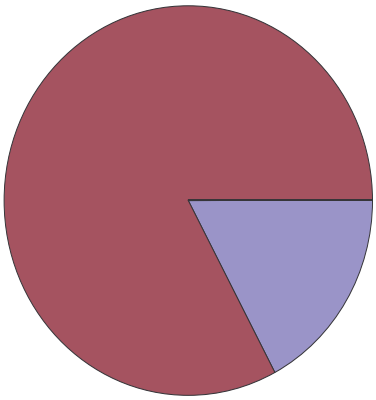


Figure 14 : Influence of People in the Reserve Around Nyandira (N=180).



The greatest influence that people have on the reserves is through extraction of wood usually in the form of fuel wood. Pitsawing was registered only in Tandai reserve sample, yet this was extremely old, with the wood being very rotten. During the collection of data two pitsawing camp sites, with several trees cut around each site, were observed in the Nyandira reserve area, sadly these did not fall into the transect lines and so cannot be used, but Nyandira is the only reserve site were recent pitsawing was observed.

Figure 15 : Average Number of Live Trees in the Different Sites.

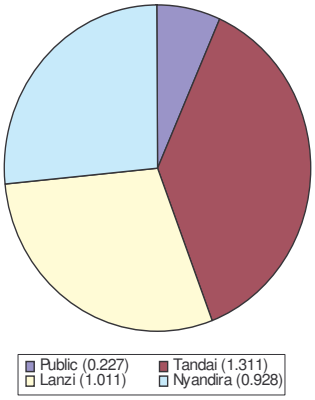


Figure 16 : Average Number of Live Poles in the Different Sites.

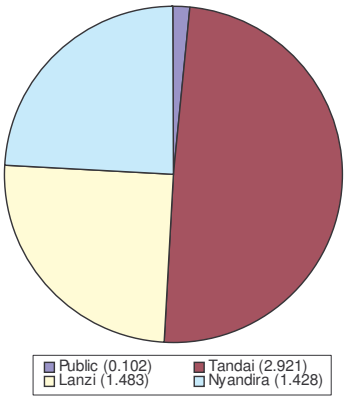


Figure 17 : Average Number of Live Saplings in the Different Sites.

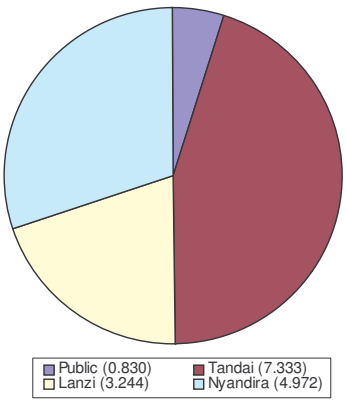


Figure 18 : Average Number of Total Live Vegetation in the Different Sites.

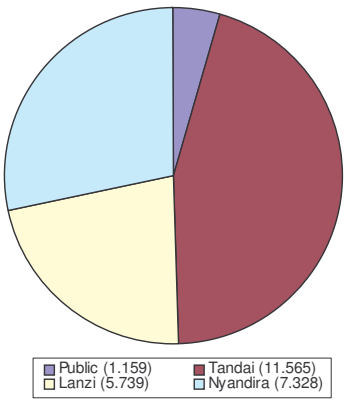


Figure 19 : Average Number of Cut Trees in the Different Sites.

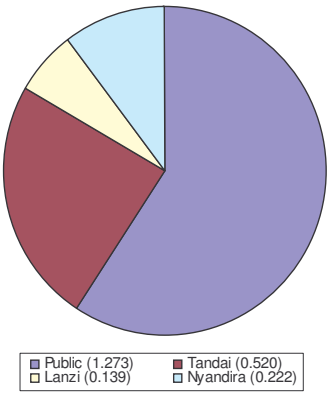


Figure 20 : Average Number of Cut Saplings and Poles in the Different Sites.

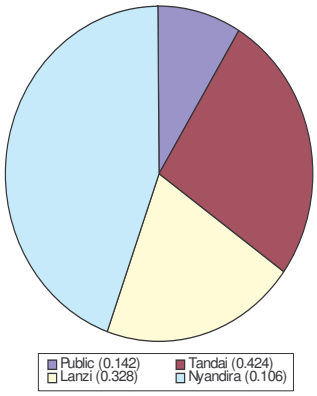


Table 9 : Number of live, naturally dead, old cut and newly cut trees in the different samples.

Site	Number of samples	Number of naturally dead trees	Average number of naturally dead trees	Number of old cut trees	Average number of old cut trees	Number of newly cut trees	Average number of newly cut trees	Total number of cut trees	Average number of cut trees
Public	176	10	0.057	217	1.233	7	0.040	224	1.273
Tandai	177	113	0.638	56	0.316	36	0.203	92	0.520
Lanzi	180	52	0.289	24	0.133	1	0.006	25	0.139
Nyandira	180	8	0.044	24	0.133	16	0.089	40	0.222

Other than the public land it is in Tandai that has the highest number of damaged trees (Table 9, Figure 19). While Lanzi has the lowest number of damaged trees though it has the same amount of old cut trees as Nyandira (Table 9, Figure 19), this may indicate that the cutting of trees in the reserve in Nyandira is a new phenomena since in the past there were fewer trees cut.

Table 10 : Number of live trees, poles, saplings and total number of live vegetation in the different samples.

Site	Number of samples	Number of live trees	Average number of live trees	Number of live poles	Average number of live poles	Number of live saplings	Average number of live saplings	Total number of live vegetation	Average number of live vegetation
Public	176	40	0.227	18	0.102	146	0.830	204	1.159
Tandai	177	232	1.311	517	2.921	1298	7.333	2047	11.565
Lanzi	180	182	1.011	267	1.483	584	3.244	1033	5.739
Nyandira	180	167	0.928	257	1.428	895	4.972	1319	7.328

Tandai has the largest total amount of vegetation of the three reserve sites (Table 10, Figure 18). While Lanzi has the lowest amount of vegetation of the three sites, though it has a similar number of trees and poles as Nyandira (Table 10, Figures 15 and 16). This again is probably a reflection of topographical differences.

Table 11 : Number of naturally dead, old cut and newly cut saplings and poles in the different samples.

Site	Number of samples	Number of naturally dead saplings and poles	Average number of naturally dead saplings and poles	Number of old cut saplings and poles	Average number of old cut saplings and poles	Number of newly cut saplings and poles	Average number of new cut saplings and poles	Total number of cut saplings and poles	Average number of cut saplings and poles
Public	176	6	0.034	19	0.108	6	0.034	25	0.142
Tandai	177	18	0.102	37	0.209	38	0.215	75	0.424
Lanzi	180	11	0.061	50	0.278	9	0.050	59	0.328
Nyandira	180	0	0.000	111	0.617	19	0.106	130	0.722

When saplings and poles are looked at most damage is found in Nyandira, with Lanzi having the lowest number of damaged poles and saplings of the three reserve sites (Table 11, Figure 20). The public land has the lowest amount of cut poles and saplings since most of it is cultivated land with no forest vegetation on it (Table 11, Figure 16 and 17).

Vegetation Structure

Figure 21 : Mean Number of Live Trees in the Public Land Around Tandai (N=176).

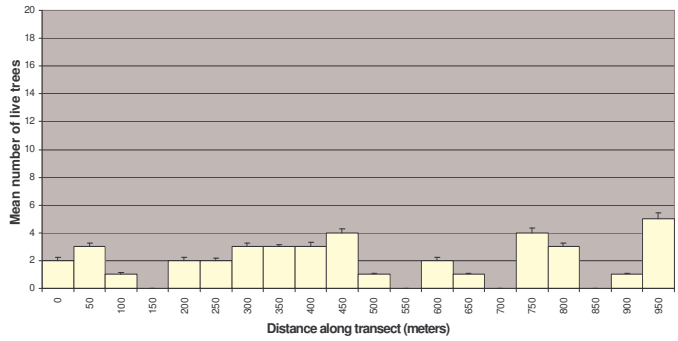


Figure 22 : Mean Number of Live Trees in the Reserve Around Tandai (N=177).

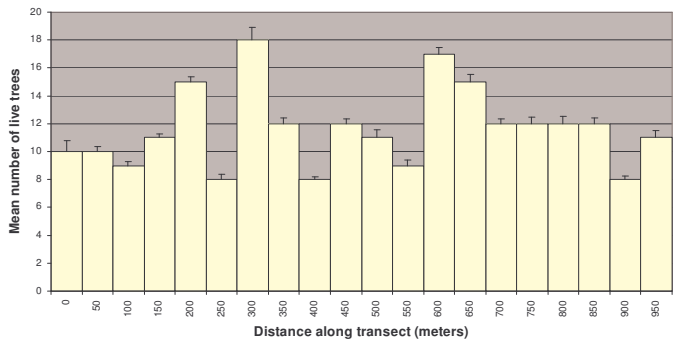


Figure 23 : Mean Number of Live Trees in the Reserve Around Lanzi (N=180).

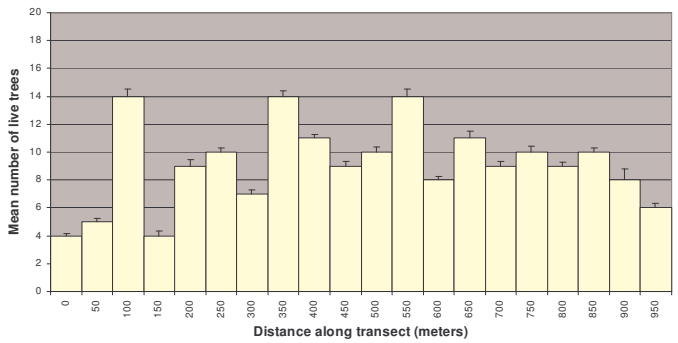


Figure 24 : Mean Number of Live Trees in the Reserve Around Nyandira (N=180).

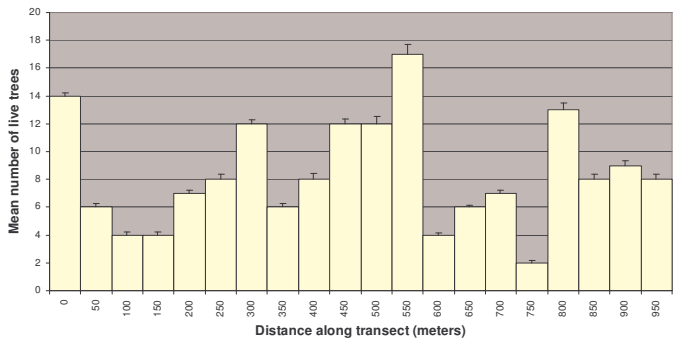


Figure 25 : Mean Basal Area of Live Trees in the Public Land Around Tandai (N=176).

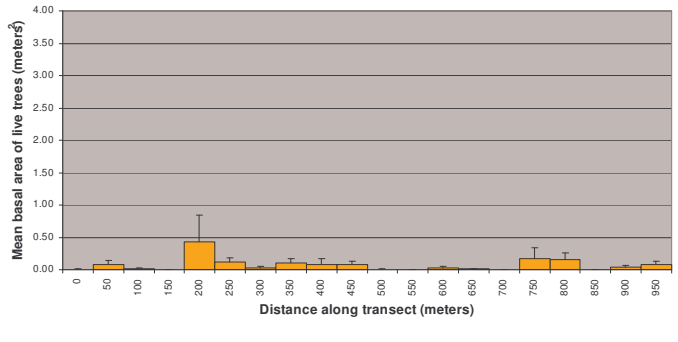


Figure 26 : Mean Basal Area of Live Trees in the Reserve Around Tandai (N=177).

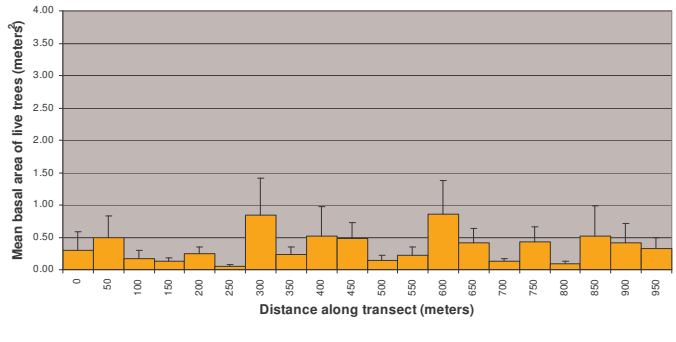


Figure 27 : Mean Basal Area of Live Trees in the Reserve Around Lanzi (N=180).

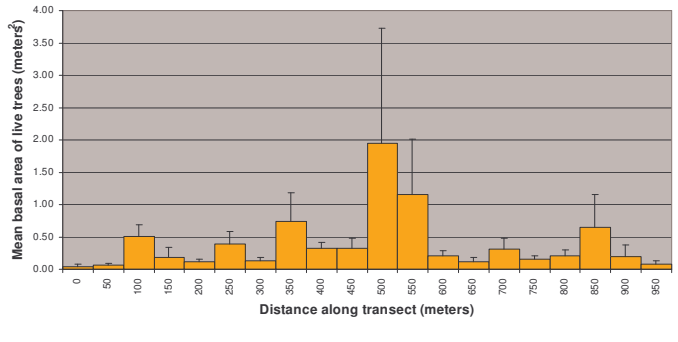
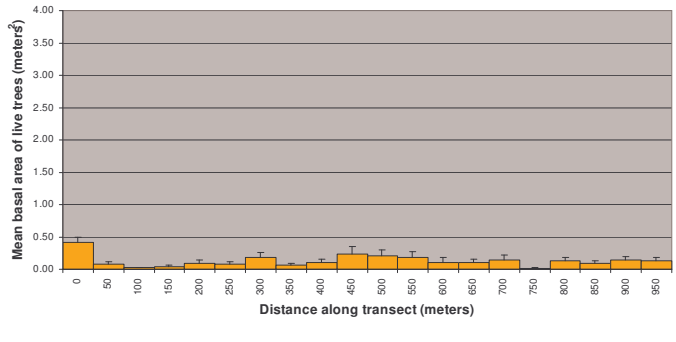


Figure 28 : Mean Basal Area of Live Trees in the Reserve Around Nyandira (N=180).



As has been mentioned care should be used in interpreting the following data since the three reserve sites are topographically different and so it would be expected that the vegetation structure would also be different. This data has been put into an access database that can be analyzed by altitude and aspect of slopes, the data here is only used to show the differences that topography can have on the vegetation, and why the database should be used.

The exception to this are the Samples in Tandai and the Public lands, both of these were choose for another project looking at the effects of policy on deforestation and so care was taken to choose two sites that were of similar topography. So the two sites can be compared, this has been done in the previous report (Hymas, 2000a).

In the Nyandira site eucalyptus marks the border of the reserve, if these were not included then there would be very few trees at the start of these transects (Figure 24) and the basal area would be lower (Figure 28). Behind this boundary line of trees the edge of the forest has been degraded to about 150 meters into the reserve after which the number of trees increases. In both the Lanzi and Nyandira sites the number of trees decrease at the end of the transect this seems to be natural, since at the end of the Lanzi transect the canopy starts to thin out, while at of the Nyandira transects large clearing being to occur (Figure 23 and 24).

Basal area along the transects of the three reserve sites is more or less constantly lowest in Nyandira (Figure 28), even though there is more vegetation in the Nyandira site than in the Lanzi site (Figure 23). This may indicate that the trees in Nyandira are of a smaller diameter than those in Lanzi, if the sites were of the same topographically it could be concluded that the larger trees have been extracted from the Nyandira site, but this is not possible due to the differences. In the future it may be possible to look at this with the Access database.

Figure 29 : Mean Number of Live Poles in the Public Land Around Tandai (N=176).

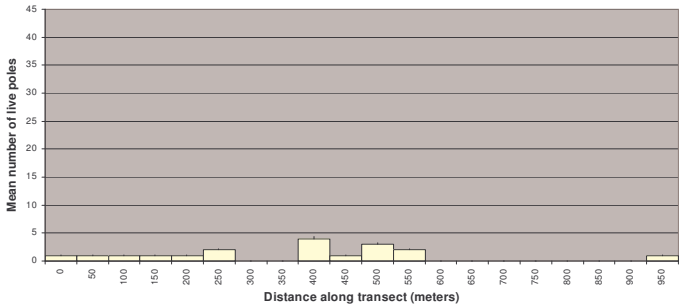


Figure 30 : Mean Number of Live Poles in the Reserve Around Tandai (N=177).

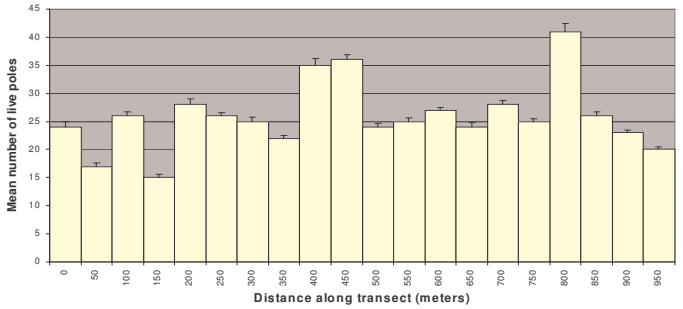


Figure 31 : Mean Number of Live Poles in the Reserve Around Lanzi (N=180).

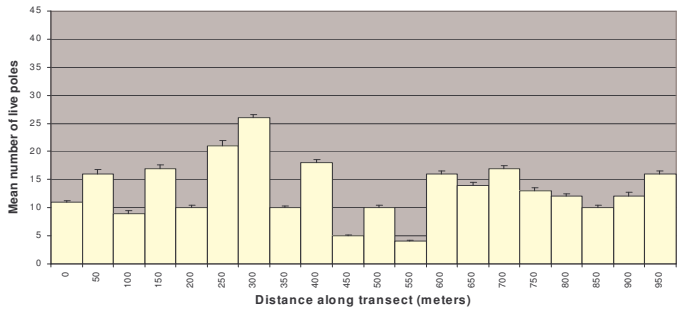


Figure 32 : Mean Number of Live Poles in the Reserve Around Nyandira (N=180).

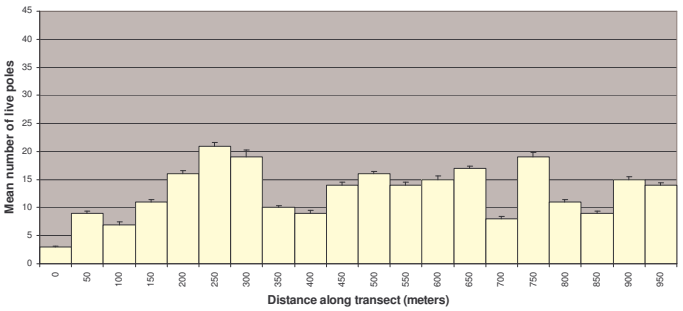


Figure 33 : Mean Basal Area of Live Poles in the Public Land Around Tandai (N=176).

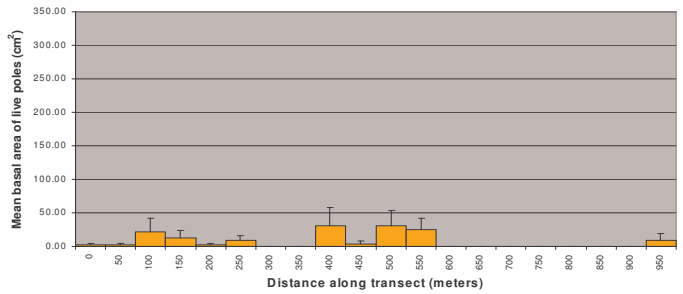


Figure 34 : Mean Basal Area of Live Poles in the Reserve Around Tandai (N=177).

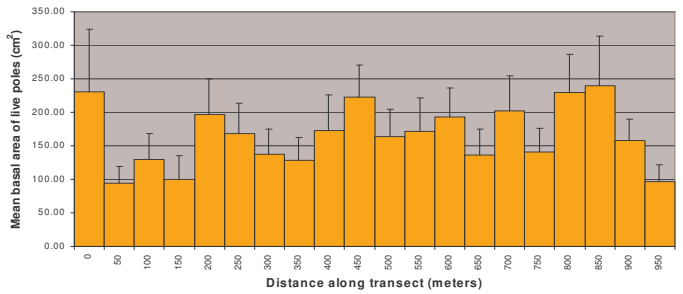


Figure 35 : Mean Basal Area of Live Poles in the Reserve Around Lanzi (N=180).

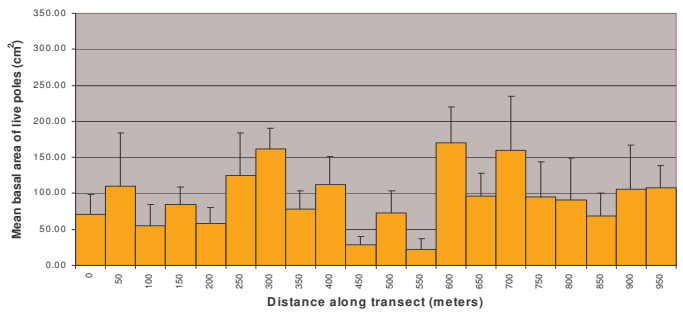
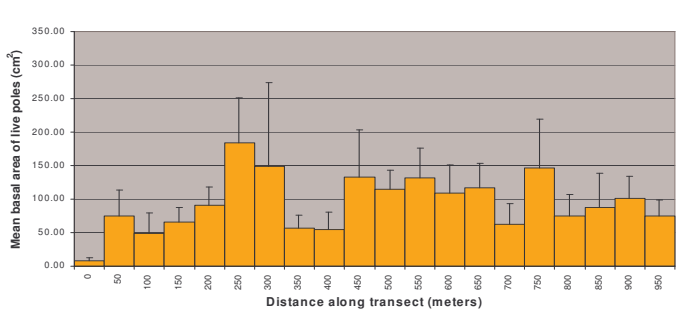


Figure 36 : Mean Basal Area of Live Poles in the Reserve Around Nyandira (N=180).



The number of poles (Figures 29 to 32) and the basal area of the poles (Figures 33 to 36) is constantly highest along the transects of Tandai. While at the start of the Nyandira transect there is a low basal area of poles with few poles (Figures 32 and 36) these are also the areas that are most damaged.

Figure 37 : Mean Number of Live Saplings in the Public Land Around Tandai (N=176).

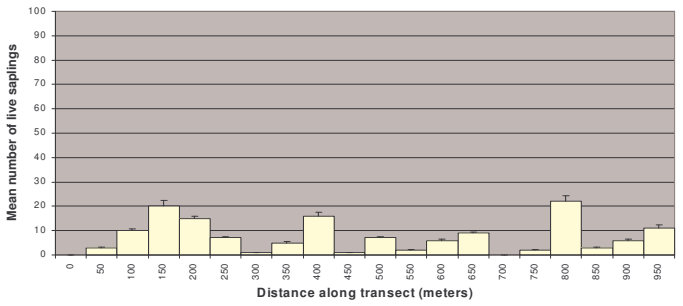


Figure 38 : Mean Number of Live Saplings in the Reserve Around Tandai (N=177).

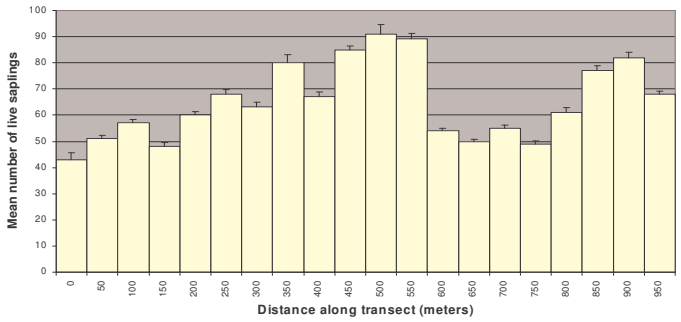


Figure 39 : Mean Number of Live Saplings in the Reserve Around Lanzi (N=180).

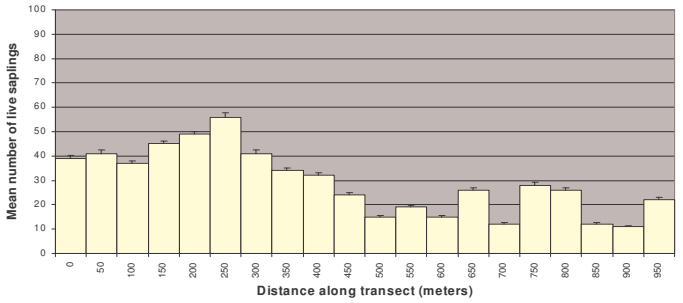


Figure 40 : Mean Number of Live Saplings in the Reserve Around Nyandira (N=180).

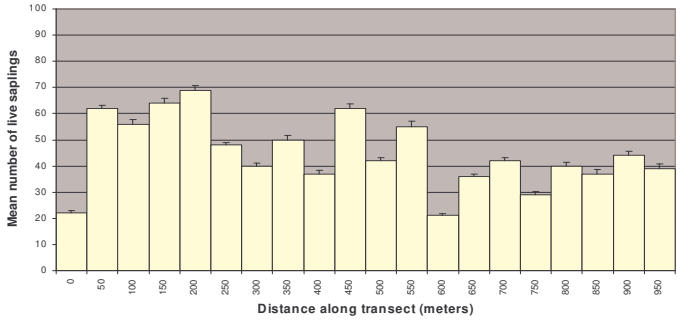


Figure 41 : Mean Basal Area of Live Saplings in the Public Land Around Tandai (N=176).

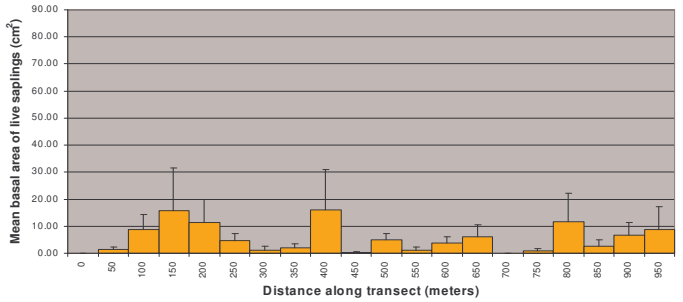


Figure 42 : Mean Basal Area of Live Saplings in the Reserve Around Tandai (N=177).

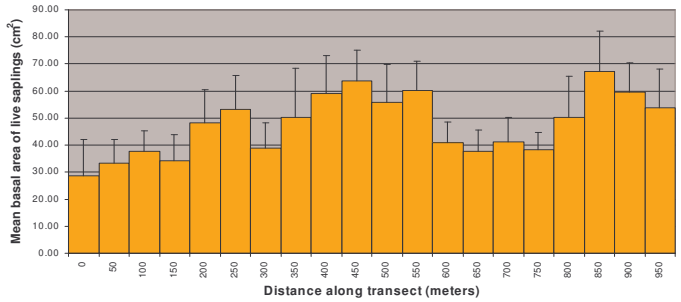


Figure 43 : Mean Basal Area of Live Saplings in the Reserve Around Lanzi (N=180).

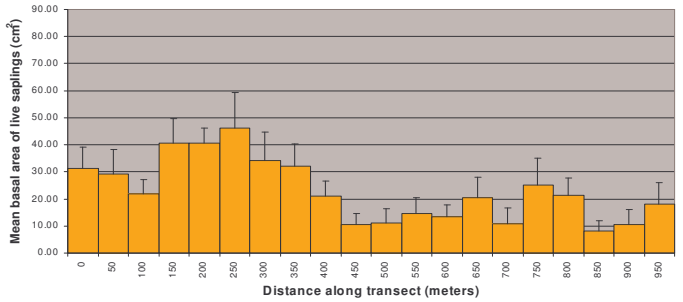
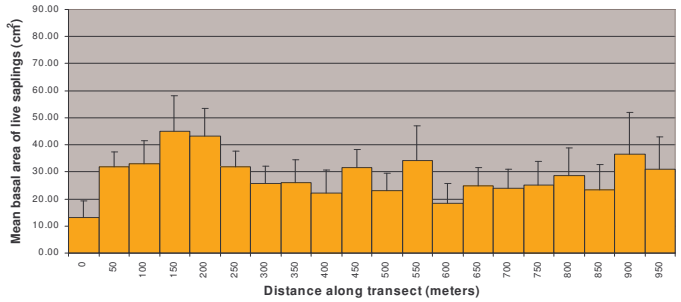


Figure 44 : Mean Basal Area of Live Saplings in the Reserve Around Nyandira (N=180).



As with the poles Tandai has more saplings than the other two reserve sites (Figures 38). In Lanzi it seems that there are more saplings at the start of the transect than at the end, but it should be noted that towards the end of the transect the canopy was thining and more grasses, which may hinder the growth of saplings (Figures 39). The same is also found in Nyandira (Figures 40) except for the very first sample where fewer saplings were found.

Figure 45 : Average Basal Area of Trees in the Different Sites.

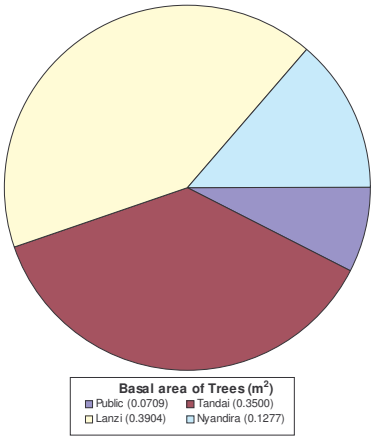


Figure 46 : Average Basal Area of Poles in the Different Sites.

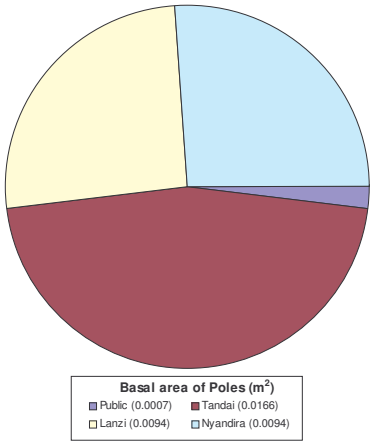


Figure 47 : Average Basal Area of Saplings in the Different Sites.

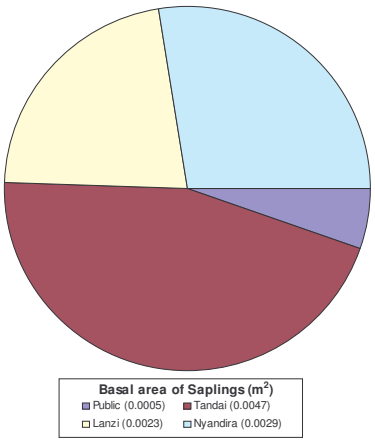
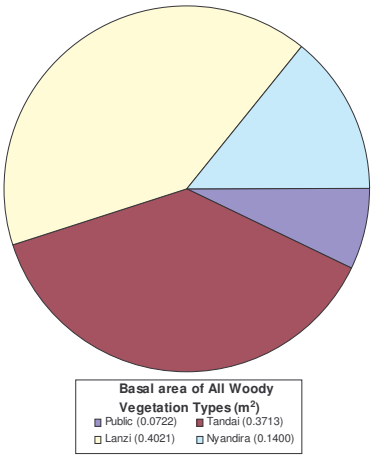


Figure 48 : Average Basal Area of All Woody Vegetation in theDiffrent Sites.



Lanzi has the largest total vegetation basal area of all the sites (Figure 48), with it having the largest tree basal area (Figure 45). But Tandai has the largest basal area for poles and saplings (Figure 46 and 47). In all cases the Public land has the lowest basal area (Figures 45 to 48). Out of the reserve areas Nyandira has the lowest total basal area of the sites (Figure 48), yet it has the highest basal area for saplings, this may be a reflection of vegetation regrowth.

Table 12 : Basal area of saplings, poles and trees in the different sites.

Site	Number of samples	Total basal area of Saplings (m^2)	Poles (m^2)	Trees (m^2)	Total basal area (m^2)
Public	176	0.09	0.13	12.48	12.71
Tandai	177	0.84	2.93	61.94	65.71
Lanzi	180	0.42	1.69	70.27	72.37
Nyandira	180	0.52	1.70	22.99	25.20

Table 13 : Number and basal area of trees per m^2 in the different sites.

Sites	Number of samples	Area of site (m^2)	Number of trees in site	Number of trees / m^2	Total tree basal area (cm^2)	Total tree basal area per m^2 (cm^2 / m^2)
Public	176	1056	40	0.04	124,811.38	118.19
Tandai	177	1062	232	0.22	619,432.81	583.27
Lanzi	180	1080	182	0.17	702,690.80	650.64
Nyandira	180	1080	167	0.15	229,856.50	212.83

Table 14 : Number and basal area of poles per m^2 in the different sites.

Sites	Number of samples	Area of site (m^2)	Number of poles in site	Number of poles / m^2	Total pole basal area (cm^2)	Total pole basal area per m^2 (cm^2 / m^2)
Public	176	1056	18	0.02	1,317.71	1.25
Tandai	177	1062	517	0.49	29,310.21	27.60
Lanzi	180	1080	267	0.25	16,867.96	15.62
Nyandira	180	1080	257	0.24	16,967.27	15.71

Table 15 : Number and basal area of saplings per m^2 in the different sites.

Sites	Number of samples	Area of site (m^2)	Number of saplings in site	Number of saplings / m^2	Total sapling basal area (cm^2)	Total sapling basal area per m^2 (cm^2 / m^2)
Public	176	1056	146	0.14	948.85	0.90
Tandai	177	1062	1298	1.22	8,387.36	7.90
Lanzi	180	1080	584	0.54	4,162.06	3.85
Nyandira	180	1080	895	0.83	5,157.10	4.78

Table 16 : Number and basal area of all the vegetation per m^2 in the different sites.

Sites	Number of samples	Area of site (m^2)	Total amount of vegetation in site	Total amount of vegetation / m^2	Total vegetation basal area (cm^2)	Total vegetation basal area per m^2 (cm^2 / m^2)
Public	176	1056	204	0.19	127,077.94	120.34
Tandai	177	1062	2047	1.93	657,130.38	618.77
Lanzi	180	1080	1033	0.96	723,720.82	670.11
Nyandira	180	1080	1319	1.22	251,980.87	233.32

Lanzi has the highest basal area per meter of all the sites, it has a total vegetation basal area per meter squared of 670.11 cm^2 / m^2 (trees = 650.64 cm^2 / m^2, poles = 15.62 cm^2 / m^2, saplings = 3.85 cm^2 / m^2). Interestingly it has the lowest amount of vegetation of the three reserve sites with 0.96 woody plant per m^2 (Table 16), indicating that the individual trees in Lanzi have a larger basal area that the other reserve sites. Nyandira has the lowest total vegetation basal area per meter squared with 233.32 cm^2 / m^2 (trees = 212.83 cm^2 / m^2, poles = 15.71 cm^2 / m^2, saplings = 4.78 cm^2 / m^2), thought it has a higher basal area per meter square for the poles and saplings than Lanzi (Table 14 and 15).

Ground, Scrub and Canopy cover

As with the Vegetation structure, the following data is influenced by topography, the data should therefore also be treated with care.

Figure 49 : Average Ground Cover in the Public Land Around Tandai (N=176).

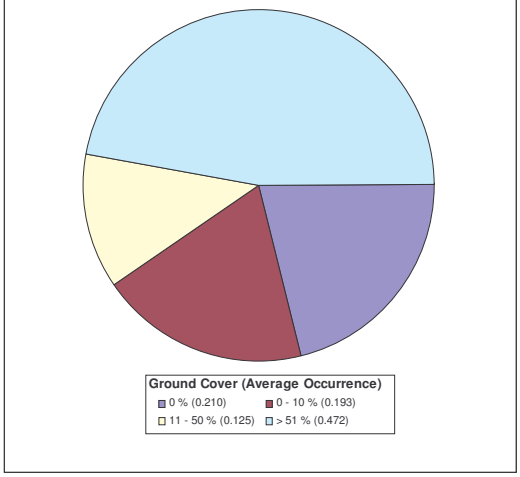


Figure 50 : Average Ground Cover in the Reserve Around Tandai (N=177).

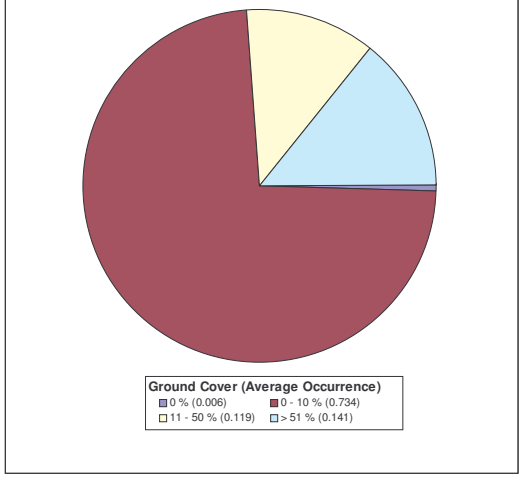


Figure 51 : Average Ground Cover in the Reserve Around Lanzi (N=180).

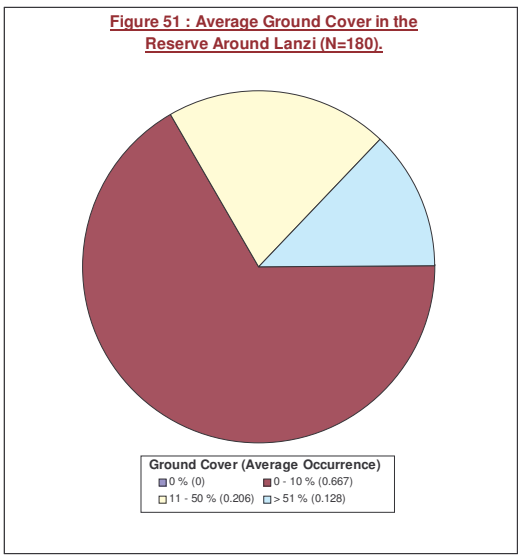
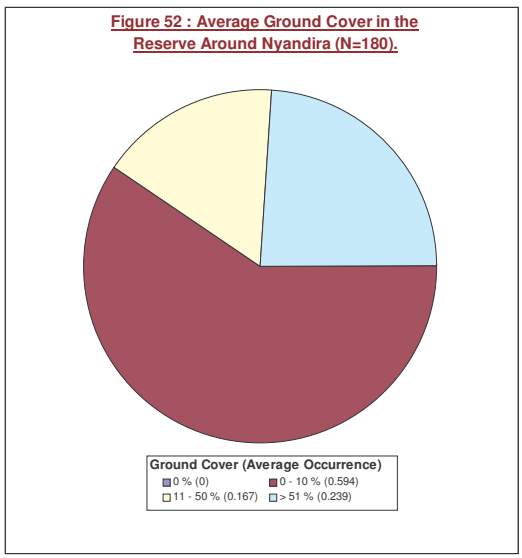


Figure 52 : Average Ground Cover in the Reserve Around Nyandira (N=180).



The Nyandira site has the largest occurrence of ground cover over 50 % of the three forest sites (occurrence >50% in Table 17 and Figure 52), so it is in this site that there is the most vegetation at ground level. While Tandai has the least vegetation cover at ground level, with it having the highest occurrence of cover in the 0 to 10 % category of ground cover (Figure 50).

Table 17 : Total and average occurrence of ground cover in the different percent categories.

Site	Number of samples	Total occurrence of ground cover				Average occurrence of ground cover			
		0%	0-10%	11-50%	>50%	0%	0-10%	11-50%	>50%
Public	176	37	34	22	83	0.210	0.193	0.125	0.472
Tandai	177	1	130	21	25	0.006	0.734	0.119	0.141
Lanzi	180	0	120	37	23	0.000	0.667	0.206	0.128
Nyandira	180	0	107	30	43	0.000	0.594	0.167	0.239

Figure 53 : Scrub Cover in the Public Land Around Tandai (N=176).

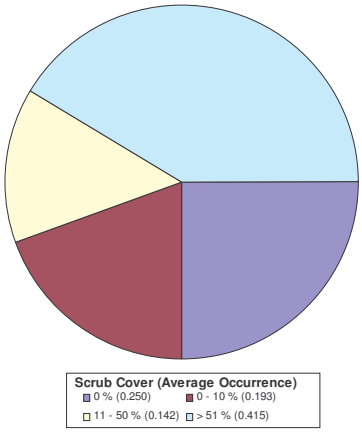


Figure 54 : Average Scrub Cover in the Reserve Around Tandai (N=177).

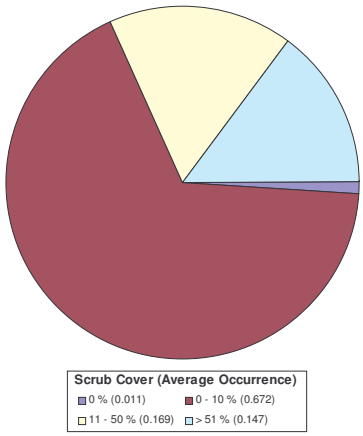


Figure 55 : Average Scrub Cover in the Reserve Around Lanzi (N=180).

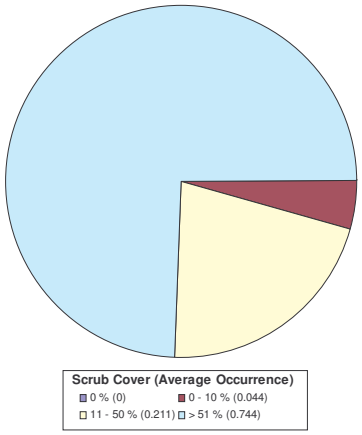
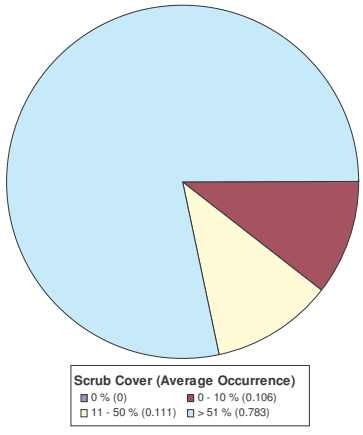


Figure 56 : Average Scrub Cover in the Reserve Around Nyandira (N=180).



Lanzi and Nyandira have a large amount of scrub cover (Table 18, Figure 55 and 56) with most of the samples being in the category of more than 50 %, this is different from Tandai where there was little scrub cover (Table 18 and Figure 54). It should be noted that there was a difference in season between the transects done in Lanzi and Nyandira and that of Tandai, which may account for this diffrence.

Table 18 : Total and average occurrence of scrub cover in the different percent categories.

Site	Number of samples	Total occurrence of scrub cover				Average occurrence of scrub cover			
		0%	0-10%	11-50%	>50%	0%	0-10%	11-50%	>50%
Public	176	44	34	25	73	0.250	0.193	0.142	0.415
Tandai	177	2	119	30	26	0.011	0.672	0.169	0.147
Lanzi	180	0	8	38	134	0.000	0.044	0.211	0.744
Nyandira	180	0	19	20	141	0.000	0.106	0.111	0.783

Figure 57 : Average Canopy Cover in the Public Land Around Tandai (N=176).

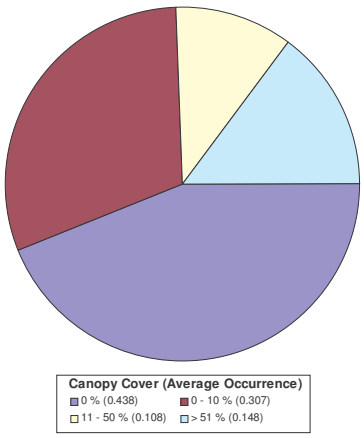


Figure 58 : Average Canopy Cover in the Reserve Around Tandai (N=177).

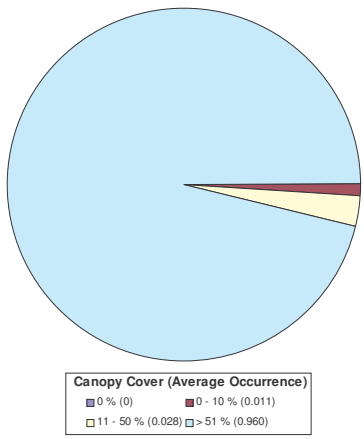


Figure 59 : Average Canopy Cover in the Reserve Around Lanzi (N=180).

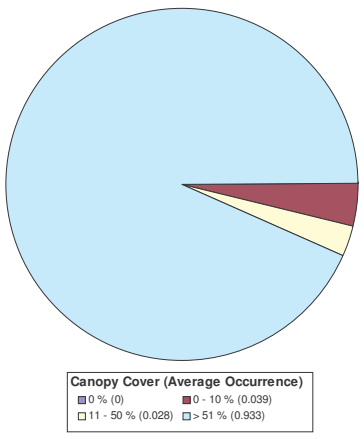
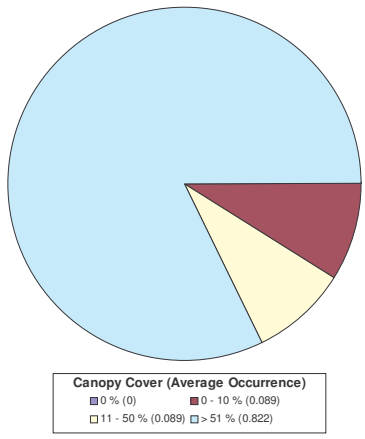


Figure 60 : Average Canopy Cover in the Reserve Around Nyandira (N=180).



Nyandira has a canopy more open than the other two reserve sites, with more occurrences in the 0 % and 0-10 % categories (Table 19 and Figure 60). Certainly higher up the transect large clearing were to be found. It is unknown whether these clearings in Nyandira are natural or due to timber extraction, from observation it seems that these clearing are natural since there is no evidence of stumps in them.

Table 19 : Total and average occurrence of canopy cover in the different percent categories.

Site	Number of samples	Total occurrence of canopy cover				Average occurrence of canopy cover			
		0%	0-10%	11-50%	>50%	0%	0-10%	11-50%	>50%
Public	176	77	54	19	26	0.438	0.307	0.108	0.148
Tandai	177	0	2	5	170	0.000	0.011	0.028	0.960
Lanzi	180	0	7	5	168	0.000	0.039	0.028	0.933
Nyandira	180	0	16	16	148	0.000	0.089	0.089	0.822

Figure 61 : Average Canopy Height in the Public Land Around Tandai (N=176).

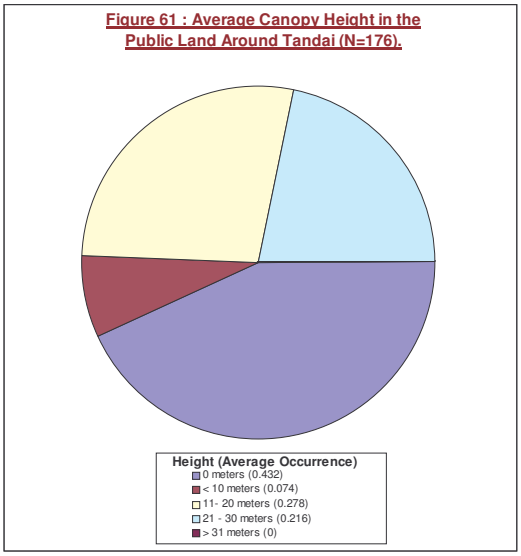


Figure 62 : Average Canopy Height in the Reserve Around Tandai (N=177).

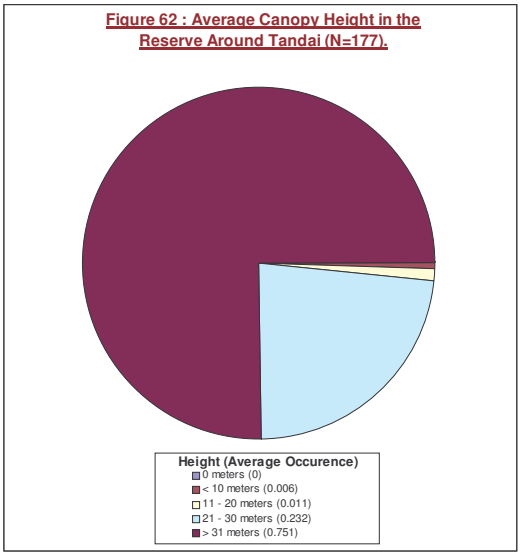


Figure 63 : Average Canopy Height in the Public Land Around Lanzi (N=180).

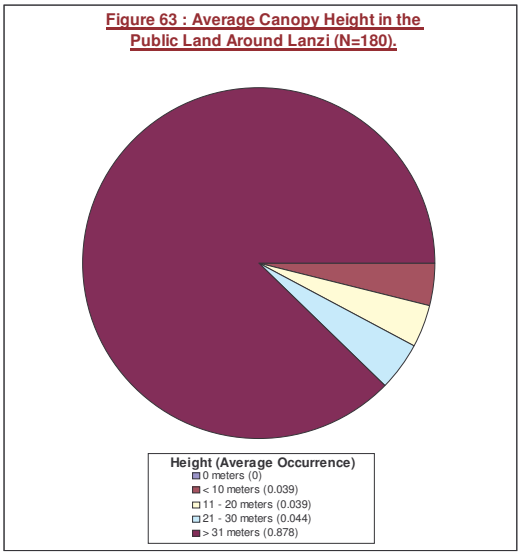
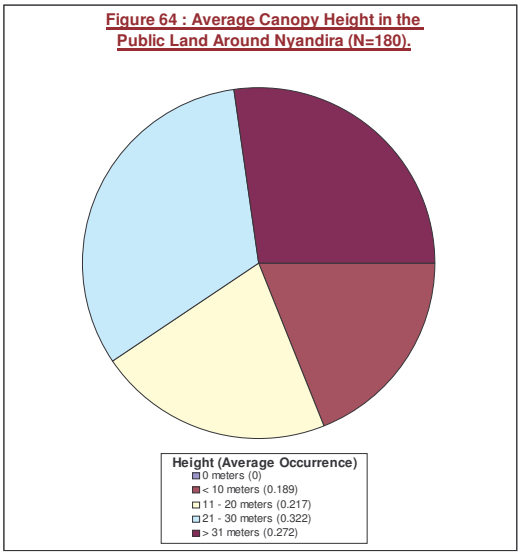


Figure 64 : Average Canopy Height in the Public Land Around Nyandira (N=180).



In Tandai and Lanzi most of the tree canopy is greater than 31 meters (Table 20, Figure 62 and 63), in Nyandira it is usually between 21 to 30 meters (Table 20 and Figure 64). As with the canopy cover and basal area this cannot be used as an indication of degradation, since this site is higher up than the other two forest sites it can be expected that the trees are smaller. This can easily be observed when walking in the forest since you start in a dimly light forest with the canopy high above and end up walking with in a brightly light forest with the canopy just above.

Table 20 : Total and average occurrence of canopy height in the different height categories.

Site	Number of samples	Total occurrence of canopy height					Average occurrence of canopy height				
		0 m	< 10 m	11 - 20 m	21 - 30 m	>31 m	0 m	< 10 m	11 - 20 m	21 - 30 m	>31 m
Public	176	76	13	49	38	0	0.432	0.074	0.278	0.216	0.000
Tandai	177	0	1	2	41	133	0.000	0.006	0.011	0.232	0.751
Lanzi	180	0	7	7	8	158	0.000	0.039	0.039	0.044	0.878
Nyandira	180	0	34	39	58	49	0.000	0.189	0.217	0.322	0.272

Discussion

With a vegetation basal area per meter squared of 233.32 cm^2 / m^2 (trees = 212.83 cm^2 / m^2, poles = 15.71 cm^2 / m^2, saplings = 4.78 cm^2 / m^2) Nyandira has the lowest vegetation basal area per meter squared of the three forest reserve sites (Table 16). Lanzi has 0.96 woody plants / m^2 which is the lowest amount of vegetation per meter squared of the three reserve sites (trees = 0.17 trees / m^2, poles = 0.25 poles / m^2 and saplings = 0.54 saplings / m^2) (Table 16).

These two statistics cannot be used by themselves as evidence that forest disturbance is greatest at these site, since the three sites differ in topography which could effect the vegetation structure and species. This can be seen when looking at the vegetation basal area per meter squared of Lanzi which is 670.11 cm^2 / m^2 (trees = 650.64 cm^2 / m^2, poles = 15.62 cm^2 / m^2, saplings = 3.85 cm^2 / m^2) (Table 16), this is the highest of the three sites. It could be suggested that the low amount of woody vegetation per meter squared and the high vegetation basal area per meter squared is evidence of a forest that has many large trees, which have not yet been cut.

Its only when the percent of vegetation damaged is looked at can we draw some conclusion. The percent amount of vegetation damaged has to be looked at rather than the amount of damage at the different sites, since the amount of vegetation in the sites are different. When this is done Lanzi with Tandai come up with the lowest amount of damage, 7.52 % and 7.54 % respectively (Table 3). Nyandira comes up with 11.42 % of damage this is the highest of the three forest reserve site, but this is not as high as the public land which has 54.97 % of the vegetation damaged (Table 3).

The difference in the amount of damage between Lanzi and Nyandira and Tandai and Nyandira is significantly different when a G-test is carried out to test for homogeneity (Table 4 and 6). While the difference between Lanzi and Tandai is significantly the same (Table 5). This indicated that the amount of damage when Nyandira is compared to the other two forest sites is not the same, where as the amount of damage occurring between Lanzi and Tandai is similar.

A second method used to measure forest disturbance was through the recording of presence or absence of disturbance at each sample along the transects. This shows that the site with the highest occurrence of no damage being in Lanzi, with Nyandira having the lowest occurrence of no damage (Table 7).

The observation that people have made concerning the relationship between forest disturbance and population density seems to be confirmed by this data. Nyandira with the higher population (Table 3) is also the area where the most disturbance to the forest is occurring (Figure 1). It is also in this site where the least naturally dead woody vegetation occurs (Table 8 and Figure 10). This be probably due to all the naturally dead plant material being collected, during the data collection it was observed that the guide regularly hit dead vegetation as he passed, taking the material that was easily extractable. The lack of naturally dead plant material indicates that the harvesting of such wood by the villagers in this area is no longer sustainable. If there are no other alternative for firewood in Nyandira then villagers will resort to cutting trees for fuel wood. This is clearly taking place in Nyandira with the constant thudding of a ax being heard in both the plantations in the public lands and to a lesser extent trees in the reserve. Only in the Public forest of Kinole is the same sound continually heard. During discussion with villagers in Nyandira carried out in a previous study (Hymas, 2000b), people also mentioned that the plantations in the area are quickly being cut.

Timber harvesting was also found in Nyandira, this is very likely due to the ease of transporting out the timber. In other areas local people have mentioned that the reason that trees, including trees of value, have not been extracted out of the reserve is due to poor transport (Hymas, 2000b). An example of this can be found in transect 6 in Lanzi where a Campher tree was found next to the boundary of the reserve (admittedly people had started to ring bark it, but this was long in the past

since the wound was covered in climbers). Campher is one of the most valuable trees in Tanzania (discussion with Mhagama, 2001), and is not found around Nyandira.

One of the reason that there is a high population in Nyandira is due to its infrastructure. It is one of the most developed areas in the mountains, with techniques such as bench terracing being introduced during colonialism and it has been the site of development projects such as UMADEP, who first started out in this area. This may have resulted in people immigrating to the area. A previous study has found that people leave areas where there is poor infrastructure (Hymas, 2000b), which may have reduced the pressure on the forest reserve.

More research is needed to look into the effects of infrastructure such as roads and markets on populations, since it seems that it is the areas that easily accessible which have a high population and the highest degradation of the reserve. This research seems to contradict the current idea that developing an area will reduce the environmental impact that people have, in the Ulugurus it seems that the places where least damage to the reserve are the areas that have not been developed. If these finding are correct then development projects need to be aware of the impact that they may have on the environment.

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Appendix 1

Wildlife Conservation Society of Tanzania (WCST)

Uluguru Mountains Biodiversity Conservation Project
In collaboration with Uluguru Mountains Agriculture Development Project (UMBCP), Regional Natural Resources Office, and the Regional Catchment Project Office

Consultancy Agreement:

Assessment of Forest Disturbance, Uluguru Mountains

Background

The Uluguru Mountains Biodiversity Conservation Project is managed by the Wildlife Conservation Society of Tanzania and is supported by DANIDA, via a Danish NGO (Dansk Ornithologisk Forening). Partners with WCST in the Uluguru Mountains are the Regional Natural Resources Office, the Regional Catchment Project Office, and the Uluguru Mountains Agriculture Development Project (at SUA).

A sum of money has been set aside within the UMBCP to employ the services of consultants to undertake tasks which support the activities of the project and which the project staff cannot do alone. These Consultancy services include the gathering of information relevant to the conservation of biodiversity in the Ulugurus, gathering information on Forest Management in the Ulugurus, promoting tourism in the mountains, and providing advice and information materials to support efforts to improve the livelihoods of the local populations in the lands surrounding the Ulugurus forests.

General Terms

1. Olivier Hymas, hereafter termed the Consultant, agrees to complete the work outlined in Appendix 1 of this agreement. The work will be undertaken on the basis of a Consultancy and payments will follow Tanzania law on taxes.

2. The agreed budget and schedule of payments for this Consultancy agreement is outlined in Appendix 2 of this agreement. Failure to deliver agreed parts of the work will necessitate a review of the agreement and if necessary the agreement can be terminated. Funding will be dispersed through the UMBCP, based in Morogoro.

3. Monitoring of the progress of this agreement is the responsibility of WCST Project Manager and the project Technical Advisor, with support as necessary from other partners in the UMBCP.

4. If during the project period there are major disagreements between the consultant and WCST or other UMBCP partners, a solution will be sought by open discussion between the relevant partners. If it is not possible to find a solution to these disagreements, then this contract can be canceled with immediate effect. In the case of contract termination, matters arising shall be settled in the court according to Tanzania laws.

5. Payments will be made to the Consultant on the basis of imprest and retirement must be accompanied by valid receipts, or invoices for time used on the project. Payment of further installments of funds will be made only when retirement is completed for the previous installment of funds.

6. Any equipment allocated to the Consultant to assist them in their work will remain the property of the UMBCP, and must be returned to the relevant office at the end of the Consultancy. The list of allocated equipment is attached to this document.

7. The Consultant exempts WCST (or any other project partners) from any civil responsibility or liability for any damage including personal injury, loss of goods or articles or any other occurrence or eventuality suffered by the Consultant when carrying out this project. Any insurance issues are the responsibility of the consultant.

8. The Consultant, by signing this agreement, accepts that the products produced will be owned by the partners in the UMBCP (UMADEP, WCST, RNRO, Catchment Forestry), as well as DOF and DANIDA. The consultant will provide copies of the product to UMBCP at the end of the consultancy period.

9. Copyright of the product will belong to WCST in Tanzania. However, any personal materials provided by the Consultant for inclusion in the product, will remain the property of the Consultant.

Name…….Signature……..Date
WCST

Name…….Signature……..Date
Consultant

APPENDIX 2:

Terms of Reference
Olivier Hymas

Background

Under Output 3.4 of the UMBCP logical framework it is stated that:

3.4 Status reports on at least two of the Uluguru Mountain endemic species produced, ***and an assessment of forest damage made within parts of Uluguru –Forest Reserves within project area***.

In order to fulfill the forest degradation part of this output, the project has so far worked in collaboration with Olivier Hymas in 2000 when he was undertaking his MSc thesis in Tandai area. During this work he collected forest disturbance data for 9 transects through the Kitundu Hills Public Land Forest (5 transects) and through the northern portion of the Uluguru North Forest Reserve (4 transects). These data are available in Morogoro in the WCST Office.

A little forest disturbance data were also collected during the project consultancy offered to TAFORI in 2000, however the methods of the collection of these data differed from that used by Olivier and hence the data cannot be easily compared.

Proposed Tasks

1) To complete forest disturbance transects in the Tchenzema-Bunduki and Lanzi areas of the Uluguru South Forest Reserve to sample rates of tree and pole cutting and to try and see the major causes of forest degradation in these two areas. Methodology will be standardised to that used previously in Tegetero and the Kitundu Hills Public Land forests.

2) To make brief written and graphical comparison between the forest degradation seen in the Tchenzema-Bunduki and Lanzi areas, and the data already collected for Tegetero area of Uluguru North and the Katundu Hills Public Land forests in Kinole and Amini Wards.

3) To provide the data to the UMBCP in such a way that it might be used for further analysis in the future and also be regarded as a part of the existing 'UMBCP Biodiversity Database'. This is a Microsoft Access Database which currently holds specimen data for animals and plants collected by the programme. This database aims to provide a baseline of the biodiversity and forest status in the Ulugurus in 2000-2001.

Inputs from UMBCP

- Permission for Olivier Hymas to undertake the work.
- Agreement with Catchment over the areas planned for this work.
- Provision of transport to get Olivier and others to the field.
- Provision of funds for fuel, food money, and money for field assistants.
- Field equipment (maps, tent, GPS, altimeter, compass, tape measure, cooking gear etc.).
- Access to computer facilities for writing up data.

Inputs from DOF (Denmark)

- Salary on the basis of 170 DKK per day for 50 days input (total = 8.500 DKK). This will be paid directly into the Bank Account of Olivier Hymas upon successful completion of the work in Tanzania. Bank details are as follows: bank account number 00020045140 in the name of Olivier Hymas at Crédit Mutuel Nord (FRANCE), sort code 5132. More details can be got by emailing 0262502@creditmutuel.fr to the attention of Mr Bezotte.

Inputs from Olivier

- Flight to Tanzania.
- Injections and other required medical issues.
- Some field equipment (clothes, boots etc).
- 6-8 weeks time in Tanzania.

Timing
Olivier would be available to start this work in mid February 2001, and would stay in Tanzania until the end of April 2001. The report would be expected by the end of April 2001.

APPENDIX 2 : BUDGET AND PAYMENT SCEDULE

- Flight	Paid by Olivier Hymas
- Salary	Paid by DOF (see above)
- Local allowance (5000 TSH per day x 60 days)	300,000 TSH
- Field food money (2000 TSH per day x 35 days)	70,000 TSH
- Diesel	140,000 TSH
- Local guides and field assistants (2000 x 1 x 35)	70,000 TSH
- Porters (3000 x 3 x 15 days)	135,000 TSH
- Catchment Forest Officer (14 days x 2 periods x 10000)	280,000 TSH
TOTAL	**995,000 TSH**

PAYMENT SCHEDULE:

- February 2001 - Field Money	500,000 TSH
- March 2001 - Field Money	495,000 TSH
- April 2001 - Salary from DOF	Paid in Denmark