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The uses, local perceptions and ecological status of 16 woody species of Gadumire Sub-county, Uganda

John R. S. Tabuti

Abstract Populations of naturally growing woody species valued for their contribution to human livelihoods are threatened with extinction. Most at risk are those existing in human inhabited areas outside protected areas that are subjected to high population pressure and to a variety of land use demands. The sustainable utilization of these plants requires as a first step knowledge, including, their ecology and an understanding of the peoples attitudes to conservation. This study was conducted to generate data that would contribute to the management for conservation and sustainable use of woody resources. The study objectives were to document local knowledge covering the uses, status, threats, habitats and management solutions of woody species; determine the abundances, distribution and population structure of 16 woody species, and assess the conservation status of the selected woody species. The study was carried out in Gadumire Sub-county, Uganda using both an ethnobotanical approach and quantitative ecological methods. The species are multipurpose and are exploited to satisfy different subsistence needs. They had population densities ranging between 3.6 and 2630 individuals ha^{-1}, and distributions ranging between 0.3 and 39.5%. The species *Acacia hockii, Albizia zygia, Acacia seyal, Markhamia lutea* and *Albizia coriaria* had a good conservation status. The remainder of the species appear threatened either because they had low densities, frequencies or less steep size class distribution (SCD) slopes. *Securidaca longipedunculata* Fres. was not encountered at all in the study plots. Community perceptions collaborated the measured population dynamics. The major threats believed to be impacting the species by the community are the growing human population, expanding crop agriculture, poor harvesting methods and over-exploitation of the species.

Keywords Ethnobotany · Harvesting patterns · Population structure · Savanna woodland

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Introduction

Many households in tropical areas depend on wild plant parts or products gathered from wild management systems. The rural poor are especially dependant on wild plants for their subsistence. They harvest products such as firewood, construction material, food, fodder and browse fodder for their wellbeing (Walter 2001; Tabuti et al. 2003a, b, c; Tabuti et al. 2004; Ticktin 2004). Furthermore, activities related to wild plants contribute to household incomes by providing employment opportunities and cash incomes from the sale of some of the products (Shackleton et al. 1998; Walter 2001). Livelihoods dependant on gathered plants or their parts are threatened by the widely acknowledged on-going loss of plant diversity. This is especially true of wild plants found in human inhabited areas outside protected areas that are subject to high population pressure and various land use demands. These areas experience habitat degradation coming as a consequence of overgrazing, increasing crop agriculture or logging (Walter 2001; Dalle et al. 2002; National Environment Management Authority 2002; Kaimowitz et al. 2004). Furthermore plants outside protected areas are routinely over-exploited. Woody plants are especially vulnerable to human related impacts because they are slow growing (Cunningham 1993; Aumeeruddy 1994; Schippmann et al. 2002).

In order to conserve vulnerable plants for sustainable utilization it is necessary to have information on aspects such as the effect of human activities on the populations of the target plant species, their ecology (Peters 1999; Dalle et al. 2002), and local harvesting methods, existing threats and attitudes to plants conservation. The measurement of ecological status is straightforward (Hall and Bawa 1993; Lykke 1998) however the investigation of human influence on plants is complicated by the need to have long-term monitoring data on population trends. There are few species for which such long-term data exists. In the absence of this information, population dynamics are commonly inferred from population structure data. Population structures are easy to assess from single survey size class frequency distributions (Hall and Bawa 1993; Cunningham 2001; Obiri et al. 2002). From this type of data, preliminary indications of how plant populations may be affected by extractive activities or other land-uses can be attained (Hall and Bawa 1993; Lykke 1998; Peters 1999; Obiri et al. 2002; Dalle et al. 2002).

This study was conducted in Gadumire Sub-county with the specific objectives of: (1) documenting local knowledge covering the uses, status, threats, habitats and management solutions of woody species; (2) measurement of the abundances, distribution and population structure of selected woody species, and (3) assessing the conservation status of selected woody species. Some uses, but not all, of the study species were documented in an earlier study (Tabuti et al. 2003a, b, c; Tabuti et al. 2004); this current study concluded the inventory of uses. It is expected that this information will help clarify decisions for management of woody plant resources for sustainable use.

Study area

Gadumire Sub-county is one of the five sub-counties that together make up Bulamogi County (The County was upgraded to district status in 2005). It is located 200 km north-east of Kampala, the capital city of Uganda, 33°30′ – 33°35′ E and

1°04′ – 1°15′ N at an altitude of 1030–1045 m a.s.l. (Government of Uganda 1963). It is made up of five parishes, namely, Gadumire, Kisinda, Lubulo, Bupyana and Panyolo.

According to Langdale-Brown et al. (1964), *Albizia-Combretum* woodlands and *Cyperus papyrus* swamp vegetation types dominate in the Sub-county. The most extensive soil type of Gadumire is the Mazimasa complex of catenas. This soil type is usually a shallow grey or brown sandy loam on laterite base rock (Ollier and Harrop 1959; Department of Land and Survey 1962). Other types are the mineral and organic hydromorphic soils influenced by permanent or seasonal water logging.

The Sub-county has an estimated population of 22,344 people and a population density of approximately 250 people/km². The population of Bulamogi is growing at a rate of 3% per annum (Uganda Bureau of Statistics 2005), and has more than tripled in the last four decades from an estimated 60–95 people/km² in 1962 to 180 people/km² by 2002 (Department of Land and Survey 1962; Uganda Bureau of Statistics 2005). The people of Gadumire are a rural peasant community whose main source of livelihood is mixed agriculture. They cultivate a variety of annual and perennial crops and keep livestock including cattle, goats and sheep.

Methods

Ethnobotanical study

Field work was carried out between August 2003 and July 2004. The study methods consisted of both an ethnobotanical study and a quantitative ecological study. This study began by holding a focus group discussion with community members using a checklist of questions. Sixteen participants (including 4 women) were selected with the help of the local area leaders to participate in the discussion. At least one participant was selected from each of the parishes of the Sub-county. All participants were over 25 years of age. During the group discussion, consensus was reached on the study species (Table 1) with regard to their uses; their preferred habitats; threats;

Table 1 Study species including their growth habit and management status. All species are indigenous apart from *Mangifera indica* L

Species	Growth habit	Management status
Acacia hockii De Wild.	Tree	Wild
Acacia seyal Del. var. *fistula* (Schweinf.) Oliv.	Tree	Wild
Albizia coriaria Oliv.	Tree	Wild
Albizia zygia (DC.) Macbr.	Tree	Wild
Antiaris toxicaria Lesch.	Tree	Wild
Carissa edulis Vahl	Shrub	Wild
Combretum collinum Fresen. subsp. *elgonense* (Exell) Okafor	Tree	Wild
Ficus natalensis Hochst.	Tree	Cultivated
Mangifera indica L.	Tree	Semi-cultivated
Markhamia lutea (Benth.) K. Schum.	Tree	Semi-cultivated
Milicia excelsa (Welw.) C.Berg	Tree	Wild
Sarcocephalus latifolius (Smith) Bruce	Shrub	Wild
Sclerocarya birrea (A. Rich.) Hochst.	Tree	Wild
Securidaca longipedunculata Fres	Shrub/Tree	Wild
Steganotaenia araliacea Hochst.	Shrub	Wild
Tamarindus indica L.	Tree	Wild

which species populations were declining or growing; which species populations were rare or abundant; and possible management solutions to protect them. The focus group discussion data was analysed and responses grouped into classes alongside the major themes of the inquiry here.

Ecological survey

The quantitative ecological study was aimed at determining the population structure, density and distribution of the study species. To achieve these objectives, the following villages were randomly selected from the five parishes that make up Gadumire Sub-county: Mpambwa (64), Bugonya (48), Nawandyo (42), Busiiro (40) Kisinda (38), Bukayale A (38), Bukayale B (37), Nyende-Igembe (35), Nabweyo (34), Nansohera (34), Kavule (31), Kyamba (31), Nandele (30), Kibale (30), Wataka (5). The numbers in parenthesis indicate study plots that were systematically placed within each village. The first plot was randomly placed. Thereafter each suceeding plot was systematically placed 50 m from the preceding one along a transect running in a south to north compass direction. Transects were followed for a maximum distance of 2000 m before a new transect would be laid out. The new transect was then laid 500 m from the preceding one.

Each study plot was nested i.e., divided up into differently sized quadrats. Within the largest quadrat of 20×50 m, large trees (≥ 30 cm dbh) were sampled; small trees (> 15 cm dbh < 30 cm dbh) were sampled in a 20×25 m quadrat placed in the larger quadrat; poles (> 5 cm dbh < 15 cm dbh) in a 10×25 m quadrat; and shrubs/saplings (> 1 cm dbh < 5 cm dbh) in a 10×12 m quadrat. Seedlings (< 1 cm dbh or < 1 m high) were sampled in 1 m sq plot randomly placed in the larger plot.

In each plot individuals of the study species encountered, were enumerated and their diameter at breast height (dbh) measured and recorded. All stumps and coppices of individuals of the study species encountered in the field were treated similarly. The soil types and land use types were also recorded according to the local classification.

Data analysis

Population structure

Data from all the study plots (537) was pooled together for the analysis. Diameter at breast height data were grouped into 27 size classes: 0–0.9, 1–1.9, 2–2.9, 3–4.9, 5–6.9, 7–8.9, 9–10.9, 11–13.9, 14–16.9, 17–19.9, 20–23.9, 24–27.9, 28–31.9, 32–35.9, 36–39.9, 40–43.9, 44–47.9, 48–51.9, 52–55.9, 56–59.9, 60–69.9, 70–79.9, 80–89.9, 90–99.9, 100–109.9 and 110–129.9 cm. The last size class included all individuals ≥ 130 cm. The class widths were made progressively wider as dbh increased from individuals with small dbh to those with larger dbh. This was done to balance samples across size classes because the number of individuals generally declines with size class (Condit et al. 1998).

For each species, the number of individuals per hectare (N_i) in each size class was plotted against class midpoint (d_i). In addition, for each species, a least-squares linear regression slope was calculated for the size class distribution (SCD) using the

software SPSS for windows. The size-class midpoint (d_i) was treated as the independent variable and the density (N_i) in each size class as the dependent variable. In order to get straight line plots the N_i was transformed by ln ($N_i + 1$) because some classes had zero individuals. The regression was calculated between ln (d_i) and ln ($N_i + 1$) (see Condit et al. 1998). This regression model was chosen over the ln (N_i) vs. d_i used by Lykke (1998) and Obiri et al. (2002) because it explained most of the variation around the regression line for 10 of the 15 species ($r^2 \geq 0.5$).

When computing the slope, only size classes up to the largest size class with individuals were included. Larger size classes without individuals were omitted. The SCD slope was used to summarize in a single number the shape of the SCD for each species (Condit et al. 1998). In this analysis negative slopes (indicative of reverse J-shaped SCD) imply stable populations that are naturally replacing themselves. While weak-negative slopes and flat slopes are taken to mean poor recruitment and declining populations (Hall and Bawa 1993; Lykke 1998; Obiri et al. 2002). Conclusions about the population structures for the different species were made on the basis of the SCD slopes and the graphical SCD plots.

Harvesting index

The influence of a tree species and stem sizes on the likelihood that an individual of a species would be harvested was estimated by a harvesting index (HI), calculated as the proportion of harvested stems (stumps ha^{-1}) to the harvestable stems (stumps and standing trees ha^{-1}) (Obiri et al. 2002). The HI was calculated only for species that had more than 10 stumps.

Species distribution and environmental variables

The relationship between species distribution and the environmental variables of habitats or land use types, and soil types were investigated by the Canonical Correspondence Analysis procedure using the software PC-ORD for windows version 4.2. Canonical ordination techniques help detect patterns of variation in species data that can be explained by environmental variables. The resulting ordination diagrams expresses both patterns of variation in species composition and the main relationships between the species and each of the environmental variables (Jongman et al. 1995).

Results

Community knowledge of uses of woody species, their status, habitats and threats

Uses of the species

The study species have multiple uses; *Ficus natalensis* had the highest number of uses (14) and *Securidaca longipedunculata* the least reported uses (2). Parts of the species are harvested for use in treating and feeding of both humans and livestock, to provide energy for cooking (firewood and charcoal), and for construction materials (Table 2). The species also have spiritual value. Field observations revealed that some plant products such as timber, charcoal, firewood, crafts and mangoes are sold in the community.

Table 2 Reported uses; major uses are denoted with ⊗ (Hm = human medicine, Ev = ethnoveterinary medicine, Fw = firewood, Char = charcoal, Spir = Home for spirits or other spiritual use)

Species	Hm	Ev	Food	Fo	Fw	Char	Timber	Construction	Crafts	Spir.	Minor uses[a]
Carissa edulis	⊗	×	×	×	×	×			×		a
Milicia excelsa	×	×	×	×	×	×	⊗	×	×	×	b, c, d, e, f, g
Acacia hockii	×	×		×	×	×		⊗	×		c
Albizia coriaria	×	×		×	×	⊗		×	×	×	i, j, b, k
Steganotaenia araliacea	⊗	×		×							
Acacia seyal	×	×			⊗	×		×			a, h
Sarcocephalus latifolius	⊗	×							×		l
Securidaca longipedunculata	⊗	×									
Antiaris toxicaria	×	×					×				m, n
Mangifera indica	×		⊗	×	×	×				×	c, w
Tamarindus indica	×		⊗	×	×	×	×			×	b, c
Sclerocarya birrea	×		⊗		×	⊗					
Albizia zygia	×			×	×	×	×	⊗	×	×	k, c
Combretum collinum	×			×	⊗	×					o
Ficus natalensis	×			×	⊗					×	b, c, h, n, p, q, r, s, t, u
Markhamia lutea	×			×	×	×	×	⊗	×	×	c, v

[a] a = Thorn used to extricate jiggers; b = Shade for crop plants e.g., bananas, coffee; c = Shade for people; d = rain formation; e = protect environment; f = fertiliser; g = season indicator (it shades its leaves at onset of dry season); h = Bark burnt to chase snakes; i = *Nkonkolo* (tool hit on anthills to force edible white ants out); j = Bark smoked to chase mosquitoes; k = Bark used to wash clothes; l = Dried flowers are burnt to produce smoke that forces edible white ants out of anthill; m = ignition wood used for lighting cooking fires; n = Bark used to make textile; o = ferment local beer; p = fibre used to make ropes (*ebibohe*); q = demarcate clan land; r = leaves used to make a "spoon" that is used when drinking porridge or to dispense medicine (*kadandi*); s = collect rain water; t = used by 'traditional priests' during traditional religious rituals; u = planted on graves of princes; v = ornamental plant; w = used to make juice and local gin (*waragi*)

Traditional landscape classification and species distribution

The people of Gadumire recognize the following habitats: *Mutala* = characterized by red well-drained soils, *Lusenyi* = characterized by sandy soils, *Kibali/Muiga* = characterized by seasonally or permanently water logged soils, and *Mabale* = rocky outcrops. Common landuse types in the area include: *Maka* = homestead, *Nimilo* = cultivated land, *Kisambu* = old abandoned garden field (1–3-year rest), *Kihindila* = fallow land (land of 5 years or more but before it has reverted to scrubland). The known vegetation types are: *Kigoola* = Scrubland/Shrubland, *Kibila* = closed scrub or tree forest, *Muiga* = swamp, and *Kisaka* = thicket. The people also classify soils into three types: *mutala* (red laterite well drained soils), *lusenye* (sandy loams) and *lumansi* (clayey seasonally water logged soils).

According to community knowledge, the species *Sarcocephalus latifolius* prefers thickets, while *Carissa edulis* prefers ant hills. Others namely, *Acacia hockii*,

Table 3 Local community knowledge of distribution of plants in different land and soil types

Species	Preferred habitat/soil types	Remarks
Acacia hockii	Everywhere	
Mangifera indica	Everywhere	
Albizia zygia	Everywhere	Coppices easily and sprouts readily from roots
Markhamia lutea	Everywhere	Germinates readily but is overexploited.
Tamarindus indica	Everywhere	
Milicia excelsa	Everywhere	
Steganotaenia araliacea	Well drained soils	
Combretum collinum	Well drained soils	Threatened by crop cultivation
Antiaris toxicaria	Well drained soils	
Sclerocarya birrea	Well drained soils	Seeds do not readily germinate
Albizia coriaria	Water logged or sandy loams	Protected by community where found
Acacia seyal	Water logged or well drained soils	Threatened by use as charcoal, does not germinate easily (sets few seeds), overexploited as herbal medicines.
Sarcocephalus latifolius	Well drained soils or brushland	Has slow regeneration
Securidaca longipedunculata	Well drained soils or sandy loams	Over exploited
Carissa edulis	Ant hill (water logged soils [a])	
Ficus natalensis	Homesteads	Cultural use as bark cloth is declining. As a consequence there is declining cultivation of the species.

[a] Personal observation

Mangifera indica, Albizia zygia, Markhamia lutea, Tamarindus indica, Milicia excelsa had no preferred habitats and could grow anywhere (Table 3).

Factors responsible for species population decline

Participants in the Focus Group Discussion stated that some of the study species had declined in their abundance and distributions (Table 4), and attributed such declines to: a growing human population associated with over-exploitation of the species to satisfy growing subsistence needs, and for sale; poor harvesting methods such as the harvesting of large quantities of bark and roots of *Sarcocephalus latifolius* for use as herbal medicine; conversion of woody plant habitats to other land uses such as crop agriculture or construction of homesteads; and use of bush fires to clear land for crop agriculture, affecting species that are poorly adapted to withstand fires like *Steganotaenia araliacea*.

Other factors mentioned were loss of traditional spiritual and cultural values. For instance the traditional use of bark cloth fabricated from the bark of *Ficus natalensis* has waned in the community leading to lowered cultivation of the species. Other factors mentioned were: short resting periods of agricultural land (fallows); the attitude that naturally regenerating species do not require propagating; live-stock grazing; and poor recruitment from seed by *Sclerocarya birrea* and *Acacia seyal*.

Table 4 Size class distribution least-squares regression slopes for the study species. Also shown are the community opinions regarding abundances and changes in population sizes of the study species

Species name	Slope	r^2	P value	Community opinions	
				Availability[a]	Changes in population sizes[b]
Group I					
Carissa edulis	− 2.0420	0.98	0.087	R	D
Acacia hockii	− 1.8600	0.83	0.000	VA	I
Sarcocephalus latifolius	− 1.2150	1.00	–	VR	D
Acacia seyal	− 1.0500	0.61	0.000	A	D
Albizia zygia	− 1.0340	0.62	0.000	A	I
Group II					
Markhamia lutea	− 0.8740	0.63	0.000	R	D
Combretum collinum	− 0.8380	0.66	0.001	R	D
Mangifera indica	− 0.7390	0.59	0.000	VA	I
Albizia coriaria	− 0.7180	0.56	0.000	A	I
Group III					
Antiaris toxicaria	− 0.6530	0.51	0.000	R	I
Steganotaenia araliacea	− 0.6050	0.93	0.035	R	D
Tamarindus indica	− 0.4710	0.39	0.001	R	D
Sclerocarya birrea	− 0.4440	0.54	0.010	VR	D
Milicia excelsa	− 0.3700	0.52	0.000	VR	D
Group IV					
Ficus natalensis	− 0.0518	0.31	0.004	R	D

[a] A = abundant; R = rare; VA = very abundant; VR = very rare

[b] D = declining; I = increasing

Ecological measurements

Population density and frequency

Among the studied species, the species with the highest densities were *Acacia hockii* followed by *Albizia zygia, Acacia seyal* and *Albizia coriaria* in that order (Fig. 1a). On the other hand *Sclerocarya birrea*, *Sarcocephalus latifolius* and *Ficus natalensis* were quite rare. *Securidaca longipedunculata* was not encountered at all in all the study plots.

Frequency for the species ranged from a low of 0.3% to a high of 39.5%. Apart from *Albizia coriaria* and *Milicia excelsa*, the majority of species under study were observed in less than 15% of the study plots (Fig. 1b). The Canonical Correspondence Analysis showed that the study plants avoided seasonally flooded habitats and water logged soils in preference to well drained soils (Fig. 2, 3). However, *Acacia hockii* and *Acacia seyal* appeared to thrive on water logged soils. These results are in agreement with the community perceptions on the species distribution. The cultivated species *Ficus natalensis* was associated with cultivated fields, and *Markhamia lutea* and *Mangifera indica* with homesteads.

Population structure

The study species were divided into four groups basing on their SCD regression slopes. Group I includes *Carissa edulis*, *Acacia hockii*, *Sarcocephalus latifolius*, *Acacia seyal*, and *Albizia zygia*. These species had the most negative SCD slopes
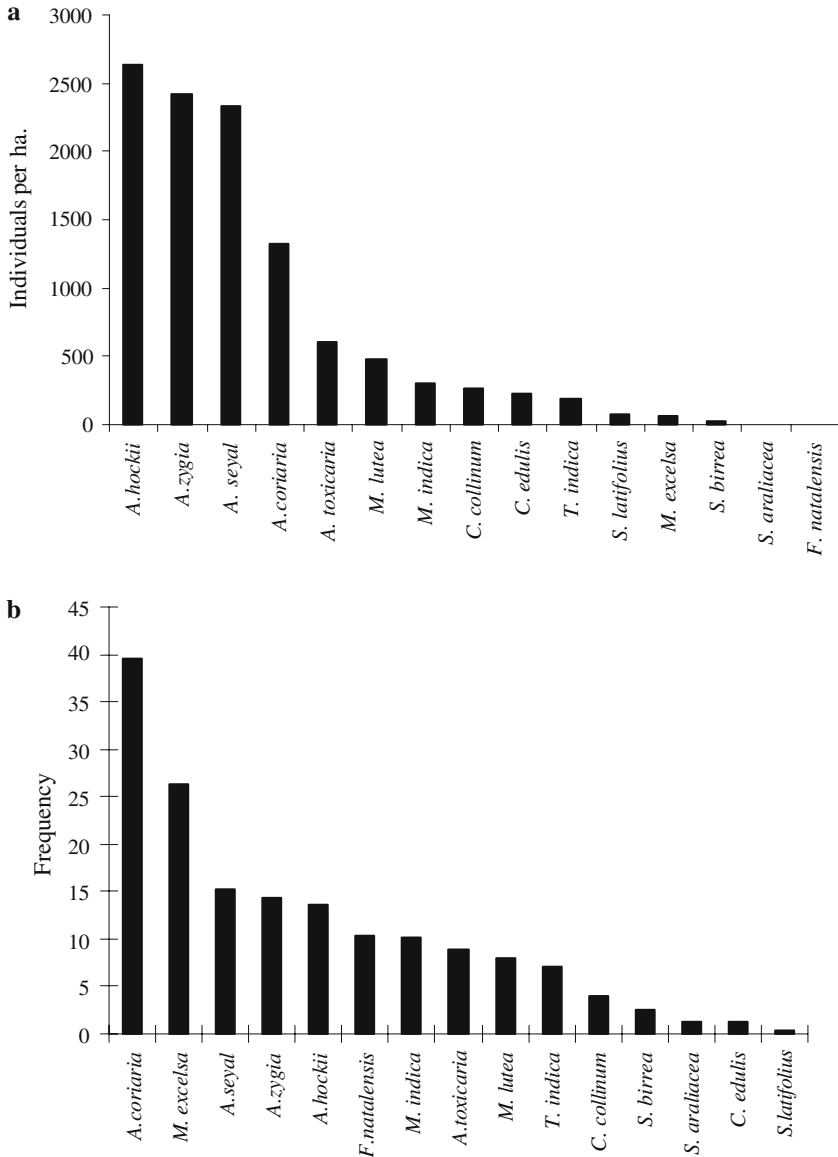
Fig. 1 (**a**) Densities (stems ha^{-1}) of the study species, (**b**) Distribution (frequency) of the study species. The densities of *Steganotaenia araliacea* and *Ficus natalensis* are 3.9 and 3.6 stems ha^{-1} respectively

ranging between – 1.034 and – 2.042 (Table 4). Group II includes *Markhamia lutea*, *Combretum collinum* Fresen. subsp. *Elgonense*, *Mangifera indica* and *Albizia coriaria*. This group exhibited a reverse J-shaped SCD but with weaker negative slopes than species in group I (– 0.718 and – 0.874). Group III includes *Antiaris toxicaria*, *Steganotaenia araliacea*, *Tamarindus indica*, *Sclerocarya birrea*, *Milicia excelsa*. Group IV contains only *Ficus natalensis*. This species had an almost flat slope – 0.0518. The SCD plots (Fig. 4) show that species in groups I and II have
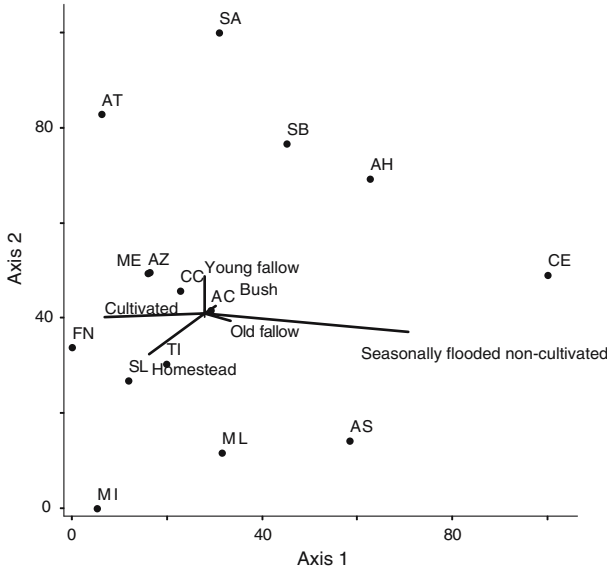
Fig. 2 Relationship between species distribution, and habitat types and land use types (AH = *Acacia hockii*; CE = *Carissa edulis*; AZ = *Albizia zygia*; AS = *Acacia seyal*; ML = *Markhamia lutea*; AC = *Albizia coriaria* Oliv.; AT = *Antiaris toxicaria*; CC = *Combretum collinum*; SL = *Sarcocephalus latifolius*; ME = *Milicia excelsa*; SB = *Sclerocarya birrea*; TI = *Tamarindus indica*; SA = *Steganotaenia araliacea*; MI = *Mangifera indica* L.; FN = *Ficus natalensis*)

Fig. 3 Relationship between species distribution and soil types. Abbreviations as in Fig. 2 (translation of soil types are in the text)
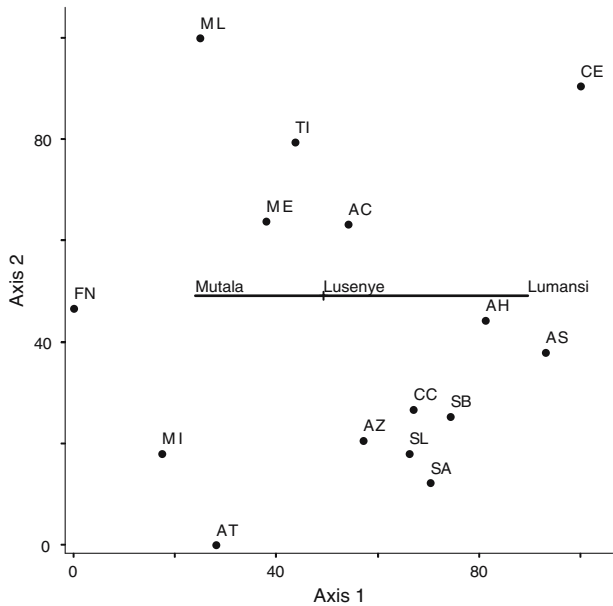
reverse J-shaped plots with relatively more individuals in the small size classes (juveniles) compared to those in the large size classes (mature/reproductive); a trend that is characteristic of species with good and stable regeneration.
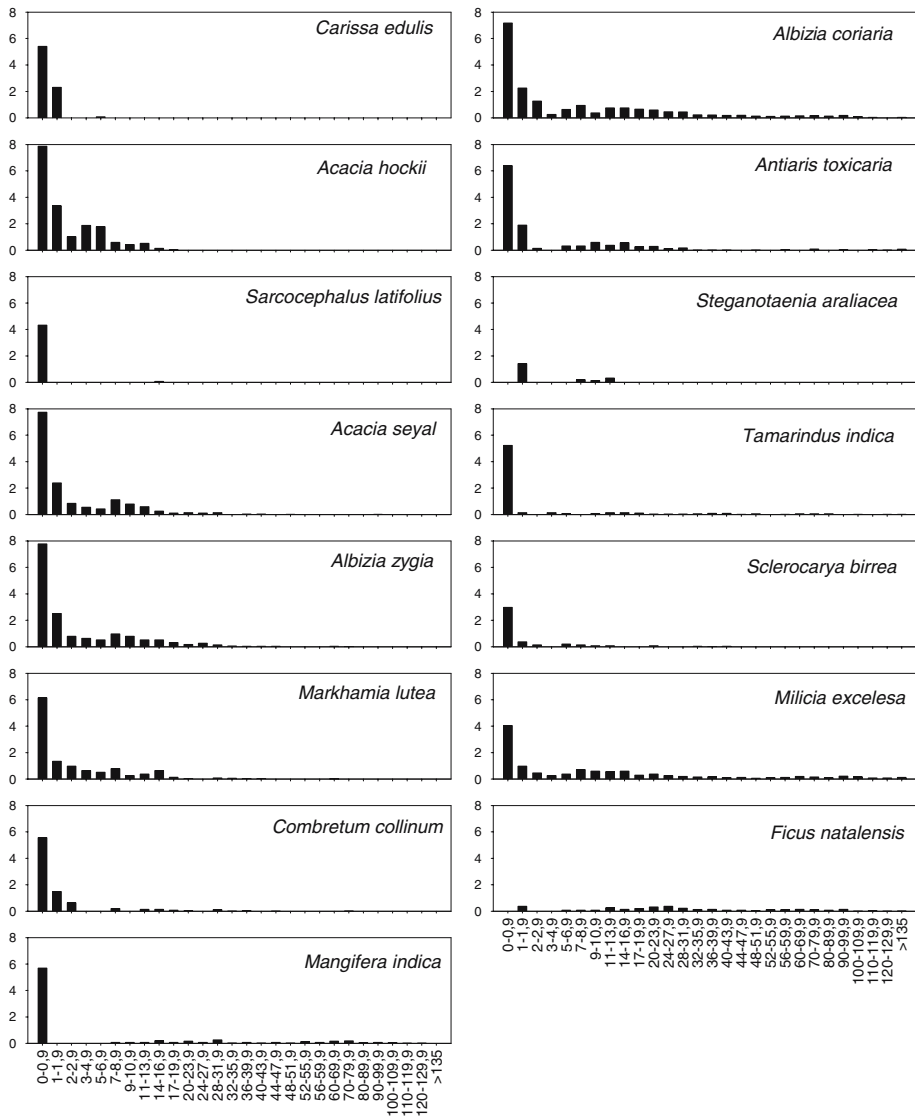
Fig. 4 Size class distributions (SCD) plots for the study species. y-axis represents ln (individuals ha^{-1} + 1) and the x-axis the diameter at breast height (cm) size classes

There was good agreement between local knowledge and results from the quantitative plant study with regard to plant population dynamics. The species for which the analysis indicated a healthy population structure, accompanied with relatively higher densities and wider distributions, were also known to be abundant and/or increasing by the local community (Table 4). Contrariwise those species known by the community to be scarce and declining had relatively weaker SCD slopes, low densities and frequencies.

All species except *Carissa edulis* and *Sarcocephalus latifolius* had coppices (Fig. 2). *Sclerocarya birrea* had an average of five coppices per stump; *Markhamia*

lutea had three; while *Acacia hockii*, *Albizia coriaria*, *Albizia zygia*, *Milicia excelsa*, *Antiaris toxicaria* had two. The rest of the study species had one coppice each per stump.

Harvesting patterns

All the species studied here are harvested destructively apart from *Steganotaenia araliacea* for which leaves are used. Stumps of all study species, excepting *Carissa edulis* and *Sarcocephalus latifolius* were found in the study area. Species with the primary use, or which possess a secondary uses, of producing firewood, charcoal or construction materials are felled down to get the required wood. For these end-uses large sized stems are harvested in preference over small sized ones (Fig. 5). Roots of *Carissa edulis* and *Sarcocephalus latifolius* are extensively harvested to produce herbal medicines.

Further to destructive harvesting, plants are also destroyed to clear land for cultivation. *Combretum collinum*, *Albizia zygia* and *Acacia seyal* had many stumps in the small size classes in areas recently cleared for cultivation. Out of the 136 plots with stumps, 113 (83%) were on lands undergoing use by community members viz cultivated fields (67), young fallows (31), cleared fields (7) and homesteads (8) (Fig. 6). This distribution highlights the negative impacts of crop cultivation on species survival.

Discussion

Importance of the study species

The woody species studied here are important to the local community, firstly the products and services acquired from them satisfy subsistence as well as cultural
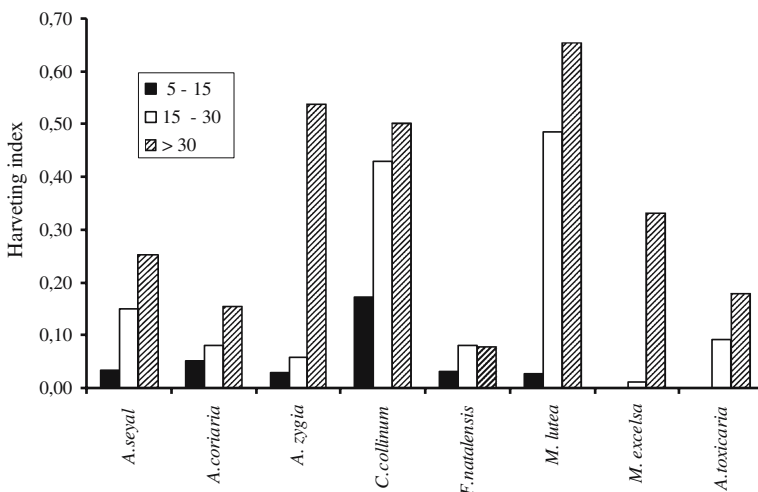

Fig. 5 Harvesting index (stumps ha^{-1}/stumps and standing trees ha^{-1}) calculated for species with 10 or more stumps. Solid bars (Dbh 5–15 cm), open bars (15–30 cm) and > 30 cm (hatched bars)
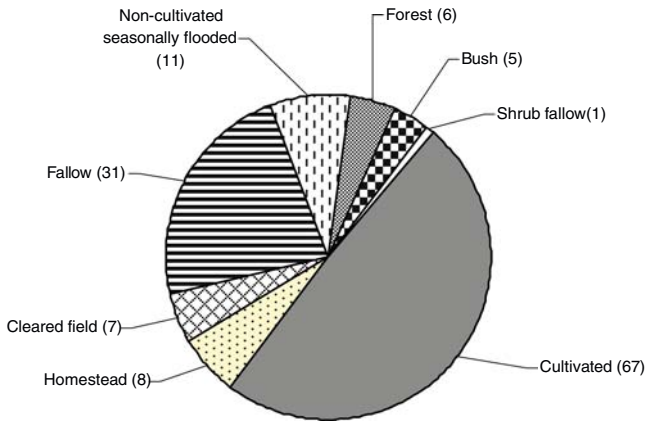
Fig. 6 Distribution of stumps in different land uses and vegetation types

needs. Besides which, their ready availability helps households to not only satisfy their consumptive needs, but to also escape from poverty (Uganda Participatory Poverty Assessment Process 2002). In a community like Gadumire, the availability of firewood, for instance, on which people depend as a source of energy (National Environment Management Authority 2002; Tabuti et al. 2003b) enables households to save money they would otherwise have spent on its purchase. This may make possible for such households to invest in the education of their children, and provide them with opportunities to escape from poverty. Secondly, whenever possible parts or products from these plants are sold to earn cash incomes. People commonly sell timber, firewood, charcoal, crafts or gathered foods like mangoes. Cash incomes from the sale of plant products can supplement subsistence agriculture and are particularly significant for rural women (Konstant et al. 1995; Shackleton et al. 1998). However, the monetary contribution of plant products to the local economy is not known and needs to be studied and quantified. Overall, the continued survival of the species studied here is important to the livelihoods of the local community of Gadumire Sub-county and their loss could result in much hardship for the communities that have traditionally exploited them

Conservation status

The continued survival into the future of the study species was evaluated against their current densities (availability of the species), frequencies (extent of their distribution) and magnitude of SCD regression slope (population structure). The calculated indices were complemented by results from the Focus Group Discussion. Species that are readily available or abundant, are widely distributed or have relatively more juvenile individuals than mature ones have better chances of regenerating into future generations and vice versa (Cunningham 1993; Primack 1998). Five species *Acacia hockii, Albizia zygia, Acacia seyal, Markhamia lutea* and *Albizia coriaria* appear to have the potential to survive under the prevailing harvest regimes and land use management practices. *Markhamia lutea*, though poorly distributed, is included in the species not immediately threatened because it is actively managed as a cultivated species. The remainder of the species ($n = 11$) appear to be

locally threatened because they are either not readily available in the study area (e.g., *Securidaca longipedunculata*), are restricted in their distribution (e.g., *Carissa edulis*) or have a weak population structure (e.g., *Ficus natalensis*).

According to the Focus Group Discussion, the growing human population of Gadumire is seen as the major threat to species survival. It is widely believed that growing human populations are significant drivers of negative environment changes (National Environment Management Authority 2002; Uganda Participatory Poverty Assessment Process 2002; Rosa et al. 2004; Twine 2005). The human population in the study area has been growing at a rate of 3% per annum (Uganda Bureau of Statistics, 2005) and has had the effect of forcing the community to allocate most of the available land to crop agriculture and to settlement. Land devoted to agricultural cropping doubled in the period 1962 to 1997 from 34.2% to 67.4% (Department of Land and Survey 1962; Forest Department 1997). The relationship between a growing human population, decisions to allocate land to crop agriculture and to settlements and its influence on woody species survival is illustrated in part by the relatively large number of small sized stumps of *Combretum collinum* stumps encountered in the two land types. As there is no reported use for juvenile plants of *C. collinum*, it can be assumed that they were destroyed to clear land for crop agriculture.

Besides the growing human population and related land use demands, over-exploitation is another threat thought to impact on plants' survival. Over-exploitation has had an impact on the survival of the prized timber species *Milicia excelsa*. The decline in *M. excelsa* has led to intense harvest pressure on *Antiaris toxicaria* as a substitute. On its part *Sarcocephalus latifolius* has been over-exploited for its bark and root used in herbal medicines.

Participants in the focus group discussion suggested that the conservation of woody species would be enhanced by protecting them where found or by planting. They also suggested that there was need to conduct awareness workshops to sensitize the community on the values of plant diversity and its conservation. And lastly, that there should be some effort to conserve cultural values.

References

Aumeeruddy Y (1994) Local representations and management of agroforests on the periphery of Kerinci Seblat National Park, Sumatra, Indonesia, People and plants working paper 3. Paris, UNESCO

Condit R, Sukumar R, Hubbell SP, Foster RB (1998) Predicting population trends from size distributions: a direct test in a tropical tree community. Am Nat 152:495–509

Cunningham AB (1993) African medicinal plants: setting priorities at the interface between conservation and primary health care. People and plants working paper 1. Paris, UNESCO

Cunningham AB (2001) Applied ethnobotany: people, wild plant use & conservation. People and plants conservation manual. Earthscan Publications Ltd., London

Dalle SP, López H, Díaz D, Legendre P, Potvin C (2002) Spatial distribution and habitats of useful plants: an initial assessment for conservation on an indigenous territory, Panama. Biodivers Conserv 11:637–667

Department of Land and Survey (1962) Atlas of Uganda. Department of Land and Survey, Uganda, Entebbe, pp 22–23

Forest Department (1997) The National Biomass Study. Land Cover Stratification map, Bulamogi County. Forest Department, Uganda, Kampala

Government of Uganda (1963) Map Series Y732: Sheets 52/4, 53/3. Scale 1:50 000 edn. I-DOS. Directorate of Overseas Survey for Uganda Government, Entebbe

Hall P, Bawa K (1993) Methods to assess the impact of extraction of non-timber tropical forest products on plant populations. Econ Bot 47:234–247

Jongman RHG, ter Braak CJF, van Tongeren OFR (eds) (1995) Data analysis in community and landscape ecology. Cambridge University Press, UK, p 137

Kaimowitz D, Mertens B, Wunder S, Pacheco P (2004) Hamburger connection fuels Amazon destruction: Cattle ranching and deforestation in Brazil's Amazon. Bogor, CIFOR

Konstant TL, Sullivan S, Cunningham AB (1995) The effects of utilization by people and livestock on Hyphaene petersiana (Arecaceae) basketry resources in the palm savanna of North-Central Namibia. Econ Bot 49:345–356

Langdale-Brown I, Osmaston HA, Wilson JG (1964) The vegetation of Uganda and its bearing on land-use. Uganda Government, Kampala

Lykke AM (1998) Assessment of species composition change in savanna vegetation by means of woody plants' size class distributions and local information. Biodivers Conserv 7:1261–1275

National Environment Management Authority (2002) State of the environment report for Uganda 2002. National Environment Management Authority, Kampala

Obiri J, Lawes M, Mukolwe M (2002) The dynamics and sustainable use of high-value tree species of the coastal Pondoland forests of the Eastern Cape Province, South Africa. For Ecol Manage 166:131–148

Ollier CD, Harrop JF (1959) The soils of the Eastern Province of Uganda: a reconnaissance survey, memoirs of the research division, series I: soils, number 2. Department of Agriculture, Kawanda Research Station, Kampala

Peters CM (1999) Ecological research for sustainable non-wood forest product exploitation: an overview. In: Sunderland TCH, Clark LE, Vantomme P (eds) Non-wood forest products of central africa: current research issues and prospects for conservation and development. Food and Agriculture Organization, Rome, pp 19–35

Primack RB (1998) Essentails of conservation biology, 2nd edn. Sinauer Associates Inc., Massachusets USA

Rosa EA, York R, Dietz T (2004) Tracking the anthropogenic drivers of ecological impacts. Ambio 33(8):509–512

Schippmann U, Leaman DJ, Cunningham AB (2002) Impact of cultivation and gathering of medicinal plants on biodiversity: global trends and issues. In biodiversity and the ecosystem approach in agriculture, forestry and fisheries: satellite event on the occasion of the ninth regular session of the commission on genetic resources for food and agriculture. Rome, 12–13 October 2002, FAO, Rome

Shackleton SE, Dzerefos CM, Shackleton CM, Mathabela FR (1998) Use and trading of wild edible herbs in the central Lowveld Savanna region, South Africa. Econ Bot 52:251–259

Tabuti JRS, Dhillion SS, Lye KA (2003a) Ethnoveterinary medicines for cattle (Bos indicus) in Bulamogi county, Uganda: plant species and mode of use. J Ethnopharmacol 88:279–286

Tabuti JRS, Dhillion SS, Lye KA (2003b) Fuelwood use in Bulamogi County, Uganda: species harvested and consumption patterns. Biomass Bioenerg 25:581–596

Tabuti JRS, Dhillion SS, Lye KA (2004) The status of wild food plants in Bulamogi County, Uganda. Int J Food Sci Nutr 55:485–498

Tabuti JRS, Lye KA, Dhillion SS (2003c) Traditional herbal drugs of Bulamogi, Uganda: plants, use and administration. J Ethnopharmacol 88:19–44

Ticktin T (2004) The ecological implications of non-timber forest products. J Appl Ecol 41:11–21

Twine WC (2005) Socio-economic transitions influence vegetation change in the communal rangelands of the South African lowveld. Afr J Range For Sci 22:93–99

Uganda Bureau of Statistics (2005) The 2002 Uganda population and housing census—main report. UBoS, Kampala

Uganda Participatory Poverty Assessment Process (2002) Deepening the understanding of poverty: second participatory poverty assessment report. Ministry of Finance Planning and Economic Development, Kampala

Walter S (2001) Non-wood forest products in Africa: A regional an national overview. FAO