ECONOMIC VALUATION OF NATURAL RESOURCES IN MOZAMBIQUE

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Acronyms

BANP	Bazaruto Archipelago National Park
CSF	Chirindzene Sacred Forest
GDP	Gross Domestic Product
INE	Instituto Nacional de Estatística
NTFPs	non timber forest products
WRI	World Resources Institute

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1. FORESTS IN MOZAMBIQUE

There appears to be reasonable knowledge about the types and extent of forest and vegetation cover in Mozambique. Woody vegetation is said to cover between 70 and 80 per cent of the total land area of the country; up to 62 million hectares (Boyd et al., 2000; FAO, 2005; MICOA, 1997b). The main vegetation units as defined by White (1983, cited in Albano 2002) are:

- Zanzibar-Inhambane coastal forest-grassland mosaic;
- Zambezian miombo woodland;
- Mopane woodland and scrub woodland;
- Undifferentiated Zambezian woodland (generally defined by the absence of the miombo and mopane dominants);
- Afromontane vegetation; and
- Mangroves (along the coast).

Other sources recognise up to 22 different vegetation types, perhaps because that within the broad categories outlined above, different types of vegetation units can be recognised on the ground, according to species composition and structure. For example, Zanzibar-Inhambane coastal forest-grassland mosaic is comprised of four forest types – lowland rainforest, swamp forest, scrub forest and undifferentiated forest (Clarke, 2000 cited in Müller et al., 2005); up to seven miombo subtypes occur in the Mozambican Zambezian Miombo region according to Wild and Fernandes (1968) cited in Müller et al., 2005.

Approximately 25 per cent of the land area of Mozambique is considered to be covered by forest (as opposed to woody vegetation, which includes thicket and shrublands), the majority of this being indigenous forest (Duarte-Mangue and Oreste, 1999; WRI, n.d.). Very little plantation forest exists in Mozambique, estimates vary between just 38,000 and 50,000 hectares (FAO, 2005; Duarte-Mangue, 1999; WRI, n.d.; MICOA, 1997b).

Mozambican forestry is conserved in a variety of forest reserves, game reserves, Coutadas, national parks and local conservation areas (even if not legally defined as such) (see Table 1). Included in these protected areas are 13 forest reserves (see Table 2), the majority of which were established in the 1950s as timber production reserves, with only a few established to protect water catchments (Müller et al., 2005). Other authors mention that 16 or 17 forest reserves exist (MICOA, 1997a; 1997b). All of these reserves are reported to have suffered from some level of disturbance resulting from human activities – timber extraction, clearance for agricultural fields and/or collection of other woodland products. Indeed, several reserves have been subjected to such severe degradation and conversion that the authors recommended that four of the current forest reserves be de-gazetted[1]. It is also reported that just two forest reserves are currently uninhabited[2] (Müller et al., 2005).

Table 1 Formal Mozambican protected areas, 2004

Category	Number	Size (km^2)
National Parks	6	36,470
Reserves	6	47,700
Hunting blocks	12	40,644
Forestry reserves	14	4,935
Integral reserves	3	54
TOTAL	**41**	**129,803**

Source: MICOA 2004 cited in Anon., 2006.

The national network of forest reserves is said to over-represent miombo and coastal forest, while under-representing mangrove and mopane. However, areas of these forest types are conserved in national parks and game reserves, as well as occasionally in locally conserved forest areas, such as

1 Mucheve, Zomba and Baizo Pinda.
2 Inhamitanga and Nhampacue.

the Chirindzene Sacred Forest (Müller et al., 2005). An assessment of Mozambique's protected areas has determined that mountainous, aquatic and marine habitats and ecosystems are poorly represented in the present network (MICOA, 2004, cited in Anon., 2006).

Table 2 Current forest network

Forest reserve	Ecoregion	Area (ha)
Baixo Pinda	Coastal	19,600
Bobole	n/a	1,910
Derre	Coastal/Miombo	170,000
Inhamitanga	Coastal/Miombo	1,600
Licuáti	Tongoland-Pondoland/Coastal	3,700
M'palue	Miombo	5,100
Maronga	Miombo	8,300
Matibane	Coastal	51,200
Mecuburi	Miombo	230,000
Moribane	Miombo	5,300
Mucheve	Miombo	9,057
Nhampacue	Coastal/Miombo	17,000
Ribáuè	Miombo	5.200
Zomba	Miombo	2,850

Source: adapted from Müller et al., 2005; MICOA 2004 cited in Anon., 2006.

1.1. The use of Mozambican forests

The most important threats to forests in Mozambique have been identified as logging, fuelwood collection and conversion to agriculture. The rate of deforestation between 1972 and 1990 has been estimated at 4.2 per cent per annum nationally, but with wide spatial variations (MICOA, 1997b). Between 1990 and 2000, World Resource Institute (WRI) estimates suggest that deforestation slowed to two per cent (WRI, n.d.).

1.1.1. Commercial use

Approximately 38 million hectares were considered to be productive forest in 1980 (Sacket 1994 and Malleaux 1980, cited in Duarte-Mangue and Oreste, 1999), though according to Fath (2002), the area of productive forest is considered to be almost 18 million hectares. Table 3 outlines the annual potential sustainable harvest from these forests, according to Fath, 2002.

Table 3 Productive forest area and potential for commercial timber extraction

Province	Area of productive forest (PF) (ha)	Potential for sustainable extraction m3/year	Annual harvest potential per ha of PF (m3/ha/year)
Maputo	488,213	3,503	0.007
Gaza	1,437,162	13,141	0.009
Inhambane	1,752,026	20,790	0.012
Sofala	2,168,358	93,790	0.043
Manica	1,046,734	21,369	0.02
Tete	1,135,698	28,898	0.025
Zambézia	3,074,324	88,014	0.029
Cabo Delgado	2,958,895	67,952	0.023
Niassa	3,851,351	108,946	0.028
Mozambique	19,735,397	500,236	0.025

Source: Fath, 2002.

Extraction potential is said to be restricted by already over-exploited forests, as well as the low increment of commercial species combined with demand for only a few species – only approximately 20 per cent of the productive forest area (Fath, 2002). WRI reports that exports of forest products between 1996 and 1998 were valued in excess of US$9.5 million, with an

approximate volume of 17 million m^3. Approximately 1.25 million m^3 of this is industrial production, the remainder being fuelwood, which in light of Table 3 would seem unsustainable.

In excess of 70 per cent of the value added of forestry and forestry exploration (Silvicultura e Exploração Forestal) is said to be accounted for by subsistence production; the remainder consisting of market fuelwood production, industrial roundwood and processed wood production (Oreste and Cuemba, 1998). Table 4 shows the Gross Domestic Product (GDP) contribution of forestry from 1996 to 2003. Calculations from Instituto Nacional de Estatística (INE) data suggest that the forestry sector has contributed between two and three per cent to total GDP in Mozambique over this time.

Table 4 Forestry and forestry exploration

	1996	1997	1998	1999	2000	2001	2002	2003
Gross domestic product (constant 1996 prices 10^9 Mt)	1,060	1,095	1,122	1,157	1,215	1,217	1,290	1,298
Gross domestic product (current prices 10^9 Mt)	1,060	1,164	1,140	1,417	1,491	2,154	2,375	2,744
% change in volume		3.4	2.4	3.1	5.0	0.2	6.0	0.6
% change in prices		6.2	-4.3	20.5	0.2	44.2	4.1	14.8

Source: Instituto Nacional de Estatística, n.d.

1.1.2. Non-commercial and small-scale forestry use

A number of studies have been undertaken in Mozambique to determine the use of various natural resources in various locations, though most have taken places in small areas of the country (as small as one or two villages) and few have quantified the volume or value of these uses. It is possible that many other studies examining forestry and woodland product use have been undertaken – particularly by non government organisations – and the results of such studies are likely to only be available as grey literature, and thus not accessible. However, a summary of published studies is presented below, in chronological order.

Karman and Lorbach (1996) undertook a study of the use of forest and woodland resources in two countries – Kenya and Mozambique. The objective of the study was to determine the variety of products used, and their manner of utilisation. In Mozambique, the field work was conducted in Cabo Delgado, in a subhumid climatic zone, in miombo woodlands – the natural vegetation characterised by *Julbernardia–Brachystegia* species. A survey was conducted in nine districts of the province in 1992/3 regarding the utilisation of tree products (including both timber and non-timber products). They undertook a further study in 1995 which paid special attention to village level utilisation and management of woodland resources, in one village only.

Karman and Lorbach (1996) found that approximately 150 trees and shrubs were utilised locally including both exotic and local species. Utilisation purposes were for food, medicine, for fibres and dyes. A number of species were used for more than one purpose (e.g. *Tamarindus indica* and *Sclerocrya birrea* used for their fruit and timber). The majority of products are consumed (and where necessary processed) within the household, though medicinal products were found to be mostly the domain of traditional healers. Few non timber forest products had been commercially developed, though there was occasional sale of fruit. The study did not quantify levels of use of these products, or the value of their consumption.
A report by the National Directorate for Forestry and Wildlife (DNFFB 1998 cited in Boyd et al., 2001) as estimating the annual value of fuelwood harvested in Mozambique in 1997 by the ‘poor’ at US$240 million, and states that bushmeat values harvested around Maputo alone were estimated at over US$1 million in 1998.

A study undertaken by TRAFFIC examined the utilisation of wild meat in eastern and southern Africa (Barnett, 1997). It estimated that 50 metric tones per month of bushmeat was traded through urban markets in Maputo Province, though in Maputo city prices for bushmeat were considerably higher (up to 15 per cent) than those for domestic meat. Considerably smaller amounts were traded in Beira and Zambezi Delta rural markets. The combined value of bushmeat traded at these four sites exceeded US$151,000 per month. The value of legal meat production 1991–1997 from (tourist) safari hunting was US$78,386, while over the same period the value of meat production from citizen hunting was US$152,152 (with a combined volume of 299.4 metric tons). The report notes that during the early 1990s it was estimated that about five million people were dependent on wildlife for between 40 and 80 per cent of their protein requirements (UNCED, 1992 cited in Barnett (1997). Indeed estimates of 182,000 to 365,000 metric tons, valued at between US$365 and US$730 million per year have been made for the total amount of bushmeat consumed annually in the country (Agostini 1993 cited in Barnett, 1997). These latter figures refer to the illegal utilisation of bushmeat. Though varying between locations across the country, the majority of this offtake is for subsistence purposes, though (illegal) commercial hunting also occurs (e.g. in the Gorongosa/Marromeu area) (Barnett, 1997).

Norfolk et al., 2001 assessed the livelihoods of communities of two areas in Zambézia Province, and noted that, in addition to agriculture and fishing, hunting and collecting woodland and forest products was extremely important to livelihoods in the region. However, as the purpose of the paper was to determine institutional and policy changes affecting natural resource management in the area, the study did not attempt to quantify the use of natural resources, nor value this use.

In an study conducted for the Food and Agriculture Organisation, Albano (2002) reviews knowledge regarding secondary forests in Mozambique, and noted that the majority of the rural Mozambicans depend on the exploitation of land and forest resources for their livelihood. According to this report, secondary forests form an integral part of the livelihood of communities living within or adjacent to them. They provide an array of both timber and non-timber products and services including grazing and browsing for livestock, firewood, timber, and a range of non-timber forest products (NTFPs). Wood products that are predominantly utilised include firewood and construction poles. The collection of NTFPs is a common activity throughout the country. Mushrooms, insects, wild fruits, honey and medicines are collected for household consumption and/or for sale to provide extra income for the household (Albano, 2002).

Albano cites a study carried out in three districts along the Beira corridor, central Mozambique, where energy sources (firewood and charcoal), construction poles (including bamboo) and medicinal plants were the three most important products collected from forests (Mlay et al., 2002 cited in Albano, 2002) (see Table 5 for the results of this study). Rural communities at household level depend on firewood for domestic energy purposes. Poles and bamboo are collected for house construction – most of the local houses are made of poles, laths and mud. Traditional medicines from plants provide the only alternative for health care in most rural areas because of the low coverage of health care facilities to cure or treat most ailments (Cunningham, 1997).

Table 5 Major products collected from secondary forests in three districts, central Mozambique

Product	% of households involved	Average distance from homestead (km)
Firewood	100	0.5
Charcoal	50.8	2.59
Construction poles and bamboo	16.9	0.75
Medicinal plants	14.5	0.56
Wild fruits	7.3	0.63
Thatching grass	6.5	2.21

Source: Mlay et al., 2002 cited in Albano 2002.

In Gilé District, Zambézia Province, a participatory analysis of the dependence of rural livelihoods on wildlife resources was undertaken. Lizon (2002) outlines the preliminary economic valuation of forest resources from this research, and suggests that wildlife contributes almost 50% of gross income in the study area. (Wildlife in this paper refers to both wild plant and animal resources.)

This study was carried out in six villages of varying distance to the National Reserve of Gilé, though it did not focus exclusively on resources utilised in the Reserve, but also in other (non-protected) forested areas nearby. Approximately 40 resources were said to be commonly exploited, including various varieties of mushrooms, caterpillars, termites, snails, grasshoppers, roots and tubers, honey, game, freshwater fish, wild fruits, palm, fuelwood and timber. Households were found to be heavily reliant on non timber forest products during the 'famine period' between January and March, when households suffer from food shortages. Poorer households tend to experience more acute food shortages, and so are more heavily reliant on the exploitation of wild foods (Lizon, 2002).

The preliminary analysis indicated a total annual value of forest resources of approximately Mts2,650,000 (US$113) per household. Half of this value is derived from fuelwood consumption and construction materials, with the rest from food items (mainly game, fish and mushrooms). Lizon notes that this is likely to be a conservative estimate, as it excluded data on some important resources (2002). The exploitation of wild resources is almost twice as valuable as that of agricultural production (crops only), which is estimated to be worth approximately Mts1,660,000 (US$70) per household per annum. In comparison to the value generated from domestic stock (poultry and pigs only), it is worth almost six times as much – with stock generating a total gross income of around Mts450,000 (US$19) per household per year (Lizon, 2002).

Table 6 Economic valuation of wildlife resources, Gilé District

Resource	Average value per household (Mts) per year
Honey	10,925
Game	607,500
Freshwater fish	364,000
Mushrooms	216,000
Caterpillars	105,000
Snails	52,500
Timber (incl. timber, bamboo and thatch)	262,500
Fuelwood	1,040,000

Source: Adapted from Lizon, 2002.

Lynam et al. (2004), conducted a study in and around Gorongosa National Park to determine the importance of different landscape units to communities as part of the process of developing a management plan for the park. The study found that livelihoods are heavily reliant on agricultural production (swidden agriculture, or slash and burn), forest products, wild foods and to a lesser

extent on purchased commodities. The latter constitute only approximately 20 per cent, increasing in drought or flood years. Forest food products and other wild foods become important in drought and flood years; sometimes almost exclusively supporting the household.

Due to the large number of products utilised, the study aggregated them into classes of products – water, agriculture, construction materials, firewood, fish, grinding sticks/stones, clay products, palm leave products, palm wine, honey, medicine, wild foods, wild fruits (listed in their ranked order of importance, highest to lowest). Following water and land for agriculture and housing, woodland products for construction (including poles, fibres, thatching grass and reeds), firewood, wood for household utensils (e.g. tool handles, reeds for mat-making and other implements) as well as wild foods were ranked as highly important contributors to livelihoods. The study determined that natural resources are utilised in an area of up to 300 km^2 (Lynam et al., 2004).

The study developed and tested an approach for estimating local importance scores for landscape units, but did not attempt to identify the value of goods or services, or assign monetary values to this use. The relative importance weights of resources to household livelihoods were determined (in terms of an average household achieving an adequate standard of living). In general, there was an intersection between the landscape units that had the highest conservation importance and the highest local livelihood importance (Lynam et al., 2004).

Norfolk (2004) notes that, in contrast to other southern African countries, there are fewer employment opportunities in Mozambique, which results in a greater reliance on natural resources (including agriculture). Norfolk (2004) quotes Pereira and Cossa (2001) noting the heavy reliance on natural resources of some rural livelihoods – with up to 93 per cent of household income earned from forest products including charcoal and traditional drinks made from *Hyphaene* species.

A reference to a study by Mauvilo, Barbarosa and Sithoe was also found (Sitoe and Guedes, 2005), but according to the abstract presented, the data from the study had not yet been comprehensively analysed and so was not presented. The study was on the conservation state of plant diversity at the Sacred Forest of Chirindzene, and the use of natural resources and their management by local communities.

2. FOREST USE IN SOUTHERN AND EASTERN AFRICA

Though few studies have been undertaken to determine the amount and value of forest product use in Mozambique, a number of studies have been undertaken in southern and eastern Africa.

Studies have been undertaken to look at the commercial value of individual species of trees/plants (e.g. *Prunus africana*), the contribution (relative and absolute) to rural livelihoods of forest products and other natural resources, or to determine the use value of the resources to be compared with alternative resource uses to determine the conservation benefits (if any) of that resource. A number of countries have also compiled satellite forestry accounts.

This literature review considered only those studies dealing with terrestrial plant-based/woodland and/or non-timber forest product resources. However, there are also a number of studies that have been undertaken in the region valuing other resource types, including water, fisheries, communal livestock regimes, wetlands, tourism and protected areas. Only those studies that undertook a quantification and/or valuation of resource use have been outlined below.

2.1. Kenya

In 1995 a study was undertaken in Oldonyo Orok forest, Kenya (straddling the Kenya-Tanzania border), using participatory environmental valuation methods to calculate values for non-traded forest products (Emerton, 1996).

The study calculated average subsistence forest use values per year of approximately KSh5,000 (US$100) for forest adjacent households – those living within 1.5 km of the forest (see Table 7 for details of forest use and values). For those households that resided further away from the forest, average subsistence forest use values of approximately KSh2,000 (US$40) per household per year were calculated. The value of the use of the forest by both the adjacent population and occasional grazers was calculated at KSh 2.4 million (US$48,000).

Table 7 Summary of annual forest values for forest-adjacent households

Forest activity	% of households	Av value (KSh/year)	Median value (KSh/year)	Distribution of value/forest-adjacent household (%)
Grazing	95	1,130	947	24.2
Water	95	995	1,052	21.2
Fuelwood	90	596	584	12.1
Construction	89	748	762	15.2
Medicines	85	565	573	11.1
Honey	64	468	435	7.1
Hunting	58	265	234	4
Wild foods	49	156	117	2
Utility items	43	302	333	3
All activities	-	4,778	4,778	100

Source: Emerton, 1996.

A similar study was undertaken at the Mount Kenya Forest Reserve (Emerton, 1997), to determine the distribution of economic costs and benefits associated with that reserve. The study estimated the annual economic benefit of the reserve to be approximately US$77 million. These benefits included those derived from watershed protection (71%), licensed use (3%), local cultivation (6%), local domestic use (17%), government (2%), recreation and tourism (1%).

The study also estimated the value of household of forest resources at approximately US$300 per year. Grazing and fodder were found to be the biggest contributors to this value (24 per cent), followed by fuelwood (20 per cent), building materials (15 per cent) and timber (13 per cent). Further value was contributed by wild foods (eight per cent), honey and medicines (seven per cent each), charcoal (five per cent) and finally hunting (one per cent). This pattern and value of use was estimated to be true for each of the 40,000 households adjacent to the forest (Emerton, 1997).

In contrast, the use of the forest land for agriculture was estimated to have a potential gross value of US$72 million a year to be sufficient to provide for the livelihoods of approximately 8,000 household (Emerton, 1997).

2.2. South Africa

A study on the extent of trading of medicinal plants was undertaken in KwaZulu Natal in the late 1990s (Mander, 1998). The study involved surveys to capture the frequency of use/sale, quantities used/sold and price of product sold of all medicinal plants the data collection was possible for. Having collated the survey responses, Mander then annualised the traded amounts and aggregated them for the number of market players in similar situations, and estimated gross quantities traded and their value.

The study found that households in KwaZulu Natal were spending between four and eight per cent of their annual incomes on indigenous medicine services, generating a massive demand is in the mass of plants consumed. Over 4,000 tonnes of plant material was estimated to be traded in a year in KwaZulu Natal, with a value of US$13 million (R60 million); approximately one-third of the value of the annual maize harvest in the province. At a national level, 20,000 tonnes were estimated to be traded in a year, with an approximate value of US$60 million (R270 million) (Mander, 1998).

Shackleton et al. (2001) in a study of the role of land-based strategies in rural livelihoods, cite Adams et al., 2000, having aggregated household and economic values of livelihoods in the South African Development Trust communal areas.

Table 8 Household and aggregate values of land-based livelihoods (Rands)

(Rand)	Current value/hh/p.a.	Current aggregate value/p.a.
Cropping	1,543	3.7 billion
Livestock production	1,200	2,88 billion
Natural resource harvesting	2,792	6.7 billion
Total	5,535	13.28 billion

Source: Adams et al., 2000 cited in Shackleton et al., 2001.

Their review found that the most commonly used resources and the main contributors to total value (see Table 9) were wood for fuel and fencing (used by 70–100 per cent of rural households), wild fruits (used by 72–100 per cent of households), wild herbs (used by 93–100 per cent of households), medicinal plants (used by 50–100 per cent of households), wood for utility items (used by 90–100 per cent of households), grazing for livestock (used by only 30 per cent of households) and thatch, clay and sand. Further, they noted that between 150 and 300 plant species were regularly procured for household use. The authors calculated that the mean gross value of household direct consumption of woodland resources was R3,154±746 (unadjusted). Mean gross value of consumption of woodland resources, adjusted for high value resources not included in some surveys was calculated as R3,522±655 (Shackleton et al., 2001).

Table 9 Mean gross value of direct use of woodland resources, seven case studies

Resource	Jinga, Zimbabwe	Bushbuck-ridge	KwaZulu Natal	Eastern Cape	Ha-Gondo, Northern Province	Kwa-Jobe, KwaZulu-Natal	Mogano, Northern Province
Fuelwood	R920 (R230)	R510	R1,307	R758	R1,569	R726	R1,736
Poles	R252 (R63)	R95	R183	R74	R2	R54	—
Fences and pens	Incl. above	R64	R226	R64	R106	R154	R5
Carving wood	—	R4	—	R113	—	R477	—
Wood for tools	R20 (R5)	—	—	—	R34	R36	R15
Wood – furniture	—	—	—	—	—	R65	—
Edible herbs	—	R532	—	—	R751	R241	R4505
Edible fruits	R396 (R99)	R16	R19	R26	R594	R436	R299
Mushrooms	—	—	—	—	R64	R44	—
Honey	—	—	—	—	R23	R3	
Insects for food	—	—	—	—	R132	R21	R148
Wild animals	R144 (R36)	—	—	—	—	—	R336
Medicinal herbs	—	R282	R521	R90	R105	R37	R149
Thatch grass	—	R414	R344	R34	R216	R113	R3
Weaving reeds	—	R10	R4	—	—	R113	R1
Construction reeds	—	R11	—	R20	R99	—	
Brooms (grass and ilala)	—	—	—	—	R12	R15	R21
Twig brooms	—	R5	—	—	R14	—	R17
Fish	—	—	—	—	—	R165	
Other minor resources	—	R88	R771	R103	—	—	—
Total	R1,732	R2,031	R3,375	R1,262	R3,619	R2,819	R7,238
Adjusted total*	R2,313		R3,826	R2,811			

Figures in brackets () have had labour costs for extraction deducted.
* Total adjusted by authors for the high-value resources not included in these surveys.

Source: Shackleton et al., 2001.

Among the other livelihood studies undertaken in South Africa include High and Shackleton (2002), who focused on home gardens in Dingleydale B in Bushbuckridge, Limpopo Province. The study randomly sampled 25 per cent of the village to determine the mean value of plants per home garden. This was estimated to be R1,694±1,362 (equivalent to a mean value of plants products per hectare of R3,330–R5,040 per annum). For the village as a whole, gardens were valued at between R333,000 and R504,000 (Shackleton et al., 2001).

The majority of this value was derived from domestic plants (R1,173 ± 1,103 per household, R220,000–R358,000 for the village, R2,200–R3,580/ha per annum). However, the values of wild plants were not insignificant – they had a mean value per household of R521±473 (R990–1,580/ha per annum); a value to the village of between R99,000 and R158,000 per year (Shackleton et al., 2001).

Hassan (2003) compiled accounts for forest and woodland resources in South Africa. These accounts incorporated asset values and flow benefits of non-traded goods and services from forests and woodland resources in SA. Four benefit categories were considered – direct consumptive use values (timber and non-timber products), non-consumptive use values (e.g. recreation), indirect use values (environmental services), and non-use values (based on contingent valuation by tourists).

Hassan (2003) concluded that the flow values (see Table 10) missing from the 'regular' national accounts were significant – amounting to two per cent of domestic product.

Table 10 Flow benefits of forest and woodland resources in SA (R million of value added in 1990 prices)

	Cultivated forest	Natural woodlands	Fynbos	Total	%
Direct consumptive use values	1,856	2,613	79	4,584	73.1
Direct non-consumptive use values	NAP	NAV	29	29	0.5
Indirect use values	-225	1,021	799	1,595	25.7
(Water)	-225	NAP	NAP	-225	-3.6
(Honey & pollination)	NAP	NAV	786	786	12.7
(Livestock grazing)	NAV	1,021	13	1,034	16.6
Non-use values	NAV	NAV	43	43	0.7
Total value added	1,631	3,634	950	6,215	100
% of total value added	26.2	58.5	15.3	100	
NAP – not applicable; NAV – not available.					

Source: Hassan (2003).

Twine et al. (2003) studied consumption and direct use values of savannah bio-resources used by rural households in part of Limpopo Province (Mametja). The study sampled five per cent of households (110 households) across the area and used a variety of questionnaires, participatory rural appraisal and key informant interviews to determine these use values. The authors calculated that annual total direct use of utilised natural resources averaged across all households was worth R3,959 per household or R564 per person, ranging between R3,280 and R5109 per household, or R497–R697 per person (Twine et al., 2003). The study also compared these values against other sources of income and subsistence in the semi-arid and agriculturally marginalised region.

A number of livelihood studies determining household resource use remain unpublished, though a review of them was published by Shackleton and Shackleton in 2003. Their review focused on relatively recent studies that focussed on the complete inventory of non timber forest products utilised by households, rather than those that focussed on only one or two resources.

Table 11 below presents the mean quantities of resource consumption per household across the case studies; Table 12 outlines the direct use values across the studies. Note that the results presented are for all households in each region – including users and non-users of resources, and figures have been adjusted to 2002 prices. The study noted that in some regions, 200–300 different plant species may be utilised, with a single household potentially using in excess of 60 species of plants to provide the household with fruit, herbs and fuelwood.

Table 11 Mean quantities of resources used per household (± standard error)

Resource	Units	Av. quantity	Range	Sampled villages
Wild spinaches	kg/yr	58.2±26.3	12.8–198.4	7
Fuelwood	kg/day	14.5±1.6	8.2–23.2	10
Grass hand brushes	no./yr	4.5±0.5	3.3–8.6	10
Wild fruits	kg/yr	104.2±15.6	19.4–165.1	10
Twig hand brushes	no./yr	4.6±0.3	4.0–5.6	6
Wooden poles for fences & kraals (excluding brush wood)	no./hh	143.1±31.3	33.1–273.0	10
Wooden poles for housing (excluding laths and brush wood)	no./hh	43.2±11.8	0–113.3	10

Source: Shackleton and Shackleton, 2003.

Table 12 Gross annual direct use values across all households

Province	Site	Gross direct use value (Rand)
Limpopo	Bushbuckridge	2,218
	Ha-Gondo	3,619
	Mametja	4,807
	Mogano	7,238
	Thorndale	3,435
KwaZulu Natal	KwaJobe	2,819
	Mtubatuba	900
	30 hhs across sites	3,375
Eastern Cape	Fairburn	2,526
	Ntilini	1,645
	Tidbury	1,607
	Hhs across sites	2,811
Mean		3,121±488

Source: Shackleton and Shackleton, 2003.

Blignaut and Moolman (2006) undertook a study in the Bushbuckridge District, Limpopo Province (including a part of the Kruger National Park, and an area of communal land adjacent to the national park). The study valued the standing stock of all tradable plant and mammal species in order to determine the value of the biodiversity composition for the study area, including direct, non-consumptive and indirectly-consumptive use.

The study calculated the value of the standing stock of all tradable plant and mammal species to determine the value of the biodiversity composition for the two study areas (a tradable species was defined as a species traded in the market and for which there is a market value). The value of the various biodiversity function components (direct use, non-consumptive and indirectly consumptive use) was then calculated. These values were treated as flow variables (i.e. generating an annual stream of income or benefits to the owner(s) or beneficiary(ies) of the goods and services provided by the respective ecosystems) (Blignaut and Moolman, 2006).

The total value within the park of tradable mammal stock was estimated at US$25.37 million (US$155.74/ha). No mammals were present on the adjacent communal land. Based on 2003 market prices for various plant products, the study estimated the value of standing stock of tradable plant species (should they all be harvested) as US$481.3 million (US$2,954.70/ha) (Blignaut and Moolman, 2006).

The actual direct consumptive use value of Bushbuckridge communal area was estimated to be US$40.63 million (US$220/ha or US$81.26 per person per year). The potential direct use values of the communal area was estimated as US$611.35/ha (see Table 13 for details of the values of individual resources) (Blignaut and Moolman, 2006).

Table 13 Comparison of actual and potential direct use values, Bushbuckridge communal area

Resource	Actual direct use		Potential direct use	
	US$	US$/ha	US$	US$/ha
Fuelwood	5.76	31.24	3.5	18.96
Timber	2.7	14.65	4.41	24.01
Crafts	0.25	1.34	51.22	278.22
Medicinal	4.78	25.92	47.11	255.38
Edible fruit, herbs and vegetables	9.28	50.36	1.51	8.19
Thatch	7.01	38.02	0.61	3.19
Livestock	9.38	50.88	0	0
Wild animals	0	0	4.3	23.4
Other (reeds, sticks, grass brushes, birds, etc.)	1.49	8.08	0	0
Total direct consumptive use	40.63	220.48	112.6	611.35

Source: Blignaut and Moolman, 2006.

The study determined that tourism was the only activity that was considered to be non-consumptive, and though it's value was significant in the relevant part of Kruger National Park (US$16 million), it had no value at all within the adjacent communal area at the time the study was undertaken. However, it was estimated that, once the degraded land of the communal area had been restored, its potential value in that region could be as much as US$18 million). The study also estimated the value of carbon storage in the communal lands as having a potential value of US$12 million (US$67 per hectare); though it was considered that the park had no potential for carbon trading as existing biomass does not contribute to additional carbon storage (Blignaut and Moolman, 2006).

2.3. Swaziland

Forest accounts have been compiled for Swaziland, as outlined by Lange (2004). These accounts include commercial forestry as well as subsistence resource use, but not marketed forest products. The accounts compiled data on the production of forest goods and services within Swaziland by ecological zone, though Table 14 presents only the national results. Lange reports that the value of commercial timber is E40.4 million[3] (€6.2 million), while the value of non market timber and non-timber forest products to local communities was E170.4 million (€26.2 million).

Table 14 Production of forest goods and services, million emlangeni, 1999

	Cultivated timber	Natural forests & woodlands	Total
Commercial timber	40.7		40.7
Own use forest products		170.4	170.4
(Timber)		155	155
(Edible plants)		1.2	1.2
(Medicines)		0.7	0.7
(Thatch, weaving grass)		9	9
(Livestock grazing)		4.6	4.6
International tourism		0.1	0.1
Carbon storage	91.3	7.9	99.2
Total			310.4

Source: Lange, 2004.

[3] E= emlangeni, the currency of Swaziland. E1=ZAR1. Author uses a currency exchange rate of E6.52=€1.

2.4. Tanzania

Chihongo (1993) undertook the pilot study on non-wood forest products for Tanzania. In his report, He notes that the production levels of non-wood forest products in Tanzania are not well quantified. However, Kowero and Hofstad (1989) are cited as having reviewed the economic aspects of Tanzanian forestry (see Table 15). Chihongo also quotes the Tanzanian Forestry Action Plan, which provides the data for the estimated gross output of forest based activities (Table 16). From Table 16, it can be seen that just less than half of the total value of forest activities is derived from wood products (49.7 per cent) and just in excess of half from non-wood products (50.3 per cent). The report also notes that tourism in the country is largely dependent on forested lands (as it is predominantly wildlife based), an activity which was thought to be worth US$95 million to the country in 1991, and is thus by far the biggest revenue earner in the non-wood forest product sector in Tanzania (Chihongo, 1993).

Table 15 Primary forest production – total value (TSh million)

Item	Value
Industrial wood	169
Non-traded wood fuels	515
Non-traded construction materials	210
Non-traded implement wood	2
Fruits, medicines, etc.	2,000
Game meat	200
Honey and beeswax	8,500
Fodder (forage)	900
Water	20
Soil conservation	1,000
Climate amelioration	-
Gene pool	-
Total	13,516

Source: Kowero and Hofstad (1989) cited in Chihongo, 1993.

Table 16 Estimated gross output of forest based activities, 1988.

Activity	Tsh million	%
Fuelwood and charcoal	9,500	34.5
Building poles	1,000	3.7
Forest industries	3,200	11.5
Honey and beeswax	1,100	3.8
Wildlife based activities	9,700	35.2
Others (wattle extract, fruits, fodder, medicinal plants)	13,900	11.3
Total	27,600	100

Source: Ministry of Lands, Natural Resources and Tourism (1991) cited in Chihongo, 1993.

Mkanta and Chitembo (2002) undertook a study focussing on flue-cured tobacco growing areas in Urambo District, Tanzania. The purpose of the study was several-fold – to estimate use values of natural forest products for tobacco growing and other activities and the rate of depletion of natural forests as a result of these economic activities; to determine the differences between the value gained in growing tobacco and the value lost in the natural environment as a result of utilisation of its products; and to recommend means of incorporating natural resource accounts into the Tanzanian national accounting process. Flue-cured tobacco growing areas were chose purposively, as they are strongly associated with natural forests, and the activity is responsible for much of the clearing of natural forests in these areas. The region is home to four forest reserves, and the villages sampled by the study were located within, or nearby, to these reserves. For those products that were traded, market prices were used to determine value, for those that were not traded, willingness to pay of forest users was determined.

The study calculated that the total value of natural forest products consumed per household was US$2,098, (US$350 per person) (see Table 17 for details of the value of each product group). Of this, almost one-third (US$662) consisted of the value of consumption of items necessary for tobacco growing, for example wood required for curing tobacco (Mkanta and Chitembo, 2002).

Table 17 Direct use values per household of natural forest products

Product	Total value (TSh)	Total value (US$)
Fuelwood		
(Home consumption)	44,561	56
(Curing: large size)	266,386	333
(Curing: medium size)	177,101	221
(Curing: small size)	86,190	108
Building earth*	34,800	44
Grazing		
(Wet season)*	115,536	144
(Dry season)*	240,794	301
Thatch grass*	36,000	45
Timber		
(Building)	463,923	580
(Fencing/other)	119,363	149
Edible fruit*	20,761	26
Edible herbs and vegetables*	25,766	32
Carving timber	45,101	56
Beehives	2,105	3
Total	1,678,388	2,098
* prices determined by willingness to pay approach.		

Source: Mkanta and Chitembo, 2002.

Lange described the partial natural resource accounts compiled for environmental services provided by the catchment forest reserves of Tanzania (2004). The study examined catchment forest reserves – those forests set aside exclusively for watershed protection. While the report did not provide the full accounts, Table 18 outlines the proportion of total value provided by each good or service from these forest reserves.

The value of water protection services was calculated using two different approaches. The first approach was to use market price plus partial replacement cost, which yielded an annual value of services of US$11.3 million. The second was the damage prevention approach, which estimated the value at US$5.4 million. Soil stabilisation services were estimated at US$1.87 million, while carbon storage values were estimated to be approximately US$5 million. Lange (2004) notes that all of these environmental services estimates are based on crude assumptions and calculations, and probably err on the side of underestimation (2004).

Table 18 Proportion of annual value of goods and services provided by conservation forest reserves, 2001

Good/service	% of annual value
Logging	3
Forest goods used by rural households	22
(Wood and wood products)	17
(Non-timber forest products)	5
Agriculture: fodder/livestock grazing	37
Services to non-forestry sectors	39
(Tourism)	3
(Environmental services)	
(Water supply protection services)	16
(Soil stabilisation services)	5
(Carbon storage)	15
Total	100

Source: Lange, 2004.

Odoul et al., (2004) published a study examining the poverty alleviation and food security values of miombo biodiversity. They estimated that between 10 and 30 per cent of fruit from the miombo woodlands in western Tanzania are harvested and used by humans. The authors state local populations have realised the potential of wild foods and fruits to have a higher food and cash value than most common fruit species (including mango, papaya, orange and avocado). They assert that, because of the high cost of modern/Western medicine, as much as 80 per cent of the population of these miombo woodlands rely on natural products for medicines.

83 indigenous tree species have been identified as bearing edible fruits and nuts in the Tanzanian miombo, along with more than 300 plants with medicinal properties that are used to treat more than 100 diseases. The majority of wild food plants are available during the dry season, and therefore provide a valuable safety net for rural populations, when agricultural food supplies are scarce, or have run out. The study did not attempt to quantify the amount or value of household use of different plant species (Odoul et al., 2004).

2.5. Zimbabwe

Campbell undertook a monetary valuation of tree based resources in Zimbabwe in the early 1990s, focussing on dry tropical savannah woodlands (miombo, mopane, teak and Acacia woodlands). The study used contingent valuation methods to value the goods and services derived from savannah woodlands by communal land residents (Campbell, 1993).

Table 19 Annual values of tree-based goods and services (contingent valuation method)

	Mean value per household		Median value per household	
	Z$	US$	Z$	US$
Fuel	373	119	500	160
Farm/house materials	290	131	400	128
Crop production	222	71	333	107
Animal feed	181	58	144	46
Ecological services	175	56	257	82
Food	136	44	200	64
Shade	102	33	125	40
Cash income	82	26	125	40
Health	71	23	100	32
Social services	46	15	47	15
Total	1,678	537	2,256	722

Source: Campbell, 1993 and authors calculations (to obtain US$ values).

The paper also utilised replacement costs and production values to estimate the total value per household and per hectare of tree-based goods and services per year (see Table 20). The total value

per household of tree based goods was estimated at between US$245 and US$402; per hectare this range was US$53 to US$68 (Campbell, 1993).

Campbell also cites Elwell and Stock (1988) having calculated Z$2.5 billion to be the annual cost of soil erosion to Zimbabwe in 1985 prices. The report also cites a preliminary valuation of the carbon sequestration function of woodlands in Zimbabwe at approximately US$200/ha paid as a lump sum or as an annual infinite payment of about US$20/ha (Bojo (1993) cited in Campbell, 1993).

Table 20 Annual values of tree based goods and services, per household and per hectare (production value and replacement cost methods)

	Value per household (Z$)	Value per hectare (Z$)
Indigenous fruits in woodland	230–360	65
Indigenous trees in cropland	10–44	
Planted exotics	12	
Other wild foods	63	11–18
Fuelwood	183	33–52
Construction wood – buildings	114	20–33
Construction wood – utensils	16	3–5
Construction wood – craft wood income	7–18	1–5
Livestock production	100–168	30
Crop production – litter from woodlands	17	3–5
Fertility from scattered trees	15	
Total	767–1,010	166–213
Cash income – exotic fruits	17	
Cash income – wild fruits	2	<1
Cash income – craft wood	7–18	1–5

Source: Campbell, 1993.

Cavendish (1999), explicitly integrated quantitative environmental data with household economic data by conducting household surveys in southern Zimbabwe. The study undertook data collection in two different years (August 1993–September 1994 and August 1996–September 1997) from random sample of 197 panel households in 29 villages.

The study valued and aggregated environmental resource use and non-environmental economic data for households involved in both market and non-market activities to produce household income accounts. Wherever possible, economic transactions were valued either at households' reported prices or at local market prices; value added was calculated where relevant, including for subsistence agriculture. Where economic valuation was difficult, methods were developed that used the best available price data (Cavendish, 1999). Table 21 outlines the value of environmental income in detail, along with the other major sources of income at the household level.

Cavendish cites Campbell et al.'s (1994) study of two villages using household interviews to assess tree-based resources use, and estimated them to be worth approximately Z$300 (US$37) per hectare per annum (1999).

Table 21 Total income by major income source

Income source	1993/4		1996/7	
	Z$	%	Z$	%
Average total cash income (Crop, livestock, unskilled labour, skilled labour, crafts and SMMEs*, remittances, miscellaneous)	52,650	26.29	81,258	34.27
Net gifts/transfers	4,282	1.48	5,547	3.38
Total own produced goods (Consumption of own produced goods, input use of own produced goods)	56,109	36.85	42,401	25.48
Total environmental income	53,631	35.38	58,712	36.87
(Gold panning)	11,434	7.30	4,414	3.20
(Natural habitat utilisation cash income)	6,961	4.61	6,977	5.43
(Consumption of own collected wild foods)	8,858	6,28	6,316	4.48
(Consumption of own collected firewood)	10,851	7.26	11,583	8.17
(Consumption of own collected wild goods)	879	0.65	1,240	0.81
(Use of environmental goods for housing)	4,055	2.73	3,500	2.59
(Use of environmental goods for fertiliser)	767	0.56	718	0.52
(Livestock browse/graze of environmental resources)	9,825	5.99	23,693	11.66
Total income	166,673	100.00	187,918	100.00
* Small, micro and medium sized enterprises				

Source: Adapted from Cavendish, 1999.

Forestry accounts were compiled for Zimbabwe by Mabuga and Chitiga and published in 2002. The report states that according to the official national accounts, forests contribute on average three per cent to Zimbabwean gross domestic product and employs some eight per cent of the manufacturing sector. In addition to creating physical and monetary accounts for commercial (i.e. plantation) forestry in Zimbabwe, the study incorporated the value of the values of timber and non-timber products in natural woodlands as well as attempting to build in values for ecological services such as carbon sequestration and water abstraction.

The report cites a further study by Campbell et al., (1994) which used a modified contingent valuation method to estimate mean direct and indirect values of a range of timber and non-timber products in natural woodlands, and found a value of Z$700 per hectare per year. The accounts used these results and extrapolated across the country, so that the total stock value of indigenous woodlands was crudely estimated at Z$14.7 billion (about 32.6% of GDP and 141.9% of agricultural GDP). The report notes that these estimates should be taken as order of magnitude estimates only (Mabuga and Chitiga, 2002).

Based on a previous study, the accounts assigned an economic value of Z$60 per hectare per year to net carbon stock stored in the form of biomass (Kundhlanden et al. (2000) cited in Mabuga and Chitinga, 2002). The authors note that this estimate is based only on above ground biomass; though below ground biomass can be critical component of net carbon storage. Extrapolating this figure to the national level, the study found that natural forests contributed 1.5% of 1997 GDP, or 9.4% of agricultural GDP (Mabuga and Chitiga, 2002).

The value of water in natural woodlands and forests stems from vegetation cover that may stabilise local climate/maintain rainfall patterns and may reduce water loss through windbreak and soil cover functions. It is also though that woody vegetation may also help to regulate stream flow, may help to improve water quality, prevent erosion and flooding and affect recharge of groundwater. The study relies Kundhlanden et al. (2000) who estimate the value of water availability through its influence on supply of wild food and plant products and services through its influence on crop production. Water is treated as a component of the production process, and changes are assessed by the response of producers through a crop and woodland product model. That study prices water in

the natural woodlands and forests through its effect on production at Z$96.60 per hectare per annum, and extrapolated to the national level, this service is worth Z$2.03 billion (Mabuga and Chitiga, 2002).

3. CARBON SEQUESTRATION

In his review of secondary forests in Mozambique, Albano (2002) suggests that secondary forests can accumulate more above ground carbon than plantation forests. He believes that this demonstrates the ecological value and importance of the successional processes of secondary forests to counter-act the greenhouse effect (e.g. Sips and Van der Linden, 1997; Campbell, 1996). However, he stated that there was no documented information on this issue for Mozambique (Albano, 2002).

Carbon trading has taken place in Mozambique[4] – the Nhambita community in the buffer zone around Gorongosa National Park are being supported to undertake reforestation activities (among several others), which are being paid for in part by selling carbon credits. Though these credits are not yet legally recognised, philanthropic purchasers are funding the scheme. It is estimated that the new plantings in the community (of indigenous species only) will lock up 90 tonnes of CO_2 per hectare. Sales have already been made, though unfortunately the market prices of credits sold are not available. Envirotrade estimate the value of a tonne of carbon sequestered to be between $US1–15 per tonne. Using the median of $US7.50, this translates to approximately $US675 per hectare for the region.

Turpie (2000) in her estimation of the resource values of the Rufiji floodplain and delta estimated indirect use values of carbon storage of the woodlands of the study area to be approximately $US650/ha (2000).

Blignaut and Moolman (2006) argue that carbon trading based on existing biomass does not count, as it doesn't contribute to additional carbon storage. However, they a estimated potential value of $US66.87 per hectare for carbon sequestration on communal land abutting a protected area (2006). This estimate was based on an price of $US15.70 per tonne of CO_2, with a carbon absorption of only 4 tonnes per hectare (the area is characterised as Lowveld Sour Bushveld and Lowveld Savannah) (Blignaut and Moolman, 2006).

[4] Though there is no published material about this scheme, information was sourced from one of the organisations supporting the scheme, and can be found on the website of Envirotrade, at envirotrade.co.uk.

4. DIRECT AND INDIRECT USES OF NATURAL RESOURCES IN MOZAMBIQUE

This study implemented a household survey at three sites in Mozambique – at the Chirindzene Sacred Forest (CSF), in the Bazaruto Archipelago National Park (BANP) and in Vilanculos – to determine direct use values of forestry and marine resources under different management institutions. BANP was chosen to represent a well established national park with active management, CSF was chosen to represent an area with the potential for improved management, while Vilanculos was determined to have no active management of natural resources.

Stratified random sampling was conducted within the survey zones of the three sites, with 125 households surveyed in CSF, 105 in Bazaruto and 95 in Vilanculos. This represented approximately 31% of the population in Chirindzene, 30% in Bazaruto and 4% in Vilanculos. The sample size for Vilanculos had been planned to be larger than those for BANP and CSF due to its much larger population (almost three times that of CSF and more than 10 times that of BANP). Due to logistical difficulties (the survey forms were mislaid by the airline transporting them between Maputo and Vilanculos) and the resultant time constraints, this was not possible. These difficulties were also the reason for the smaller than planned sample size in BANP.

CSF was surveyed between 7 and 11 August, 2006, by six enumerators (four of whom were members/staff of ACOSADE). The investigation area was Chirindzeni Village, one of a group of five villages creating the Greater Chirindzene area. The Greater Chirindzeni area housed a population of 7 019 people[5]. The Chirindzene Village (populate 2,070) was divided into four zones (*bairros*), and from size of the zones a proportionate sample number was derived for each zone, making the assumptions that the population growth ratio of the zones against each other remained the same; that the population growth ratio of the village between the years 2002 and 2006 remained the same; and that each household had an average of five members. Interviewed households were selected through an elimination process, with only every third household being selected. Should the selected household be unavailable or unable to respond, the neighbouring household was selected, and the elimination process restarted. The first pilot questionnaire was conducted as a group with the Political Leader of the village as a respondent. Interviewers discussed how questions were best asked and the use of terms in the local language with the leader. Units of measurement were also established and doubts on the completion of the questionnaire were cleared. Enumerators were also sent on individual pilots, in the presence of the supervisor. Households interviewed during pilot process were not included in the sampling for actual interviews.

Five enumerators surveyed 95 Vilanculos households between 14 and 16 August, 2005. Six main coastal zones (*bairros*) were identified within the Vilanculos Municipal Area. No information was available with regards to the number of inhabitants in each zone at the time of survey implementation, and so the sample was divided equally among the five zones[6]. For safety reasons, enumerators preferred to be dispersed as a group into the same zones for the completion of the survey. Households were selected according to a process of elimination where only every third house was interviewed. A letter of introduction and request for permission was drawn and handed to the municipal office, informing of the work to be done in the area, and the duration of the same. Individual letters were provided to each enumerator introducing them and their tasks to the respondents. At each zone, the first questionnaire was to be completed by the zone leader/chief after permission and information was given and received about the work at hand. An appointment was made, yet not honoured by the head of the Fishing Association to conduct the initial group pilot questionnaire. Individual questionnaires were conducted by enumerators and evaluated in group

[5] The population numbers are based on the census conducted in the year 2002, and act only as an indication of the village size and distribution. (Numbers derived from the Chirindzeni Political Leader).

[6] Subsequent population estimates were obtained from INE statistics, which estimated that the 1997 population of Vilanculos was 20,513. This estimate was used for the extrapolation of results presented.

sessions at completion. At these sessions, questions were asked and answered with regards to the completion of the questionnaire, correct terminology in the local language, and different possible scenarios.

The survey was conducted by five enumerators in Bazaruto between 14 and 17 August, 2006. The island of Bazaruto has a total population of 2,379 people[7] distributed through three major areas Pangaia, Zingueleni and Sitone-Machulane. The sample number of 105 households interviewed was distributed across these areas proportionate to their population. From the size of the areas, the sample numbers were extracted under the assumptions that the population growth ratio between the zones remained the same; the population growth ratio of the island was the same for 2005 and 2006 and the average household consists of seven members. Due to the distance between each area, enumerators visited areas collectively, dispersing on arrival. A group pilot was conducted with the community chief of Pangaia and individual questionnaires were conducted under supervision, the enumerators had already participated in a group session of questionnaire analysis with the Vilanculos group, where questions had been asked and answered.

The survey instrument was designed to elucidate information regarding the range of forestry resources harvested by households. Bazaruto and Vilanculos households were also questioned about their use of marine resources. Householders in Chirindzene were not asked about their use of marine resources, as the village is not located on the coast. While boat building wood is not technically a marine resource, it has been grouped with these resources for ease of comparison.

The values of resource use presented below are gross values – extraction and processing costs (predominantly labour costs) have not been calculated. Other studies, however, have shown these labour costs to be in the range of 37–75 per cent of the gross value of harvested resources (see Shackleton et al., 2002).

These gross values have been calculated for tradable resources utilised in the three regions. A number of resources harvested are neither traded commercially nor bartered, thus a value of exchange for these resources could not be determined. In these cases, results are presented simply for the total quantities harvested.

Survey results are presented below, unless otherwise stated. The survey results have been extrapolated across the 415 Chirindzene households, 340 Bazaruto households and 2,564 Vilanculos households. It must be stated that care should be used if utilising the results of this study to extrapolate across a larger area of Mozambique, as the study areas are not necessarily ecologically or socio-economically representative of other regions of the country. Results are reported using the Mozambican New Metical (MZN), as the survey took place after the official change in currency (from the Mozambican Metical (Mts). The exchange rate used from Meticias to United States dollars was the average value for the previous 12 months[8].

It is likely that the results presented below underestimate the resource use of the Chirindzene residents; the household survey specified their resource use in the Sacred Forest which has strict rules and regulations regarding resource use within the forest. However, residents also use the additional forest resources outside the boundaries of the Sacred Forest.

It should also be noted that in order to obtain the most accurate data regarding the harvesting and use of natural resources, data collection should ideally occur regularly throughout a 12 month period, increasing the likelihood of accurate recall. It is recognised that survey respondents' ability to accurately recall information decreases over time. This is likely to result in the underestimate of

7 Population numbers based on a census conducted in the year 2005.

8 This value was MZN1:USD0.03877 (oanda.com/convert/fxhistory).

the harvest and use levels of some resources – particularly those harvested opportunistically. Further, as the survey respondent was primarily the household head – particularly the opportunistic harvesting of food resources by children – may well be underestimated.

4.1. Household survey results – direct consumption value

The total population of the 325 households sampled was 2,330. These households had an average size of seven (median=6, mode=5), ranging between one and 39 (see Table 22 for breakdown by region). 48 per cent of household members are 17 years of age or younger, with 52 being 18 years or above. This hardly changes in each region, except in Vilanculos, where only 43 per cent of household members are 17 years or younger, and 57 per cent are 18 years or older. Table 23 describes the gender of household head by region, and Table 24 outlines the highest level of education of the household heads.

Table 22 Household size by region

	Chirindzene (n=125)	Bazaruto (n=105)	Vilanculos (n=95)	Total (n=325)
n	125	105	95	325
Total	760	781	789	2,330
Average	6	7	8	7
Median	6	7	6	6
Mode	6	3	5	5
Range	1–14	1–24	1–39	1–39

Table 23 Gender of household head, by region (%)

	Chirindzene (n=125)	Bazaruto (n=105)	Vilanculos (n=95)	Total (n=325)
Male (%)	64	89	81	77
Female (%)	36	11	19	23
Total	100	100	100	100

Table 24 Level of education of household head, by region (%)

	Chirindzene (n=125)	Bazaruto (n=105)	Vilanculos (n=95)	Total (n=325)
None	44	55	35	45
Primary	54	34	44	45
Secondary	2	10	20	10
Matriculation	0	0	1	0.3
Tertiary	0	0	0	0
Total	100	100	100	100

Within the households, 28 per cent of adults[9] considered themselves unemployed, 19 per cent were employed, while 53 per cent were self-employed (see Table 25 for a regional breakdown). It is not clear why a considerably greater proportion of Chirindzene residents consider themselves to be unemployed compared to those in Bazaruto or Vilanculos; it may be a matter of interpretation (e.g. it is possible that agricultural activities may be considered as an own small business by some respondents and not by others).

Table 25 Employment status of adults, by region (%)

	Chirindzene (n=125)	Bazaruto (n=105)	Vilanculos (n=95)	Total (n=325)
Employed	23	19	18	19
Self-employed/Own small business	24	66	68	53
Unemployed	54	14	17	28
Total	100	100	100	100

[9] For the purposes of this report, and adult is considered to be 18 years of age or older.

Average household income was reportedly MZN12,500 (approx. $US486), with a median of MZN5,000 ($US194). 15 per cent of households reported no cash income at all (modal income=MZN0). The maximum income reported was MZN436,000 ($US16,904). Table 26 provides details of household income by region, while Figure 1 illustrates the proportion of households falling within different income brackets.

Table 26 Household income, by region (MZN)

	Chirindzene (n=125)	Bazaruto (n=105)	Vilanculos (n=95)	Total (n=325)
Average	3,500	12,300	24,670	12,500
Median	2,000	6,000	12,000	5,000
Mode	0	0	10,000	0
Range	0–24,000	0–436,000	0–120,000	0–436,000

Figure 1 Proportion of households by income bracket (MZN)

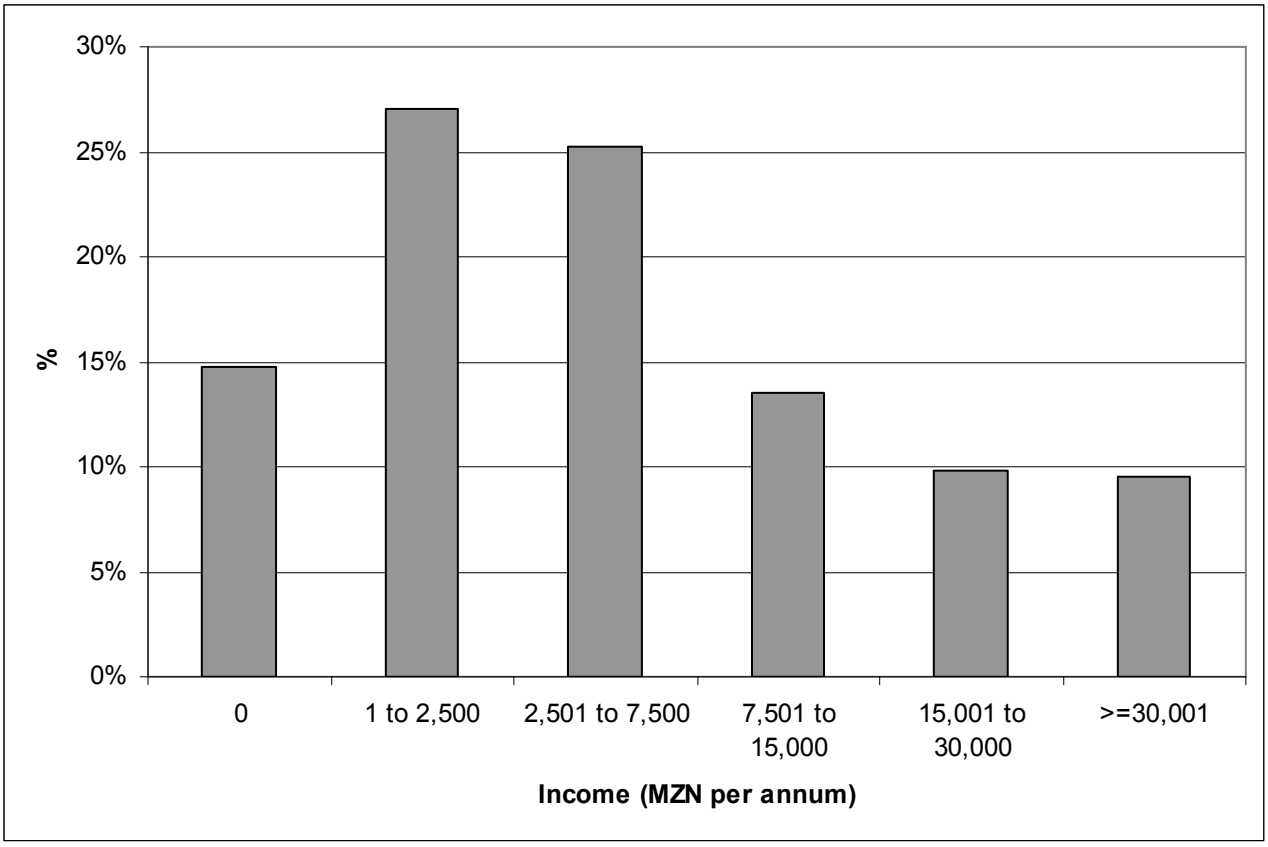

Table 27 Household livelihood activities, by rank (%)

Rank	Cropping	Livestock	Forestry	Fishery	Wetland	Cash	Govt.	Other
1	51	5	5	13	4	23	2	0
2	14	8	22	18	5	23	2	0
3	4	14	17	8	8	18	1	0
4	0	10	8	0	9	4	1	0.3
5	1	4	1	0	4	4	1	0
6	0	1	0	0	0	1	1	0
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
0	31	58	47	61	71	26	94	99
Total	100	100	100	100	100	100	100	100

Table 28 shows the proportion of households assigning a rank to each activity. That is, 51 per cent of households ranked cropping (cultivation of land for subsistence and sale) as the most important

activity to their household livelihood, 14 per cent ranked it as the second most important contributor, 31 per cent stated that it did not contribute to the household livelihood at all (i.e. it was ranked '0'), etc. It can be seen from this table, 74 per cent of households ranked cash as important to the household livelihood and 69 per cent ranked cropping as contributing to household livelihoods. 53 per cent of households ranked forestry resources as contributing to household livelihoods, followed by livestock production (42 per cent of households) and fisheries (39 per cent of households), while wetland resources contributed to 29 per cent of household livelihoods. Government/pensions and 'other' contributed to just six per cent and one percent of household livelihoods respectively.

No household ranked more than six of the eight activities as being important to their household. It can be seen from Table 28 that a higher proportion of households in Chirindzene rely more heavily on cropping to support the household, as compared to Bazaruto and Vilanculos households, where the major contribution to household livelihoods is slightly more evenly spread between cropping, fishery resources and cash income. It is thought that on Bazaruto, the comparatively low reliance on cropping is the result of poor soil fertility and a lack of adequate farming area; the latter reducing field sizes available to households. In Vilanculos, considered the northern capital of Inhambane, the reduced reliance on natural resource-based livelihood activities (excluding fisheries) is thought to be the result of additional commercial and economic activities associated with larger populations and a more diverse local economy.

Table 28 First and second most important contributions to household livelihoods, by region

	Cropping	Livestock	Forestry	Fishery	Wetland	Cash	Govt.	Other
Rank 1								
Bazaruto	45	11	5	19	8	15	2	0
Chirindzene	75	1	0	0	2	21	1	0
Vilanculos	27	2	11	24	3	36	2	0
Rank 2								
Bazaruto	0	9	21	47	9	12	1	0
Chirindzene	20	4	26	0	4	36	2	0
Vilanculos	20	12	19	9	1	18	3	0

Only ten types of resources were harvested by more than 10 per cent of the sample. In descending order of importance, these resources are firewood (90%), fisheries (38%), fruit (24%), crabs (21%), sand oysters (19%), thatching grass (18%), leaves and herbs (16%), seeds and nuts, medicinal plants for human use and reeds (all 11%). It is interesting to note that three of these resources are marine, and thus exclude Chirindzene residents from consideration.

Only five resources were not reported to be harvested or used at all – 'other' grass, dugong, turtle, sea cucumber and large game. It is possible that the because it is illegal to harvest these resources (except 'other grass'), their use was not reported, even if some harvesting of these animals is undertaken.

As noted above, there was no commercial trade or barter in a number of resources. Those resources that were not traded were fruit, leaves and herbs, seeds and nuts, medicinal plants (both for human and veterinary uses), plants used to make household utensils and for other uses, palm harvested to make baskets, 'other' edible plants and 'other' wood. In fact, fruit was traded by two households (both in Bazaruto), there were not enough price data to reliably estimate the total value of fruit harvested, nor was it certain that prices would be the same across the three sites. This was also the case (i.e. insufficient price data) for medicinal plants for human use and leaves and herbs.

Table 29 Proportion of households using forestry and marine resources (%)

	Bazaruto (n=105)	Chirindzene (n=125)	Vilanculos (n=95)	All sites (n=325)
Marine resources*				
Boat building wood	10	-	2	6
Crabs	48	-	19	34
Fish	78	-	44	62
Lobster	2	-	2	1
Sand oysters	48	-	11	30
Squid/octopus	26	-	3	15
Forest resources				
Birds	-	4	-	2
Building poles	1	4	-	2
Fencing/kraal wood	1	5	1	2
Firewood	92	98	78	90
Fruit	40	28	1	24
Furniture wood	-	1	1	1
Honey	-	2	-	1
Leaves and herbs	13	29	1	16
Medicinal plants (human use)	11	18	2	11
Medicinal plants (veterinary)	1	-	2	1
Mushrooms	-	6	-	2
Other edible plants	3	-	2	2
Other plants (utensils)	7	2	-	3
Other use plants	2	8	-	4
Other wood	1	-	3	1
Palm (baskets)	10	-	2	4
Palm wine	21	-	-	7
Reeds	11	17	1	10
Roots and tubers	10	-	-	3
Seeds and nuts	34	-	-	11
Small game	-	4	-	2
Thatch grass	17	23	12	18
Timber	-	-	1	0
* The proportion of households using marine resources for all sites includes only Bazaruto and Vilanculos households.				

While households in Bazaruto and Vilanculos both harvested six marine resource types, considerably higher proportions of households in Bazaruto harvest marine resources (with the exception of lobster). However, it is not possible to tell whether this is due to a relative abundance and availability of these resources to Bazaruto residents, compared with those of Vilanculos, or whether the (expected) number of alternative economic activities available to Vilanculos residents means that they are less reliant on marine resources to contribute to household livelihoods.
In terms of forest resources, Bazaruto residents harvested 17 different types of resources, Chirindzene households harvested 15 different types of resources and Vilanculos households harvested 13 different types of resources. Once again, the relatively lower figure for Vilanculos households may be the results of a larger number of livelihood alternatives, being resident in a large town, that are not available to the residents of Bazaruto or Chirindzene. (Appendix 1 provides a list of there tree resources used for various purposes including timber, building poles, furniture wood, boat building wood, etc.)

No questions were asked about the availability of harvestable resources to households. Thus, no conclusions can be drawn with regard to why households in some areas do not harvest particular resource types, and it is not clear why the proportions of households in some areas harvest particular resource types differ between areas.

Table 30 Number of resource types harvested by household (%)

Resources harvested	Bazaruto (n=105)	Chirindzene (n=125)	Vilanculos (n=95)	% of households
1	30	7	40	25
2	27	12	35	25
3	21	9	18	16
4	11	21	2	12
5	6	20	3	10
6	2	9	-	4
7	2	7	1	3
8	1	8	-	3
9	-	3	-	1
10	-	2	-	1
11	-	2	-	1
12	-	2	-	1

The lack of information regarding resource availability (e.g. abundance, regulations over access and quantities harvested, or distance from the homestead) or alternative economic opportunities means that it is not possible to explain why a different proportions of households harvest a different number of resource types between sites.

As can be seen in the two tables below, the average number of resource types harvested does not differ greatly between sites. However, the range of resources harvested at Bazaruto is higher than at other sites – across both forestry and marine resources, the maximum number of resource types harvested by a Bazaruto household was 12, while in Vilanculos it was only 7 (Chirindzene residents did not harvest marine resources) (see also Table 30).

Table 31 Forestry resources types utilised by households, by region

	Bazaruto (n=105)	Chirindzene (n=125)	Vilanculos (n=95)	Total (n=325)
Average	3	3	1	2
Median	2	2	1	2
Mode	1	2	1	1
Range	1–8	0–9	0–4	0–9

Table 32 Marine resource types utilised by households, by region

	Bazaruto (n=105)	Vilanculos (n=95)	Total (n=200)
Average	2	1	1
Median	2	1	1
Mode	2	0	1
Range	0–4	0–4	0–4

As a result of separating marine and forestry resources for Bazaruto and Vilanculos, it is possible for these household to appear to harvest no resources. However, in aggregate, all households harvest at least one resource (see also Table 30); some households harvest only forest resources, and others harvest only marine resources.

Table 33 Use of marine and forest resources by households, Bazaruto

	n	Household use (%)	Bartered (%)	Sold (%)
Marine resources				
Boat building wood	8	100*	-	-
Crabs	50	30	16	55
Fish	82	6	7	87
Lobster	2	-	-	100
Sand oysters	50	24	8	68
Squid	27	8	-	92
Forest resources				
Building poles	1	100	-	-
Fencing	1	100	-	-
Firewood	97	80	6	14
Fruit	42	85	1	14
Leaves and herbs	14	100	-	-
Medicinal plants (human use)	12	79	4	17
Medicinal plants (veterinary)	1	100	-	-
Other edible plants	3	100	-	-
Other use plants	2	100	-	-
Other wood	1	100	-	-
Palm (baskets)	10	100	-	-
Palm wine	8	30	6	64
Plant (utensils)	7	100	-	-
Reeds	12	47	18	35
Roots and tubers	10	100	-	-
Seeds and nuts	36	100	-	-
Thatching grass	18	60	-	40

On average, Bazaruto households consume more than 72 per cent of all resources within the household, bartering on average almost three per cent; the remainder (25 per cent) being sold. As can be seen from the table above, with the exception of boat building wood, the majority of marine resources harvested are commercially traded. (Boat wood is consumed entirely within the household, and the finished boats are then sold.) On average, 67 per cent of marine resources are sold, with 28 per cent consumed within the household and five per cent bartered. This is in stark contrast to forest resources – an average 87 per cent are consumed within the household, two per cent bartered and 10 per cent sold. Though 14 per cent of the fruit harvested was sold, this was done so by only two households of the 42 that harvested fruit. It is likely that this high level of own consumption is due to BANP regulations that limit the harvesting of forest resources for own consumption/subsistence use. That is, they are not permitted to use resources for commercial purposes without appropriate licenses. As Bazaruto householders live within a national park, it is likely that the monitoring and enforcement of these rules is relatively effectively in ensuring resource harvesting is predominantly for own use. Of all of the resources harvested by Bazaruto households, only four were harvested by approximately half of all households –firewood, fish, crabs and sand oysters. Other resource types were harvested by fewer than one third of all households interviewed.

Table 34 Use of forest resources by household, Chirindzene

	n	Household use (%)	Bartered (%)	Sold (%)
Birds	5	91	3	6
Building poles	5	81	17	1
Fencing	6	89	8	3
Firewood	122	62	5	33
Fruit	35	100	-	-
Furniture wood	1	100	-	-
Honey	2	92	0	8
Leaves and herbs	36	92	1	7
Medicinal plants (human use)	22	100	-	-
Mushrooms	7	69	12	19
Other use plants	10	100	-	-
Plant (utensils)	2	100	-	-
Reeds	21	77	6	17
Small game	5	71	23	6
Thatching grass	29	80	6	13

Only one resource type harvested by Chirindzene households was harvested by more than half of all households – firewood was harvested by 98 per cent. The remaining resources were each collected by fewer than one third of households, with wood for furniture making being collected by only one household. On average, 87 per cent of resources harvested were consumed within the harvesting household, with five per cent being bartered, and eight per cent being sold. The high levels of household consumption of harvested resources may relate to regulations regarding the harvesting of different resources within the CSF, and larger numbers of resources may be collected in the surrounding forests, that are not part of the CSF.

Table 35 Use of forest and marine resources by household, Vilanculos

	n	Household use (%)	Bartered (%)	Sold (%)
Marine resources				
Boat wood	4	100	-	-
Crabs	18	24	12	65
Fish	42	4	2	93
Lobster	1	-	-	100
Sand oysters	10	10	7	83
Squid	3	9	18	73
Forest resources				
Fencing	1	100	-	-
Firewood	74	71	9	20
Fruit	1	100		
Furniture wood	2	100	-	-
Leaves and herbs	1	20	-	80
Medicinal plants (human use)	2	69	6	25
Medicinal plants (veterinary)	2	100	-	-
Other edible plants	2	100	-	-
Other wood	3	100	-	-
Palm (baskets)	2	100	-	-
Reeds	1	-	-	100
Thatching grass	11	32	-	68
Timber	1	-	-	100

In Vilanculos, only firewood is harvested by more than half of all households (78%), and with the exception of fish (harvested by 44 per cent of households), all other resources were harvested by fewer than 20 per cent of households. Though 25 per cent of the medicinal plant (for human use) was sold, this was done by just one household, as were the sales of leaves and herbs. It appears that households in Vilanculos are more likely to harvest resources with a commercial value than

households elsewhere (i.e. in Bazaruto or Chirindzene), but this may be due to the greater potential for a market for these products in an urban area, as compared to rural villages where each household has a greater ability to harvest resources themselves. As the distance travelled by households to collect resources, it may be that some Vilanculos households travel to collect resources that can be sold in the town, an option that may not be open to all households (perhaps through a lack of transport and/or labour). On average, 69 per cent of marine resources harvested by households are sold, with six per cent bartered and 25 per cent consumed within the household. For forestry resources, 69 per cent are consumed within the household, only one per cent is bartered and 30 per cent are sold. Across all resources, these proportions are 55 per cent, three per cent and 42 per cent respectively.

Market activity may account for the comparatively high number of households ranking forestry products as most important to their households in Vilanculos (11% in Vilanculos, 5% in Bazaruto and 0% in Chirindzene); while the high proportion of households that ranked forestry products as making the second most important livelihood contributions (19% in Vilanculos, 21% in Bazaruto and 26% in Chirindzene) could be explained by the subsistence value of these products to their households. From the three tables, firewood appears to be the only forest product for which there is an active market at each site.

Table 36 Resource harvest and value, by region, survey results

	Bazaruto (n=105)		**Chirindzene (n=125)**		**Vilanculos (n=95)**	
	Amount	**Value**	**Amount**	**Value**	**Amount**	**Value**
Marine resources						
Boat building wood (bundles)	2,540	93,667	-	-	1,748	20,333
Crab (t)	28	288,787	-	-	11	110,604
Fish (t)	116	1,370,095	-	-	90	1,152,148
Lobster kg	80	12,000	-	-	20	3,000
Sand oysters (t)	17	167,404	-	-	11	112,795
Squid (t)	16	354,970	-	-	1	30,330
Sub-total	*n/a*	*2,286,923*			*n/a*	*1,429,211*
Forestry resources						
Birds	-	-	1,660	12,450	-	-
Building poles (poles)	60	2,700	3,986	179,370	-	-
Fencing/kraal wood (bundles)	180	6,300	3,264	112,320	12	660
Firewood (t)	264	353,087	662	549,128	247	325,099
Fruit (t)	7	-	2	-	0.02	-
Furniture wood (t)	-	-	0.05	4,320	2	166,500
Honey (kg)	-	-	19	2,360	-	-
Leaves and herbs (kg)	266	-	6,162	-	8	-
Medicinal plants (veterinary) (kg)	24	-	-	-	2	-
Medicinal plants (human use) (kg)	130	-	103	-	84	-
Mushrooms (kg)	-	-	72	360	-	-
Other edible plants (kg)	21	-	-	-	372	-
Other use plants (branches)	336	-	192	-	-	-
Other wood (t)	0.36	-	-	-	2	-
Palm (baskets) (t)	1	-	-	-	1	-
Palm wine (*l*)	13,462	67,310	-	-	-	-
Other plants (utensils) (kg)	53	-	0.08	-	-	-
Reeds (bundles)	3,092	58,601	4,492	86,562	24	240
Roots and tubers (kg)	880	8,800	-	-	-	-
Seeds and nuts (t)	4	-	-	-	-	-
Small game	-	-	663	49,725	-	-
Thatching grass (rolls)	3,197	61,823	8,251	174,950	2,156	35,136
Timber (t)	-	-	-	-	0.5	21,750
Sub-total	*n/a*	*558,621*	*n/a*	*1,171,545*	*n/a*	*549,385*
Total	**n/a**	**2,845,544**	**n/a**	**1,171,545**	**n/a**	**1,978,596**

A note on the value of leaves and herbs – approximately 52 kilograms of leaves and herbs was estimated to be approximately the equivalent value of 1 x 50kg bag of maize meal in Chirindzene. Thus, the harvested quantity of leaves and herbs in Chirindzene is approximately equal to the value of 5 bags of maize. This value cannot be transferred to the Bazaruto or Vilanculos sites, as the standard unit of measurement for estimating a barter value at those locations was a 50kg bag of rice.

In terms of marine resources, boat building wood is the only resource that yields a price premium. This wood is referred to as *cavernas* and is used in to build the structure/skeleton of a boat. The harvesting of other types of wood required from boat building are forbidden in BANP, and not conducted in this location. However, the value of boat building wood is relatively higher in BANP than in Vilanculos, which may be related to BANP resource harvesting regulations, or to local availability.

As can be seen from Table 36 and Table 37, few resources are harvested by households in all three locations. Of those that are, three are used in homestead construction (fencing/kraal wood, thatching grass and reeds), firewood is also harvested at all locations, as are medicinal plants for human use and leaves and herbs.

Table 37 Total resource harvest and value, survey results

	Total harvest	Total value (MZN)	Total value (USD)
Marine resources			
Boat building wood (bundles)	4,288	114,000	4,420
Crab (t)	39	399,391	15,484
Fish (t)	206	2,522,243	97,787
Lobster kg	100	15,000	582
Sand oysters (t)	28	280,199	10,863
Squid (t)	17	385,300	14,938
Sub-total	*n/a*	*3,716,133*	*144,074*
Forestry resources			
Birds	1,660	12,450	483
Building poles (poles)	4,046	182,070	7,059
Fencing/kraal wood (bundles)	3,456	119,280	4,624
Firewood (t)	1,173	1,227,314	47,583
Fruit (t)	9	-	-
Furniture wood (t)	2	170,820	6,623
Honey (kg)	19	2,360	91
Leaves and herbs (kg)	6,435	-	-
Medicinal plants (veterinary) (kg)	26	-	-
Medicinal plants (human use) (kg)	318	-	-
Mushrooms (kg)	72	360	14
Other edible plants (kg)	393	-	-
Other use plants (branches)	528	-	-
Other wood (t)	3	-	-
Palm (baskets) (t)	2	-	-
Palm wine (*l*)	13,462	67,310	2,610
Other plants (utensils) (kg)	53	-	-
Reeds (bundles)	7,608	145,403	5,637
Roots and tubers (kg)	880	8,800	341
Seeds and nuts (t)	4	-	-
Small game	663	49,725	1,928
Thatching grass (rolls)	13,604	271,909	10,542
Timber (t)	0.5	21,750	843
Sub-total	*n/a*	*2,279,551*	*88,378*
Total	**n/a**	**5,995,684**	**232,453**

Table 38 Extrapolated resource harvest and value, by region

	Bazaruto		Chirindzene		Vilanculos	
	Amount	**Value (MZN)**	**Amount**	**Value (MZN)**	**Amount**	**Value (MZN)**
Marine resources						
Boat building wood (bundles)	8,225	303,302	-	-	47,178	548,786
Crab (t)	90	935,120	-	-	298	2,985,138
Fish (t)	374	4,436,498	-	-	2,431	31,095,880
Lobster kg	259	38,857	-	-	540	80,968
Sand oysters (t)	55	542,070	-	-	306	3,044,278
Squid (t)	53	1,149,427	-	-	27	818,591
Sub-total	*n/a*	*7,405,273*			*n/a*	*38,573,641*
Forestry resources						
Birds	-	-	5,511	41,334	-	-
Building poles (poles)	194	8,743	13,234	595,508	-	-
Fencing/kraal wood (bundles)	583	20,400	10,836	372,902	324	17,813
Firewood (t)	853	1,143,328	2,197	1,823,106	6,670	8,774,263
Fruit (t)	21	-	8	-	1	-
Furniture wood (t)	-	-	0.2	14,342	50	4,493,747
Honey (kg)	-	-	63	7,835	-	-
Leaves and herbs (kg)	860	-	20,459	-	202	-
Medicinal plants (veterinary) (kg)	78	-	-	-	40	-
Medicinal plants (human use) (kg)	422	-	343	-	2,267	-
Mushrooms (kg)	-	-	239	1,195	-	-
Other edible plants (kg)	68	-	-	-	10,040	-
Other use plants (branches)	1,088	-	637	-	-	-
Other wood (t)	1	-	-	-	65	-
Palm (baskets) (t)	5	-	-	-	16	-
Palm wine (*l*)	43,591	217,956	-	-	-	-
Other plants (utensils) (kg)	172	-	0.3	-	-	-
Reeds (bundles)	10,012	189,755	14,913	287,386	648	6,477
Roots and tubers (kg)	2,850	28,495	-	-	-	-
Seeds and nuts (t)	13	-	-	-	-	-
Small game	-	-	2,201	165,087	-	-
Thatching grass (rolls)	10,352	200,190	27,393	580,834	58,189	948,290
Timber (t)	-	-	-	-	13	587,021
Sub-total	*n/a*	*1,808,868*	*n/a*	*3,889,530*	*n/a*	*14,827,612*
Total	**n/a**	**9,214,141**	**n/a**	**3,889,530**	**n/a**	**53,401,252**

According to the extrapolated results, in Bazaruto the average annual gross income to household from marine resources is approximately MZN21,780 ($US844). Average annual household gross income from forest resources is approximately MZN5,320 ($US200). In Chirindzene, the average annual gross household income from forest resources is approximately MZN9,370 ($US363). Average annual gross household income from marine resources in Vilanculos is approximately MZN15,044 ($US583) and from forestry resources is estimated to be MZN5,783 ($US224).

Table 39 Extrapolated harvest and value summary, all sites

	Total harvest	Total value (MZN)	Total value (USD)
Marine resources			
Boat building wood (bundles)	55,402	852,088	33,035
Crab (t)	388	3,920,258	151,988
Fish (t)	2,805	35,532,378	1,377,590
Lobster kg	799	119,826	4,646
Sand oysters (t)	361	3,586,348	139,043
Squid (t)	81	1,968,017	76,300
Sub-total		*45,978,914*	*1,782,603*
Forestry resources			
Birds	5,511	41,334	1,603
Building poles (poles)	13,428	604,251	23,427
Fencing/kraal wood (bundles)	11,743	411,115	15,939
Firewood (t)	9,721	11,740,697	455,187
Fruit (t)	30		
Furniture wood (t)	50	4,508,090	174,779
Honey (kg)	63	7,835	304
Leaves and herbs (kg)	21,521		
Medicinal plants (veterinary) (kg)	118		
Medicinal plants (human use) (kg)	3,032		
Mushrooms (kg)	239	1,195	46
Other edible plants (kg)	10,108		
Other use plants (branches)	1,725		
Other wood (t)	66		
Palm (baskets) (t)	21		
Palm wine (*l*)	43,591	217,956	8,450
Other plants (utensils) (kg)	172		
Reeds (bundles)	25,573	483,618	18,750
Roots and tubers (kg)	2,850	28,495	1,105
Seeds and nuts (t)	13		
Small game	2,201	165,087	6,400
Thatching grass (rolls)	95,935	1,729,314	67,046
Timber (t)	13	587,021	22,759
Sub-total	*n/a*	*20,526,010*	*795,793*
Total	**n/a**	**66,504,924**	**2,578,396**

Lizon (2002) as noted above is the only study found that quantified the gross income of various livelihood strategies. The study in the Zambézia Province, found that the gross income per household from agricultural (cropping) activities was approximately $US70 per annum, while that from livestock was just $US19 per annum, and gross income from other activities (e.g. temporary farm work on other farms, selling drinks, remittances, trade of non-agricultural products and craftsmanship) was only $US16. This study quantified the household use of honey, game, freshwater fish, mushrooms, caterpillars, snails, timber and fuelwood, household gross income from which was valued at $US113 per annum, or approximately 50 per cent of household gross income. Given the considerably wider range of resources covered in this study, it is perhaps not surprising that average gross income per household from forest resources has been estimated. Using Lizon's estimates for agriculture, livestock production and other sources, forest products would contribute 78 per cent of gross household income in Chirindzene, 17 per cent in Bazaruto and 25 per cent in Vilanculos; marine resources contribute 73 per cent in Bazaruto and 64 per cent in Vilanculos. Given these relatively high contributions to gross household incomes for forestry products – particularly in the case of Chirindzene, it is likely that incentives to use these resources sustainably could be provided (though given this analysis is taking place without information regarding current sustainability levels, it is also possible that existing harvest levels of forest products are sustainable). While few households rank forest products as being the most important contributor to household livelihoods (see Table 28), these results would suggest that forest resources are

particularly important. It is not known what causes the apparent difference between the perception of these resources and their estimated actual value; this should be a matter for further research. Working with communities to feed back results regarding these values (of resources utilised) and quantifying the contributions of other livelihood activities would encourage improved management of resources.

Table 40 Forest resource harvest and use (%), extrapolated results by region

	Bazaruto		Chirindzene		Vilanculos	
	Amount	**Value**	**Amount**	**Value**	**Amount**	**Value**
Birds	-	-	100	100	-	-
Building poles	1	1	99	99	-	-
Fencing/kraal wood	5	5	92	91	3	4
Firewood	9	10	23	16	69	75
Fruit	72	-	25	-	2	-
Furniture wood	-	-	0.3	-	100	100
Honey	-	-	100	100	-	-
Leaves and herbs	4	-	95	-	1	-
Medicinal plants (veterinary)	66	-	-	-	34	-
Medicinal plants (human use)	14	-	11	-	75	-
Mushrooms	-	-	100	-	-	-
Other edible plants	1	-	-	-	99	-
Other plants	63	-	37	-	-	-
Other wood	2	-	-	-	98	-
Palm (baskets)	22	-	-	-	78	-
Palm wine	100	-	-	-	-	-
Plant utensils	100	-	0.2	-	-	-
Reeds	39	39	58	59	3	1
Roots and tubers	100	-	-	-	-	-
Seeds and nuts	100	-	-	-	-	-
Small game	-	-	100	-	-	-
Thatching grass	11	12	29	34	61	55
Timber	-	-	-	-	100	100

Tables 40 and 41 demonstrate that the value of resources seem to be the same across the three regions – the exceptions to this are that firewood is slightly cheaper and thatching grass slightly more expensive in CSF, than in BANP and Vilanculos. Boat building wood also commands a price premium in BANP compared to Vilanculos.

Table 41 Marine resource harvest and use (%), extrapolated results by region

	Bazaruto		Vilanculos	
	Amount	**Value**	**Amount**	**Value**
Crab	72	72	28	28
Fish	56	54	44	46
Lobster	80	80	20	20
Sand oysters	60	60	40	40
Squid	94	92	6	8
Boat building wood*	15	36	85	64

4.2. Direct non-consumptive use

Non-consumptive use values refer to the values derived from the resources without harvesting or consuming them. Recreation and tourism values are thought to be the most significant in Bazaruto and Vilanculos where the tourism industry is based on the presence of wild natural resources. The majority of tourists that visit BANP and Vilanculos do so for diving, snorkelling, swimming and boating opportunities over the coral reefs, sport fishing and other recreational activities.

Tourism industry turnover in the BANP/Vilanculos region was estimated to be US$17.5 million in 2005 (approximately MZN451 million), and is expected to increase to approximately $US63

million (approximately MZN1.6 billion) by 2007 (Consultec, 2006) . This figure may slightly overestimate non-consumptive use values, as it includes estimates for some forms of consumptive tourism, such as sport fishing, which could not be disaggregated from the available data. However, as this activity is not estimated within the direct use values, it would not be double counted in a calculation of the total economic value.

The industry also has an impact at the household level, through the wages and salaries paid to employees of the tourism industry. Approximately 10 per cent of tourism enterprise staff within BANP being locally employed (Engdahl et al., 2001), while the proportion of local employment in Vilanculos tourism enterprises is unknown. This impact has been captured in the in the household survey tool, by questions relating to total household cash income and the ranking of livelihood activities. However, due to the priority of the survey in valuing the direct consumption use of natural resources, and the length of the survey tool, additional information about employment and income in the tourism industry was not requested from respondents, and so cannot be disaggregated from total household cash income.

No data is currently available regarding the size of the tourism industry in Chirindzene, however, given that virtually no tourism occurs as yet in the CSF, current direct non-consumptive values are thought to be negligible. However, the community reported would like to develop cultural tourism activities based in and around the forest in the future, so any follow-up research to determine resource use should include a tool to estimate the value of the tourism industry.

4.3. Indirect use and non use values

In order to determine the total economic value of a resources, non use values should be considered, in addition to the use values outlined above. The two sections above outline the direct use value of the resources. In addition to these – and often of considerable significance – are indirect uses, such as the benefits received from ecosystem functions, option values and non-use values including bequest values and existence values. These values have not been quantified as part of this study, but are described briefly below.

Option values reflect the value that an individual would be willing to pay to ensure the resource was available for possible future use. It can be thought of as being similar to an insurance premium to guarantee the future supply of a good or services that may otherwise be uncertain (Pearce and Moran, 1994).

Non use values consist of bequest and existence values. A bequest value reflects the benefit that may accrue to an individual from ensuring that a good and/or service will be available to others in the future. Existence values reflect those benefits that an individual may receive from awareness of the existence of a good and/or service, though they do not directly use it (Pearce and Moran, 1994).

In terms of indirect use values, forests provide a number of ecosystem services, including (but not necessarily limited to):

- watershed protection and water cycle regulation;
- soil stabilisation, the prevention of soil erosion and nutrient cycling;
- carbon sequestration (estimates available for miombo woodlands suggest that this value is approximately $US650–675 per hectare (Turpie, 2000; Envirotrade, n.d.)) ;
- habitat for biodiversity (protected forests and those with regulated sustainable use can also act as sources of biodiversity to surrounding areas);
- improve air quality;

Marine resources also provide a number of ecosystem services, including but not limited to:

- storm protection;
- habitat for biodiversity (with the coral reefs of BANP home to some of the highest marine biodiversity in East Africa, including rare and endangered species of turtle, and dugong);
- spawning grounds and nursery areas for productive fisheries;
- protection of coral reefs;

It was not appropriate to use the household survey to value these non-use values, and virtually no research has been undertaken into the value of environmental services in southern Africa (as evidenced by the lack of information in the literature review provided above). Thus, in the absence of valuation studies undertaken at sites with similar ecological characteristics, even benefit transfer cannot be used to value ecosystem services and functions at the three sites.

In Chirindzene in particular, cultural values are high. The Sacred Forest is important to the residents as it is the main means of communication between the community and the spirits of their ancestors. It is where these spirits are contacted and consulted about local issues, and where traditional ceremonies are collected. The forest also houses the burial ground of the first inhabitants of the area, and it is believed that the spirits of these ancestors inhabit the forest, and remain the guardians of the village. A number of ceremonies are conducted within the forest, including prayers for rain, prayers against pests, the introduction of newcomers and visitors, and prayers asking forgiveness for offenders of the forest, and prayers seeking blessing for the communities endeavours.

The Chirindzene Sacred Forest also protects a spring, which is the major water source for the village, thus if it were to become degraded or converted to agriculture, the supply of the water to the village would likely diminish in quantity and/or quality. This would impose a significant cost on the residents, as the nearest alternative water sources are between four and eight kilometres from the village.

5. DISCUSSION AND RECOMMENDATIONS

The total value of marine and forestry resource use in these three locations was equal to approximately MZN66.5 million ($US2.5 million) for the 12 months prior to the survey; approximately MZN46 million ($US1.8 million) derived from marine resources, and MZN20 million ($US796,000) from forestry resources. This equates to an annual gross income of between $US535 and $US844 per household derived from marine resources, and $US200 to $US224 gross household income from forestry resources.

In order to gain an understanding of why differences occur in the number and quantity of resources harvested between sites, information regarding the locally available quantity and quality of resources is necessary, as is information about local rules and regulations regarding harvesting resources and the effectiveness of enforcement of these rules. In the absence of such information, it is not possible to draw firm conclusions regarding the sustainability of resource use at any site, nor about the differences between them. Information about the quality and quantity of existing resources is vital to determining whether current offtake/harvesting levels are sustainable in the long run, whether over harvesting is occurring, or indeed whether more could be sustainably harvested. This information is also vital to setting efficient rules regulating harvest levels.

Differences between sites can be attributed to a variety of reasons, none of which are certain in the absence of the above-mentioned information. For instance, BANP was chosen as a case study site for this research as it is a well established national park, with active management of natural resources – that is, rules and regulations regarding what resources can be harvested, by whom and for what purpose. As the residents live within a national park, it is expected that monitoring and

enforcement of these rules and regulations is undertaken, and is relatively efficient. This should imply that resource use should be sustainable, as the regulations should have been devised using ecological stock data to determine sustainable harvest levels. It is also expected that monitoring and enforcement within a national park would be efficient and effective, thereby reducing the likelihood of illegal resource harvesting.

Chirindzene Sacred Forest was chosen as a case study site, as it is an area that has the potential for improved management. Existing management relies almost entirely on traditional law. In the absence of legislatively regulated harvest levels and/or the absence of effective enforcement, traditional rules can be very effective. (Indeed, they can also be effective when implemented in conjunction with formal regulations.) Such rules should ensure sustainable use as they have generally been locally developed, and so tend to be appropriate to the local environment, having taken local resource quality and quantity into account in their development. Such regulations are likely to be most successful in ensuring sustainable use of natural resources in areas where traditional authorities remain relatively strong and where customary law is still largely adhered to. However, such regulations may become less effective in areas where there is a high rate of immigration (where immigrants are not necessarily bound to the local traditional authority) and/or where population growth is particularly fast (where regulations may not be able to adapt quickly enough to increased numbers of resource users).

Vilanculos was chosen as a site with no active management relating to natural resource use. In such a case, it is assumed that resources are treated as open access, and are not sustainability utilised – an effect likely to be exacerbated when population densities and growth rates are high – leading to rapid declines in the quantity and quality of resources available locally. Conversely, it is possible that in Vilanculos, because of the size of the town and the comparatively more diverse local economy, the larger number of alternative economic activities that household members can pursue may in fact reduce the reliance on natural resource contributions to household livelihoods.

The results from this survey suggest that high levels of forest resource consumption within households at each site, and the extent of their contribution to gross household income indicate that the benefits of woodland resources could not easily be replaced by alternative economic activities. The relatively small contributions to gross household income from cropping and livestock (see Lizon, 2002) suggest that productivity in these sectors would have to increase greatly, as would the area utilised for these activities, before the benefits of forest resource harvesting could be equalled, let alone exceeded. Perceptions of the contributions of forest resources appear to be relatively low (evidenced by the small proportion of households ranking forest resources as the most important contribution to household livelihoods). However, the quantification of the value of this use (on average valued at MZN6,200 across the three sites) would suggest otherwise, especially when compared with average household (cash) income (MZN12,500 across all three sites).

It is possible that feedback of these results to local communities in areas where community based natural resource management activities are being undertaken (or planned) to highlight the real value of resources harvested compared with returns from other economic activities, perceptions about the value of these resource contributions may change and could increase residents' incentives to sustainably manage these resources. This is even more likely in areas where resource areas have high spiritual and cultural values, which would increase the value of resources even further. (Note that in the absence of data relating to current resource stocks, it is not known whether current harvesting levels are already sustainable.)

Household surveys such as the one undertaken by this study can be used to provide information regarding the quantity and values of resource use at the household level. Thus they are an appropriate tool to provide information for the compilation of natural resource flow accounts.

However, household surveys are not an appropriate tool to gather information for natural resource stock accounts. Appropriate ecological expertise is necessary to assess the quantity and quality of the physical stock of different resources, which can then be valued in order to compile physical and monetary stock accounts for natural resources.

In order to accurately determine the net value of resources use, then it is recommended that future studies amend the survey tool to include questions regarding time taken to collect each unit of resources, labour costs, and a quantification of any resources that are processed within the household for later sale. This could be complemented by focus group discussion and/or key informant interviews which could be used to establish approximate values of those resources for which no markets exist (e.g. to identify substitutes for resources that are not traded, and the approximate value of these substitutes), as well as other inputs (if any) used in processing of different resources and the capital investments required to undertake this. These focus group discussions and/or key informant interviews could be used to determine both non-consumptive use (recreation and tourism) and non-use values of the resource area in question (e.g. cultural values). They could also be used to gain an understanding of any existing rules and regulations governing resource use. An amended survey tool can be found in Appendix 2. Appropriate focus group discussion and/or key informant interview tools should also be developed as necessary. In addition to the above recommendations, and given the almost complete lack of information regarding the value of ecosystem services in southern Africa, it is recommended that studies are undertaken to value ecosystem services across the region, including terrestrial, aquatic and marine values.

Caution must be exercised when using results from household surveys in few sites to try to build a picture of resource use at the national level. It is only appropriate to extrapolate results to areas with the same socio-economic and ecological characteristics. Household resource use may vary greatly across the country, as a result of different resource availability, different income levels, alternative economic opportunities, etc. It is recommended in future that any studies to determine household level resource use should work in conjunction with the team compiling natural resource accounts (for the appropriate resources), in order to minimise possible duplication and maximise the coverage of data collection across the country. This may also enable the use of data related to stocks of resources, which would facilitate analysis regarding the sustainability of reported harvest levels.

If information were available regarding the quality and quantity of resources, the data presented from the survey results above could be used to determine the sustainability of resource harvest levels. However, in the absence of information about the stock of resources, this is not possible.

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APPENDIX 1 TREES USED FOR FIREWOOD, TIMBER, BUILDING POLES, FENCING, BOAT BUILDING, FURNITURE AND OTHER WOOD

Unfortunately, it was not possible to determine the scientific names of all species used, but common names are provided below.

Balatangati
Casuarinas
Chafuta
Chalita
China Wood
Chingono
Chirole
Chotila
Mangueira
Cina/Cuna (?) Wood
Diospyros Rotundifolia
Gogololane
Jambire
Jambueiro
Laca-laca
Mafura Tree
Mango Tree
Marula Tree
Massaleira (Oncoba Spinosa)
Mbimbi
Misasa
Mugogolelwane
Muvangaza
Ndziva
Ngogolwane
Obovata
Palm Tree
Papo
Rangoza
Seringueira
Simbire
Tambeira
Tilhazwa (Obovata)
Tsanho
Tsondzo
Tungu-tungu
Umbila
Umbire
Vangasso
Xinongo

APPENDIX 2 AMENDED SURVEY TOOL

A. Demographics

1	What is the total number of adults (over 18 years of age) in the household? (this includes non-family household members including employees, etc.)	
2	What is the total number of children (17 years and under) in the household?	
3	What is the total number of people living in the household (*Enum*: check this should equal Q1 + Q2)	

4	Is the household head: (*Enum*: tick as appropriate)	Male	Female

5	What is the highest level of education of the household head? (*Enum*: tick as appropriate)	None	Primary	Second-ary	Matricula-tion	Tertiary/ further

6	How many adults (18+) are in each of the following categories? (*Enum*: CHECK - Total should equal Q1)	Employment	Own business/Self employed	Unemployed

7	Can you please give us an estimate of the total **HOUSEHOLD** income (i.e. from all members of the household) in the last 12 months?	Mtn

8 We are interested in the activities that contribute to the livelihood of the household, which includes both cash/income and in kind/own produce activities. What, of the following activities, does your household undertake?
(*Enum*: read list of activities; mark with a cross those that the household does not undertake). Of the activities that your household does undertake, can you please put them in order of their importance (i.e. the value to your household of their contribution)
Enum: this end result should be a list of activities ranked 1 (highest) through 8 (lowest). No activities should be ranked with the same number)

		Rank
8a	Cropping (for own consumption and sale)	
8b	Livestock (for own consumption and sale)	
8c	Forestry resources (e.g. timber, firewood, construction materials, wild food & medicinal plants, animals, etc.)	
8d	Fishery resources (e.g. fish, lobsters, oysters, etc.)	
8e	Wetland resources (e.g. reeds, thatching grass, wild food plants, medicinal plants, animals, etc.)	
8f	Cash income (e.g. formal/informal employment, own small business not related to agriculture/fisheries, remittances, etc.)	
8g	Government/pensions	
8h	Other, if any (please describe)	

We are now going to ask you a number of questions about the household use of natural resources. **Please remember that when we ask whether 'you' undertake an activity, we mean yourself and/or anyone in the household including women and children.**

B. Resource XXX [for harvest of single species]

		Yes	No
9	Has anyone in the household harvested **XXX** in the last 12 months? (*Enum*: tick as appropriate)		

If no, go to Q**xx**

10 What species did you harvest? (*Enum*: please give the common Portuguese name for the species where possible)

a …

b …

c …

d …

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
11	What months of the year is **XXX** harvested by members of the household?												
12	Is there a peak season for harvesting **XXX**, if so, when is it? (*Enum*: make a cross in the boxes where relevant, i.e. where harvesting takes place, or for the months of the peak season)												

13 How many trips per month do people in the household take to harvest **XXX** during the harvesting season?

a Harvester 1 …

b Harvester 2 …

c Harvester 3 …

d Harvester 4 …

e Other …

		Peak	Rest of year	Units of measurement (*Enum*: be specific)
14	How much does one person harvest on a single trip?			

		%
15	Of the **XXX** harvested, how much was consumed in the household (as a proportion of the total harvested)?	
16	Of the **XXX** harvested, how much was bartered/exchanged (as a proportion of the total harvested)?	
17	Of the **XXX** harvested, how much was sold (as a proportion of the total harvested)? And what is the average price for one unit? (*Enum*: Q15+16+17 MUST = 100%)	

		Unit	Average price/unit
18	What is the average selling price for one unit?		Mtn

		Number	Units of measurement
19	How much **XXX**, on average, would need to be bartered/exchanged in order to purchase a 50 kilogram bag of maize/rice (**AS APPROPRIATE IN THE REGION**)?		

C. Resource XXX [for harvest of multiple species]

		Yes	No
20	Has anyone in the household harvested **XXX** in the last 12 months? (*Enum*: tick as appropriate)		

If no, go to Q**xx**

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
21	What months of the year is **XXX** harvested by members of the household?												
22	Is there a peak season for harvesting **XXX**? If so, when is it? (*Enum*: make a cross in the boxes where relevant, i.e. where harvesting takes place, or for the months of the peak season)												

23 How many trips per month do people in the household take to harvest **XXX** during the harvesting season?

a	Harvester 1 …	
b	Harvester 2 …	
c	Harvester 3 …	
d	Harvester 4 …	

		Peak	Rest of year	Units of measurement (*Enum*: be specific)
24	How much does one person harvest on a single trip?			
a	Species 1 …			
b	Species 2 …			
c	Species 3 …			
d	Species 4 …			

		%
25	Of the **XXX** harvested, how much was consumed in the household (as a proportion of the total harvested)?	
a	Species 1…	
b	Species 2…	
c	Species 3…	
d	Species 4…	

		%
26	Of the **XXX** harvested, how much was bartered/exchanged (as a proportion of the total harvested)?	
a	Species 1…	
b	Species 2…	
c	Species 3…	
d	Species 4…	

		%
27	Of the **XXX** harvested, how much was sold (as a proportion of the total harvested)?	
a	Species 1…	
b	Species 2…	
c	Species 3…	
d	Species 4…	

(*Enum*: Q25a+26a+27a MUST = 100%, as for b, c and d)

		Number	Units of measurement	Average price
28	What is the average selling price for one unit?			

a	Species 1…			Mtn
b	Species 2…			Mtn
c	Species 3…			Mtn
d	Species 4…			Mtn

		Number	Units of measurement
29	How much of **XXX**, on average, would need to be bartered/exchanged in order to purchase a 50 kilogram bag of maize/rice (**AS APPROPRIATE IN REGION**)?		
a	Species 1 …		
b	Species 2 …		
c	Species 3 …		
d	Species 4 …		

Optional questions – depending on purpose of questionnaire

30	How long, on average, is each trip to harvest **XXX**?	hours

		Yes	No
31	From the harvest of **XXX**, did any members of the household make items to sell in the last 12 months?		

If no, go to Q**xx**

		%
32	What proportion of the total household consumption was used to make these items?	

33 If yes, how many of which items were made and sold, and what was the average sale price?

		No. of items made	No. of items sold	Average price
a	Good 1 (describe)			Mtn
b	Good 2 (describe)			Mtn
c	Good 3 (describe)			Mtn
d	Good 4 (describe)			Mtn