THE USE AND VALUE OF NATURAL RESOURCES OF THE RUFIJI FLOODPLAIN AND DELTA, TANZANIA

Prepared by

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EXECUTIVE SUMMARY

This resource economics study was commissioned by the Rufiji Environmental Management Project, as an input into the development of a management plan for the lower Rufiji River floodplain and delta, situated in the Rufiji District, Tanzania, The study area is dominated by the river, its floodplain grasslands and lakes, and a mangrove delta, which are surrounded by bushlands and miombo woodlands and forest. It is home to approximately 100 000 rural Tanzanians in 16 100 households, concentrated into 52 villages. The area is rich in wildlife and plant resources, which form an important part of the livelihoods of the population, in addition to their agricultural activities. However, there is concern that the area's biodiversity is under threat from unsustainable use of these resources, necessitating a sound management plan which will maximise the value of the area without compromising its ecological integrity and conservation importance. This study serves to articulate the value of these resources to the local population, and to Tanzania as a whole, and investigates some of the economic and other factors which determine household behaviour and threaten the future value of the area's natural resources.

The 720 000 ha study area was divided into three ecoregions, the floodplain area (8700 households), delta area (5093 households), and a 'transition' area between the two (2300 households), where people have access to both floodplain and delta resources. In order to estimate the direct consumptive use value of natural resources (from direct harvesting and value added), a survey was carried out in nine villages across these three ecoregions. In each village, survey methodology involved meetings with village government representatives, village mapping, focus group discussions on a range of natural resources, key informant interviews and informal discussions, and household questionnaire surveys. A total of 128 households were surveyed. The various methods aimed to ascertain the different types of natural resources used, the numbers of users, quantities of different resources used, and a number of other details needed to determine the value of natural resource use. Indirect use values could not be estimated with any accuracy in this study, but are broadly considered on the basis of available information. Value estimates were assigned to different broad habitat types in the study area, using a GIS coverage of the study area to estimate the area of different habitat types within each of the ecoregions. All quantities and values are expressed as annual values. Values are expressed as gross financial value (the total market value of production), net financial value (the total subsistence plus cash value to households net of input costs but not labour costs), cash income, and net economic value (using shadow prices and net of labour inputs).

Numerous natural resources are harvested and processed in the study area, and a high proportion of households are involved in many of these activities (Table 1). Some 1.5 tons of salt is extracted by women in the delta, mainly for sale to fishers. Most households use clay pots for cooking, and about 44 500 pots are produced annually by potters, made from clay collected along the rivers and estuaries. These are only sold locally, as they are not of a high enough quality to be marketed further afield. Grasses, sedges and reeds are used by many households for making fences, mats, chicken coops, grain storage containers and in house construction, but in small quantities relative to other wetland areas. About 23 000 bundles of grass, 1600 bundles of sedges and 19 000 bundles of reeds are harvested annually. Grasses and reeds are widely available, but sedges are fairly scarce in the study area. Bamboo products are also made in the upland areas.

Table I. Percentage of households in each area and in the overall study area engaged in different natural resource-related activities.

Activity	Floodplain	Transition	Delta	Overall
Salt-making	0	0	32.6	10.3
Pottery	9.3	3.4	28.3	14.5
Grass harvesting	25.9	24.1	2.2	18.1
Reeds harvesting	14.8	10.3	6.5	11.5
Sedge harvesting	3.7	0	0	2.0
Medicinal Plant harvesting	55.6	41.4	34.8	47.0
Food Plant harvesting	94.4	99.3	71.7	87.9
Milala harvesting	92.6	55.2	37.0	69.7
Milala Products	90.7	58.6	34.8	68.4
Ukindu harvesting	0	69.0	54.4	27.1
Ukindu Products	27.4	79.3	60.9	45.4
Firewood harvesting	90.7	100	93.5	92.9
Charcoal making	3.7	3.5	0	2.5
Pole cutting	46.3	20.7	41.3	41.1
Timber cutting	11.1	6.9	4.4	8.4
Furniture making	7.4	10.3	6.,5	7.5
Small wood Products	1.85	6.9	8.7	4.7
Canoe making	0	3.5	4.4	1.9
Jahazi building	0	0	2.2	0.7
Fishing	55.6	51.7	60.9	56.7
Hunting game	0	6.9	2.2	1.7
Hunting birds	5.6	10.3	2.2	5.2
Honey collecting	7.4	20.7	15.2	11.8

Palms are an important resource in the study area, and the lala palm (milala) and wild date palm (ukindu) are particularly important. Their leaves used for making sleeping bags, mats, drying mats, baskets, bed ropes, hats, food covers, fans, ornaments, brooms and grain silos, with all but the latter being ubiquitous in the households of the study area. Ukindu leaves are superior for this purpose, and are dyed to make multi-coloured products, but they are mainly restricted to the delta area. Some 40 000 bundles of milala and 2.2 million small bundles (vichanga) of ukindu are harvested annually in the study area, and at least 63 000 milala products and 30 000 ukindu products are made annually.

A high proportion of households harvest food and medicinal plants for home consumption. At least 10 species of wild grains and tubers, 20 species of leaf vegetables and 60 types of fruits are harvested from the floodplain, marshes and forests, the starches and vegetables forming an important fallback during the famine season. About 1 720 tons of wild foods are harvested annually. At least 24 species of medicinal plants are used, with an annual harvest of about 98 tons.

Almost all households collect fuelwood from the forest or mangrove areas as a source of energy. It is estimated that over 2.5 million bundles or logs of fuelwood are harvested annually, with very little of this being sold. Charcoal is made in kilns in the woodland areas for commercial purposes. Because the activity requires a licence, much of the charcoal production in the study area is illegal, and it is difficult to get accurate estimates of production. At least 20 500 bags are produced annually in the study area, but the actual production is likely to be substantially higher.

Poles of a variety of thicknesses are cut from both forests and mangroves, both for use in construction and, especially in the case of mangrove poles, for export from the district to major urban centres. Over 1.3 million poles, including withies, are harvested from the woodlands, this similar to the estimated amount required annually in local building construction. Relatively few of these are sold. Mangrove pole cutting is a major commercial activity, involving an annual harvest of 126 000 scores of poles, most of which are sold. The commercial demand is for 3 of the 8 mangrove species: *Rhizophera*, *Ceriops* and *Brugiera*. Mangrove pole cutting requires licences, and consequently the business is mainly in the hands of outsiders who may or may not employ locals to do the cutting.

Similarly, timber cutting, a major commercial activity in the woodland areas, is a regulated activity which is largely controlled by businessmen from major centres who sometimes employ locals or buy from local pitsawers. As with pole cutting, the activity is fuelled by high demands from Dar es Salaam and other centres. The most valuable species, *Pterocarpus angolensis* is already scarce due to overexploitation, and the highest demand is now for its substitute, *Afzelia quanzensis*. Several other species are also cut for timber. It is estimated that about 12 000 trees are cut annually in the study area. Some timber is used locally in production of furniture and dhows. Trees are also cut for the production of other wooden products such as dug-out canoes, handles, ladles and ornaments.

Fishing is a highly important activity in the study area, both in freshwater systems and in the estuarine-marine systems of the delta. Most freshwater fishing takes place in the numerous permanent lakes of the floodplain, which provide breeding habitat for fish and are replenished in most years by floods. In the delta fishing is in estuaries and in the shallow inshore waters along the coast. The majority of fishers use nets, a relatively recent phenomenon, although traditional traps and hooks are also still commonly used. Women use fine-meshed nets in the delta. The freshwater fishery is very unselective in terms of both species composition and size: over 40 freshwater fishes occur in the floodplain system, and over 30 species were named in this study as being caught. It is, however, dominated by the most common species, notably the cichlid fish *Oreochromis urolepis* ('Tilapia'), catfishes (*Clarias, Schilbe, Bagrus*) and *Alestes*. A further 30 marine species were named in this study, and several other marine species are also known to be caught in the delta. The most important fish in the delta are *dagaa* (a general term for several small fishes such as mullet) and *mbarata* (clupeid fish such as *Hilsa kelee*). Prawns (*Metapenaeus monocerus, Penaeus monodon*, and especially *Peneaus indicus*) are the most valuable fishery in the delta, and form a large proportion of catches in this area. While most fish in the study area are sold dried or smoked, except for a small proportion sold locally, prawns are sold fresh. Prawn dealers supply nets and ice boxes, and are nearly always on hand to ensure the swift export of prawns from the delta. Within the floodplain, fishing is year round, but with a strong seasonal change in effort corresponding to periods of flooding. In the delta, fishing is year round, with less of a marked seasonal change in catches, as fishers tend to track the changes in availability of prawns along the coast.. The total finfish catch is estimated to be about 9000 tons per year, with freshwater fish making up about 5500 tons, within the estimated sustainable yield of the floodplain area. The artisinal prawn fishery catches in the order of 2 200 tons per year. In addition, at least 113 tons of shrimps and 34 tons of crabs are caught.

Hunting is carried out throughout the study area, mainly by about 265 - 370 'professional' hunters with guns who supply the villages, but also by youths who target smaller species with traps and catapults. Hunting is generally unselective, with over 17 species of mammals and 26 types of birds being hunted, although certain species such as impala and buffalo are

preferred. Hunting requires a licence, but control is weak and most hunting is probably illegal. An estimated 160 tons of game and 51 000 birds are hunted annually. Sport hunting is negligible or absent within the study area, although it is carried out in hunting areas nearby.

Wild honey is collected throughout the study area from woodlands and mangroves, and hives are also kept to a limited extent. The estimated annual harvest is 32 000 litres of honey, about half of which is sold locally.

The total estimated value of the different natural resource harvesting and value-adding activities is summarised in Table II. Natural resources in the study area are estimated to have an economic direct use value of $10.3 million per year. The total net financial value (net value to households in terms of home consumption and cash income) of natural resource use is estimated to be $9.2 million, or $575 per household per year, of which a large proportion is realised as cash income. Over 70% of this value is attributable to the area's fisheries.

Table II. Summary of the annual values of natural resource use estimated in this study (US$)

Resource	Gross Financial Value	Net Financial Value	Cash Income	Net Economic Value[1]
Salt	141 140	94 065	132 478	116 127
Clay	12 937	8 763	10 214	9 983
Grass	6 308	6 099	-	6 573
Reeds	6 689	6 556	-	7 036
Papyrus	604	581	-	626
Medicinal Plants	104 426	103 990	58 925	119 144
Food Plants	294 124	293 733	8 197	303 076
Milala	14 662	14 484	797	15 312
Milala Products	234 023	212 506	11 899	220 970
Ukindu	113 309	112 998	84 327	128 668
Ukindu Products	93 713	45 130	16 545	51 608
Charcoal	25 973	25 873	25 973	28 613
Firewood	796 455	792 716	4 885	750 641
Poles & withies	477 002	472 953	315 187	535 257
Timber	268 028	265 746	259 249	313 633
Wood Products	278 141	184 844	231 289	215 165
Canoes	28 239	28 163	24 777	32 773
Jahazi	20 722	20 722	20 722	21 413
Fish & Crustaceans	7 776 486	6 505 568	6 896 038	7 354 530
Mammals & Birds	36 040	29 804	13 469	34 140
Honey	24 958	24 793	12 877	29 138
Total	**10 753 979**	**9 250 088**	**8 127 849**	**10 294 426**
Value Per Hh	668.24	574.79	505.05	639.68

Nearly all households in the study area have fields and consider farming as their primary economic activity. With an average field size of 0.77 - 1.2 ha in the three different areas, the total area planted each year is about 16 242 ha. At least 24 types of crops are grown, with rice, the staple food, being grown by 76% of households in the study area. Rice, maize, sweet potatoes, millet, vegetables and fruits are grown largely for subsistence, but with a proportion being sold for cash income. In addition, crops such as cashew nut, sesame and coconuts are grown primarily for cash income. Crop production is estimated to have a gross market value of $3.8 million annually, with a net economic value of about $2.6 million.

Grains, especially rice, make up over half of this value, and cash crops less than 10%. A large proportion of households also keep livestock, mostly fowl, but also goats and cattle to a very limited extent, the latter only being found in the delta. These activities have a total gross value of $784 000. Coconut palms, grown mainly in the delta, provide additional value, in that numerous household products are made from their leaves, sap and husks.

Including rough estimates of income from other business as well as from agriculture and natural resources, it is estimated that natural resources account for 33-59% of net income to households (including subsistence income), and 32-63% of household cash income. Thus natural resources are extremely important in the household economy in the study area. The gross financial value of natural resources in the study area is more than double that of agricultural production, and their net economic value is triple that of agricultural value. Furthermore, natural resources are particularly important in providing livelihood security to poor households and in years of poor agricultural production.

Natural resources do have some drawbacks, however. A high proportion of households suffer damages to crops and livestock from wild animals, with crop damage mainly by wild pigs, elephants, monkeys, warthogs, hippos and birds, and livestock losses mainly to predators such as cats and birds of prey. Crop and livestock losses amount to an estimated $1 million annually in terms of their market value, and an estimated 19% of total crop production is lost. Households also spend time and effort in keeping vigilance against and hunting pest animals.

A comparison of net financial returns to labour time (including subsistence value) for different agricultural and natural resource use activities can explain household strategies to some extent. Returns are highest for timber cutting and prawn fishing, which, coupled with the high demand for these products, explains the abundant and increasing supply of labour for these activities. Returns are also high for canoe production and medicinal plant collection, but both these activities are limited by a relatively low demand. Crop cultivation yields low returns, yet takes up a major proportion of household labour time. The seemingly misspent effort put into growing crop surpluses can be explained by the fact that this activity is predominantly carried out by women, for whom the opportunity cost of time is even lower than the returns to agricultural labour. Most activities carried out by women yield low returns, with the exception of shrimp-fishing and salt-making in the delta, neither of which can be carried out at their fields. Fuelwood collection is another low-value, but time-consuming activity, which is carried out by women out of pure necessity. This is the only low-value activity that may be having a significant impact on the environment, simply due to the scale of the activity.

The values elicited in this study can be attributed to different habitats within the study area. Villagers access natural resources mostly within a radius of about 10km from the village centres, and based on this, the total area used by the study area population is about 720 000 ha. Over 90% of this area is under natural habitats. Of the permanent aquatic habitats, rivers and lakes make up 39 000 ha, the estuaries and inshore areas of the delta make up 82 000 ha, swamps cover 3 000 ha. Floodplain grassland covers 180 000 ha, terrestrial, mainly woodland habitats, cover 295 000 ha, and mangrove forest covers 55 000 ha. Some 58 000 ha are transformed into cultivated lands, and another 3700 ha are under settlements.

The direct use values of the broad habitat types are roughly $192/ha/y for estuaries and inshore waters, $42/ha/y for freshwater systems, $17/ha/y for mangroves, $14/ha/y for

bushlands, woodlands and forests, and $2/ha/y for floodplain grasslands. In comp cultivated lands are worth $63/ha/y.

However, the above values are only part of the total economic value of natural h These include indirect use value from ecosystem services, recreational use value, opti existence value, all of which were beyond the scope of this study. Indirect use include flood attenuation, groundwater recharge, sediment retention, inputs to agric water purification, nursery functions, micro-climate regulation and carbon sequestr Rough estimates can be made for some of these. The annual flooding of the Rufiji probably contributes about $2.75 million to the agricultural value of the floodplain delta provides a nursery function for the offshore commercial prawn fishery, worth $4.5 million. Carbon sequestration values may be as high as $230 million. Taking values into account, the value of natural habitats can be seen to be substantially hi ranging from $17/ha for floodplain grasslands, but with all other habitats having higher v than the $63/ha for cultivated lands. Indeed, the value of grasslands would also undoub be higher if the water purification function could be estimated and if their role in fis productivity was taken into account. All of these values require further investigation.

The final part of the report considers issues that need to be taken into conside[redacted]tio devising a management plan for the study area. The importance of ecological sustainat cannot be emphasised enough. This is fundamental to preserving the stocks of[redacted]at resources and functioning of ecosystems which will give rise to flows of value [redacted] fut years. However, the current status of natural resources is little known, as there is a lacl comprehensive assessments or monitoring on individual resources or on ecosystem hea It appears that woodlands in the study area are under a real threat of overexploitati following trends that have been observed elsewhere in Tanzania. Effective management urgently required before road access to these areas improves. In the delta, mangrc cutting is selective, and may not threaten the ecology of the delta as a whole. However, tl needs to be further investigated. No stock assessments have been carried out for fish and appears that the freshwater fishery is already close to or exceeds its sustainable yield. Tl status of the marine fisheries is unknown and could be under threat. Wild animals are st fairly abundant in the study area relative to other inhabited areas of Tanzania, probab mainly due to the proximity of a large source area (Selous Game Reserve). There are nc data to suggest trends in animal numbers, but these resources could be being overutilisec Other plant resource stocks, such as palms and wild foods, appear to be relatively s[redacted]ure but again, need to be assessed.

There are many reasons that certain resources are apparently being utilised beyonc sustainable levels. An appreciation of sustainability issues will not have been engendered in a community which has until only recently had access to abundant resources, and some of the impacts of overutilisation are not likely to be felt by the users themselves. Overexploitation is fuelled by demands from outside the study area, as well as inappropriate or ineffective institutions and systems of control.

There are no quota or effort limits, and the use of several resources is 'controlled' by a licensing system. The licensing system is unwieldy and provides a comparative advantage to wealthier outsiders to enter into trade in natural resources. Locals lack the up-front cash ay for licences, and obtaining licences also requires travelling to both the area of on and to the district capital. Thus most licenses are in the hands of outsiders. censing system creates an incentive for illegal harvesting of resources. Policing

is not strong enough to curtail illegal exports from the area. At the local level, there is no control of resource use within villages, whose boundaries are ill-defined, and all resources are subject to open access. This also creates the incentive to overexploit resources, and no incentive to manage them sustainably. Moreover, villagers probably lack the scientific capacity to manage their resources in an integrated, optimal way.

Securing and improving the future livelihoods of people within the study area requires an optimal mix of development and conservation action within the area, and careful decision-making beyond the study area. Beyond the study area, the onus is on government to address the enormous demand for charcoal and timber in urban centres, through exploring alternatives. National-level decisions also include those which affect broad-scale habitat alteration (e.g. proposed commercial prawn-farming initiatives or oil exploration) or the hydrology of the area (e.g. the proposed dam at Stiegler's Gorge). Other decisions that may be taken at a local government level include those involving development schemes for agriculture or industry. All such decisions need to take the economic consequences of their ecological impacts into consideration, not only at the aggregate scale, but in terms of their impacts on peoples' livelihoods, especially those that do not benefit directly from such schemes. This study suggests that large-scale expansion of agriculture may not be wise, and that a major water scheme could have severe consequences for fisheries, among the most valuable resources in the study area.

Considering the high reliance on natural resources, conservation and the establishment of sustainable use practices within the study area is particularly important. Systems of control need to be revised, starting with establishing well-defined and secure property rights over resources. This involves defining village boundaries and giving village authorities real legal powers. Government intervention will probably be necessary at some level, however, to ensure the conservation and wise use of nationally-important resources. Depending on the resources involved, this may take the form of advice, the introduction of incentives, or quotas allocated at the village level. Licensing systems, if continued, should be administered at a village level, with inputs to government. There is scope for implementing schemes to improve the profitability of resource use, but these should first be carefully analysed in terms of the types of incentives that they would create under the prevailing circumstances. In general, the management strategies employed should be adaptive so that they can be revised on the basis of monitoring and improved information.

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