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Species inventory and the local uses of the plants and fishes of the Lower Sondu Miriu wetland of Lake Victoria, Kenya

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Abstract

This investigation has surveyed the plants and fishes of the Lower Sondu Miriu wetland and described their use by adjacent communities. Poverty is endemic in the area. Fish samples were caught by beach seines, fence, weir traps, baskets, spears and gill-nets. A schedule (structured/openended) was used to discover the major local uses of wetland plants. A total of 37 species of aquatic plants were identified. The dominants were *Cyperus papyrus* L. (Papyrus), *Eichhornia crassipes* Mart. Solms-Laubach (Water hyacinth),*Vossia cuspidata Roxb.* (Hippo grass*)* and *Phragmites australis* (Cav.) Trin. ex. Steud. (Reeds) in a descending order of dominance. The invasion of the wetland by Water hyacinth *Eichhornia crassipes*, which has lead to sudden disappearance of submerged macrophytes at the swamp–lake interface zone, is reported here for the first time. Twelve families consisting of 28 species of fish were identified, the bulk of which consisted of the indigenous fish species of Lake Victoria. A dependence on the wetland plants for the supply of building material and cooking fuel is highlighted. Traditional use is recommended as opposed to commercial-scale enterprise and industry based on swamp plants, since subsistence utilization is compatible with sustainable utilization.

Introduction

River valleys and their associated floodplains have served as centres of human population since the earliest times. Even today, the wetlands which nurtured the great civilization of Mesopotamia, Egypt, the Niger, the Indus valley and the Mekong delta continue to be essential for the health, welfare and safety of the people that live near them. Most of the freshwater and many seawater species, that form the basis of the human diet across Tropical Africa depend on wetlands at some stage in their life cycle, while millions of cattle and wild herbivores are supported by floodplain pastures. Wetlands may also serve as refugia for indigenous fishes from predatory species because of their structural complexity, which may reduce hunting efficiency or deter encroachment by the predators through low oxygen conditions that prevail in the swamp (Chapman & Chapman, 1996). In Mauritania, the tidal flats of Banc d'Arguin national park provide a wintering site for some 3 million shorebirds. In Brazil, the Pantanal covers over 10 millions hectares with large populations of Caimans (*Melanosuchus niger)*, Capybara (*Hydrochoerus hydrochaeris)* and Jaguar (*Panthera onca)* as well as one of the most distinctive mosaics of vegetation in Latin America (Prance and Schaller, 1982). In addition, wetlands serve a wide variety of other functions including flood control, water purification and shoreline stabilization (Dugan, 1990).

Despite the importance of the range of goods and services which wetlands provide, these have tended to be taken for granted (Denny, 1994). The policy for most countries is to drain the wetlands to create land for agriculture. Major wetlands in Kenya are restricted to the river mouths of the major rivers draining into Lake Victoria. Of these, the Yala swamp (western Kenya) is already under pressure from agriculture. This investigation aimed at making an inventory of the aquatic macrophytes of the Lower Sondu Miriu wet-

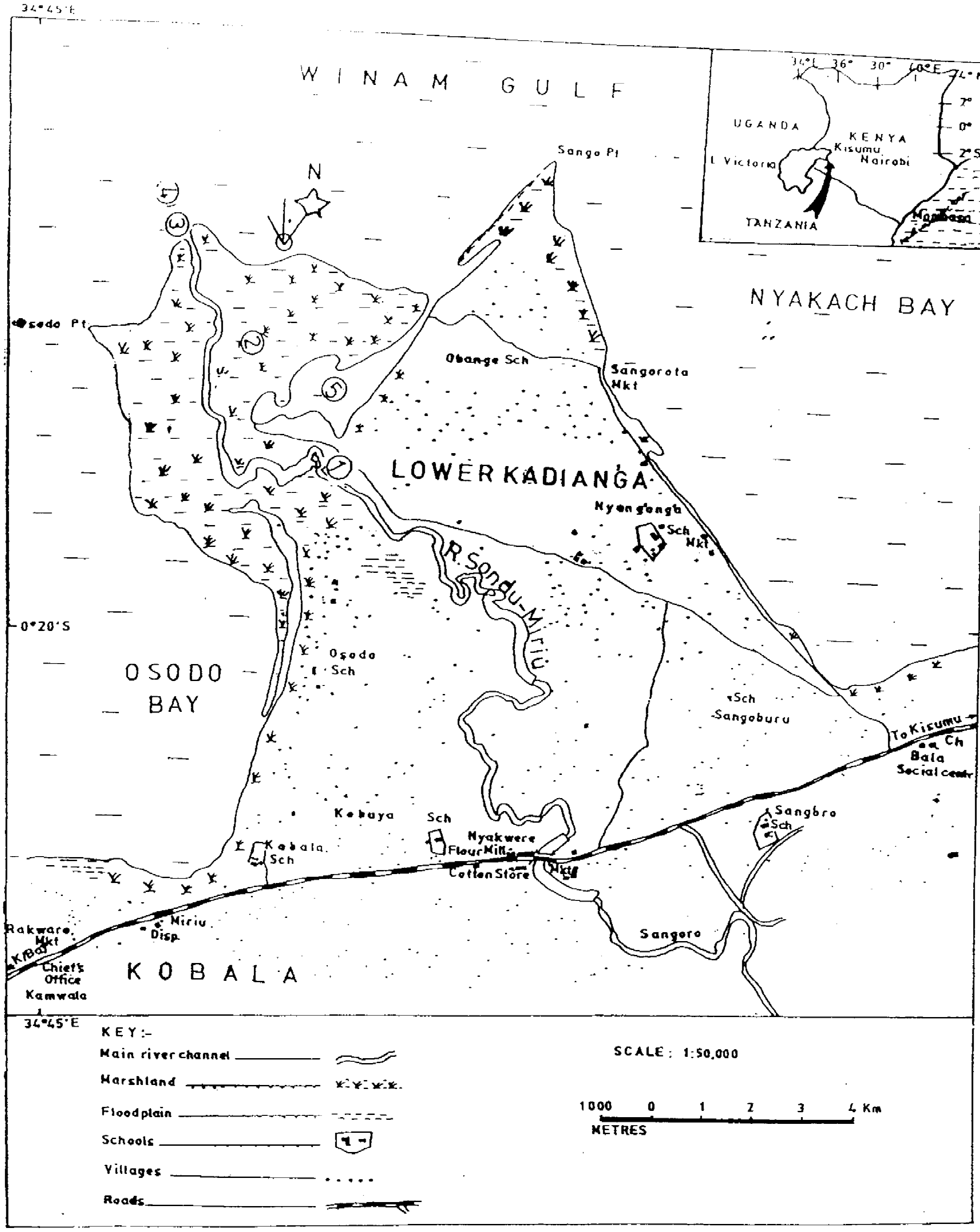

Figure 1. The map of the Lower Sondu Miriu wetland showing the sampling areas 1–5 and the locality of the communities (1: Main river channel, 2: Swamp, 3: Lake–swamp interface, 4: Lake, 5: Side pools).

Table 1. Macrophyte vegetation of Lower Sondu Miriu wetland, western Kenya

Species	Common name
Emergent	
Marsilea macrocarpa Prerst.	
Phragmites australis (Cav.)Trin. ex. Steud.	Giant reed
Cyperus papyrus L.	Common papyrus
Melanthera scandens Schumach. and Thonn.	
Ludwigia stolonifera (Guill. &Perr.) Raven	
Echinochloa pyramidalis (Lam.) Hitch & Chase	Sedge
Cyperus latifolius Poir.	
Utricularia spp.	Bladderwort
Ipomoea aquatica var. *aquatica* Forsk.	Swamp cabbage / water spinach
Vossia cuspidata (Roxb.) Griff.	Hippo grass
Cyratia ibuensis (Hook.f.) Suesseng	
Vigna nilotica (Del.) Hook.	Wild cowpea
Typha domingensis Pers.	Narrow leafed cattail
Aeschynomene elaphroxylon (Guill. and Perr.) Taub.	
Convolvulus kilimandscharicum Guill. and Perr.	
Mimosa pigra L.	Catclaw mimosa
Sesbania sesban (L.) Merrill	Sesbania
Mikania cordata (Burm. f.) B. L. Robinson	
Triumfetta macrophylla K. Schum.	
Solanum nigrum L.	Black night shade
Hibiscus diversifolius Jacq.	
Dryopteris striata (Schumach.) Schelpe	Common fern
Amaranthus dubius Mart.	African spinach
Submerged	
Potamogeton pectinatus L.	Pond weed
Potamogeton schweinfurthii A. Benn.	Pond weed
Ceratophyllum demersum L.	Hornwort, Coontail
Najas horrida A. Br. ex Magnus.	Naiad, Bushy pondweed
Vallisneria spiralis L.	Eel grass, Tape grass
Myriophyllum spicatum L.	Water milfoil
Floating leaved	
Polygonum senegalense Meisn.	Amphibious bisort
Trapa natans L.	Water chestnut
Nymphaea spp.	White waterlily
Nuphar lutea Thumb.	Yellow waterlily
Free floating	
Eichhornia crassipes (Mart.) Solms - Laubach	Water hyacinth
Lemna perpusilla Torrey	Duckweed
Azolla nilotica Decne ex Mett.	Water fern, Water velvet
Pistia stratiotes L.	Nile cabbage, Water lettuce

land and to evaluate their socio-economic benefits to adjacent rural and poor communities.

Materials and methods

The Lower Sondu Miriu wetland (00° 18′ S; 34° 46′ E) lies at the mouth of Sondu Miriu river in western Kenya and covers an area of about 5.5 km^2 (Fig. 1).

Sampling for wetland plants was carried out between January 1993 and March 1994 except April and May 1993 when the swamp was flooded. Additional samples were taken between June and November 1998. Samples were obtained from two ecological zones namely the swamp and the swamp–lake interface. Within these two ecological zones, macrophytes were collected on a transect from the swamp to the swamp–lake interface. Plant parts with diagnostic features such as flowers, fruits, shoots and rhizomes were collected and correctly pressed and labeled with the accurate swamp locality, a brief habitat description and associated taxa. Identification was carried out by use of keys of Cook et al. (1974), Kokwaro & Johns (1998) and Sainty & Jacobs (1994).

Sampling for fish was carried out once a month during the period January 1993 and March 1994 except the months of April and May 1993 when the swamp was flooded. Fish samples were caught in various ecological zones within the wetland. These included the main river channel, the swamp, the side pools and the lake–swamp interface. Different gears of varying mesh sizes were used to catch fish in the wetland owing to its structural complexity. The gears used consisted of a beach seine (117 × 2.8) m in size and 50 mm stretched mesh size, and a gang of gillnets (225 × 2.3) m in size and 37.5, 50, 62.5 and 75 mm stretched mesh size. Other gears used were mainly the traditional types consisting of fence, weir traps, baskets and spears. Gill nets were set overnight and hauled the following morning at 7 a.m. For the seine nets, three hauls were conducted in the side pools. The standard and total lengths of the fish were measured to assess the size structure of the fish. Identification was carried out using the keys of Greenwood (1966), Witte & Van Densen (1995) and Eccles (1992).

For collecting socio-economic information, interviews were performed on a monthly basis between January 1993 and March 1994 except the months of April and May 1993 when the villages were vacated due to flooding. A standard schedule (structured/open ended) was used to evaluate the socio-economic benefits of the wetland plants to the adjacent rural poor communities (Appendix). Interviews were conducted revolving around the utilization of the macrophytes. At every stage in the survey, photographs were taken and tape recordings done with the kind permission of the respondents. The photographs taken were meant to stimulate the respondent's insights and to serve as a source of data. In-depth interviews and follow-up visits were made to 50 key informants from the three hundred homes. These key informants were selected on the basis of their experiences and reliance on the macrophytes and their willingness to talk to us and provide explanations. On each of these homes we performed in-depth probes on the art of thatching and cooking using the macrophytes. The in-depth probes included addition of such phrases as 'That's interesting, tell me more about it', or What do you mean by that?' to stimulate further discussions.

Results

The macrophytes found are listed in Table 1. Except for the water hyacinth, which is introduced, the rest were endemic wetland plants characteristic of the Lake Victoria's littoral zones. The dominant wetland plants were *Cyperus papyrus, Eichhornia crassipes, Vossia cuspidata* and *Phragmites australis* in a descending order of dominance. *Cyperus papyrus* was dominant in the emergent zone while *Eichhornia crassipes* dominated at the swamp–lake interface zone.

We report here for the first time, the invasion of the swamp by the water hyacinth (*Eichhornia crassipes*). This was not observed in previous studies (Gichuki & Odhiambo, 1994). The invasion of the swamp by the water hyacinth has led to the disappearance of the submerged and floating vegetation of the swamp–lake interface zone.

In total, 12 families consisting of 28 fish species were identified (Table 2). Most of the fish caught are endemic to the region and consisted of prey fish species. The most dominant fish species were *Clarias gariepinus* (16.7%), *Synodontis victoriae* (13.9%), *Synodontis afrofischeri* (13.1%), *Protopterus aethiopicus* (11.8%), *Schilbe intermedius* (11.6%), *Labeo victorianus* (10.5%), *Oreochromis niloticus* (7.4%), *Xenoclarias eupagon* (9.2%), *Tillapia zillii* (1.3%) and others (4.5%).

Of the 300 respondents interviewed, 249 used macrophytes for roofing material, 50 used corrugated iron and 1 used tiles (Fig. 2).

Table 2. Fish species identified in the Lower Sondu Miriu wetland, western Kenya

Family/order	Species
MOCHOKIDAE	*Synodontis afrofischeri* Hilgendorf
	Synodontis victoriae Boulenger
CLARIIDAE	*Clarias gariepinus* Burchell
	Xenoclarias eupagon Norman
CYPRINIDAE	*Brycinus sadleri* Boulenger
	Barbus altianalis Boulenger
	Barbus neglectus Boulenger
	Barbus jacksonii Gunther
	Labeo victorianus Boulenger
MORMYRIDAE	*Hippopotamyrus grahami* Norman
	Pollimyrus nigricans Boulenger
	Petrocephalus catastoma Gunther
	Gnathonemus longibarbis Hilgendorf
	Marcusenius victorie Worthington
	Mormyrus kannume Forskall
CENTROPOMIDAE	*Lates niloticus* Linnaeus
CICHLIDAE	*Oreochromis niloticus* Linnaeus
	Oreochromis variabilis Boulenger
	Oreochromis leucostictus Trewavas
	Tilapia zillii Gervais
	Pseudocrenilabrus multicolor Hilgendorf
	Haplochromis spp.
PROTOPTERIDAE	*Protopterus aethiopicus* Heckel
MASTACEMBELIDAE	*Aethiomastacembelus frenatus* Boulenger
SCHILBEIDAE	*Schilbe intermedius* Linnaeus
BAGRIDAE	*Bagrus docmac* Forskall
ANABANTIDAE	*Ctenopoma murei* Boulenger
AMPHILIDAE	*Amphilus jacksonii* Boulenger

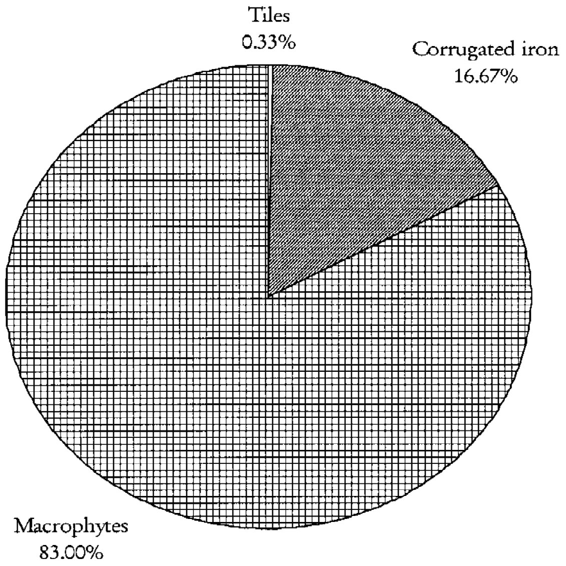

Figure 2. The sources of roofing material for the communities of the Lower Sondu Miriu.

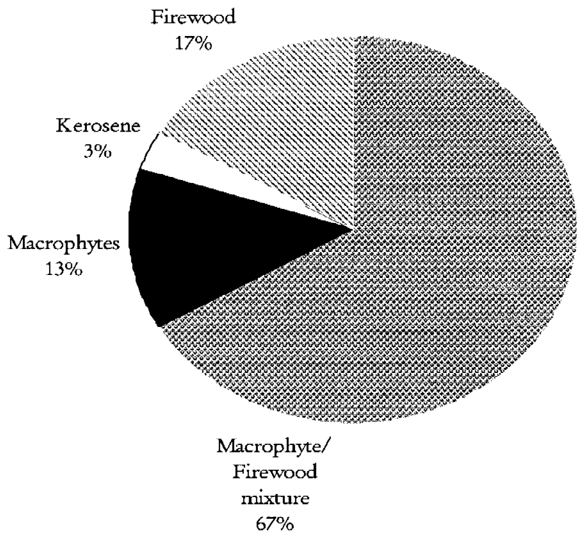

Figure 3. The sources of cooking fuel for the communities of Lower Sondu Miriu.

Figure 3 illustrates the sources of cooking fuel for the communities of Lower Sondu Miriu. From 300 respondents interviewed, 40 used macrophytes, 200 mixed macrophytes and firewood, 50 used firewood and 10 used kerosene for cooking.

There were mixed reactions regarding the interviewees perception on the status and the extent of the papyrus resource. Forty percent of the respondents said the resource was decreasing, while 45% of the respondents indicated that the resource was increasing. The rest had no knowledge on whether the resource was diminishing or not. Of the 40% who indicated that the resource was decreasing, 70% associated this to increased number of harvesters of papyrus following the collapse of the fishery associated with the water hyacinth infestations and the introduction of exotic fish species, while the rest associated this decrease to agriculture. Regarding the 45% of the respondents who averred that the resource was increasing, 90% associated the increase to reduced harvesting as more people turned to using the corrugated iron roof compared to the situation previously where people relied entirely on the sedge roofs while the rest of the respondents associated this to reduced harvesting due to poor prices offered in the markets for the papyrus byproducts. According to some respondents (mainly the older generation), the previous swamp which existed before 1962 was destroyed during the heavy *El nino* rains of 1962. The present swamp was formed after 1962. To them, therefore, the wetland was increasing.

Discussion

The Lower Sondu Miriu is endowed with a rich macrophyte flora with more than 37 plant species. The main uses of many of these macrophytes are for building material and as a source of cooking fuel. According to Gichuki & Odhiambo (1994), some wetland plants of the Lower Sondu Miriu are used by the local community for food, fodder and compost, while some have medicinal value.

From this study, there is evidence that the Lower Sondu Miriu provides a major proportion of roofing material and cooking fuel for the adjacent rural poor communities. The swamp serves also as the only source of green pasture for domestic and wild animals during the dry season (Gichuki & Odhiambo, 1994). During the period of high water, which occurs in April and May, the villages adjacent to the swamp are vacated. As the flood recedes, the cattle enter the swamp behind the falling water where good grazing land is available.

Roofing material

The main 'emergents' used for roofing are senescent *Cyperus papyrus*, dried *Phragmites australis* and dried *Typha domingensis*. Due to the lower biomass of *P. australis* and *T. domingensis* compared to *C. papyrus*, most of the houses in the Lower Sondu Miriu are roofed using senescent *C. papyrus*. The houses constructed using grass or sedges are mainly round with few rectangular ones. The sequence of roofing a grass or sedge-roofed house is as follows: (1) Bundles of five senescent *C. papyrus* culms are tied together and then tied all round a roof to form a waterproof roof circuit around the house. The bundles are laid side by side so that the tops are all at the apex of the roof. (2) The second layer is made up of dry grass, which compacts the roof, making it completely waterproof.

A house constructed this way lasts for 10 years before repair need be done. A house that uses *C. papyrus* is cooler, and also cheaper to make and maintain, than a comparable corrugated roofed house.

Cooking fuel

Senescent plants of *C. papyrus*, *T. domingensis* and *P. australis* that are of too low a quality for roofing are used as fuel. The material may be mixed with firewood but for the poor, who cannot afford to pay for firewood, wetland plants remain their only source of cooking fuel.

Fish and fisheries

According to Barilwa (1995), marginal edges of lakes and floodplains may contribute important harvests because they form temporary feeding habitats for fish, especially during periods of floods and also because they are spawning and nursery habitats.

For the people of the Lower Sondu Miriu, the fishing industry in the swamp provides the bulk of the protein in their diet. Fishing methods include gill-nets, fences, weir traps, baskets and spears. Other methods are restricted by sometimes dense vegetation. Many of the fish species are trapped when fish leave the body of the lake to spawn in the shallow water as the water levels rise over the floodplain during the rains. The tall fence trap is successful when the floodwater is rising. Basket fishing is carried out during all seasons but is most effective when receding water traps fish in small pools during the months of June and July. Chapman & Chapman (1996) observed that *C. papyrus* swamps represent an important and widespread refugium for prey fish species. This is consistent with our findings in the Lower Sondu Miriu wetland where 12 families consisting of 28 species of fish species were identified, the bulk of which consisted of prey fish species. Furthermore, the swamp forms a spawning and nursery habitat for these prey fish species.

Sustainable use of resources in the Lower Sondu Miriu wetland

The Lower Sondu Miriu wetland plays a crucial role on the economy of this region where poverty is endemic. There is no other source of income. It is, therefore, of critical importance that this natural resource is reaped on a sustainable basis. Consequently, there is a need to prudently minimize the negative ecological impacts associated with large-scale removal of papyrus for roofing and fuel. This in turns calls for the development of realistic and appropriate policies and guidelines for sustainable harvesting of papyrus biomass.

In Rwanda, and in other parts of Kenya, projects on the use of papyrus biomass for paper, fibre-board and briquette production have been made, and it appears their commercial potential is substantial (Muthuri, 1985; Muthuri et al., 1989). For the Lower Sondu Miriu wetland, we recommend traditional use as opposed to commercial-scale enterprises and industries based on wetland plants, since subsistence use is compatible with sustainable harvest. Experiences from other parts of Kenya on commercial-scale enterprises is that they are externally driven motivation of very powerful persons who have both monetary and political connections and are able to circumvent the law (Viet, 1988). It is these outsiders who not only benefit but do so while undermining the livelihood of the local people putting their social well-being at risk, and pushing them further behind. The goal of sustainable utilisation of wetland plants can probably only be achieved through community training, with the emphasis on rational, wise and non-destructive utilization. It is envisaged here that the community will be trained to value their resource so that they can safeguard it. Since a fundamental requirement of sustainable use of a resource is such that it promotes conservation, the community will undertake replanting schemes for the overexploited species. Other options available include the possibility of evoking traditions, which in the past served well in the protection and preservation of wetlands. Local people have always had historical and spiritual relationship with wetlands with customary rules enacted by a council of elders to regulate access and use of wetland resources through a mixture of spiritual beliefs and superstition. In this way, sustainable cropping and needs of the local people can then be balanced with the natural functions and values of the wetland.

All efforts should be directed to halting exploitation programmes that may lead to decline in swamp area. Any loss of swamp area would inevitably lead to a reduction in the number of people the swamp can support, and a decline in crucial diversity of indigenous species by loss of habitat, destruction of refugia and faunal mixing.

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Appendix

(I) Introduction

Name of the interviewer:

Date:

Station (description):

Interviewee name:

Age:

Sex:

Marital status (No. of wives):

No. of children:

Profession (main occupation):

How long have you lived in this area?; reason for immigration into this is:

(II) Papyrus area

Where is the papyrus growing?, / (if possible go to the growing area)

Is the papyrus area decreasing or increasing?

Estimated speed of disappearance; where was the boundary 5 years ago and where is it now? (use a string to measure)

(II a) If the papyrus is decreasing

Reason for disappearance: agriculture, livestock, use of the papyrus plant as building material,

How do you feel about the disappearance? good or bad

What are the consequences in terms of the water quality and fish population?

Have you also cut the papyrus and for what reason?

Do you use papyrus or not?

(II b) If the papyrus is increasing

Why is it increasing?

Is agriculture important in the area or is fisheries the major activity?

Is it bad to have more papyrus around?

What are the consequences of growing papyrus fringe?

Do you intend to reverse the situation or will you leave it like that?

(III) Uses

Roofing material

a) What materials do you use for roofing your house? (Tick one)

1. Papyrus
2. Corrugated iron
3. Tiles
4. Others

b) If Papyrus, describe how you roof the house using Papyrus

c) How long does the Papyrus roof last? (Tick one)

1. Less than 5 years
2. Between 5 and 10 years
3. Over 10 years (specify years)

d) What is the advantage of using Papyrus for roofing

1. Low building costs
2. Availability of Papyrus
3. Durability
4. Others

e) At what stage is the Papyrus ready for roofing? (Tick one)

1. Young
2. Mature
3. Senescent

Fuel

a) What type of fuel do you use for cooking your food? (Tick one)

1. Papyrus
2. Wood
3. Kerosene
4. Others

b) At what stage is Papyrus ready for use as cooking fuel?(Tick one)

1. Young
2. Mature
3. Senescent

c) Do you use the Papyrus alone or as a mixture with other fuels? (Specify)

(V) Fish species diversity

a) What kind of fish species do you catch in the swamp?

b) What methods do you use for catching the fish

c) Do you see fish you never saw before?

If yes

Which ones?

Are there fish that you catch now which you did not catch before?

If yes

i. Which ones?
ii. What are their sizes?
iii. Are sizes increasing or decreasing?
iv. Why?

Appendix. A standard schedule (structured/open ended).