

Managing the natural capital of papyrus within riparian zones of Lake Victoria, Kenya

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Abstract The harvesting of natural products such as papyrus (*Cyperus papyrus* L.), whether for subsistence value or for the production of commodities intended for sale at local markets, contributes to the well-being of riparian peoples around Lake Victoria, Kenya. Serious losses of papyrus wetlands across East Africa have been reported, most of which are attributed to increasing anthropogenic stressors. Recent studies have called for restoration of these wetlands, emphasizing the need for sustainable harvesting strategies to be put in place, although few have provided suggestions as to how this might happen in practical terms and, crucially, with the consent and active participation of local communities as key stakeholders. Here we explore the socioeconomic characteristics of livelihoods based on papyrus, presenting data generated from surveys,

interviews and group discussions collected at multiple sites within the Nyando river basin, Kenya. Conceptualizing papyrus stands as living stocks of natural capital, we then outline our proposal for maintaining the provisioning services of this species, without compromising the critical ecohydrological functions of these swamps as land–water buffer zones. Finally we suggest how this approach might be adapted for wider dissemination around Lake Victoria and beyond, motivated by what we believe to be the first reported case of successful papyrus restoration by a local community.

Keywords *Cyperus papyrus* · Sustainable harvesting · Rural livelihoods · Socioeconomic services · Wetland restoration

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Introduction

The giant sedge papyrus (*Cyperus papyrus* L.) is an emergent macrophyte (Fig. 1) with high photosynthetic and productive potential owing to the presence of C₄ photosynthesis (Jones, 1986). Jones & Muthuri (1997) calculated the net primary production of a papyrus swamp at Lake Naivasha in Kenya to be >6 kg dry weight m⁻² year⁻¹, which is among the highest recorded productivities for natural ecosystems. Several studies of papyrus utilization in East Africa (e.g. Gichuki et al., 2001; Maclean et al., 2003; Kansiime et al., 2007) have reported

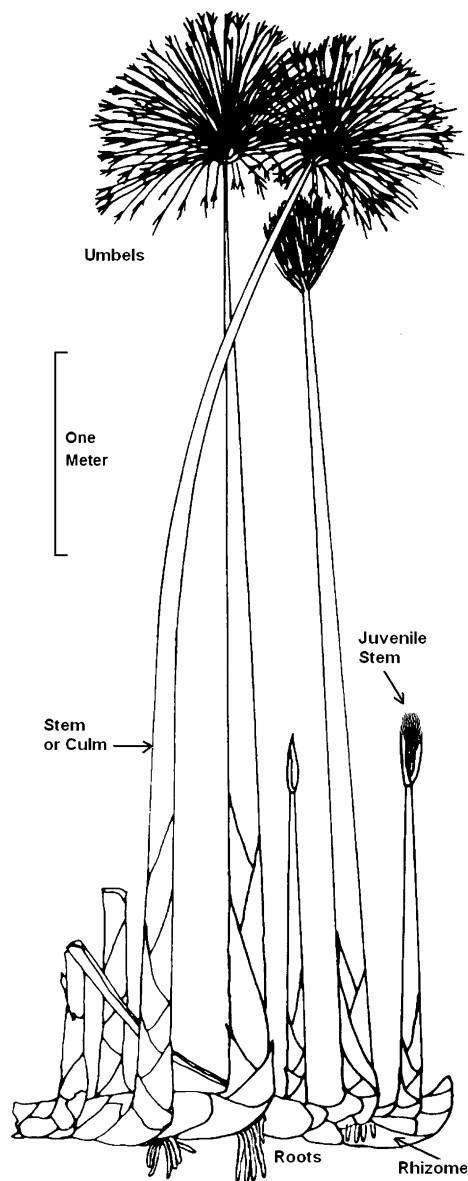


Fig. 1 Sketch of papyrus showing different life stages (kind permission from J. Gaudet)

that many rural communities living in close proximity to these swamps depend, to a greater or lesser extent, on the availability of the plant's biomass to support their livelihoods. Marketable goods derived from harvested papyrus fibres include furniture, mats, baskets and other handicrafts which are products of the provisioning services (Millennium Ecosystem Assessment, 2005) of wetlands.

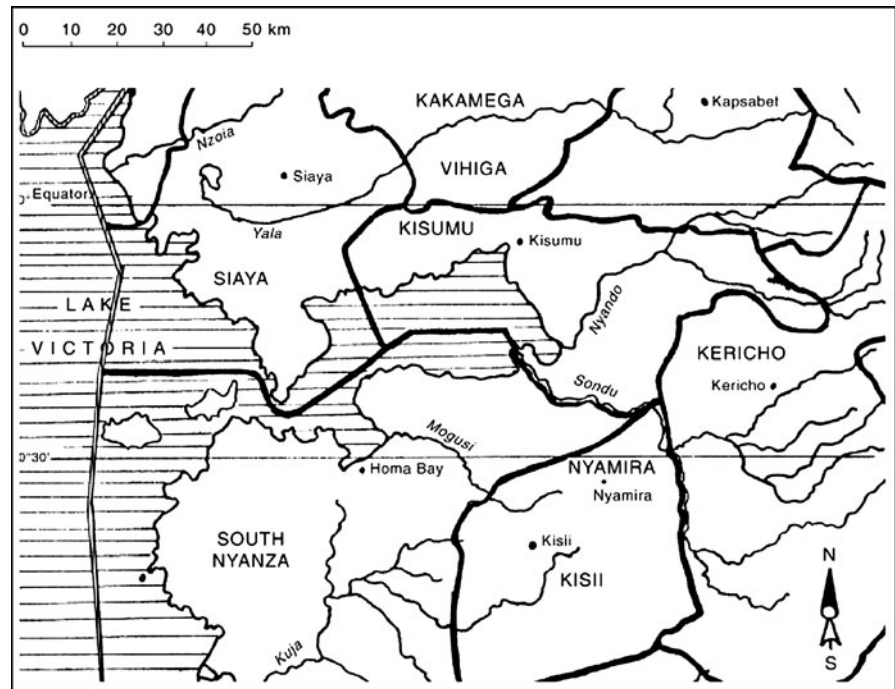
Natural resources, particularly vegetation found in local environments, are attracting increasing interest

for their potential contribution to rural livelihoods in Africa and beyond (Kepe, 2008). Whilst the harvesting of natural products, whether for subsistence value or as commodities intended for sale at local or regional markets, undoubtedly contributes to the well-being and, in some cases, the very survival of millions of people in rural poor households, there remains a paucity of empirical studies across a range of climatic regions, ecosystem types and socio-economic contexts necessary to gauge the ability of these natural products to provide sustainable opportunities for poverty alleviation in the long term (Sunderlin et al. 2005; Shackleton et al., 2008).

In common with many other wetland systems around the world (Mitsch, 2010), East African papyrus swamps, such as those of Lake Victoria, are experiencing severe stress (Kairu, 2001) emanating from the combined threats of (i) rising human population pressures (Balirwa, 1995), (ii) conversion to agriculture through drainage (Schuyt, 2005), (iii) unsustainable levels of exploitation driven by perennial harvesting (Osumba et al., 2010), (iv) weakly enforced management systems (Harterter & Ryan, 2010), (v) lowering of lake levels through over-abstraction leading to destruction by large mammals (Morrison & Harper, 2009) and (vi) the complex challenges presented by a changing climate (Odada et al., 2009). Owino & Ryan (2007), for example, recorded serious (up to 50%) habitat loss and degradation (attributed to conversion to agriculture, increasing demand for papyrus products and a general lack of clear policy on wetland conservation) within three important papyrus wetlands in the Kenyan portion of Lake Victoria over the period 1969–2000.

Much research on papyrus over the last 30 years (e.g. Gaudet, 1977; Jones & Muthuri, 1984; Harper, 1992; Boar et al., 1999; Boar, 2006; van Dam et al., 2007) has explored in some detail the ecology of the species in relation to processes operating within the freshwater ecosystems of which it is a critical component. Very few socioeconomic studies (cf. Gichuki et al., 2001; Maclean et al., 2003) have been made, on the other hand, with the studies that do exist rarely examining the context and drivers of local resource use and knowledge. Recent investigations (e.g. Owino & Ryan, 2007; Osumba et al., 2010) have highlighted the need for more effective wetland management systems to be put in place, but only a few (e.g. Denny et al., 2006) offer critical insights as to how this might be

Fig. 2 Location map (modified with permission from Kairu, 2001) showing the Nyando river (centre right) entering Lake Victoria within Nyanza Province of western Kenya (solid lines show original Districts prior to further subdivision in 1990s)



achieved in practical terms and, crucially, with the active participation of local communities. One such study concluded that the future state of Lake Victoria and the welfare of its human population are “highly related to the future of its papyrus wetlands” (Kiwango & Wolanski, 2008), in which the authors called for certain areas to receive full protection and others to be designated sites of sustainable harvesting. These are undeniably sensible suggestions, yet no potential means of achieving either condition were offered.

The objectives of the present study, then, are (i) to provide a more nuanced understanding of the relationship between the riparian peoples (or ‘wetlanders’: Coles & Coles, 1989) of Lake Victoria and the papyrus swamps which support their livelihoods, in order to (ii) suggest practical, sustainable means by which these communities might manage their resources for continued human use, without compromising the critical function of these wetlands as land–water ecotones (Bugenyi, 2001).

Materials and methods

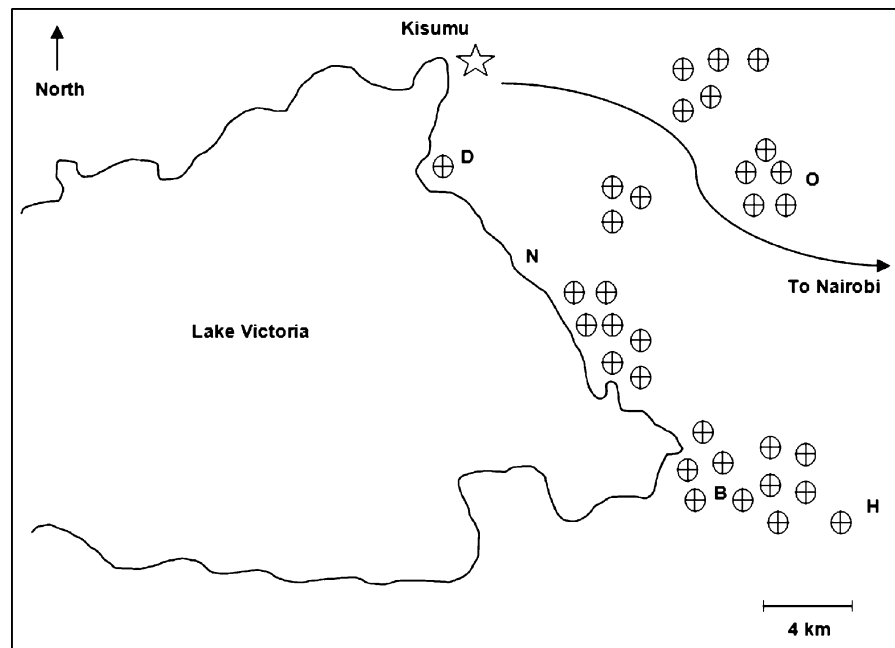
After an initial visit to the region (January 2010) during which potential study sites and methodologies were discussed with local communities and key

actors under the facilitation of Victoria Institute for Research on Environment and Development (VIRED, a regional NGO with research ties to UNESCO-IHE), the authors returned in May the same year for an intense period of data collection in partnership with local wetland researchers.

A survey instrument was compiled which sought to generate a comprehensive understanding of the demographic, historical and economic attributes of individual wetlanders in relation to their use of papyrus within the Nyando river basin (Fig. 2) of Nyanza Province, Kenya. This was piloted at Dunga, a well-researched site outside the Nyando basin whose communities have been involved in previous studies (e.g. Aseto & Onga’nga, 2003), prior to actual data collection. A total of 110 questionnaires were subsequently completed, typically taking 30–45 min each, in 33 villages (Fig. 3) within 7 sub-locations¹ throughout the region. These sites were chosen from a stratified random sample of a longer list of villages (compiled by field assistants) where papyrus harvesters were known to reside but which had experienced little to no previous contact with wetland researchers.

¹ A sub-location is the smallest administrative unit in Kenya; these are, in turn, part of a division, a district and a province (Francis, 2000).

Fig. 3 Sketch map (not to scale) showing approximate location of the 33 villages (circles with crosses) visited during the study as well as other sites mentioned in the text (B Bugo, D Dunga, H Harambee, N Nyamware, O Okana)



Since the objective was to gather information from papyrus harvesters specifically, a purely random sample of all villages within the Nyando river basin was not chosen as it would have yielded fewer useful results (owing to the great divergence of livelihood strategies within the lake's riparian zone) within the limited time available.

The approval of an area chief, senior village elder or other well-respected figure from each site was sought prior to any data collection and, in many cases, a dedicated visit was made in the preceding days. This individual was also asked to appoint a member of their community, known for using papyrus, who would be willing to complete the survey in the first instance. He/she was then asked to nominate another; this snowballing system was continued until it was deemed that a point of saturation in the resulting survey data had been reached (Patton, 1990). In addition to the questionnaire, at each of the sub-locations one or more key informants (such as village elders, teachers, herbalists, etc.) participated in semi-structured interviews, typically of around 30 min duration, during which issues of papyrus harvesting, commodity production and marketing were discussed. These interviews allowed for greater depth of expression and insight from participants than the survey instrument alone. Finally, focus group

discussions were held at 3 of the sites (Bugo, Harambee and Okana: Fig. 3), lasting between 45 and 90 min and attended by around 10–15 members of the community. Okana was chosen for its known contact with VIRED, whilst Bugo and Harambee were selected at random. Focus group members were mobilized by a village elder and efforts made to ensure a fair representation of age and gender. Recordings of the interviews were later transcribed and translated into English where necessary. Data analysis proceeded through coding of qualitative materials and statistical analysis of quantitative socio-economic data using SPSS 18 (2010).

Results

The results presented in Table 1 describe the profile of a 'typical' papyrus wetlander in the Nyando river basin: a Luo² female over 46 years of age, out of formal education since primary school, who has been resident

² There are at least forty tribes in Kenya. Districts lying at the edge of the belt of Highlands running north–west from Nairobi are considered the home area of the Luo people (Francis, 2000); every questionnaire respondent in this study happened to be a Luo.

Table 1 Selected pooled results ($n = 110$: 72 ♀, 38 ♂) from survey data

	Age	Educ.	Res.	Size	Dist.
Min.	16–25	None	2	<1	<0.5
Max.	>46	College	>10	>5	>3
Mode	>46 (0.49)	Primary (0.65)	>10 (0.90)	>5 (0.89)	<0.5 (0.23)
CI	+0.10/ -0.10	+0.10/ -0.09	+0.05/ -0.07	+0.05/ -0.07	+0.09/ -0.07

	Pap.	D. in	D. out	H/hold	Harv.	Users
Min.	1	0	0	1	4	4
Max.	65	12	8	18	28	420
Mean	18	3	2	6	17	114
CI	±2.52	±0.54	±0.36	±0.60	±1.09	±21.60

Age of informant, *Educ.* highest level of education attained, *Res.* years living in village, *Size* of wetland used (ha), *Dist.* from wetland used (km), *Pap.* years working with papyrus, *D. in* dependents supported from within household, *D. out* dependents supported from outside household, *H/hold* household size, *Harv.* number of harvests per month, *Users* number of others using same wetland. 95% confidence intervals (CI) are given for modes (expressed around proportions) of nominal data (top panel) and means of numerical data (bottom panel)

in her village for over a decade and making a living from papyrus most of her adult life. She harvests papyrus stems approximately every other day from within a wetland over 5 ha in size, located less than half a kilometre away from her homestead, along with over 100 other people. Profits from the sale of papyrus

commodities support dependents both within, and beyond, her immediate household of 6 people (polygamy being common within traditional Luo culture).

Moving up from the level of the individual to that of the community, Table 2 shows that the general ‘business’ of making a living from papyrus is likewise attributed to women, with major roles played by older (>45 years) females in all three major activities (harvesting, production and marketing) whose level of involvement has not changed much over the last 10 years and indeed remains the highest of all cohorts today. The equivalent male age group has, on the other hand, declined in terms of its relative efforts in each activity, as has the intermediate grouping (men aged 18–44), although the latter’s involvement has declined to a lesser extent: a reduction in harvesting effort, for example, of 10% over the decade, which is not statistically significant [$X^2(1, n = 110) = 1.70, P = .19$], as opposed to a highly significant [$X^2(1, n = 110) = 12.48, P = 0.0004$] reduction of around 30% for men aged >45 years.

The involvement of women aged 18–44 in all activities has, however, increased over the decade, significantly so [$X^2(1, n = 110) = 14.58, P = 0.0001$] in terms of harvesting effort which has risen by around 25% since the year 2000. Younger women (<17 years) are consistently the least involved in each activity among all cohorts, although their efforts in the marketing of papyrus appear slightly greater now than 10 years ago (a rise of around 6%). Similarly, the youngest group of males (<17 years) are the least active of all men in the trade, although

Table 2 Changing trends in different age-sex cohorts’ involvement in harvesting, producing and selling papyrus over the period 2000–2010

Cohort/Year	Harvesting		Trend	Production		Trend	Marketing		Trend
	2000	2010		2000	2010		2000	2010	
♂ >45	70.0	41.8	↓	54.5	39.1	↓	20.9	17.3	↔
♂ 18–44	64.5	54.5	↘	45.5	36.4	↘	25.5	23.6	↔
♂ <17	14.5	17.3	↔	7.3	15.5	↗	(6.4)	(12.7)	↗
♀ >45	72.7	71.8	↔	88.2	85.5	↔	87.3	86.4	↔
♀ 18–44	45.5	70.0	↑	75.5	80.9	↗	76.4	77.3	↔
♀ <17	(4.5)	(4.5)	↔	(6.4)	(10.9)	↔	(6.4)	(12.7)	↗

Values are percentages, for example 70% ($n = 110$) of respondents agreed that ‘men over 45 did the harvesting 10 years ago’. Arrows illustrate relative change over the decade from an arbitrary scale in which: horizontal = little change (± 0 –5%), sloping = moderate change (± 5 –15%), vertical = larger change (± 15 –30%). The cohort with the greatest perceived involvement in each activity is italicized, that with the least shown in parentheses

their involvement has also risen slowly over the last decade, particularly in terms of commodity production (Table 2).

The significant rise in efforts of women aged 18–44 years in harvesting since the year 2000 was frequently attributed by participants to the increasingly poor health (through years of physical exertion in the wetlands) of men aged over 45 years, whose own harvesting efforts have correspondingly, and significantly, declined over the same period. In other words, as older men have grown tired and weak over the last 10 years' toil harvesting in the wetlands, younger women (perhaps their wives or children) have increased their relative efforts in order to maintain the balance of household income.

Table 3 lists all the uses of papyrus identified by informants from the questionnaire responses and during semi-structured interviews. The plant patently has an enormous utility, manifest in its multiple nutritional, medicinal, cultural, agricultural, practical and economic functions. As such, papyrus clearly plays a highly significant role in the lives of rural communities living in close proximity to these wetlands—a statement supported by the fact that 60% (66/110) of questionnaire respondents reportedly generate over half of their total income from

papyrus alone, and 40% have no other means of livelihood support whatsoever (Fig. 4). This level of dependence has contributed to a general decline in the area of available papyrus, with over 65% of participants reporting a perceived decrease in the size of their wetlands over the last decade (Fig. 5). This is perhaps not surprising, given that many hundreds of people may be harvesting within narrow bands of papyrus at any one time, and doing so at regular intervals (Table 1).

Table 4 lists the constraints, or limiting factors, to livelihoods based on papyrus as identified by participants in this study, organized into 12 groups (boxes) of similar attributes and presented in decreasing order of

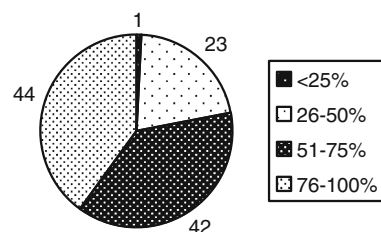


Fig. 4 Number of respondents ($n = 110$) for whom papyrus constitutes <25, 26–50, 51–75 and 76–100%, respectively of total household income

Table 3 Socioeconomic services of papyrus identified in this study and the life stages of the plant from which they are made

Life stage	Uses and notes
Flower heads (umbels)	Fed to livestock (cattle, sheep and goats) Used for making brooms As decorations
Stems (culms)	As fuel; for making fish traps and cooking utensils; made into <i>kayamba</i> or 'raft rattles' (musical instruments); building <i>odeso</i> (small rafts); for roofing material (thatch); making ropes used in construction and for tethering boats and livestock; fashioned into hats and boxes for storage Mats: for sleeping; sitting on; drying grains and small fish (<i>omena</i>); as racks in market places; window blinds; ceiling board; flooring; doors; constructing granaries and walls of houses and kiosks (shops); fencing homesteads Baskets: many shapes and sizes, typically used for carrying goods to/from market places and for storage in homestead Furniture: chairs, settees, tables, picture frames, murals and table mats
Inner pith	Chewed to quench thirst when working (<i>sensu</i> sugar cane); coiled into a soft Support when carrying loads on head; as a mosquito repellent <i>When burned</i> : used as fertilizer; smeared on walls of traditional houses; as a herb for cooking vegetables ('soda ash'); for preserving fish; as a treatment for oral infections of small children (also reportedly for treating 'epilepsy' and mental health problems)

In addition to the items of furniture listed by the survey respondents, the authors discovered additional 'value-added' papyrus goods (combining use of metals, paints, dyes, etc.) such as beds, shelves, CD towers, magazine racks, TV stands and lamp shades on sale (at above average market prices for the products listed in Table 3) in Kisumu town

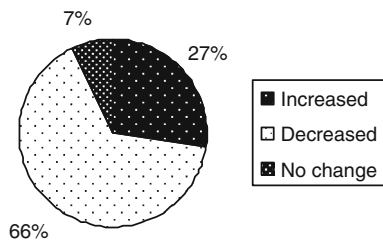


Fig. 5 Percentage of respondents who perceived their wetlands to have increased, decreased, or remained the same size over the period 2000–2010

‘citation frequency’ (=number of citations/total citations, expressed as a % value). Also shown in Table 4 are suggestions commonly provided by respondents for

Table 4 In decreasing order of citation frequency from the survey data, the common limiting factors to livelihoods based on papyrus, as well as the suggested means of addressing these

Box	Citation frequency (%)	Limiting factors identified	Respondents’ commonly suggested means of addressing issues
1	15.6	Waterborne diseases (malaria, bilharzia, sleeping sickness, cholera) from long hours spent harvesting in standing water; diarrhoea and pneumonia	Spraying of swamps with insecticide, provision of mosquito nets, anti-malarial drugs and other medication (no indications of assumed responsibility)
2	13.3	Bites from snakes, leeches, red ants and ‘ <i>chwe</i> ’	Spraying of swamps; removal of snakes by Kenya Wildlife Service
3	12.7	Limited marketing opportunities; price fluctuations; poor transport infrastructure	External support (e.g. from NGOs) in developing marketing skills; road improvements
4	10.9	Difficult working environment; operating barefoot, often naked; physical demands of job (e.g. carrying heavy loads long distances) resulting in backache, leg injuries; minor accidents	Recognition of need for other sources of income; general calls to “Government” to make secondary education free; desire for cheap supply of gumboots
5	10.9	Flooding reducing access and harvesting potential; unpredictable conditions in lake; risk of drowning	Channels to be dug for controlling movement of water during rainy seasons
6	8.9	Cuts from papyrus, accidents with <i>pangas</i> (machetes) and processing tools (e.g. needles); chest problems, asthma-like breathing difficulties; sun-blindness, eyesight damage; other work-related illnesses	Calls for cheap supply of protective clothing such as gloves; better access to medicines
7	8.7	Attacks from hippopotamuses, crocodiles, monitor lizards and other wild animals	Fencing to keep hippos out of harvested zones
8	6.0	Large number of processes involved in the trade, length of time demanded; boredom	Need for product diversification; external sources of training
9	5.8	Low profit margins, exploitation by brokers, agents or middle-men/women	As above, marketing skills necessary to “cut out” agents; small loans scheme for capital during times of low demand
10	3.7	Competition with other wetlanders; theft of harvested papyrus stems; competition from weeds (<i>mboha</i>)	Formation of cooperative societies to enhance sales; greater security, stores for harvested material
11	2.5	Conflicts with fishermen and farmers (e.g. deliberate/accidental fires, swamp drainage)	Introduction of rules such as no smoking within the wetlands
12	1.0	Marital issues (adultery, sexual underperformance, divorce) caused by long absences and physical fatigue; incidences of rape in isolated parts of swamp	Need for more lucrative sources of income requiring less physical effort; working in groups for safety

addressing the concerns they raised. Even a perfunctory review of this information tells us that the majority of these wetlanders thus face serious threats to their social and economic welfare due to the high risk of physical injury associated with harvesting papyrus and the seemingly weak position in the commodity chain, and market more generally, that they occupy.

The papyrus trade is not the only means of generating an income (nor the only source of degradation) within the riparian zone, however, with subsistence farming and fishing being common alternative livelihood strategies around Lake Victoria. Interestingly, over half (52%) of the questionnaire respondents who participated in this study cited farming as the principal cause of

concerns which were forwarded by the respondents when asked ‘How best do you think these constraints can be overcome?’

diminishing wetlands: herdsman cut papyrus flower heads to feed to their livestock, particularly during dry seasons when wetlands may be the only available source of green vegetation; farmers may also clear swamps (through cutting or burning) during low lake levels when previously inundated fertile soils become accessible, in order to cultivate land they regard as contiguous with their own plots. Less than 10% of informants blamed fishermen for the perceived degradation (for example by uprooting papyrus plants to catch mudfish which find refuge in the dense rhizomes), on the other hand, and only 4% considered that they, as papyrus harvesters, were in part responsible for the perceived losses.

A common cause of wetland degradation, irrespective of livelihood strategy, is the seemingly ubiquitous reliance on papyrus as a source of fuel—either on a daily basis, or when charcoal, firewood or other options (such as kerosene) are unobtainable. Every single participant in our study informed us that they use papyrus in this way for at least part of the year. The vast majority (95%) use the plants' stems (in some cases this represents waste material discarded during commodity production, in others plants are harvested explicitly for use as fuel), but a large proportion (69%) also use the roots (being woodier and thus burning more efficiently) which of course greatly reduces the regenerative capacity of the plant (Fig. 6). Despite being a poor quality fuel—hard to light, difficult to keep lit, and producing excessive amounts of smoke and ash—having to burn the very same resource on which you rely for cash income is stark illustration of the 'poverty-environment trap' which some researchers argue is widely responsible for the simultaneous degradation of ecosystems and human well-being throughout the entire Lake Victoria basin.

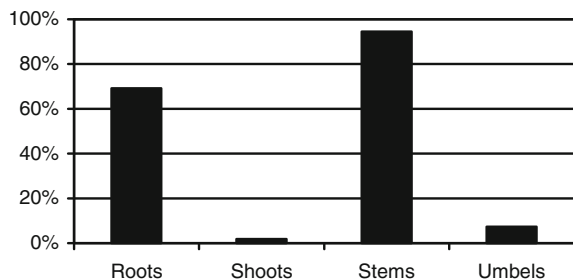


Fig. 6 Percentage of respondents who use the roots, shoots, stems or umbels of papyrus as fuel

Discussion

Papyrus swamps are often sites of environmental degradation, for one (often anthropogenic) reason or another (Boar et al., 1999; Gichuki et al., 2001; Owino & Ryan, 2007; Morrison & Harper, 2009). Indeed, the loss of papyrus around Lake Victoria, recorded in different studies conducted over the last 15 years, is frequently attributed to human activities (Balirwa, 1995; Kairu, 2001; Swallow et al., 2009). The overall impression of the Nyando river basin's papyrus swamps is one of sustained resource degradation, driven by widespread rural poverty (Gichuki et al., 2001) and a population growth rate above the national average (Swallow et al., 2009). This regional assessment finds agreement with the broader analysis of Odada et al. (2006) who reported similar trends of wetland losses around the lake's entire (international) shoreline.

From a socioeconomic perspective, the results of our study present papyrus as a highly valued source of 'natural capital' (Cairns, 1993), providing multiple benefits to impoverished riparian communities. Even *natural* capital comes with interest, however, with Table 4 illustrating some of the associated costs to individuals of a livelihood based on papyrus. But how can the constraints faced by these wetlanders be addressed?

The aforementioned nongovernmental organization VIRED has, in collaboration with Kenya Wildlife Service (KWS), worked since the late 1990s with one such wetland community around the settlement of Okana, located inland from the lake around 17 km south-east of Kisumu town (Fig. 3). Okana's population once had access to an extensive area of swamp from which they formerly harvested papyrus, arrowroot, medicinal herbs and wild animals such as sitatunga (*Tragelaphus spekii*). By 1999, the vast majority of their wetlands had been lost, following a prolonged period of unchecked harvesting and the gradual conversion of the swamps to cultivated fields. The impetus for action was the realization by elder members of the community that they no longer had adequate supplies of papyrus for the production of mats, ropes and other commodities derivable from the plant as outlined above.

After a period of consultation under the facilitation of VIRED and KWS, it was decided that the erstwhile wetland be restored. Around 80 community members

subsequently collected, by hand, living papyrus material (a mixture of rhizomes and young shoots) from Nyamware, a site approximately 14 km from Okana close to the lakeshore (Fig. 3). This they placed in a makeshift ‘nursery’ (a region of swampy ground) until such time as it was deemed ready for transplantation to the site of the former wetland, on the outside meander of a river which seasonally floods (allowing water levels in the wetland to be maintained). Having initially re-established approximately 2 ha of papyrus in 2000, the site during the authors’ visit (10 years later) was estimated at over 7 ha.

At the same time as recreating the wetland area, members of the community formed themselves into a self-help group, again with the assistance of VIRED. The primary motivation for doing so was to coordinate, and cooperate on, wise-use of the papyrus which they had recently toiled to restore. Today, the ‘Okana Wetland Self-Help Group’ consists of 38 individuals comprising a General Chairman, Vice-Chairman, Treasurer, Secretary and voting Members who are themselves organized into sub-committees of common interest groups such as aquaculture and apiculture (although sustainable management of the wetland remains top priority). During a group discussion, the Chairman noted the resurgence of a wide variety of wildlife around the village (including waterbuck, sitatunga, mongoose, snakes, egrets and weaverbirds) which he attributed to the restored wetland; young children are now reportedly seeing these animals for the first time and being educated on the value of wetland biodiversity by their village elders. Papyrus now plays a highly significant role in the (social and economic) functioning of the community who are, perhaps, particularly sensitive to its values having recently experienced the near total loss of its services.

Proposal

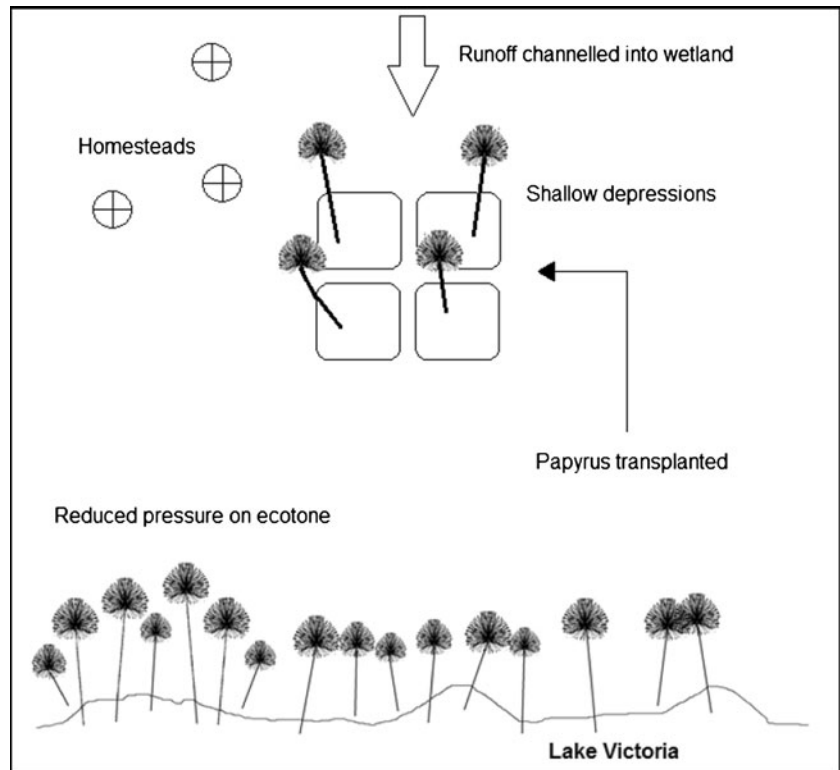
Okana may be the only successful case of papyrus restoration reported in East Africa. We propose the example be a model of wetland (re-)creation for wider dissemination around the shores of Lake Victoria (and potentially beyond) given the simple, inexpensive and yet seemingly highly effective methodology employed.

Much, of course, depends upon the availability of water. Okana’s wetland is situated on the banks of a

seasonally flooding river, allowing pulses of freshwater to maintain productivity. Many of the 33 villages visited during the present study, however, are not. Figure 7 provides a simplified sketch of our proposal to create similar wetlands in a way that enables surface runoff (overland flow) to support continued growth of transplanted papyrus stems, designed for sites within the riparian zone of the lake that are not subject to flooding by rivers. Suitable locations would have to be identified where the water table is high enough to permit shallow excavations to fill with water. The amount of moisture would have to be considered carefully as regenerating papyrus is sensitive to water depth (Boar, 2006); a simple notched weir on the downward face might be used to control water height within the stands. Freshness could be maintained by constructing these depressions on gently sloping land with a network of shallow rills channelling surface runoff (following rain events) into the wetlands. The square design with criss-cross pathways running at ground level would permit easier access to the papyrus and might also serve as the basis of a harvesting strategy whereby each section is cropped sequentially, allowing for a ‘fallow’ period in which young shoots are allowed to reach maturity before being harvested.

However, what constitutes a ‘sustainable’ harvesting interval for papyrus is somewhat contested. From our own study, the results of the survey indicate that it takes, on average, 3.5 months for stems to reach maturity, according to the perceptions of local harvesters—a finding which matches well the observations of Thenya (2006: cited in Osumba et al., 2010) who advocated cutting at 14-week intervals. Other studies have suggested that cleared papyrus stands are only able to regain their original biomass after a period of 9–12 months of uninterrupted growth (Hails, 1997; van Dam et al., 2007). Elsewhere, at Lake Naivasha, the recommended minimum interval may be twice this (24 months: Kariuki et al., 2001). What harvesting frequency is sustainable is likely to be site-specific, related to factors such as altitude and local and micro-climatic conditions. We err on the side of caution and tentatively support the recent findings of Osumba et al. (2010) who suggested a harvesting program be established at Lake Victoria based on the seasonal cycle, employing a staggered cropping regime and cutting roughly every 6 months.

Fig. 7 Simplified sketch showing papyrus transplanted into shallow excavations receiving surface runoff; the criss-cross pathways permit easier access for harvesting



Expected benefits

If such a method as described above was to be successfully implemented, the benefits to riparian communities could be tremendous. Returning to Table 4, the establishment of the wetland design we propose would go some way towards easing the constraints to livelihoods based on papyrus identified by survey respondents as described in boxes 1, 4, 5, 7, 10 and 11. If we combine the respective citation frequencies of these factors, over half (52.3%) of all constraints highlighted by participants could potentially be addressed in this way. Examples of each are given below:

Box 1 We might expect a reduced prevalence of waterborne diseases if harvesters can access the papyrus along the criss-cross pathways, negating the need to spend hours in standing water.

Box 4 Physical demands could be lessened if papyrus were to be transplanted closer to homesteads, minimizing the distance covered when carrying heavy loads to sites of processing.

Box 5 Growing papyrus in dedicated stands would greatly reduce the risks to harvesters presented by flood conditions in the lake, with potentially greater control of water levels provided by a weir.

Box 7 Harvesting papyrus inland, away from the lake edge, may to some extent reduce the risk of (at times fatal) attacks from animals active among the papyrus; hippos, for example, are unlikely to occupy the restored plots during the day (when harvesters are active) owing to their sensitive skin.

Box 10 Theft of harvested stems could be avoided if communities control access to their respective wetlands and competition from invasive weeds (e.g. ‘mboha’: *Pergularia daemia*) could be reduced by increasing access to stands along pathways—allowing the proliferation of climbing species, for example, to be more easily controlled.

Box 11 One might expect conflicts with other livelihood strategies to be somewhat ameliorated, for example by negating the need to pay fishermen for use of their boats when floating harvested bundles of papyrus inshore, a common expense for many

wetlanders which could be avoided by providing papyrus ‘offsite’.

So far we have only described the *socioeconomic* services of papyrus, but what of its ecological services? Functioning papyrus wetlands, at a minimum: (i) act as land–water buffer zones (ecotones), protecting lake shallows from suspended solids arriving in runoff by trapping sediments within their extensive rhizome mats; (ii) assimilate and recycle, through their high productivity, excess nutrients washed down from the catchment originating as fertilizers applied to cultivated fields, and (iii) constitute valuable habitat for wildlife including hippopotamuses, fish, birds and invertebrates, amplifying biodiversity and improving food chain support (Morrison & Harper, 2009). Whilst we are not directly addressing these functions in our present proposal, by promoting the establishment of papyrus stands away from the immediate lake edge, it is envisaged that human pressure on the ecotone will be reduced (as wetlanders concentrate their efforts closer to their homesteads) and thus degradation of the buffer zone somewhat decelerated. As noted in the introduction, Kiwango & Wolanski (2008) called for certain areas of papyrus to receive full protection whilst others be designated sites of sustainable harvesting—here we offer practical suggestions as to how this duality might be effected.

Next steps

Further development of our proposal will be in part guided by the six conditions outlined by Denny et al. (2006) which emphasized wetland ‘wise-use’ principles vis-à-vis their study of the potential of fingerponds to enhance food security for the riparian peoples of Lake Victoria. Adapted here towards the maintenance of natural capital stocks, these conditions require that the transplanted papyrus wetlands we propose be: (i) acceptable environmentally, conserving biodiversity; (ii) sustainable and compliant with the Ramsar Convention’s wise-use philosophy; (iii) acceptable culturally and socio-economically to the wetlanders; (iv) simple, and willingly adopted by the target groups; (v) self-sufficient, using local wetland resources and not reliant on external support and (vi) designed to enhance local livelihoods (modified from Denny et al., 2006).

Clearly there is much research still to be done and multiple questions need addressing before such a proposal could be successfully implemented: *Where should these wetland restoration projects be piloted? What will the environmental impacts of new wetlands be and how can we assess these? What constitutes a sustainable harvesting schedule? At what scales will cooperative societies function effectively in a competitive trade? Does a supporting legislative framework for creating new wetlands exist?*

In view of the last question, Swallow et al. (2009) provide a concise summary of the multiple environmental and developmental initiatives that are, or have recently been, in operation within the Lake Victoria basin, as well as a list of the various Government Ministries and Authorities charged with responsibility for different aspects of environmental management throughout the region. As regards our preliminary study into the potential for wetland rehabilitation around the lakeshore, it is hoped that the results of our ongoing research will usefully inform efforts detailed within the Environmental Management and Coordination (Wetlands) Regulations (2009) in which provisions are made for the “restoration or enhancement” of certain wetlands (Section 8, Part 2c).

In 2012, the Water Resources Management Authority (WRMA) shall “prepare and maintain an inventory of all wetlands in Kenya” towards the development of management plans to “prevent and control degradation” of her wetlands (Section 10, Part 1). The first principle of these recently (13/02/09) gazetted Regulations is that Kenya’s wetland resources be “utilized in a sustainable manner compatible with the continued presence of wetlands and their hydrological, ecological, social and economic functions and services” (Section 5, a). Here we contribute original data on the socioeconomic functions of wetlands in the Nyando river basin and report, for the first time, a working example (Okana) of papyrus stands being restored and utilized in ‘a sustainable manner’ at the local level, but with potentially much wider application.

Conclusion

The riparian communities of Lake Victoria who depend upon papyrus to support their livelihoods are

arguably *de facto* wetland managers. Effective means of maintaining, and enhancing, their ability to sustainably manage papyrus swamps should be promoted, with an enabling policy framework agreed upon in partnership with local people. This may perhaps be achieved by promoting the formation of community-based ‘self-help’ groups and cooperative societies (such as at Okana) under the facilitation of WRMA, whose own legislative framework, the 2005 Water Act, encourages the decentralization of responsibility for water resource management to regional WRUAs (Water Resource Users’ Associations). Common interest groups (such as papyrus harvesters) could operate within the structure of these incipient WRUAs and, as such, negotiate access to sources of external support where needed.

However, Kenya would do well to learn lessons from a recent study of wetland management systems in Uganda which found that, despite some improvements following a similar national drive towards devolution, confusion at the local level can remain regarding exact rights and responsibilities, which has in some cases perpetuated exploitation and degradation of wetland resources (Hartter & Ryan, 2010) or, in other words, ‘business as usual’. Moreover, careful consideration of the particular type and characteristics of such institutional arrangements is duly warranted in light of another recent study into wetland management regimes in neighbouring Ethiopia by Maconachie et al. (2009) who argue that decentralization there has in fact restricted development of certain community-based institutions owing to its inherently “political interventionist” nature. The Chairman of the Okana self-help group, when asked if intervention from WRMA or other Government bodies of Kenya would be welcome, although responding positively, provided an intuitive sense of such potentially conflicting agendas by stipulating that any external support received would be treated cautiously, with priorities established from the outset which explicitly favour local development goals.

Sustainable natural resource management directives must be developed from the bottom-up, “where the problems and solutions are perceived as local” (Hartter & Ryan, 2010). Although our research is by no means complete, here we hope to have provided some insights from one such ‘bottom-up’ perspective, examining in greater detail the dependence of riparian communities on the natural capital of papyrus

swamps, highlighting some of the factors which continue to drive the loss of these wetlands, and suggesting how the situation might be more sustainably managed through applied socio-ecological research and collaborative action at the grassroots level.

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