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Assessing indigenous knowledge of forest and lake resources degradation: a case of Chisi Island, Lake Chilwa, Zomba, Malawi, Central Africa

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Abstract

A study was carried out on Chisi Island to examine the indigenous people's knowledge of forest and lake resources degradation and factors that lead to the degradation. A structured household questionnaire, key informants, focus group discussions, historical matrices and transect walks were used to examine the people's knowledge of the indicators and causes of resources degradation or factors that affect the status of the resources at a particular time. The results indicated growth of secondary colonizers, scarcity of medicinal plants and migration of wild pigs as indicators of forest degradation. Low fish catches and declining numbers of waterfowl were also reported as indicators of lake resources degradation. Forest degradation resulted from poverty and famine. Low fish catches and presence of *Hippopotamus amphibious* and *Typha domingensis* in the lake was determined by the water level. Use of seine nets also contributed to fish degradation. These results show that local people have the potential to provide accurate ecological knowledge. This study therefore, argues that scientific studies on Chisi Island should integrate local ecological knowledge in determining resources degradation and monitoring resources population in management projects.

Key words: indigenous ecological knowledge; conservation and scientific studies

Introduction

Until recently, indigenous knowledge (IK) has been grossly undervalued by western-trained scientific managers in terms of its potential practical applications. The scientists assume that empirical facts about biology or ecology can not be extracted from indigenous ecological knowledge (Hamilton and Walter 2000). Yet studies show that much western science and technology emanates from traditional knowledge or IK. Furthermore, according to Ghimire *et al.* (2004) in the context of community based projects[1], global perceptions of biodiversity conservation and scientific understanding of ecosystem dynamics are confronted with local communities knowledge of, perceptions of, and values associated with the different components of the system. They argue that IK has to be analysed and understood so that appropriate management practices that build on both scientific and local knowledge may be developed.

Johnson (1992) defines IK as a body of knowledge built up by a group of people through generations of living in close contact with nature. According to Johnson, this knowledge includes a system of classification, a set of empirical observations about the local environment, and a system of self-management that governs resource use. This involves an ability to analyse situations and interpret the results; practical experience of tackling problems and perspective of having an overview of a subject or issue. This may mean skill and knowledge of what is good to collect or eat, where best to find particular resources and when and how to avoid resource degradation. Thus, IK builds upon the experiences of the past and adapts to present changes in technology and socio-economics. IK includes ecological information on resources, such as animal and plant species,

[1]Recently, governments and institutions interested in biodiversity conservation have realised that centralised management of resources, that excludes resource users seems unable to halt or reverse depletion of natural resources and degradation of the environment on its own (Lévêque 1999). They are advocating co-management or local participation which involves the participation of the resource users in planning, implementation, monitoring and evaluation of projects.

biological resources interrelationships and indicator plants. It also includes experimentation of, for example healer's tests of new plant medicines.

IK classification systems of fish, animals, terrestrial and aquatic plants, soil, water, air, weather, empirical knowledge about flora, fauna and inanimate resources and their practical uses; resource management knowledge and the tools, techniques, practices and rules related to resource use such as fishing, gathering of wild food, agriculture and agroforestry; and the world view or way the local group perceives its relationship to the natural world (Pomeroy and Rivera-Guieb 2006) may appear very different from those of science. While IK cultivate an authority based, non systematic, holistic approach; science is essentially systematic, driven by counterdiction, verification, falsification and validation and to a very large extent, reductionistic (Hens 2006). Yet, if IK is well tested can produce similar results to conventional science.

Furthermore, although IK may often be imprecise and qualitative, it is nevertheless valuable because it is based on observations over long periods, incorporates large sample sizes, is inexpensive, invites the participation of resource users as researchers, and sometimes incorporates subtle multivariate cross checks for environmental change (Moller *et al* 2004). According to Moller *et al* (2004), a few simple rules suggested by IK may produce good management outcomes consistent with fuzzy logic thinking. In monitoring resource degradation or management, science can sometimes offer better tests of potential causes of population change by research on larger spatial scales, precise quantification, and evaluation of population change where no harvest occurs. However, science is expensive and may not always be trusted or welcomed by resource users. Short scientific studies, for example, in which traditional monitoring methods of resources are calibrated against population abundance could make it possible to mesh traditional ecological knowledge with scientific inferences of prey population dynamics. Combining scientific and traditional monitoring methods can not only build partnership and community consensus, but also, and more importantly, allow indigenous wildlife users to critically evaluate scientific predictions on their own terms and test sustainability. For example, according to Pomeroy and Rivera-Guieb (2006) interviews with fishermen can be used to extract large information on, say, fish behaviour and fishing patterns. The body of information held by local resource users has an important role to play in resources (such as fisheries) assessment. When this body of knowledge matches scientific assessments, uncertainties are reduced and the assessments become more convincing to resource users. When these two sources of information diverge, information from both sources needs to be reassessed or re examined (Pomeroy and Rivera-Guieb 2006). Hence development, implementation and monitoring of resource management approaches, development of alternative economic strategies, conservation, environmental assessments and biological and ecological research (such as updating resource inventories and resources' status) can benefit from IK.

Roy and Holly (1996) report that modern natural history arose through a combination of indigenous scholarship and field studies that often drew heavily on the knowledge of local experts; for example, native descriptions of plant ecology, growth patterns and habits. During the 19th and 20th centuries, IK was increasingly systematically tapped and codified. Such act resulted in the publication of scientific accounts of new species and revisions of classifications which ironically depended upon a set of diagnostic and classificatory practices which though represented as western science, had been derived from earlier codifications of IK.

Significant contributions of IK to global scientific knowledge have also been incorporated in modern applied sciences such as medicine, architecture, engineering, pharmacology, agronomy, animal husbandry, fish and wildlife management, nautical design, plant breeding and military and political science. For example, in the field of medicine, International Development Research Centre (IDRC) is conducting a research on medicinal properties of the neem tree (*Azadirachta indica*) based on IK (World Bank 2001). Similarly, Snively and Corsiglia (2000) report that traditional Native American healers discovered and used quinine, aspirin and other 500 important drugs used in modern hospitals today to cure malaria, and other diseases and reduce pain. Furthermore, Msonthi (1994) and Ndibwami *et al*. (1998) report that phytochemical[2] analysis results of about 90% of the selected medicinal plants such as *Kigelia africana,* collected from Malawian traditional healers in

[2] The plants were extracted, purified and tested for their biological activity.

the 1990s, supported the claims by the traditional healers[3]. According to Msonthi (1994), many of the compounds tested showed antitumour, antifungal, antibacterial, molluscidal, hypoglycemic and antifeedant and to some extent, as immunostimulants.

Value of indigenous knowledge systems to the conservation of Lake Chilwa

Lake Chilwa is an important ecosystem that supports a variety of valuable common property resources such as forests, lake, fish and waterfowl (Sambo and Munyenyembe 1999). Like most lakeshore populations, the majority of the people in the Lake Chilwa basin rely on these resources for their livelihood.

In 1997 the Malawi government signed and ratified a convention on Wetlands, the Ramsar Convention[4] that made Lake Chilwa the first wetland in Malawi to be registered as a wetland of international importance (GOM 2000a). The mission of the Ramsar Convention is conservation and wise utilisation of wetlands by national action and international cooperation as a means of achieving sustainable development throughout the world (Ramsar Convention Bureau 1971, IUCN 1998). By signing this convention, the Malawi government accepted the wise use concept[5] and other obligations mentioned in the convention.

The Ramsar Convention Bureau (1971) also notes that local inhabitants ecological knowledge can make significant contributions to wetland management strategies, especially when blended with the best science. According to Ramsar Secretariat (2004), one of the greatest advantages of blending IK with scientific understanding in resources management is its potential for more effective wetland management. Local people, particularly if they are users of wetland resources, have the opportunity for continuous observation of their surroundings, and often have detailed knowledge of the local ecosystem. In this recognition, the Bureau concludes that indigenous peoples' involvement can, if carried within the framework of action encouraged by the Convention, contribute significantly to maintaining or restoring ecological integrity of wetlands as well as contributing to communities well being and more equitable access to resources.

The conservation of lake and forest resources is a major national concern. Chisi Island is endowed with important natural resources which could be utilised for sustainable conservation and management programme. Development of sustainable conservation and management programmes with local people's involvement is crucial but the first component is to identify the resources to be conserved, determine their uses, status and threats using IK because these can provide useful information cheaply, and lack of their involvement may lead to misunderstanding of the projects and hence continued unsustainable utilisation of resources. Although the value of IK in scientific research has become more apparent and accepted, its wider application remains limited. Earlier studies conducted on the Island resources incorporated limited contribution of indigenous ecological knowledge (Sambo *et al.* 1999, Mfune and Mhango 1998). This study therefore sought to examine and assess existing knowledge of forest and lake resources degradation with a view to identifying those aspects that could be integrated in scientific studies that would lead to development of management projects.

The study is premised on the notion that conservation and sustainable resource management could benefit from the integration of what local inhabitants already know and practise[6] and has been demonstrated to be effective.

General objective of the study

The aim of the study was to assess the existing indigenous knowledge of forest and lake resources degradation and potential of integrating or combining this knowledge into/with convectional science when updating Chisi Island resources checklists, studying resources behaviour and monitoring their status.

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[3] The value of IK in the identification of naturally occurring chemicals in wild species, especially for medicinal purposes is significant. Such species are predominantly found in areas traditionally inhabited by indigenous peoples and therefore can most easily be identified and collected by indigenous peoples (Ambasta 1999).

[4] The Ramsar Convention is a global inter-governmental treaty on conservation and the wise use of wetlands resources. It has 138 member countries world-wide and provides the framework for international co-operation on wetland issues (Ramsar Convention Secretariat 2004, Ramsar Convention Bureau 1999, IUCN 1998).

[5] This concept refers to sustainable utilisation of wetlands for the benefit of mankind in a way compatible with the maintenance of the ecosystem. Sustainable utilisation refers to human use of the wetland so that it may yield the greatest continuous benefits to both the present and future generations (GOM 2000a).

[6] Traditional management practices are not part of this paper. They are discussed in detail in Sabola (2007).

Specific objectives
Specifically the study attempted to:

1. determine people's knowledge of plant and animal species found in the forest and lake on Chisi Island
2. establish the uses of the identified resources
3. explore people's knowledge of the status of specific identified resources over time, indicators of degradation and causes of degradation.

The survey was more qualitative in nature, hence no hypothesis was tested. However, the range of selective information differed from one person to another depending on age of the respondent or length of stay on the Island, occupation and gender. The knowledge is largely oral and subject to effects of memory loss.

Methodology

Description of the study site
Chisi Island was chosen because according to Kayambazinthu (2001 pers. comm.), it is small, supports a lot of natural resources and is famous for indigenous knowledge (IK). It is further unique in that it is volcanic in origin. It has richer soils, very high in phosphates and rich in rare earths's bauxite, than other hills of the Lake Chilwa catchment area such as Chikala and Malosa. Furthermore, the vegetation types found on the island such as *Albizzia, Acacia*, *Ficus*, *Adansonia digitata* and *Mucuna pruriens*, differ in distribution from other hills, Malosa, Mpyupu and Chikala which are extensively covered in *Brachystegia* (Wilson 2002 pers. comm.). The study focused on the forest and lake only, based on the local people's choice of prioritised resources.

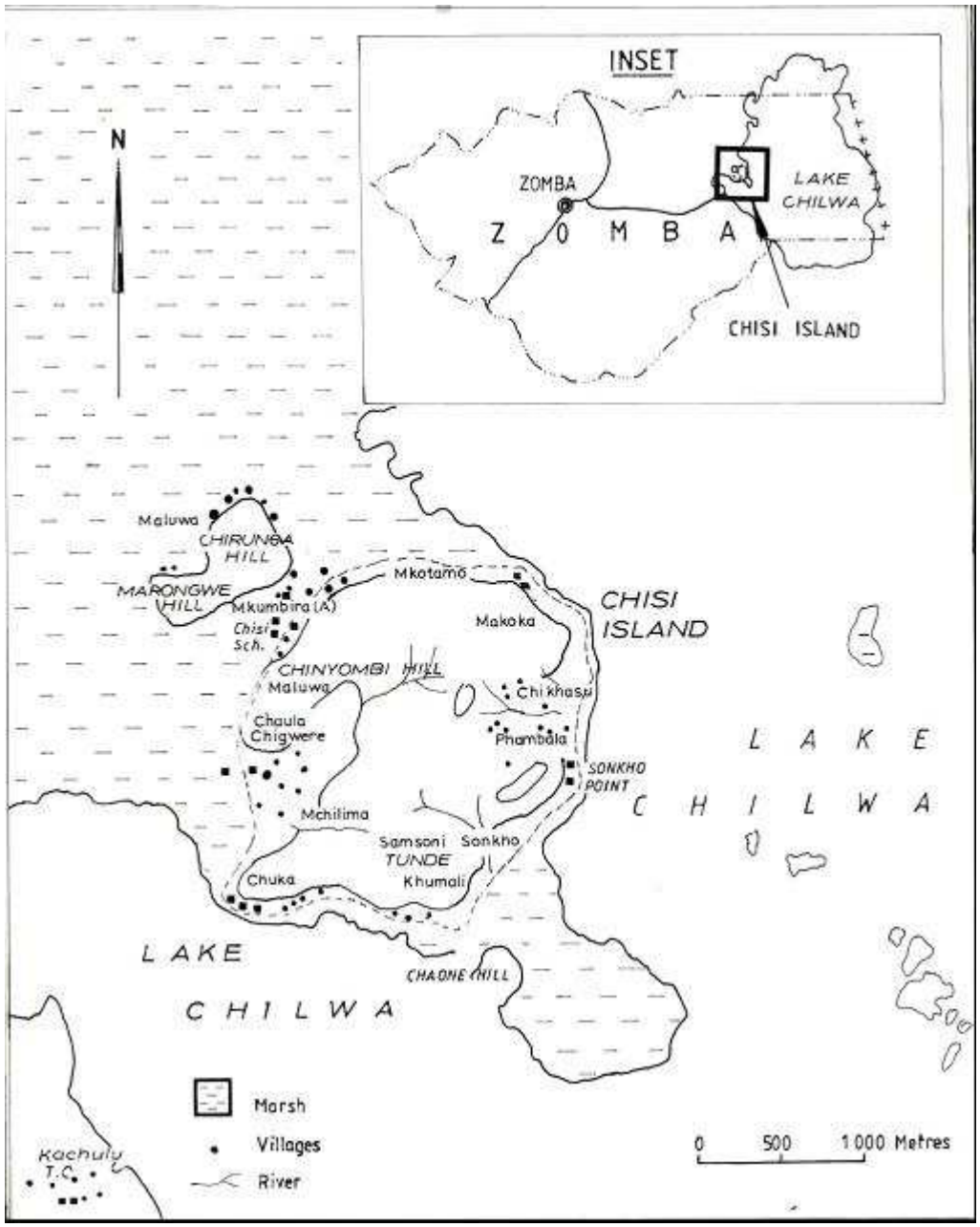
Geographical features
Chisi Island is located at between 30^0 35' and 30^0 38' East of Greenwich Meridian and 15^0 18' and 15^0 21' South of the Equator. It is situated in the area of Traditional Authority Mkumbira of Zomba district, Southern Region of Malawi in Central Africa. The Island has area coverage of about 21 square kilometres (km²) and is surrounded by marshes to its west and open waters to its east. It is located at a distance of about five kilometres (km) from Kachulu harbour and about 35 km from Zomba Municipality (Fig 1).

Zomba is in the Lake Chilwa Basin. Lake Chilwa is a tropical lake without an outlet. The lake and wetland is roughly 40 km across and 60 km from north to south giving a total area of 2,400 km². Open water can cover up to 1,500 km². In "normal" years, however, one third is open water, one third is swamp and marsh and one third is floodplains. It is located in Southern Malawi on this country's Eastern border with Mozambique, to the North of Phalombe plain between Zomba and Mulanje. The entire catchment area of the Lake Chilwa basin is 8,350 km² large, of which 2,700 km² is in Mozambique. The catchment area that belongs to Malawi, 5,650 km² comprises: Phalombe District, most of Zomba District and 43% of Machinga District. The term "Lake Chilwa catchment" is therefore used interchangeably with "the Lake Chilwa Districts"

Population characteristics
This Island has 13 villages with a total population of 1591. Males in almost all age groups dominate the population. The total population comprises 884 males and 568 females of 5 years and above. The males make up about 60% of the population and the sex ratio[7] is estimated at 130 (GOM 1998). This sex ratio is higher than the average sex ratio, 92 for all the Lake Chilwa districts.

The population is ethnically heterogeneous and culturally similar in that it is matrilineal. According to Kayambazinthu and Chabwera (1999) the major ethnic group in this site is the Nyanja. Chisi Island people originated from Mozambique and they belong to different religions such as Christianity and Islam. About 93% of the population are Christians, 5% are Moslems, 0.4% belong to other religions and about 1.6% have no religion (GOM 1998).

[7] Sex ratio is defined as number of males per a hundred females,



Source: National Statistics Office

Figure 1 Map of Chisi Island

Education

Literacy levels on Chisi Island is estimated at 87%. This percentage is considerably higher than the average 50%, for the whole Lake Chilwa wetland and catchment area[8]. Only 13% of Chisi inhabitants are illiterate.

Occupation

Lake Chilwa basin is characterized by low incomes ranging from zero to MK3, 000 (20 USD) per year for 30% of the households except in Zomba urban. Farmers have highest incomes immediately after crop harvesting and fishermen have highest incomes during the fishing season (GOM 2000b). 30% of the Island's

[8] In this study, the literate refers to the population that knows how to read and write.

economically active group (who are 10 years and above) depend on agriculture, 69% are employed in other employment sectors such as firewood selling and fishing and 1% are unemployed (GOM 1998).

Sample Population

A sample population was taken from all the 13 villages found on Chisi Island. The study had two sample populations. The first population covered 200 households. The Island has 545 households most of which are semi permanent and others are traditional or temporary. The sample selected for the study may not represent the whole country, all wetlands and even the whole Lake Chilwa Wetland and Catchment area because the study was only concentrated in a small area. Further more in different locations people's behaviours and IK are not uniform. Hence this sample only represented the population of Chisi Island where the study was undertaken.

Sampling of the study population

Systematic Sampling of the households

The sampling frame was obtained from the National Statistics Office lists of households for the 1998 Population and Household Census. The sampling frame for Chisi Island has 545 households on its list. A systematically selected sample of 200 households was drawn from this frame. This sample reflected the proportion of the total population in each village. The sample was selected at an interval based on the following formula:

$k = N/n$ where k is the sampling frame

N is the total number of households on Chisi Island

n is the sample size (Burns 1994)

For this sample n=200, N=545 and sampling interval k=545/200=2.7 ~3

Since k is 3 therefore every third household from the list was selected. The first household was randomly selected from the first 3 households on the list. A table of random numbers was used to decide on the starting point. If the k^{th} household no longer existed in the village, the next household in the line (k+1) was included in the sample. After this occurrence, the rest of the households in the sample shifted automatically. In the selected households, all household heads or their spouses were targeted for the survey to capture the views of the middle aged and elderly population.

Snowball rolling for sampling the key informants

Snowball rolling was applied to identify key informants interviewed for specific information. The traditional authority was used to identify one unit who helped to identify and locate another unit. This process continued until 20 units were sampled. The key informants were interviewed to supplement and provide in depth explanation on the information obtained from the individual interviews and the focus group discussions (FGDs). The key informants included the Traditional Authority, village headmen, fisheries officer, traditional healers, and the oldest inhabitants because they are regarded as repositories of IK (Kayambazinthu 2001 pers. comm.). The oldest inhabitants included all inhabitants who were aged 60 years and above.

Data collection techniques

The study used several data collection techniques to examine indigenous knowledge of the changes in resources status, indicators and causes of degradation. This combination contributed to a thorough data collection because one method could not provide all the needed information about the respondents. Information obtained from the household interviews was triangulated through the four FGDs and 20 key informants interviews. The FGD participants also drew historical matrices that show the perceived changes in status of the forest and lake resources from the 1940's to 2001.Two transect walks were done to verify the reported resources distribution. The survey was conducted from 23rd October 2001 to 9th November, 2001.

Data analysis techniques

Quantitative data was coded and analysed using Statistical Package for Social Science (SPSS) software package. Descriptive statistics was used to create frequency tables, percentages and cross tabulations showing the proportions of respondents who have knowledge of particular resources status and factors affecting the status of the resources. All qualitative data obtained from the FGDs were compiled and transcribed using line by line coding. The coding involved categorizing all emerging issues into different themes. This analysis was applied to list available natural resources and their status on Chisi Island.

Results and Discussions

Identified forest and lake resources

This subsection assesses the potential of integrating IK in compiling or updating checklists and distribution of vegetative and animal species and their utilization patterns around Chisi Island. From the results of the survey, the household respondents and FGDs participants identified a total of 14 forest and 15 lake resources (Tables 1 and 2). The percentages do not add up to 100% because responses were derived from multiple response questions. The respondents used two broad classifications for the identified resources, namely, forest resources which include all resources found in the forested area (hills) and lake resources that include all resources found in the lake and its shoreline. Although this classification differed from that used in conventional science, the identified resources include vegetation, mammals, reptiles, amphibians, fish and birds.

Table1 Identified forest resources[9]

Resource and common names	Species (Scientific name)	Local name	Percentage
Trees			98
Baobab	*Adansonia digitata*	Mlambe	
	Euphorbia ingens	Gowoka	
	Faidherbia albida	Nsangu	
	Albizzia gummifera	Mpalankhanga	
	Adina microcephala	Mchonya	
Mahogamy bean*	*Afzelia quanzensis*	Ngongomwa	
	Ficus capensis	Mkuyu	
	Ficus natalensis		
	Hoslundia opposite	Chanzi	
Mahogamy*	*Khaya anthoteca*	Mbawa	
	Kigelia africana	Mvunguti	
	Parkia filicoidea	Mkundi	
	Trichilia emetica	Msikitsi	
	Uacapa kirkiana	Msuku	
	Strychnos spinosa	Mateme	
	Vangueria infausta	Ziru	
	Zahna Africana	Mtalala	
	Sterculia quinqueloba	Terela nyani	
	Commiphola Africana	Khobo	
	Antidesma venosum	Likambako	
	Flueggea virosa	Zengo	
	Mangifera indica	Mango	
	Leersia hexandra	Likakazi	
	Deinbolia nyikensis	Mtalala	
Domesticated dogs			16
Grass	*Beckeropsis uniseta*	udzu	30
Hyrax	*Dendrohyrax brucei*	Mbira	14
Great canerat	*Thyrononmys swinderian*	Mtchezi	87
Mice	*Rattus natalensis*	Gwede	8
	Rattus rattus	mbewa	
Birds			31
Red bishop*	*Euplectes orix*	Chete	
Firecrowned bishop*	*Euplectes hordeaceus*	Chete	
Redheaded quelea××	*Quelea erythrops*	Mpheta	
Redbilled quelea××	*Quelea quelea*	Mpheta	
Hamerkop	*Scopus umbretta*	Natchengwa	
Marsh owl	*Asio capensis*	Kadzidzi	
Pied crow	*Corvus albus*	Khwangwala	
Small plover	*Charadrius pecuarius*	Nazeze	
Vervet monkeys	*Cercopithecus aethiopis*	pusi	94
Snakes			72
Oliver green snake	*Philothamus hopolast*	Namasamba	
Python	*Python sebae*	Nsato	
Egg eater	*Daspeltis scabra*	Kasambwe	
Boomslang	*Dispholidus typus*	Mamba	
Puff adder	*Bitis arietans arietans*	Mphiri	
Lizards (various species such as skinks and geckos)	*Mabuya striata and Hemidactylus mabonia*	Buluzi and nalimata	1
Bush squirrel	*Paraxerus cepapi*	Gologolo	1
Buffalo bean	*Mucuna pruriens*	Chitedze	68
Bush pig	*Potamachoerus porcus*	Nguluwe	11
Monitor lizard	*Veranus niloticus*	Ng'azi	7
Four-toed hedgehog	*Erinaceus albiventris*	Chisoni	

* and ×× have same local name but they are of different species, however respondents were able to describe and identify the two species based on some body features such as colour.
*Protected by law in Malawi

[9] Species shown in Table 1 which have no percentages were derived from FGDs.

Table 2 Identified lake resources[10]

Resource and common names	Species (Scientific name)	Local name	Percentage
Fish			100
Cichlid	*Oreochromis shiranus chilwae*,	makumba	
Cyprinid minnow	*Barbus paludinosus*	matemba	
Clariid catfish	*Clarius gariepinus*	mlamba	
False bulrush or reedmace	*Typha domingensis*	njeza	87
Hippos	*Hippopotamus amphibious*	mvuwu	83
Waterfowl			76
Fulvous whistling ducks	*Dendrocygna bicolor*	chipiyo	
White-faced whistling ducks	*Dendrocygna viduata*	chipiyo	
Reed cormorant	*Phalacrocorax africanus*	mpipi	
Lesser moorhens	*Gallinula angulata*	nthutuwiri	
Lesser gallinule	*Porphyrio porphyrio*	nadititi	
Spur-winged goose	*Plectropterus gambensis*	sekhwe	
Pink-backed pelican	*Pelecanus rufescens*	chikovili/vuo	
Great white pelicans	*Pelecanus anocratalus*	chikovili/vuo	
Little egret	*Egretta garzetta*	kakowa	
Cattle egret	*Bubulcus ibis*	kakowa	
Yellow billed egret	*Egretta intermedia*	kakowa	
Grey headed gulls	*Larus cirrocephalus*	nkhalakata	
	Diplachne fusca	mabawe	62
	Ipomoea aquatica	mkokabwato kakombwe Lenjele	
Serrated terrapin	*Pelusios simutans*	nkhasi	
Striped skink	*Mabuya striata*	Gulo	
Chameleon	*Chameleon dilepis*	nazikambe	
Frogs (Broad Banded Rana)	*Ptychadema mascareniensis*	achule	60
Snakes (lowland swamp viper)	*Atheris superciliaris*		50
Floaters	*Aeschomene pfundi*	mabungwa	
Sedge	*Cyperus articulatus*	mlulu	49
Hippo grass	*Vossia cuspidate*	duvi	25
Reeds	*Phragmites mauritianus*	bango	22
Soft-shelled turtle	*Cyloderma frenatum*	nombo	13
Nile cabbage or water lettuce	*Pistia stratiotes*	chipiri	2
Hornwort	*Ceratophyllum demersum*	kakombwe	2
Water hyacinth	*Eichornia crassipes*	namasipuni	1

The reported species for other resources were obtained from both the male and female FGDs and there was no gender and age differences in terms of identification of all the species except for trees where females managed to identify all the 24 species and males only mentioned six species, namely, *Adansonia digitata, Euphorbia ingens, Ficus capensis, Ficus natalensis, Khaya anthoteca, Faidherbia albida.* These identified resources agree with Wilson (1999), Mfune and Mhango (1998), Kabwazi and Gulule (1999) and Phiri *et al.* (1999) findings. The respondents also reported presence of water hyacinth (*Eichornia crassipes)* which was previously discovered in Lake Chilwa catchment only and hippos *(Hippopotamus amphibious)* which were not captured by Mfune and Mhango (1998). Furthermore, it was learnt from the FGDs and transect walks that baobab (*Adansonia digitata)* and *Euphorbia ingens* are abundant tree species on the Island. This result concurs with Sniverly and Corsglia (2000) observation that traditional people know their resources and can provide useful information about plant and animal species supported in their environment. Sniverly and Corsglia (2000) IK study conducted in Phillipines established that traditional people possessed detailed knowledge of the local plants and animals; this included the ability to recognize 1600 plant species. Therefore, scientific studies can apply this knowledge when creating or updating resources checklists on the Island.

Furthermore, among the identified lake resources, Phiri *et al* (1999) indicate that nile cabbage (*Pistia stratiotes)* and hornwort *(Ceratophyllum demersum)*[11] are alien invasive species which are posing threats to utilization and conservation of the lake resources. *Ceratophyllum demersum* is perceived as a priority aquatic

[10] Species shown in Table 2 which have no percentages were derived from FGDs.
[11] These aquatic plants are found in abundance on the western side of the Chisi Island.

weed in the wetland due to its rapid growth, level of abundance and potential threats it poses to the aquatic system. Potential problems caused include displacement of native vegetation, blockage of washing points and disruption of recreation due to formation of impenetrable mats and decreased water flow. In contrast, only 2% of the household respondents raised these threats. In addition to the above threats, the respondents reported that this weed also blocks fishing nets (gill nets) and harbour poisonus water organisms such as water snakes. *Pistia stratiotes* forms dense mats that alter aquatic ecosystem and clog water ways (Phiri *et al* 1999). However, FGDs participants did not raise these threats. Further, the small percentage of the household respondents who raised the threats of these plants suggests that probably the majority of the inhabitants use or is not aware of the possible threats of these plants. Phiri *et al* (1999) note that *Ceratophyllum demersum* cover expanse hectarage of up to 0.1 hectares on one location and the weed occurs extensively in mixed swards with either false bulrush (*Typha domingensis)* or hippo grass (*Vossia cuspidate).* Their study noted that there were indications that the weed was proliferating and had high potential due to its range of coverage. People's livelihood on the Island largely depends on the lake and its resources. There is urgent need therefore to increase awareness of these threats and to involve the local people in implementing or designing the ways of eradicating the weeds. This awareness should also include information on dealing with water hyacinth (*Eichornia crassipes)*, another invasive species with similar threats, although it was identified by very few respondents (1%).

Identified uses of the forest and lake resources on the Island

The identified resources form an important component of the ecosystem because they contribute to the maintenance of essential ecological processes such as food, shelter and breeding sites for a diversity of animals and plants. In addition to providing essential needs to the local people, these are also a source of scientific and educational material.

From the household respondents and FGDs, it was learnt that some of the identified resources have several uses whereas others have limited usage. Tables 3 and 5 present percentage of respondents who reported some of the uses of the identified utilized resources but the percentages do not add up to 100% due to multiple responses.

Table 3 Uses of the identified forest resources

Use	**Resources**						
	Trees	Grass (*Beckeropsis uniseta*)	Birds∗	*Dendrohyrax brucei* (hyrax)	*Thyrononmys swinderian* (great cane rat)	*Rattus natalensis* and *Rattus rattus* (mice)	Domesticated dogs
Fodder	11						
Habitat	5						
Food	71		13	86	22	9	
Income	82						
Building material	49	35					
Fuel wood	97						
Shade	4						
Add soil fertility	22						
Medicine	38						
Hunting							26

Note∗ These include all identified species excluding hamerkop *(Scopus umbretta)* and marsh owl *(Asio capensis*) whose hooting are associated with witch craft and coming of bad news such as death of somebody; small plover *(Charadrius pecuarius*) because they like landing in pit latrines and their presence is used in the prediction of the onset of the rainy season and pied crow *(Corvus albus*) whose meat is considered ugly and tasteless.

Table 3 indicates that trees have several uses compared to the other forest resources. However, the FGDs participants reported that uses depended on species properties. Table 4 provides the identified uses of specific

tree species. From the male FGDs, it was reported that *Commiphora Africana* is not used for roofing poles due to its susceptibility to termites, but is used for bathing fences due to its regeneration properties. This suggests that the local people have vast knowledge of the properties and specific uses of the trees hence can be used to compile or update lists of species and their particular uses. Thus the findings indicate that IK is very reliable in scientific investigations. The result supports Sniverly and Corsiglia (2000) observation that IK can provide useful and highly reliable and cost effective information about plant and animal species.

The results in Table 4 further show that knowledge of tree species uses differed both in number and use by gender. Women showed more knowledge of uses per tree species than men. Similarly, a survey in Sierra Leone revealed that women could name 31 products that they gather or make from the nearby bush while men named only eight. These differences reflect gender differences in terms of reproductive and productive roles (Fernandez 1994). For example, medicinal use of specific trees was reported from the women FGDs only because women are particularly interested in medicinal tree products, as it is their job to look after the family's health. These findings agree with Kayambazinthu and Chabwera (1999) observation that women have greater knowledge of particular areas of the forests such as sources of medicinal plants, mushrooms, termite mounds, trees for firewood and thatch. This indicates that gender differences have to be considered when compiling lists of uses of trees, based on IK

Table 4 Uses of trees

Species (Scientific name)	Local name	Fruit		Medicinal		Sacred		Multiple (firewood, fruit, medicine)		Building		Boat construction	
		M	F	M	F	M	F	M	F	M	F	M	F
Adansonia digitata	Mlambe		x				x						
Euphorbia ingens	Gowoka							x					
Faidherbia albida	Nsangu									x			
Ficus capensis	Mkuyu						x						
Ficus natalensis							x						
Hoslundia opposite	Chanzi				x								
Khaya anthoteca	Mbawa											x	
Kigelia africana	Mvunguti				x								
Parkia filicoidea	Mkundi	x	x										
Trichilia emetica	Msikitsi				x								
Uacapa kirkiana	Msuku	x	x										
Strychnos spinosa	Mateme	x	x										
Vangueria infausta	Ziru	x	x										
Zahna Africana	Mtalala	x	x										
Sterculia quinqueloba	Terela nyani									x		x	
Commiphola Africana	Khobo									x			
Antidesma venosum	Likambako				x								
Flueggea virosa	Zengo		x		x				x				
Mangifera indica	Mango		x						x				
Leersia hexandra	Likakazi				x								
Deinbolia nyikensis					x								

Note: M stands for male.
F stands for female.

Table 5 Uses of identified lake resources

Resource and common names	Scientific name	Use									
		Fodder	Food	Income	Recreation	Mattress filling	Mosquito repellent	Building material	Fuel wood	Safety net from waves	Mats raw material
Fish			100	98							
Cichlid	*Oreochromis shiranus chilwae,*										
Cyprinid minnow	*Barbus paludinosus*										
Clariid catfish	*Clarius gariepinus*										
False bulrush	*Typha domingensis*		62			60	68	91			
Waterfowl			74	16	35						
Fulvous whistling ducks	*Dendrocygna bicolor*										
White-faced whistling ducks	*Dendrocygna viduata*										
Reed cormorant	*Phalacrocorax africanus*										
Lesser moorhens	*Gallinula angulata*										
Lesser gallinule	*Porphyrio porphyrio*										
Spur-winged goose	*Plectropterus gambensis*										
Pink-backed pelican	*Pelecanus rufescens*										
Great white pelicans	*Pelecanus anocratalus*										
Little egret∗	*Egretta garzetta*										
Cattle egret∗	*Bubulcus ibis*										
Yellow billed egret∗	*Egretta intermedia*										
Grey headed gulls∗	*Larus cirrocephalus*										
	Diplachne fusca									66	
Floaters	*Aeschomene pfundi*								38		
Sedge	*Cyperus articulatus*										51
Hippo grass	*Vossia cuspidate*	30									
Reeds	*Phragmites mauritianus*										26

Note: ∗It was learnt from the FGDs that these species are not killed for food or income generation because they are linked with some beliefs or taboos. For example little egret *(Egretta garzetta*), cattle egret *(Bubulcus ibis*) and yellow billed egret *(Egretta intermedia*) are sacred; grey headed gulls *(Larus cirrocephalus*) are used to locate, discover or identify drowned persons or corpses[12].

From Table 5 it can be seen that *Typha domingensis* has a variety of uses some of which may be scientifically investigated to contribute to global knowledge. For example, about 68% of the household respondents reported that *Typha domingensis* fruits are used as mosquito repellent when burnt. Malaria is number one killer of the diseases in Malawi. Several studies are being conducted by different organizations such as Malaria Project or Alert Centre under the College of Medicine, a constituent college of the University of Malawi to find possible ways of preventing its growth or reducing the rates more especially among pregnant women and under five children. This result may therefore be scientifically tested and if the claim proves to be true the IK can be applied in the fight against malaria thereby reducing maternal and infant mortality rates attributed to malaria.

Further, in the development of co-management to meet economic needs of the people, uses of *Typha domingensis* for making mattresses and pillow fillings may be encouraged and improved for marketing. The

[12] When these birds swim in large numbers and assemble at a particular site, the local people know that somebody had drowned and there is a dead body to be discovered.

activity will provide cash income to the inhabitants. The benefits from the sales may motivate people to sustainably utilize the *Typha domingensis.* This result concurs with World Bank (2001) report that IK can improve and sustain local lives and biodiversity.

The high percentages on uses of waterfowl (74%), fish (100% and 98%), *Typha domingensis* (62%, 60%, 68% and 91%) and mabawe (*Diplachne fusca)* (66%) suggest that many inhabitants know the importance of these resources to their lives. Enhanced knowledge of indigenous useful plants will therefore facilitate the development of measures to conserve them and prevent the genetic erosion and possible extinction of many species.

Perceived historical trends of the forest and lake resources

Sustainable co-management strategies will not be designed and achieved without assessing and incorporating local people's knowledge of the status of the resources to be conserved. Furthermore, after implementation of management projects, there is need to monitor resource recovery or population status to assess the sustainability or effectiveness of the projects. IK would also play a role in this aspect. Since most of the identified resources are utilized by the local people directly or indirectly, local people's knowledge of resources status, factors affecting the status of a resource at any given time and indicators of degradation would help them see or understand the need of conserving the resources.

According to Moller *et al.* (2004), in scientific practice, ideal population monitoring methods are precise and easily measured in an objective and repeatable manner. However, conventional scientific research and monitoring can be expensive, often require specialized skills or technology, and are usually not practicable in the remote places in which customary resource use occurs. In such places, local communities possess neither a science capacity nor a tradition and trust in science. In addition, customary users are likely to be too busy to divert time to complicated monitoring methods, especially if the methods are independent of their harvesting.

Most traditional monitoring methods used by indigenous people are rapid, low-cost, and easily comprehensible assessments made by the resource users themselves as they utilise the resources. Hence, most of the known methods for monitoring populations are based on some aspect of the harvest or on observations related to harvests (Moller *et al*. 2004). This sub section shows potential of utilizing IK in determining the status of identified species for a given period, predicting movement of fishery and other aquatic animals such as hippos and other animals.

When the respondents were asked to describe changes in status (historical trends) of their resources over the past years, the household respondents, FGDs and key informants reported that some of the resources have declined in status over the years and others have maintained their status (Tables 6 and 7). Tables 6 and 7 are historical matrices that the FGDs participants drew and the numbers in the tables are presenting abundance of the resource, not the actual number of the resource.

Table 6 shows changes in status of the forest resources, *Typha domingensis,* fish (*Oreochromis shiranus chilwae)* and all identified waterfowl. The table further depicts change in status of *Hippopotamus amphibious* in relation to water level. In contrast to Phiri *et al.* (1999) water hyacinth (*Eichornia crassipes)* is shown as a new plant in the waters close to Chisi Island. The respondents reported that *Eichornia crassipes* has been observed along the lakeshore (mainly in Chigwere, Maluwa and Sudzi villages). However, during the transect walks, the *Eichornia crassipes* was not captured because the reported site was inaccessible at the time of the study.

Table 6 Historical matrix for forest and lake resources around Chisi Island

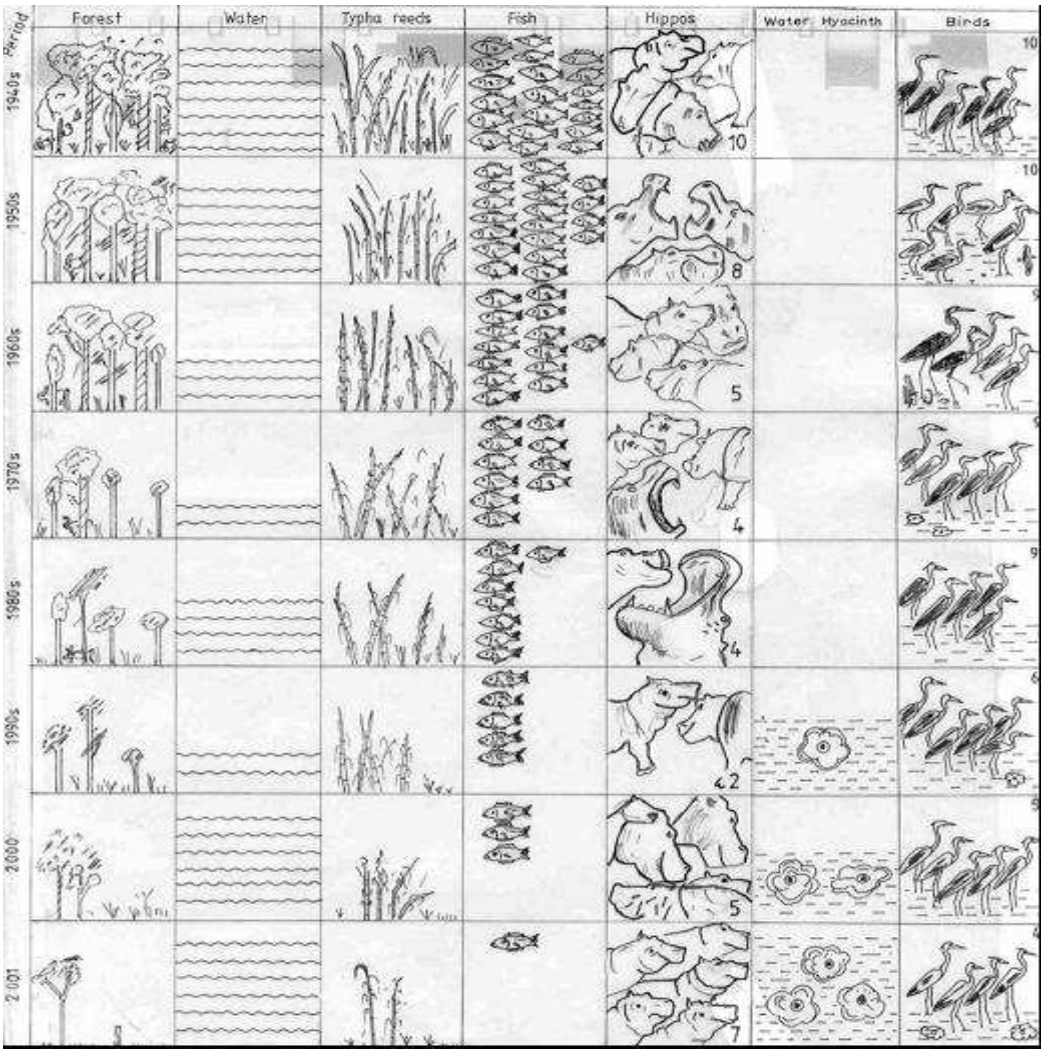


Table 7 Historical matrix of forest resources on Chisi Island

Resource and common names	Species (Scientific name)	Period 1940s	1950s	1960s	1970s	1980s	1990s	2000	2001
Trees[a]		***** *****	***** *****	***** *****	***** ****	***** ***	***** *	*****	****
Secondary colonizer[+]						*	***	****	*****
Grass	*Beckeropsis uniseta*	***** *	***** *	***** *	***** *	*****	****	***	***
Tree climbers	*Flueggea virosa*	***** *****	***** *****	***** *****	***** ****	***** ***	***** **	******	*****
Bush pigs	*Potamachoerus porcus*	***** *****	***** *****	***** *****	***** ***	***** *	***	**	**
Buffalo beans	*Mucuna pruriens*	*	*	*	**	***	*****	***** **	***** ***
Great cane rat and Hyrax	*Thyrononmys swindrian* and *Dendrohyrax brucei*	***** *****	***** *****	***** *****	***** ****	****** *****	***** **	***** ***	***** ***
Vervet monkeys	*Cercopithecus aethiopis*			*	***	*****	***** **	***** **	***** **
Domesticated dogs				*	***	*****	***** **	***** **	***** **
Birds[a]		***** *****	***** *****	***** *****	***** *****	***** ****	***** **	***** *	***** **
Pythons	*Python sebae*	***** *****	***** *****	***** *****	***** ***	***** *	***	****	****

[a]Include all identified species (tabooed or with restricted use and those widely utilised by the local people)
[+] Thorny bushes and shrubs characterize these colonizers (species not identified).
* Abundance of the resource

Table 7 shows secondary colonizers as new vegetation, dogs and vervet monkeys (*Cercopithecus aethiopis*) as introduced animals on the Island. The table further shows that hyrax (*Dendrohyrax brucei*), great cane rat (*Thyrononmys swindrian*), dogs, *Cercopithecus aethiopis* and bufallo beans (*Mucuna pruriens*) have increased or maintained their status probably due to local people's restricted utilization. From observation, these resources tend to be conserved perhaps because the inhabitants heavily rely on fish and trees for their survival.

The FGDs and key informants reported that there is extensive degradation of some of the forest resources such as trees, grass and birds. The original forest cover that was on most parts of the hills is no longer there. Transect walks done at various selected sites confirmed loss of these resources indicating that the local people are aware of the changes occurring in their environment. However, few sites contained a lot of trees.

Perceived indicators of forest resources degradation

Scarcity of medicinal herbs and trees

The FGDs participants reported that the medicinal herbs and trees, which were abundant in the past decade, are scarce. Such herbs and trees include *Antidesma venosum* (likambako), *Flueggea virosa* (zengo), *Deinbollia nyikensis* (mtalala), *Hoslundia opposita* (chanzi), *Leersia hexandra* (likakazi) and *Trichilia emetica* (msikizi). These medicinal herbs and trees are also documented by Mwanyambo and Mwabumba (1999). According to the respondents, scarcity of these trees may pose a threat to their lives because there is no hospital on the Island and some of the medicines obtained from these trees heal diseases (associated with evil spirits) that cannot be dealt with by western medicine. This finding tends to support Ndibwami *et al.* (1998) assertion that traditional healers address a much wider range of problems than western medicines, such as healing patients with psychomatic or psychiatric problems and conditions caused by witchcraft. These plants may be phytochemically analysed to test their medicinal value.

Thick growth of bushes and small trees

The FGDs participants reported that two decades ago, the forest was characterised by big trees with a lot of open spaces. The situation has changed now that the trees, which grow, are smaller than the original species and the dense bushes (which hinder firewood collection), cover the open spaces. These new growths are secondary colonizers (Figure 2). However, the present study did not identify the specific species of these colonizers due to limited time set for the survey. Despite this limitation, the finding supports Munyenyembe and Sambo (1998) report that the vegetation around the perimeters of Chisi Island is much disturbed and is for the most part secondary. This shows that local people may be used in monitoring the forest resources changes in status.

Figure 2 Secondary colonizers growing in deforested hills.

Scarcity of birds, other useful tree climbers and wild pigs

Results of the household questionnaires showed that reduction in forest cover has further led to scarcity of birds (5%), other useful tree climbers such as *Flueggea virosa* and other animals such as wild pigs (*Potamachoerus porcus*) (11%). Similarly, in Western Australia vegetation clearance has significantly reduced many bird species by half, in distribution or abundance (Rundel *et al*. 1998). Trees are habitats for other terrestrial bird species. Birds build their nests in trees. Reduction of trees implies reduced habitats hence birds become scarce or extinct as they retreat or migrate to other forested areas. Similarly, the bush pigs (*Potamachoerus porcus*) live in thick forests hence reduction of trees has led to their retreat as well. Emphasizing their point, the respondents reported that some of the remaining *Potamachoerus porcus* retreated to Nansembe hill, which is still under thick forest cover. This site is very steep and inaccessible hence the presence of *Potamachoerus porcus* was not verified in the present study. However, the respondents claim should be utilized in future studies, for example in updating fauna inventories, determining their distribution and abundance on the Island.

Perceived causes of forest degradation

Intensification of firewood collection and selling

Over half of the household respondents (55%) and the FGDs participants reported that firewood collection and selling had intensified at the time of the study due to famine and fish scarcity. People had no alternative sources of livelihood. It was further reported that even men had joined the business of selling firewood which

was earlier regarded as women's occupation. The FGDs participants noted that this problem had led to cutting down of trees, which were not used in the past two decades. They reported that at the time of the study most of the trees associated with taboos were being used for fish smoking and cooking. This finding suggests that there is urgent need for intervention during times of famine to reduce forest degradation.

According to Sambo *et al*. (1999) and Kabwazi and Wilson (1998) Lake Chilwa produces on average 13,000 tons of fish per year. About 65% of these fish are smoked either by traditional open fire or in wood conserving kilns introduced by MAGFAD. This process consumes an estimated 7500 metric tons of hardwood per year and it exerts enormous pressure on indigenous forest such as *Albizia zimmermannii*, *Acacia seyal, Pericopsis angolensis* and *Combretum* species.

Other than famine, the key informants reported that newly migrating women have also contributed to cutting of restricted trees. Majority of the married women on Chisi Island are migrants who attain secondary rights to access forest resources through marriage. Therefore, what other trees mean to the indigenous women may not be the same to the migrants. Thus, as the indigenous women see other trees as sacred or restricted for use, the migrating women may see them as good species for firewood hence, they end up cutting them. These conflicting perceptions lead to deforestation and weakening of the local regulations, controls and undermining of the authority of the village headmen discussed in detail in Sabola (2007).

The intensification of firewood collection could also result from government's adoption of Structural Adjustment Policy (SAP) in the 1980's. SAP was associated with removal of subsidies on farm inputs. The removal of government subsidies on farm inputs forced up prices and made them unaffordable by the majority of small-scale farmers and this reduced their use. The reduced use of farm inputs led to low food production which in turn has led to high prices of farm produce. Chisi Island has limited land for cultivation; hence the inhabitants rely on maize bought from other areas. To purchase enough food therefore, the inhabitants who have limited sources of cash income could intensify firewood selling.

Uncontrolled bush fires

About 12% of the respondents reported that intensified firewood collection at the time of the study led to frequent bush fires that were set to burn *Mucuna pruriens*. The respondents reported that these fires kill both young and old trees.

Opening of farms in the hills and forest fringes

The FGDs and key informants reported that until the late 1980's farming was done in the hills. This farming was based on shifting cultivation. Before the late 1970's, this practice was sustainable because population was small. These findings agree with Attwell and Cotterill's (2000) report that resources in the past years were conserved because there was small population to exert pressure on them. With increase in population fallow periods declined and soil fertility also started to decline. Further, *Cercopithecus aethiopis* which were introduced as domesticated animals in the1960's, had spread to the hill thus plundering crops. Hence, farming that was done on the hills stopped, less than five gardens were captured in the hills. At the time of the study farms were being opened on forest fringes. This practice was reported by the FGDs participants as destroying a lot of vegetation. Similarly, Rundel, *et al*. (1998) report that an area reclaimed for agricultural production in Western Australia has resulted in significant reductions in many vegetation types. Hence less percentage of their original extent remains.

Perceived indicators and reasons for lake resources degradation

The respondents recognized waterfowl decline and fish degradation as indicators for lake resources degradation as evidenced through low catches and small sizes of fish being caught. The low catches and presence of other water resources were attributed to various factors.

Overfishing

About 35% of the household respondents and FGDs reported overfishing as the biggest perceived threat to fisheries overall. It was learnt from FGDs that this problem results from increased economic needs, demand exerted by high population of fish buyers, consumers and fishermen. These findings tend to agree with Weber (1994) report that fish populations can tolerate only so much exploitation, based on their numbers, reproductive rate and death rate all of which, are hard to estimate. If fishermen catch young fish that are growing rapidly, such "growth" over fishing reduces the potential catch in the Lake Chilwa. Over fishing can

further reduce the overall catch and affect reproduction of the population by removing too many adults[13]. However, some participants in the FGDs conducted, felt that they cannot overexploit the fish resource because of the notion that fish would always be there. This finding agrees with Weber's report (1994) that fish have a higher fertility rate than mammals hence fishermen have apparently never fished any to extinction. However, Weber (1994) notes that some species can be depleted to commercial extinction – the point that catches are so low that fishing is no longer economical.

Use of seine nets

The FGDs and 74% of the household respondents reported that although over fishing is the biggest threat to fisheries overall, use of seine nets is one of the wasteful fishing practices that can damage fisheries profoundly.

The household respondents and FGDs participants reported that seine nets are very destructive because they catch large quantities of non-target species, every size of fish and other water organisms, some of which may be disposed of, as wastes or thrown back into the waters often dead or dying. The research finding supports Weber (1994) report that the seine nets have high bycatch[14] because they have very small mesh sizes. Nyasulu (2002) also notes in fisheries frame survey report of 2002 that between 1976 and 1999 increase in seine nets effort resulted in the reduction in the total yield. Conditions changed between 1981 and 1995 where reduction in effort resulted in an increase in fish yield.

The respondents reported that seine nets are a new technology introduced by visiting fishermen from Mangochi. Thus, supporting Phiri *et al* (2001) report that seine nets in Lake Chilwa were introduced by migrating fishermen prior to 1996. These came to fish on Lake Chilwa during the closed seasons on Lakes Malombe and Malawi. According to Village headman Khumali and Tchuka (both males and over 50 years of age), in 1980 there were only four seine nets but in 1999 there were about 700 and at the time of the study there were over 700 seine nets on Lake Chilwa only. This finding agrees with that of the fisheries frame survey, which has shown an increase in seine nets from 422 (37 on Chisi Island) in 1995 to 758 (42 on Chisi) in 1999 (GOM 2000c).

The respondents reported that besides causing declines in fish commercial species, heavy and wasteful fishing practices might have contributed to the disappearance or reduction of other waterfowl through reducing their food stock. The finding agrees with Weber's (1994) observation that use of seine nets can wreak havoc not only on fish, but the entire ecosystem as well. This suggests that an intensive use of seine nets harm wildlife. This IK can assist in the designing of a better and sustainable harvesting method or tool that can help reverse the situation and restore the ecosystem.

Reduction in *Typha domingensis*

From the household respondents, both male and female FGDs and Key informants it was reported that destruction of the *Typha domingensis* might have reduced fish species. Sambo *et al*. (1999) predict that the *Typha domingensis* of the marsh (in the northern part of the lake) may advance about one kilometre into the open water by the 21st century, depending on the rate of the siltation which leads to increasing shallowness of the lake levels. However, the present survey results contradict this prediction, 85% of the respondents reported that there is a drastic decrease in the *Typha domingensis* in the recent years, starting from the1970's and the process continues to do so depending of the prevailing factors. For example, an old lady in Sudzi village recounted that before the1970's the *Typha domingensis* covered vast area up to Chidyamphiri Island[15](Fig 1). This area contained abundant full-grown *Oreochromis shiranus chilwae*. She further recounted that even women and children could go to the shores to catch fish using simple baskets. The lady emphasized that the practice no longer exists because the *Typha domingensis* has declined. From the FGDs and Key informants it was reported that in the 1950's, mid 1960's and early 1970's the *Typha domingensis* covered a distance from Chigwere village to Chidyamphiri Island. In the past 10 years the *Typha domingensis* covered a distance of about three kilometers offshore.

[13] This phenomenon is called recruitment overfishing (Weber 1994).
[14] Catching of non-target species which is another indicator of over fishing (Weber 1994).
[15] Area which is now covered by open waters.

It was learnt from the household respondents and both male and female FGDs participants that the main perceived reasons for the decline of the *Typha domingensis* are the very high water levels over the last two years (65%) and the drying of the lake in 1995 (44%) (Table 6). The *Typha domingensis* started to decline when the lake dried in 1967 and 1973. Aerial photographs taken in 1948, 1956, 1965, 1974, 1982 and 1995 confirm these results (Sabola 2002). The situation became worse in 1995 because of the fires that were set on them to clear land for agriculture. The people believe that fires restrict regeneration of *Typha domingensis*. At present, the remaining sectors regarded as abundant *Typha domingensis*, only cover a distance of less than a kilometer. As stated above, increased level of water in the lake has also contributed to reduction of *Typha domingensis.* The high water levels destabilise the *Typha domingensis* hence they are uprooted by the strong wind or waves. This observation supports Otte (1991) who reports that the *Typha domingensis* can only live at a depth of up to about one meter; hence beyond this depth they lose support. This proves that through living in close contact with the *Typha domingensis* resource, the inhabitants are well knowledgeable about the changes that are taking place and causes of those changes. This knowledge may be incorporated in the conservation and management of *Typha domingensis*.

According to the household respondents and FGDs participants, reduced *Typha domingensis* implies declining catches of fish and waterfowl because breeding and hiding sites are scarce. Earlier studies in the Lake Chilwa tend to agree with this finding. For example, Nyasulu (2002) report that estimates of catches ranged from 1000 to 24 000 tonnes in the 1980s. In the years 1975, 1978 and 1995 no catches were recorded because of the drying of the lake. At 1999 total catches had declined to about 12 566 tonnes. Similar findings are also recorded by Kabwazi and Wilson (1998) (Fig 3). Figure 3 shows the estimated total annual yield from Lake Chilwa for all the fish species, for a period 1974 to 1995. Among other factors, decline in *Typha domingensis* could have contributed to decline in fish catches (Table 6). This result provides important information pertaining to temporal pattern in fish ecology.

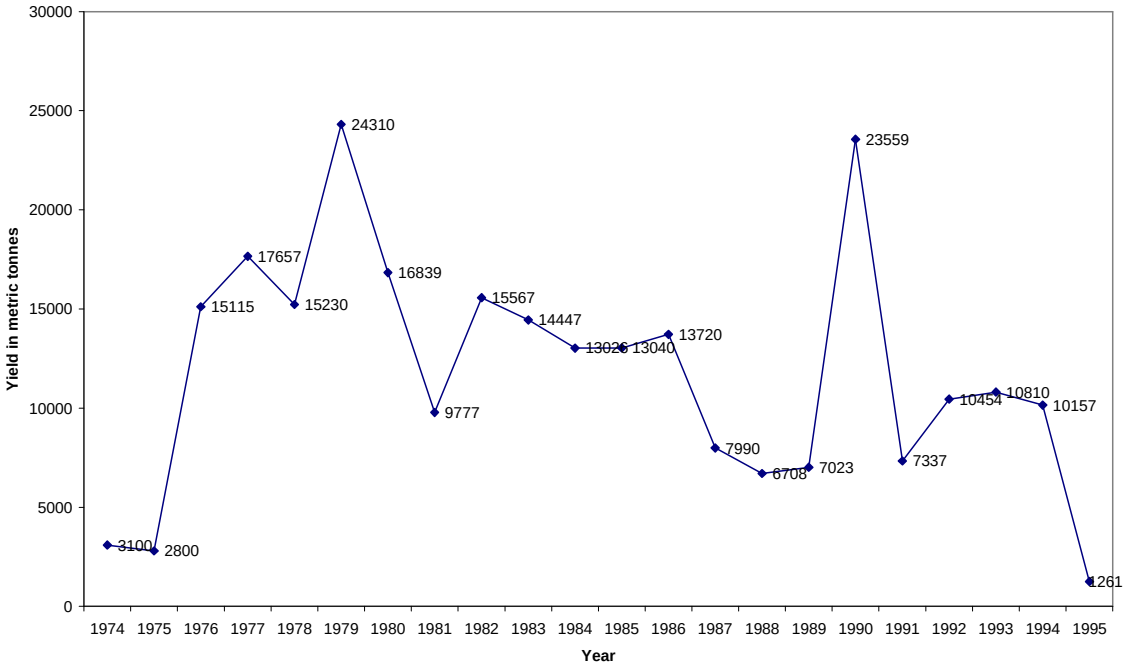


Figure 3 Estimated total annual yield from Lake Chilwa – all species (1974-1995) (adopted from Kabwazi and Wilson 1998)

The finding further shows that there are conflicting uses of *Typha domingensis* and their ecological zones at different periods. In normal years, *Typha domingensis* are fish habitat but when the lake recedes the *Typha domingensis* swamps provide fertile land for food production. This conflict needs to be considered in the designing of co-management projects for fish around Chisi Island.

Changes in winds

About 10 % of the household respondents reported changes in winds as one of the causes of decline in fish catches. From the male FGDs it was learnt that southerly (mwera) wind in the months of May to (mid) August is associated with fish scarcity whereas northerly (mpoto) wind (from mid August to mid November) is associated with abundant fish. The respondents reported that when there is southerly wind fish hide in inaccessible areas. In contrast to the household respondents' claim that the winds contribute to decline in fish harvest, a report from the male FGDs suggests that the winds are responsible for seasonal and directional fish movement. Similarly, Hamilton and Walter (2000) report that in Roviana Lagoon of Solomon Island, the local fishermen provided accurate predictions of fish aggregate behaviour, fish movements related to lunar cycle. This finding can therefore be investigated further for accuracy. If the results are valid, it suggests that the fishermen can be used to provide information on fish movement patterns through their catch and spatial patterns. Although the local people's explanations for the mechanisms underlying these movements may not be compatible with scientific paradigms, this knowledge can be used in the creation of the research design that would maximize the likelihood of scientists' observation of the predicted behaviours. Furthermore, this information can be useful in conjunction with genetic information, tagging experiments and morphometric studies in identifying stocks (Neis *et al.* 1999).

Fishing around once traditionally protected and sacred hills

From the FGDs it was reported that fish catch has further declined because of encroachment on the once traditionally protected sacred sites. These sites served as undisturbed habitat for reproduction and growth. They created a fish (*Oreochromis shiranus*) breeding sanctuary where big females, which produce large quantities of eggs, could breed. Breaking the practice destroyed the function and leads to fish resource degradation. The FGDs participants reported that this has become a big problem because of the existing use or ownership rights of the lake. They reported that the lake has an open access regime where all fishing grounds are open to everyone including those from outside the community. This finding was confirmed by a follow up interview with the fishermen in Mkotamo, Sudzi, Chikhasu and Khumali fishing grounds who indicated that some of them were visiting fishermen coming from areas such as Mangochi and had no knowledge of these earlier traditional practices.

Perceived factors that have led to decline of waterfowl

The FGDs and 12% of the household respondents reported that reduction in *Typha domingensis* is contributing to decline in waterfowl. About 22% of the respondents stated that a lot of birds have migrated to other sites due to this reduction of the *Typha domingensis*. From the FGDs it was established that white-faced whistling ducks (*Dendrocygna viduata*), geese (*Plectropterus gambensis*), and fulvous whistling ducks (*Dendrocygna bicolar)* build their nests in the *Typha domingensis* hence need to be properly managed. However, when the household respondents were asked to describe how the *Typha domingensis* are managed it was established that these have no management technique and mismanagement is what is attributing to their decline. The FGDs participants reported that a lot of fires set on the *Typha domingensis* kill the young birds. The FGDs participants further reported that fires that are set on the *Typha domingensis* as people open vegetable gardens when the lake dries, destroy the birds' habitats. It was also reported that when the lake dries, pails and baskets full of hundreds of birds' eggs are collected from the lake for food[16]. This implies few eggs are hatched and reduction in *Typha domingensis* also implies retreat of waterfowl to other sites and resultant decline of their populations. Continued unsustainable utilisation of waterfowl and degradation of *Typha domingensis* may lead to decline of waterfowl beyond the population requirement that meets the Ramsar criteria for designating a wetland as a Ramsar candidate. Consequently, Lake Chilwa will lose its status as a Ramsar listed site. This suggests that there is an urgent need to address all the reported factors that contribute to the decline of waterfowl on Chisi Island.

Factors affecting the status of hippos in the lake

About 46% of the household respondents reported that hippos are increasing in number. However, earlier studies have indicated that hippos are rare. When the respondents were asked to explain the present trend, they reported that previously, the hippos retreated to other sites when the lake dried. According to the respondents, the presence and abundance of these animals depend on the water level (Table 6). When the level is very low they retreat to other areas with higher levels of water and they come back when the water

[16] When the lake dries, fish, which acts as a main source of livelihood, is so scarce that people use any resource in their vicinity for example, waterfowl, that can provide them with food.

level is high. Following the heavy rains of 1999 and 2000 rainy season, the Lake Chilwa received abundant water from its catchment area and the water level increased. This explains the presence of hippos in the lake at the time of the survey in which four hippos were captured. According to Stuarts and Stuarts (1988) hippos require sufficient water in their habitat to allow submergence. The earlier study of Mfune and Mhango (1998) documented the absence of hippos in the Lake Chilwa probably because it was conducted when the lake (level was very low) had just started recovering from 1995 recession. Hence the explanation given by the respondents could be true. This indicates that through generations of living in close contact with their nature, Chisi inhabitants have studied and known the movements of hippos in relation to their habitat. This observation supports Posey (1999) who notes that IK embraces information among other things, about location, movements and factors explaining spatial patterns and timing in ecosystems, including sequences of events such as aquatic mammal sightings.

Conclusion and recommendations

A study was carried out on Chisi Island, Lake Chilwa in Zomba district, Malawi, to examine indigenous knowledge of forest and lake resources degradation and factors that lead to degradation. It was conceived with the premise that integration of IK in scientific studies can substantially contribute to scientific knowledge as well as effective or sustainable co-management or participatory management practices. The study found that Chisi inhabitants have developed and maintained some local ecological knowledge that can have significant implications in scientific research and on the management of forest and lake resources on the Island. The results indicated growth of secondary colonizers, scarcity of medicinal plants and migration of wild pigs (*Potamachoerus porcus*) as indicators of forest degradation. Low fish catches and declining numbers of waterfowl were reported as indicators of lake resources degradation. Forest degradation resulted from poverty and famine. Low fish catches and presence of hippos (*Hippopotamus amphibious*) and false bulrush (*Typha domingensis*) in the lake was determined by the water level. Use of seine nets also contributed to fish degradation. Although none of the information collected in this survey is quantitative and classification of resources differs from conventional science, it shows potential of being utilised in scientific research, designing and implementing sustainable management strategies.

Ramsar convention recognizes the value of IK and suggests its integration in scientific studies, designing and implementation of sustainable management or conservation measures of wetland resources. This study therefore, argues that future scientific studies on Chisi Island should integrate local ecological knowledge. It is recommended to conduct a comprehensive survey that integrates IK in updating checklists of flora and fauna, monitoring movements or behaviour of aquatic, terrestrial and land animals such as fish, waterfowl, *Hippopotamus amphibious* and *Potamachoerus porcus* on the Island because the local people have shown that they can give reliable information and that will help to cut study costs. The scientists in future studies can further utilize the IK in exploring ethnoecological knowledge and management or conserving medicinal plants on the Island because the local people have depicted knowledge of resources with medicinal properties such as selective trees and *Typha domingensis*. Thus, future studies are recommended to use IK to compile a detailed list of trees species claimed to have healing properties and associated illnesses and conduct phytochemical analysis. If the results are valid, the scientists or conservationists should help in marketing the products, the resource users should be recognised and make them benefit economically, from the market proceeds. This study also recommends inclusion of IK in monitoring flora and fauna populations. This can be done through integrating IK in determining uses, status and causes of resources degradation at a particular period. The above recommendations should also be applied to the whole Lake Chilwa wetland area. This involvement will help local people appreciate the value of sustainable utilisation and empower them to fully participate in the designing, implementation of management projects and monitor resources populations during implementation.

Participatory research or resources management requires full community involvement to reduce conflicts and for sustainability of the projects. However, gender, occupational and age differences need to be considered or understood in these studies because the results show that IK is not evenly distributed. Females have more knowledge of forest resources and uses than males who have vast knowledge of lake resources compared to the ladies. This difference is related to their productive roles, labour divisions in the family, occupation and experience. Almost all men on the Island are fishers and women rely more on income and other provisions obtained from forest products such as firewood and traditional medicine. Oldest residents also provided detailed information on resources status over a long period. Thus age has to be considered on specific data to be collected. Furthermore, as with scientific knowledge, IK has its own limitations and these have to be

recognised. Thus, information from IK in future studies should be accepted critically. If problems are identified they need to be raised to the resource users, help them understand them and change for sustainable utilisation and conservation to be maintained. For example, the study established that fishers do not believe fish can become extinct though they are able to see declining catches. Scientists can assist fishers to know and understand quantitative sustainable catch levels and consequencies of harvesting beyond such level with concrete evidence. These efforts will help Malawi retain Lake Chilwa as a Ramsar site.

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