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# KILORWEMP

KILOMBERO AND LOWER RUFIJI WETLANDS ECOSYSTEM MANAGEMENT PROJECT

# TECHNICAL ADVISORY SERVICES FOR BIODIVERSITY CONSERVATION AND WETLAND MANAGEMENT IN KILOMBERO VALLEY RAMSAR SITE

# THE KILOMBERO FISHERY DIAGNOSTIC STUDY

**FINAL 02/06/17**

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# 1 ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| BMU | Beach Management Unit |
| BTC | Belgian Development Agency |
| CPUE | Catch Per Unit Effort |
| EAF | Ecosystem Approach to Fisheries |
| GCA | Game Controlled Area |
| GIS | Geographic information system |
| GPM | Gross Profit Margin |
| HH | Household |
| HHQ | Household Questionnaire |
| KGCA | Kilombero Game Controlled Area |
| KII | Key Informant Interview |
| KILORWEMP | Kilombero and Lower Rufiji Wetlands Management Project |
| KVRS | Kilombero Valley Ramsar Site |
| m.a.s.l. | Metres above sea level |
| MNRT | Ministry of Natural Resources and Tourism |
| MSY | Maximum Sustainable Yield |
| PRA | Participatory Rapid Appraisal |
| TZS | Tanzanian Shilling |
| URT | United Republic of Tanzania |
| USAID | United State Agency for International Development |
| WMA | Wildlife Management Area |
| WWF | World Wide Fund for Nature |

# EXECUTIVE SUMMARY

This report provides an overview and assessment of the current status of the fishery sector in the Kilombero Valley. It has been prepared under the framework of and as a contribution to the Kilombero and Lower Rufiji Wetlands Management, or KILORWEMP Project, currently being implemented as a collaborative effort between Belgian Technical Cooperation (BTC) and the Tanzania Ministry of Natural Resources and Tourism (MNRT) with financial support from Belgian Aid and the European Union. The overall goal of KILORWEMP is to promote the sustainable management of the wetlands ecosystem of the Kilombero Valley and Lower Rufiji.

The report is based on a review of previous literature and incorporates and synthesizes the findings of an initial PRA study carried out in 14 villages and four fish camps and a subsequent detailed household questionnaire (HHQ) survey implemented in 10 villages and 12 fish camps, combined with insights obtained through key informant interviews (KIIs) concerning the structure and functioning of the fish value chain within the Kilombero Valley, and a limited study of fish catches. Field work was carried out from June to September 2016.

**The fishers**

The Kilombero Valley supports a rich fish resource and there is a long tradition of fishing activities carried out by the indigenous inhabitants: today the principal fishing groups are the Ndamba, Ngoni and Pogoro, plus the Ngindo, Bena, Nyakyusa and Ndwewe.

The Kilombero Valley continues to experience a high level of in migration and population growth. Roughly, one third of HHQ respondents were migrants to the Kilombero Valley and annual population growth was estimated in 2012 to be 3.9%.

Crop production is the most common and important form of livelihood among rural communities in the Kilombero Valley, followed by fishing activities, and with strong linkages between the two, a so-called agro-fishing food production system. Fishing is done for both subsistence and cash income purposes to supplement crop farming. In this study 50.7% of households were engaged in fishing activities including the catching, processing and trading of fish.

Three types of fishermen were recognized based on their length of stay per year in fishing camps: village fishermen who base their fishing activities from their households in the villages, seasonal fishermen who stay in fish camps for part of the year and permanent fishermen who stay in fish camps all year round. Village and seasonal fishermen were usually also engaged in crop farming. Some permanent fishermen were immigrants from elsewhere; others were employed by seasonal agro-fishers, such that their fishing equipment and catches were owned by their employers rather than themselves.

Seasonal and permanent fishermen were predominantly men, but included a variety of ages from youths to elders, whereas village fishermen included also women and children. Fishermen in fish camps were reported to fish mainly for income rather than for food, particularly seasonal fishermen in order to generate income to support farming activities. Village fishermen, in contrast, fish mainly for food for their households; although at times some are able to sell excess fish the money obtained is generally sufficient to purchase small items. Virtually all households in villages own some land, whilst in fish camps roughly one third do not own land. The most frequent source of capital for starting fishing activities was through the selling of crops, followed by employment and loans.

**Fishing grounds, gear and methods**

Fishing is carried out away from farms in a wide variety of habitats, including within the main river, small rivers or river channels, oxbows, swamps, flood plains and in deep water or shallow water, water that is rising or receding and submerged grass. Some activities are carried out all year round; others are much more seasonal and tied to particular hydrological conditions that occur at specific times of the year. Some techniques are carried out by men, others by women and children.

Importance scores for different techniques varied widely between villages, but overall the use of nets, specifically gill nets (*kutega*) and casting weighted nets (*ndatula*) were considered to be the two most important techniques, followed distantly by *ndanga* fish traps and two hook and bait methods (*ndoano kitanzi kuning'iniza* and *ndoano mshipi*).

Some of the fishing techniques and gear used are illegal, including the use of mosquito nets and other nets with mesh size smaller than three inches (*kokora*), as well as the use of poisons and the *pumunda* netting technique (*pumunda* netting involves covering an area of water and grass with fine meshed nets then cutting all the grass so enabling the fishermen to pull out everything covered by the net, including small fishes and other aquatic organisms). While survey participants acknowledged the use of illegal fishing gears, and it appears that there has been a shift towards increased use of smaller mesh sizes, the results of the fish catch survey indicate that the majority of fish are still being caught in mesh sizes greater than three inches (the minimum legal mesh size).

**Fish species**

Of the 49 fish species that have been recorded from the Kilombero system, fourteen species dominate in terms of abundance and as sources of food and income. Results of the present limited fish catch survey, as compared to a previous much larger survey carried out in 2000, suggest that there have been no significant changes in terms of either species composition or fish sizes.

**Fish catches, consumption, processing and trading**

Fish catches are strongly seasonal and are dominated by large fish (> 300 g in weight) rather than small fish. The bulk of fish caught were reported to be sold, with much lower volumes of consumption and spoilage. Nevertheless, fish is more frequently consumed than alternative foods such as vegetables then chicken and beef. Consumption by respondents was mainly from own catches.

The most common sites of marketing were at landing sites and fish camps, where there are traders waiting to purchase fish, but the prices they offered were usually lower than those obtainable in villages or urban centres. So, if a fisherman wants to get a better price than that obtainable at the fish camp he will take his fish to the village or to urban centres within the Kilombero Valley such as Ifakara, Malinyi, Mlimba and Mahenge.

The bulk of trade occurs in the form of fresh fish. Processing of fish was carried out by two fifths of respondents in fish camps and one quarter in villages. In fish camps fish processors mainly purchase their fish from fishermen whereas those in villages usually process fish that they have caught themselves. Smoking is the main form of processing, the main costs being for firewood and for transport of fish to markets. The bulk of processed fish is sold rather than being for own consumption: the bulk is sold to traders in fish camps and in local markets in villages, with smaller portions being marketed in urban centres within Kilombero Valley or beyond. External markets were more important for processors in fish camps, the main markets being Dar es Salaam, Kilosa, Mbeya, Morogoro and Songea. In villages the bulk of processed fish was sold to other households in the village.

Volumes produced and sales of processed fish follow the same general trends as for fish catches, being higher in fish camps than in villages and being strongly seasonal in response to the hydrological cycle.

**Seasonality**

Fishing activities and catches in Kilombero, as for all floodplain fisheries, fluctuate seasonally in response to the hydrological cycle. Fish catches start to rise during December and January during the first rains when water starts to enter the flood plain. During February and March seasonal fishermen are typically busy working on their farms, as this is their main occupation, and usually they fish mainly to get fish for food for their households rather than for income. As water levels on the flood plain continue to rise so many of the fish camps close to the Kilombero River are

submerged, such that many of the permanent fishermen are forced to move to other fish camps in upland areas. As water starts to recede from the flood plain back to the main river during April and May, fish catches rise as fishermen, in particular seasonal fishermen (who have temporarily stopped crop farming work) and permanent fishermen, can now go fishing to get fish mainly for income. Fish catches peak during May, June and July and start to decline in August as water recedes back to main channels. In September to November water levels are low and fish catches decrease and seasonal fishermen stop fishing and move from fish camps back to the villages for harvesting their crops in their farms. In fish camps mainly the permanent fishermen continue to fish in the main river.

Levels of consumption and sales of fish follow the same general pattern as for fish catches, whereas fish prices show an inverse trend being lowest during the period of highest supply and rising during periods when fish catches are reduced.

**Value chain analysis**

A basic analysis of the Kilombero fish value chain of producers, processors, fish traders and consumers, was carried out. These calculations suggest that more than 50,000 households are involved in fishing activities and that the total catch is in the order of 25,000 metric tonnes. Based on the total number of households, the percentage of households involved in fishing, mean annual catches of fish and mean prices of fish; the total value of annual fish production within the Kilombero Valley was estimated at 541 billion TZS.

A market margin analysis was carried out, based on calculations of gross profits achieved by fishermen, fish processors and traders, where the market margin is equivalent to the ratio of consumer price to the difference between the consumer price and producer price. These results indicate that fishing activities are profitable and that fish traders achieve a higher gross profit margin than fishermen and fish processors.

**Difficulties and conflicts**

One of the main problems raised during KIIs was the lack of cooperation and mutual understanding between fishers and fisheries officers. The fishers claim that some officers are highly corrupt and unfair in their treatment of the fishers. Apart from the issue of corruption and mistrust between the officers, fishers also cited a problem of environmental degradation which they claim affects the availability of fish. They feel that pastoralists and crop farmers are destroying their fishing grounds through their livestock and farming practices; this was the primary form of conflict identified between fishers and other land users. Other perceived difficulties included declining availability of and increased difficulty in landing fish, poor fishing gear, and dangers posed by large animals, specifically crocodiles and hippos. Suggested solutions were for improved land use planning and the reduction and control of cattle; better support by government and strengthened regulation of the fishery.

**Trends**

Study participants perceived trends of declining volumes of individual fish catches, declining sizes of fish caught, declining frequency and volume of consumption of fish, and declining sales of fish. The number of fishermen and proportion of households fishing were perceived to be increasing. Gear was generally reported to be much the same, although there was a perceived trend towards increased use of smaller mesh sizes. Mixed trends were reported concerning the processing and trading of fish. All these trends are based on individual perceptions of the situation, in which respect there is always likely to be an inverse correlation between individual output and total output in a fishery with increased number of participants.

**Management of fisheries**

Management of fisheries is presently conducted by government through fisheries officers under the respective district councils and through the various village governments. Fisheries officers are responsible for issuing fishing licenses and fishing business licenses, registration of fishing boats and patrolling to prevent illegal fishing activities. Village governments act through village leaders,

Village Natural Resource Committees, Village Environmental Committees and Village Game Scouts. Through these bodies village governments are responsible for the protection of natural resources, forests, wildlife and fisheries; patrolling to stop illegal fishing activities including stopping fishing without fishing licenses; inspecting fishing nets used by fishermen to ensure they don't use fishing nets with small mesh size, and for stopping any fishing of small fish.

Fishermen were well aware of the existence of such regulations, specifically concerning the need to have a license and that certain activities, such as the catching of small fish, are illegal. Study participants claimed that the bulk of fishermen comply with these rules and, for those that don't, the main reason for non-compliance was due to declining personal catches.

**Concluding analysis**

The final portions of the report attempt to place the Kilombero fishery within a broader theoretical context and in relation to comparative experience from other African floodplain fisheries. Based on this analysis it is concluded that:

- Ecological information is mainly qualitative and contains very little actual data (catch statistics, effort, and changes). However, there are no indications that the general pattern, biology and productivity deviates from similar floodplain fisheries elsewhere in the region.

- There are no signs of biological overfishing from any of the verifiable indicators. The fishery is artisanal multi-gear and multispecies, and appears well balanced and adapted in terms of species diversifications and sizes. The fact that there are no strong size or species preferences suggests that fishers should be allowed to use a wide variety of gears and mesh sizes, in order to be able to catch the same wide variety of species and sizes.

- There are no clear indications that either the overall species composition, or the average sizes of fish caught has changed significantly. Thus, taken together there are no clear solid signs of a fishery that is deteriorating or in a bad shape.

- Individual catches per fisher are declining, which is a normal event with an increase in numbers of fishers, but overall catches are most likely increasing (although reliable statistics are missing).

- Fish are not getting smaller, but more small fish are being caught due to increased use of smaller mesh sized gears. This a good sign in terms of achieving a balanced fishery in accordance with the Ecosystem Approach to Fisheries as it spreads the fishing pressure over a wider range of the fish community.

- Use of 'illegal' gears is increasing, but again this is a normal expected consequence of decreased individual catches, and has no proven adverse ecologically impacts. Limiting the fishery to legal gears only will decrease catches and unbalance the fishery towards the least productive segments.

- There is a conceptual mismatch between the overall goal of an ecosystem approach to fisheries aiming at conserving the ecosystem structure and functioning and the current fisheries legislation aiming at a highly selective fishery targeting only large fish.

- Much of the ecological assessment is based on limited information and comparative inferences from similar ecosystems elsewhere. There is a need for a comprehensive mapping and monitoring of the fishery over at least one hydrological cycle before any informed management decisions can be made.

- The establishment of BMUs' in their present form, and with the current by-laws, is premature and will most likely be unsuccessful as experienced elsewhere. There is a need for locally adapted mutually agreed by-laws based on local assessments of regulatory needs.

- Maintenance of the natural hydrological floodplain pattern is by far the greatest priority for a sustainable, healthy and productive fishery. The hydrology is by far the most important driver for the biology, and as long as the natural cycles are maintained, then the fishery will be reasonably robust to exploitation. However, maintenance of the hydrology depends to a large degree on external activities outside the control of the Kilombero Valley.

**Recommendations**

Two main recommendations are put forward:

- To establish a long term fisherman based monitoring system, and
- To revise and modify the present BMU management approach to allow true cooperative management and self regulation of the fishery.

# 2 BACKGROUND

This report provides an overview and assessment of the current status of the fishery in the Kilombero Valley. It has been prepared under the framework of and as a contribution to the KILORWEMP Project (Kilombero and Lower Rufiji Wetlands Management Project), currently being implemented as a collaborative effort between Belgian Technical Cooperation (BTC) and the Tanzania Ministry of Natural Resources and Tourism (MNRT) with financial support from Belgian Aid and the European Union. The overall goal of KILORWEMP is to promote the sustainable management of the wetlands ecosystem of the Kilombero Valley and Lower Rufiji.

The report is based on a literature review of a limited amount of previous studies and surveys and incorporates and synthesizes the findings of the present project activities, consisting of an initial PRA study and a subsequent detailed household questionnaire (HHQ) survey, insights obtained through key informant interviews (KIIs) concerning the composition, dynamics and economic functioning of the fishery value chain within the Kilombero Valley, and a limited fish catch survey. Field work was carried out from June to September 2016.

The study highlights the important contribution of fish to the local economy, enhancing food security and food production, and providing the basis for the value chain of fish in the Kilombero Valley. The majority of the fishing activities take place on the central floodplain of the Kilombero Valley, which is being re-designated as a Game Controlled Area (GCA) under the jurisdiction of the Tanzania Wildlife Authority. Permanent settlement in this area is prevented by natural flooding, which poses particular challenges to the fishery management.

The report is organised into three main parts. First an introduction and description of the general hydrology of the Kilombero Valley and of the methodology used is provided (Chapters 2 to 4). The main results are presented in the following 15 sections (Chapters 5 to 19). The concluding section (Chapters 20 to 24) provides a summary of the fishery, a discussion of the reported symptoms of concern and their interpretation with regards to fisheries management under an Ecosystems Approach to Fisheries, followed by conclusions and a list of recommendations for future development and management of the fishery sector in the Kilombero Valley.

# 3 INTRODUCTION

The Kilombero or Ulanga Valley is an extensive low lying fault depression (210–250 m.a.s.l) of highly fertile land, situated in south-central Tanzania between the highlands of Iringa District and the Udzungwa escarpment in the north and west, and the Mahenge uplands to the south and east (Beck 1964, WWF 1992). It is part of the Greater Rufiji Basin catchment area (Fig. 1 and Table 1) and encloses the largest seasonal freshwater floodplain in East Africa. It has received increasing attention for its almost intact natural wetland, and its importance for both local food production and being a biological hotspot in terms of wildlife (most of the valley is a Game Controlled Area, GCA, although the game itself has nearly disappeared), and its designation as a Ramsar wetland sanctuary. The Kilombero Valley wetland provides a range of essential ecosystem services, including natural water regulation, flood control, sediment retention, ground water recharge, food, and income and biodiversity conservation to a broad range of beneficiaries. However, its total uses and functions are still only partially understood and documented (WWF 1992).

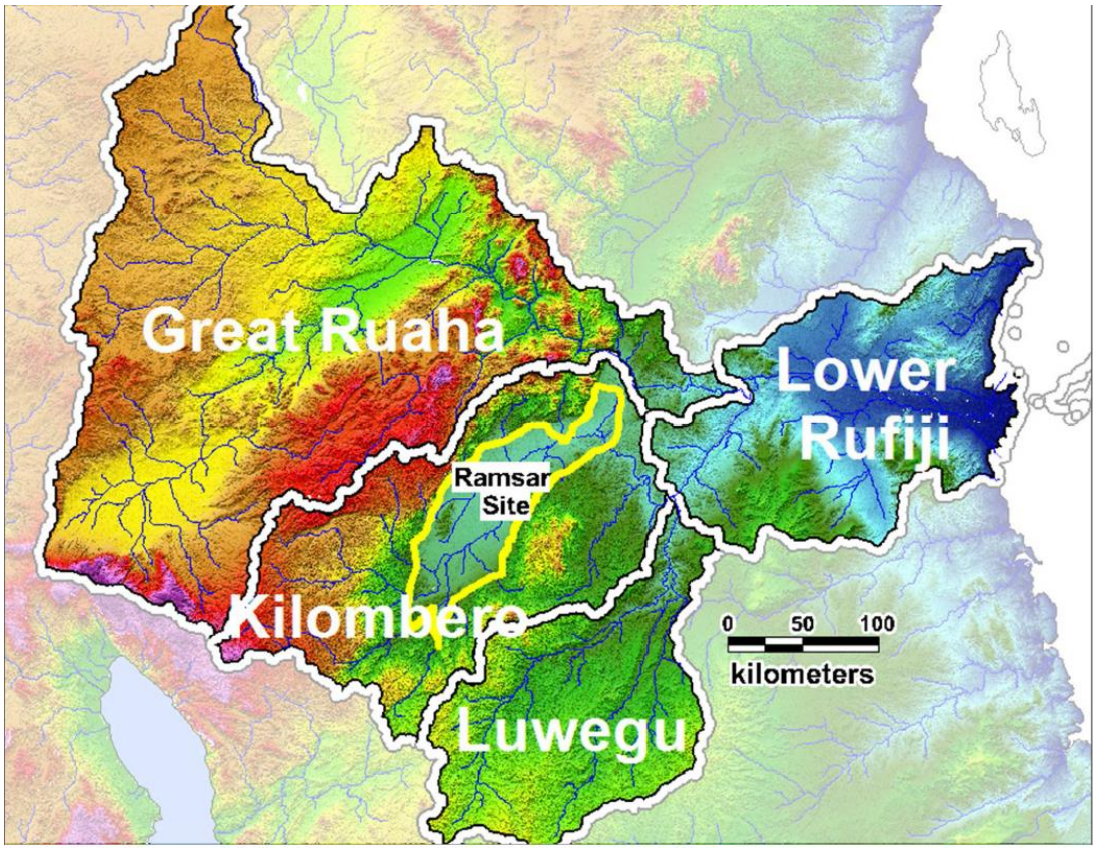


**Figure 1: The Kilombero Valley in the Rufiji Basin catchment area and the location of the Ramsar area. (Source: AMBERO GIS).**

The Kilombero floodplain is about 260 km long and up to 52 km wide, and covers an area of around 400,000 - 625,000 ha (4,000 - 6,250 km$^2$) during inundation at high water level (Vanden Bossche and Bernacsek 1990, WWF 1992, Utzinger and Charlwood 1996). It is intersected by a meandering anastomosis of multiple channels comprising the Ulanga River (also known as the Kilombero), which runs through the valley and is fed by the Ruhudji, Mnyera and Pitu Rivers from the south, as well as numerous lateral tributaries from the adjacent highlands After leaving the valley at Ifakara, along the western border of the Selous Game Reserve, the Ulanga River feeds into the Luwego River and together they continue as the mighty Rufiji River into the Indian Ocean. The Kilombero floodplain is an important breeding and nursery grounds for many commercially important fish species and plays a vital role in sustaining the whole of the greater Rufiji River system further downstream (Mwalyosi 1990, WWF 1992).Strong seasonal water level fluctuations with relatively low inter-annual variations (USAID-EFA 2015) create annual changes in habitat availability (areas of inundation), pathways of fish dispersal, and pulses of food availability and fish biomass.

**Table 1. Rufiji basin catchment area. (Source: Arvidson et al. 2009).**

| River | Area (km$^2$) | Percentage of area | Percentage of run-off |
|---|---|---|---|
| **Great Ruaha** | 83,970 | 47 | 15 |
| **Kilombero** | 39,990 | 23 | 62 |
| **Luwegu** | 26,300 | 15 | 18 |
| **Rufiji (lower river)** | 27,160 | 15 | 5 |
| **Total** | **177,429** | **100** | **100** |

Fishing and farming (primarily rice, maize and beans) have always been the principal and most important economic activities, and fish is and has traditionally been the main source of high quality protein. Previously, most people in the Kilombero River basin derived a major part of their income from fishing (Mwalyosi 1990), while cattle breeding was limited due to east-coast fever and trypanosomiasis (Beck 1964). More recently rice farming has become increasingly important as a cash crop, and livestock keeping driven by immigrant pastoralists is also playing an increasing role (Mombo, 2013; USAID-EFA 2015). During the dry season there is extensive annual burning of grass and bush land in order to prepare for fresh regrowth after the next inundation. Swelling population pressure and associated human activities, coupled with growth of livestock herds, have led to growing competition for land. With the ensuing strain on land and water resources resulting in increased conflicts, attempts have been made to resettle some of the pastoral communities in order to achieve sustainable management of resources (WWF 1992, Nindi et al. 2014). The traditional fishery is also experiencing changes, with the influx of new immigrants and the deterioration of local customs and traditional controls of fishing activities as well as the introduction of new fishing gear and methods (Monson 2012).

# 4 HYDROLOGY AND THE FLOODPLAIN

The climate is characterized by two distinct seasons: a rainy season from November until mid May (with peak flood in March/April) and a dry season from June to October (Fig. 2). Each year beginning in late November or early December the river floods and overspill the banks, creating the large floodplain, which gradually recedes back to the main channels during May and June.

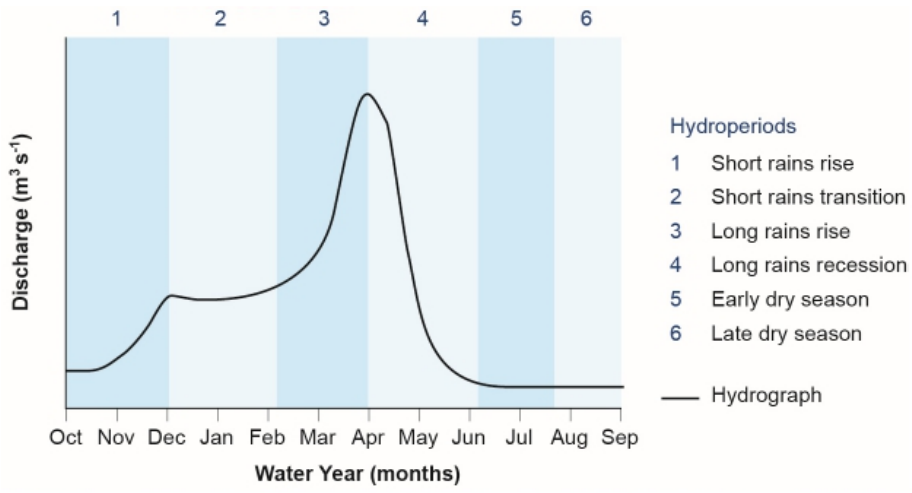


**Figure 2: Schematic diagram of six 'hydro-periods' distinguished for the Kilombero River Sub-basin. (Source: USAID-EFA 2015).**

This annual inundation created by the seasonal flood pulse is the key environmental driver of both terrestrial and aquatic production. Both the fishery and the fish biology are strongly adjusted to the annual cycles (Figs. 3 and 4). The seasonal nutrient inputs from rivers loaded with run-offs and the flooded marginal areas are very important in stimulating fish production. When water level rises terrestrial vegetation is submerged and nutrients leaching from decomposing organic matter (dung, terrestrial grass, shrubs and trees) and directly from rivers, result in increased plankton and fish production (Kolding and van Zwieten 2006, Kolding 2011, Mosepele et al. 2017).

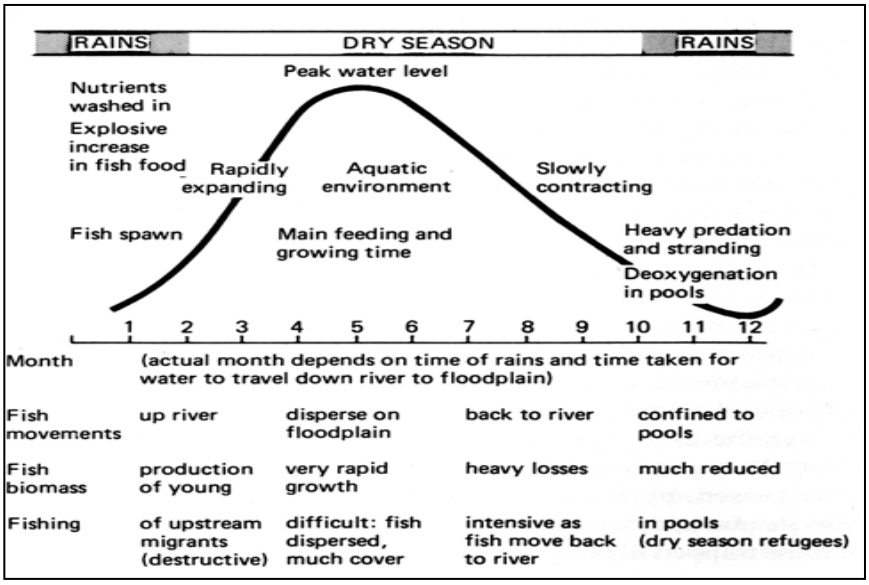


**Figure 3: The seasonal cycles of events in a general floodplain river in relation to the hydrograph. (Source: Lowe McConnell 1987).**

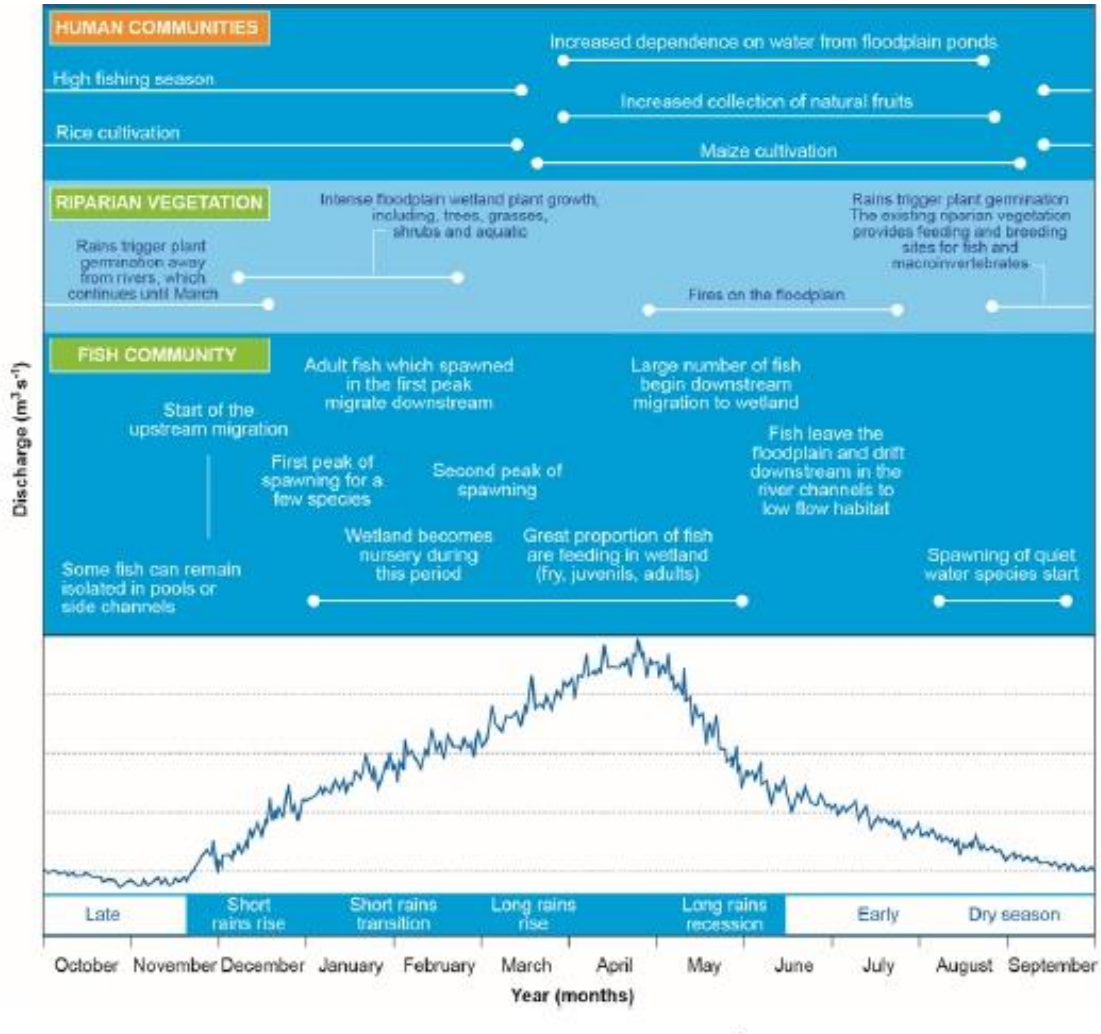


**Figure 4: Hydrological and biological dynamics and associated human activities of the Kilombero floodplain. (Source: USAID-EFA 2015).**

# 5 METHODOLOGY

The present assessment is based on: i) a review of relevant literature on fisheries within the Kilombero Valley and beyond, ii) an initial field visit to Kilombero, Malinyi and Ulanga Districts (January 2016) in order to obtain a baseline perspective to inform the study design and preparation of research tools, and iii) the collection of field data, which involved a participatory rural appraisal (PRA), questionnaire survey and fish catch biophysical measurements (July-September 2016). The PRA and household questionnaire surveys were done in both villages and fish camps, while fish catch biophysical measurements were done at fish camps. The PRA survey preceded the household questionnaire survey such that the PRA results could be used to inform and improve the questionnaire research tool.

The PRA study was implemented in 14 villages (Namawala, Mgugwe, Ngalimila, Chita, Mofu, Lukolongo, Igota, Kivukoni, Namhanga, Ngoheranga, Misegese, Njiwa, Tanga, and Biro), and four fish camps (Dinari, DC, Mikeregembe and Abdallahngwillah) (Figs. 5 and 6). For the villages the PRA work was carried out in conjunction with the pastoralism diagnostic study. Forty participants were selected at random from the village register, and then subdivided into four subgroups based on their economic speciality, including fishers as one subgroup (those individuals with knowledge of fishing activities, including the catching, processing and trading of fish). For the fish camps, forty participants were selected per camp, so enabling work to be carried out in four subgroups of ten participants each. In both villages and fish camps each PRA study was carried out over a single day.

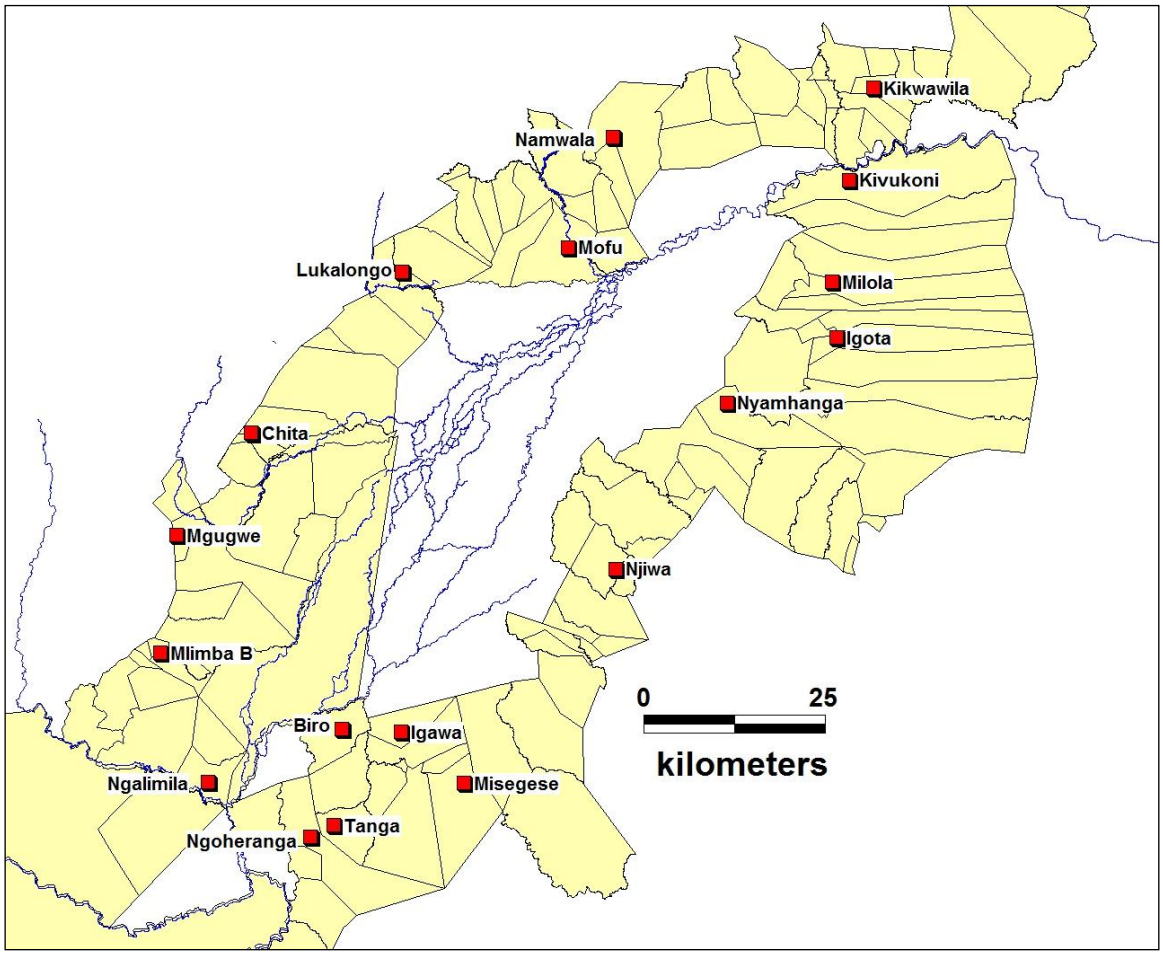


**Figure 5: Location of study villages for PRA and HHQ surveys (Source: Ian Games, 2017).**

The central part of the PRA work comprised semi-structured group interviews. While sensitive topics are often better addressed in interviews with individuals, other topics of more general concern are amenable to focus group discussions and community meetings. During the PRA sessions, several diagrammatic techniques were used to stimulate debate and record the results. The tools that were employed included semi-structured interviews, maps (social mapping and resource mapping), timelines (historical mapping), time charts or seasonal calendars, wealth ranking, venn diagrams on institutions, structured direct observations, and key informant interviews.

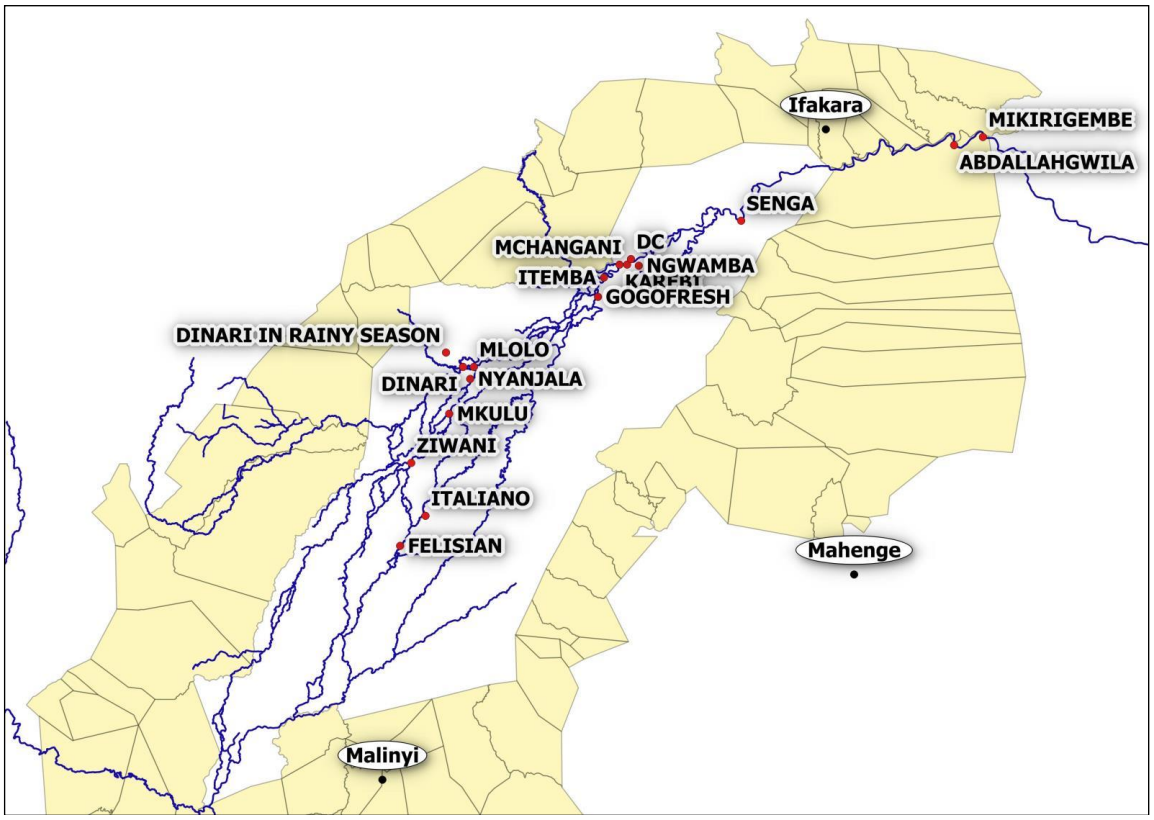


**Figure 6. Location of fishing camps surveyed during PRA and HHQ surveys (Salmon, 2017).**

The household questionnaire was administered in 10 villages (Misegese, Igawa, Biro, Kivukoni, Igota, Milola, Ngalimila, Mlimba B, Mofu and Kikwawila) and 12 fish camps (Dinari, Ziwani, DC, Itemba, Gogo-fresh, Senga, Ngwamba, Mchangani, Abdallahngwillah, Mikeregembe, Feliciani and Italiano) (Figs. 5 and 6). A total of 310 questionnaires were recorded comprising 150 from villages (15 per village from 10 villages) and 160 from fish camps (16 per fish camp for 8 camps plus 16 per pair for two pairs of camps). Questionnaire respondents were selected at random from respective village and fish camp registers.

The household questionnaire was kept brief (keeping questions short, and asking one question at a time); objective (paying attention to neutrality of the words); simple (using language which is simple in words and phrase); specific (asking precise questions); and informative (covering all necessary information needed). Three types of question formats were used: multiple choice (closed ended) questions, numeric open-ended questions, and text open-ended questions. Attention was given to issues such as opening questions, question flow, and location of sensitive questions. The answers to questionnaires were recorded on portable tablets and subsequently transferred to an electronic data base for export and analysis in Excel and SPSS.

Fish catch biophysical measurements were done using a prepared template whereby information on fish species, total length, fishing gears/methods and fish price was collected and exported to an electronic database.

A value chain analysis was conducted based on a simple market organization of the fishery to get an insight as to how the trade operates and what roles it plays in the general economy (Appendix 1). The study mapped the chains from the primary production level (fish camps) and processing and trading centres that exist within the fish camps to the village markets in the KVRS. The chains outside the KVRS were not studied although outside markets were identified.

The study also calculated gross profit margins and market margins (Appendix 1). The gross profit margins give an indication of how the trade is performing but cannot provide the exact profits accrued from the trade unless a lot of assumptions (e.g. returns to investment) are validated. The market margins provide the extent to which each stakeholder benefits from the trade. However, since the data collected was largely based on memory, the resulting estimates should be treated with caution. Nevertheless, the study does give useful insights as to how the trade operates, indicating whether the trade is profitable or operating with negative margins i.e. losses.

Summary results of the PRA, HHQ, value chain and biophysical fish measurement studies are presented below in an integrated fashion; detailed results are presented in accompanying annexes (Annex 1-3).

# 6 PEOPLE AND LIVELIHOODS

**Tribes**

The Kilombero Valley has a long history of immigration and settlement. The Ndamba (fishermen) and Pogoro (small farmers) are generally recognized as the oldest residents and, together with the Mbunga, are considered as natives to the Kilombero Valley. Other relatively early and prominent immigrant groups include the Bena, Ngindo, Ngoni and Hehe. More recently, there has been a pronounced in migration of pastoralists, especially from the Barbaig, Maasai and Sukuma ethnic groups.

Data on ethnic composition of fishermen was recorded from eight villages. Ndamba were recorded from all eight villages, Ngoni from six villages, Bena and Sukuma from five villages each, Nyakyusa from three villages, Pogoro from two villages and Nswampba from a single village.

The four fish camps included members from 14 different tribes, with each camp having members of 8 to 10 different tribes. Those that were present at all four camps were Ndamba, Nyakyusa, Ngoni, Pogoro, Hehe and Ngindo, followed by Bena, Ndegereko and Mbunga (each 2 camps) and, in one camp each, Ndindu, Matumbi, Gogo, Jalou and Kinga.

The principal tribes among the 310 HHQ respondents were Ndamba (30.6%), Ngoni (16.1%), Pogoro (12.9%), Ngindo (7.7%), Bena (7.1%), Nyakyusa (4.8%), Ndwewe (3.9%), with members of another 23 minor tribes making up the balance of 16.9%.

**Migration history**

Overall 61.0% of questionnaire respondents were native to the Kilombero Valley, whilst another 9.0% had migrated internally within the valley and the balance of 30.0% had migrated to Kilombero from outside. Nearly two thirds of respondents (62.6%) were long terms residents (>20 years), with one quarter (25.8%) being present for less than 10 years, 17.1% for less than 5 years and 5.8% for less than 2 years.

**Demography**

Spurred by immigration, the average annual population growth rate in Kilombero in 2012 was estimated at 3.9% (URT, 2013). About 50% of the population in 2012 was below 20 years while 75% were below 40 years. The proportion of females to males was roughly equal; the average

household had four to five members, and slightly less than a third of the population (28.2 percent in 2012) resided in urban areas (URT 2013, WREM International 2015). In contrast, HHQ respondents in this study were dominated by men (87,7%); ages ranged from 18 to over 60 with a modal range of 45-60 years; the modal household had five to seven members (44.8%), with 31.9% smaller families (1-4 members) and 23.2% large families (8->10 members); and most respondents were married (85.8%), the balance being divorced (5.8%), single (5.1%) or widowed (3.2%).

**Establishment of fish camps**

Abdallangwilah and Dinari were the oldest of the four camps having been established between 1940-1948 and in 1946, respectively, followed by Mikeregembe in 1974 and DC in the early 1980s. These camps have thus each been in place for between 35 and 70 years.

**Historical events**

PRA participants from the four fish camps were asked to recall important historical events, according to previous presidential eras. The Nyerere era (1961-1985) was remembered as a time of wars, hardships (disease and famine) and poor social services, but also for the introduction of various development programmes. The subsequent Mwinyi era (1985-1995) was seen as being generally positive, with lots of fish, trade liberalization and good prices for fish, thus resulting in good incomes and increased wealth; there were also many hippos which caused crop damage and a notable flood. The Mkapa era (1995-2005) was seen as a time of privatization, of declining water levels and fish populations, of drought and disasters in the form of road accidents and the sinking of the MV Bukoba ferry. Key events during the Kikwete era (2005-2015) included conflicts with pastoralists and cattle, together with the eviction of pastoralists (operation TOKOMEZA), failure to respect human rights and a growth of corruption. It was also a time of disaster due to fires. Most recently, the Magufuli era (2015-present) was characterised by a drive against corruption, with some people leaders having to resign; problems with obtaining fishing licenses, as well as by flooding and the capsizing of the MV Kilombero ferry in the Kilombero River.

While a range of natural disasters were mentioned (disease, famine, floods, drought and fire), these appear to be relatively infrequent and no particular events were mentioned across all four fish camps.

**Economic activities and livelihoods**

The main livelihood activity is crop farming, often carried out in combination with fisheries activities and livestock keeping; other important livelihoods include running small businesses and elementary occupations. These main occupations are all directly or indirectly based on natural food production.

According to focus group discussions, households undertaking farming activities comprised more than 95% and crop farming contributed about 60% to 80% of the village incomes, which is in accordance with previous studies in the same area (Kangalawe et al. 2005, Mombo 2013, USAID-EFA, 2015). The main crops cultivated consist of rice, maize, cassava, sweet potatoes, bananas, ground nuts, sugarcane and vegetables, with rice being the most important crop cultivated by most households.

Among questionnaire respondents crop farming was the most frequently mentioned household economic activity (88.5% of respondents), followed by fishing (77.9%), running a small business (24.7%) and livestock production (15.1%). These results are not directly representative of the overall community in that 160 out of the 310 respondents (51.6%) were drawn from fish camps and are thus expected to include a higher proportion of fishermen and fish traders.

Roughly half (48.7%) of the village respondents identified themselves as farmers, 38.0% as fishermen, 10.7% as both farmers and fishermen, and only 2.0% as fish traders or other business operators (0.7%) (Table 2). The situation in the fish camps was quite different. Here 48.1% of respondents were fishermen and only 15.6% farmers and 7.5% combined fishermen and farmers;

there were also higher proportions of fish traders and other businessmen (both 13.8%), as well as a small proportion of salaried employees (1.3%).

**Table 2: Stated occupation of HHQ respondents. (Source: HHQ survey).**

| Occupation | % Villages (n=150) | % Fish camps (n=160) | % Overall (n=310) |
|---|---|---|---|
| Crop farmer | 48.7 | 15.6 | 32.1 |
| Fisherman | 38.0 | 48.1 | 43.0 |
| Combined crop farmer and fisherman | 10.7 | 7.5 | 9.1 |
| Fish trader | 2.0 | 13.8 | 7.9 |
| Business operator | 0.7 | 13.8 | 7.2 |
| Salaried employee | | 1.3 | 0.7 |
| **Total** | **100.1** | **100.1** | **100.1** |

Fishing is done for both subsistence and cash income purposes to supplement crop farming. According to USAID-EFA (2015), fishing is estimated to engage about 10% to 30% of the households and contributes about 10% to 30% of the village incomes. However, this study found that in villages 48.7% of the households are engaged in fishing and in fish camps 52.1%, or if one includes fish traders, then 50.7% and 60.0%, respectively (Table 2). Although fishing is regarded as the second most important economic activity in the area and significantly contributes to household incomes, some of the fisher folks, in particular those permanently living in the fishing camps, were claimed to be among the poorest in the area. This was narrated by key informants during interviews. This is because some permanent fishers are employed by seasonal land-owning agro-fishers, and therefore their fishing equipment and catches are owned by their employers rather than themselves.

### Annual income

The annual income distribution among HHQ respondents ranged from about TZS 50,000 to about TZS 5,000,000. A large percentage of the respondents (37.4%) obtained an annual income ranging between TZS 600,000 – TZS 1,990,000.

### Houses

Three quarters (75.2%) of the HHQ respondents had houses made of burnt bricks for most of the walls. None of the respondents in villages had houses with walls made of reeds/straw/grass/fibre while in the fish camps 0.3% of respondents in fish camps had such houses. There were more respondents in villages (8.1%) with houses made of mud and poles/withies than in fish camps (5.2%). Most of the respondents (72.3%) had houses with iron or other metal roofing; 15.8% of the respondents in villages had houses with thatch roofing, while 11.3% of respondents located in the fish camps had houses with thatch roofing. Overall, most of the respondents (65.5%) had houses with earth floor, and the balance predominantly with cement floors (33.9%).

### Household assets

Overall the most frequently owned household assets were hand hoes (90.0%), machetes (84.5%), phones (81.9%), radios (77.1%) and bicycles (76.5%). The most frequently owned items of fishing equipment were fish nets and hooks (both 51.9%), followed by non motorized fish boats (29.0%). Chickens were the most frequently owned livestock (44.8% of households), followed by cattle (7.7%). Other frequent household assets were TVs (16.5%), solar panels (16.1%), spray pumps (11.6%), motorbikes (9.4%), and ox ploughs (5.8%).

In accordance with some fishers in the camps being hired labourers, village respondents reported higher levels of ownership of fishing equipment than fish camp respondents: fishing nets 57.3% versus 46.8%, fish hooks 58.0% versus 46.2% and fishing boats 34.0% versus 24.4%. Items more frequently owned in fish camps than villages were phones, radios, TVs and motorbikes, which suggests a stronger labour/business orientation as opposed to owner/production orientation in villages where, in addition to fishing equipment, ownership was higher of hoes, machetes, bicycles, chickens, solar panels, spray pumps, cattle and ox-ploughs.

**Access to land**

Land is accessed in several ways in the Kilombero Valley including sales of rights from individuals, allocation through village government or through inheritance (Mombo et al. 2012). Virtually all village HHQ respondents owned some land (94.0%), varying in size from 1 to over 20 acres, but with a modal size of 5-10 acres (30.7% of respondents), and with 24.0% having land larger than 10 acres, and in this case usually less than 20 acres. The situation in fish camps was somewhat different, with 31.9% not owning any land, and among land owners the modal size of land was 3-5 acres, with only 6.3% having land greater than 10 acres.

Renting of land was relatively minor, with only 19.3% of village respondents and 25.0% of fish camps respondents reporting any rental of land. Among those who do rent land the modal size for both village and fish camp respondents was 1-3 acres.

HHQ respondents were asked to identify their initial source of capital for fishing activities, the results of which emphasize the linkages between farming and fishing. Results from respondents in villages and fish camps were largely consistent. The most frequent source of capital for starting fishing activities was through the selling of crops (overall 43.2%), followed by employment (15.5%), other sources (10.0%) and loans (9.0%). Less frequent sources of capital were through using natural resources (4.2%), business profits (3.2%) and the selling of livestock and using old mosquito nets (both 0.6%).

# 7 FISHERMEN

## 7.1 Household members involved in fishing activities

The modal figures for the number of household participants engaged in fishing were one male and zero females per household in both villages and fish camps. The overall ranges for women were 0-3 members per family and for males were 0-7 members. Participation by women was slightly higher in the villages (one member for 17% of families in high season and for 15% of families in low season) than fish camps (c. 9% in high season and 10% in low season). The number of men (1 member in 55-60% of families) was much the same across villages and fish camps and across seasons.

Hiring of people was limited, across all 310 respondents comprising a total of 33 men and six women in the high season and just 13 men and one woman in the low season.

## 7.2 Types of fishermen

Communities recognised three types of fishermen based on their length of stay in fish camps per annum: (i) village fishermen who base their fishing activities from their households in the villages, (ii) seasonal fishermen who stay in fish camps for part of the year and (iii) permanent fishermen who stay in fish camps all year round. Seasonal fishermen, as for village fishermen, are usually also engaged in crop farming, whilst permanent fishermen were reported to often be people who had come from other parts of Tanzania and/or who did not have land in any village close to the fish camp.

Seasonal and permanent fishermen were predominantly men, but included a variety of ages from youths to elders, whereas village fishermen included also women and children. Women and children usually participate in fishing activities through using mosquito nets to catch fish in small swamps during low water levels i.e. during September to November. They also use fish traps such as Livaghaya. Fishermen in villages also catch fish during "*Lipupu'* –which is usually carried out during December to January when the fist rains come, and when fish especially cat fish can be found in the first waters entering the flood plain. People use spears *"Umbage",* bush knives or hitting tools to hit and capture fish in the flood plain as water starts entering the valley.

Fishermen in fish camps were reported to fish mainly for selling rather than for food, particularly seasonal fishermen in order to generate income to support farming activities. Village fishermen, in contrast, fish mainly for food for their households; although at times some are able to sell excess fish the money obtained is generally sufficient to purchase only small items such as salt or soap. Among HHQ respondents, however, in both villages and fish camps, respondents reported that the bulk of fish is sold rather than being consumed (see Section 10).

Village fishermen were identified by PRA participants as being present in all 14 study villages (Fig. 7); overall they were estimated to include members from 64.3% of households (estimates ranged from 5-100% for different villages), and were rated as being the most important types of fishermen in 12 villages (other than Njiwa, seasonal fishermen and Tanga, permanent fishermen). Seasonal and permanent fishermen were noted from 12 villages (other than Mgugwe and Misegese – both situated at a considerable distance from the Kilombero River), with mean frequency of 47.9% of households (range 0-80%) for seasonal fishermen and 15.0% for permanent fishermen (range of 0-35%). In general, less people were engaged in fishing activities in the four villages of Mgugwe, Misegese, Njiwa and Tanga than for the other ten study villages.

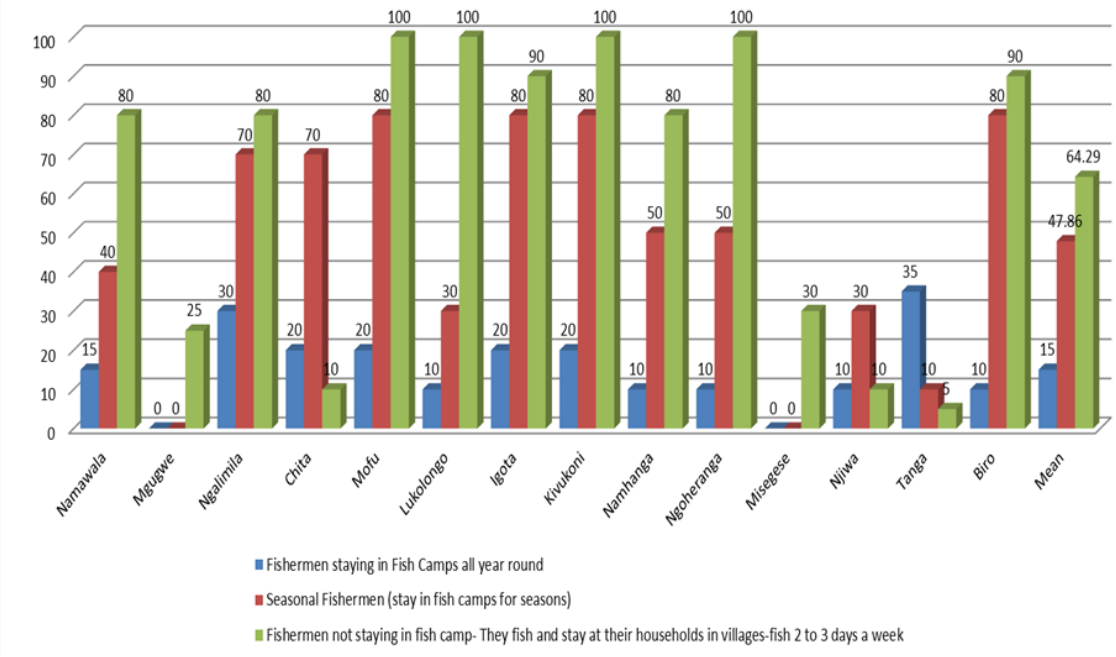


**Figure 7. Types of fishers (permanent, seasonal and village) by villages. (Source: PRA survey).**

Differences between types of fishermen were much less marked when scored in terms of perceived importance. Overall mean importance scores were lowest for village fishermen (28.9%), intermediate for permanent fishermen (32.9%) and highest for seasonal fishermen (38.9%), but with all categories showing wide variations between villages; highest importance scores were allocated to village fishermen in four villages and to seasonal and permanent fishermen in five villages each.

The implication for fisheries management would be to focus on all three types of fishermen when planning for management of the sector. For example in Namawala, Ngalimila, Lukolongo, Njiwa and Tanga villages improving management of fishermen staying in fish camps all year round would have greater impact to the communities as the fishermen were viewed by the communities to be of greater importance in these locations. However, for Chita, Mofu, Igota, Namhanga and Ngoheranga fisheries management could have greater impact if greater efforts were put into improving activities of seasonal fishermen i.e. fishermen who stay at the fish camp for a season and do other economic activities such as crop farming in villages. For Mgugwe, Kivukoni, Misegese and Biro villages improving management of fishermen not staying in fish camps but rather fish and stay at their households in villages would have greatest impact to these communities.

## 7.3 Experience of fishermen

Fishing is mainly carried out by knowledgeable and skilled fishers. On average 54.8% of all HHQ respondents had more than 10 years experience in fishing (Fig. 8), being slightly higher in villages (62.0%) as compared to fish camps (48.1%). Overall, 19.0% of respondents have been involved in fishing activities for less than five years and only 4.5% for less than one year, with a further 14.5% of respondents not being involved in fishing activities at all.

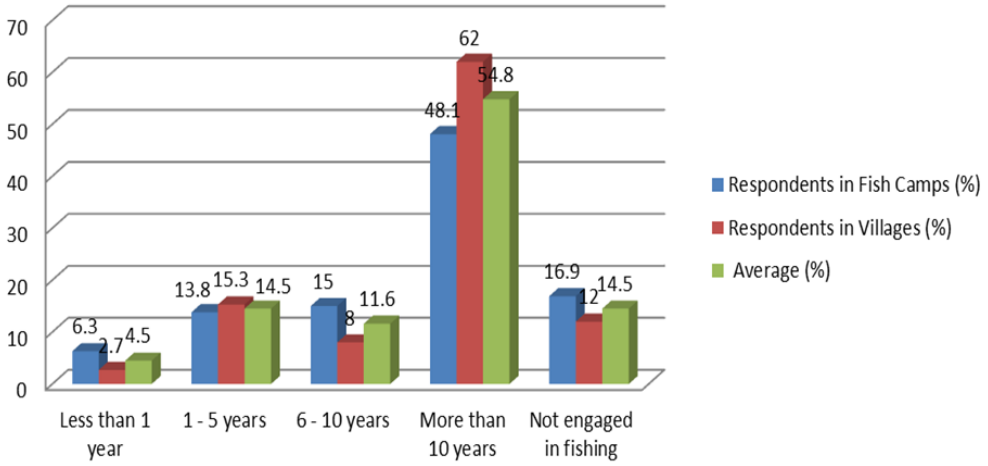


**Figure 8: Fishing experience expressed as a percentage of HHQ respondents. (Source: HHQ survey).**

# 8 FISHING GROUNDS AND GEAR

Fishing is predominantly carried out away from the farms from 70-80 recorded fishing villages distributed along the main river channels (Fig. 5). The majority of the fishing camps are seasonal due to the annual floods (particularly in the upper reaches), except for a few permanent camps closer to the Selous Game Reserve. The camps comprise mostly of small dwellings made of mud walls and grass thatching with no proper ventilation. Most of the dwellings have no toilets as camp residents use the river to flush off body waste and cleanse themselves at the same time. Health facilities including dispensaries and hospitals are largely inaccessible to the fishing camps residents (Games et al. 2016).

## 8.1 Fishing grounds

The number of fishing grounds identified by PRA participants per village ranged from three for Mgugwe to 25 for Kivukoni, with a total of 146 grounds identified altogether. These included the

Kilombero River (for 8 villages), other rivers (n=73), seasonal rivers (for five villages), swamps (n=55), ponds (n=4, possibly the same as swamps) and the floodplain (one village).

Rivers were consistently scored as being the most important fishing grounds, other than for Tanga where swamps were scored at 51.2% versus 48.8% for other rivers. The Kilombero River was rated as being most important fishing ground in four out of seven villages, and other rivers were scored as most important in the remaining nine villages. Floodplains were mentioned only once, for Misegese Village, where it was scored at 49.8%, only marginally below other rivers (50.0%).

## 8.2 Fishing camps

PRA participants were asked to identify fishing camps where people from their village go to fish. The number of camps ranged from 0 camps per village for Mgugwe and Misegese, to 23 for Kivukoni and 25 for Chita. Overall, respondents from the 14 villages identified a total of 113 fish camps; most camps were mentioned only once but a few were identified by up to four villages.

In terms of importance, for the 12 villages listing one or more camps, most were dominated by a single camp (range =54.4-98.2% of overall importance per village) other than for Igota (2 camps) and Njiwa (6 camps). Of the 13 most important camps, DC was mentioned twice (Namawala and Kivukoni villages) and the other 11 were unique. In other words fishermen from each village tend to go to a particular camp but which varies from one village to the next.

## 8.3 Fishing methods and gear

PRA participants identified a total of 21 fishing methods across the 14 study villages, comprising fishing nets (7 types), hooks (3 types), traps (8 types), plus the use of spears, poison and catching by hand (Table 3).

**Table 3: Types of fish methods employed by fishermen in Kilombero Valley. (Source: PRA survey).**

| Description | Season | Habitat | No of villages | % of hh | Relative importance (%) |
|---|---|---|---|---|---|
| Fishing nets using **Kutega** fishing method (gill nets) | All year | Rivers, oxbows, swamps, flooded plains | 13 | 51.4 | 30.9 |
| Fishing nets using **Ndatula** fishing method (casting weighted nets - fish nets are tied to and pulled by two adjacent boats along the river) | June-Dec, weak | Deep water or when water draining back into channels | 11 | 31.4 | 30.5 |
| Fishing nets using **Kokora** method (small mesh size fishing nets, sometimes as small as 0.25 inch) | July-Dec | River, oxbows and swamps when water level is not high | 3 | 12.1 | 2.1 |

| Description | Season | Habitat | No of villages | % of hh | Relative importance (%) |
|---|---|---|---|---|---|
| Fishing nets using **Kubundila** or **Pumunda** fishing method (fish nets are used to cover a portion of grass in water (where fish hide), the grass is then cut and the fishermen who stay on the elevated area adjacent to the river bank pull the nets in so capturing all the fish and all other aquatic creatures) | July-Dec | Grass in water, applied when water levels are not high | 6 | 10.7 | 0.8 |
| Fishing nets using **Kimea** fishing method | July-Dec | Rivers, when water has drained back to the main channel | 5 | 8.9 | 0.3 |
| Fishing nets using **Kutanda** fishing method (old mosquito nets) | May-Dec | Swamps and small rivers | 11 | 21.1 | 0.0 |
| Fishing nets using **Gudusi** fishing method | July-Jan | Main river | 1 | 5.7 | 0.0 |
| Hooks and baits technique known as **Ndoano Kitanzi Kuning'iniza** ("don't touch" – where the hooks and bait are partially submerged in water) | All year | Main river, flooded plains, swamps | 14 | 48.6 | 9.4 |
| Hook and bait technique known a **Ndoano mshipi/Chamlopo** | All year | Main river, small rivers, oxbows, floodplains, | 14 | 36.1 | 8.6 |
| Hooks and baits used as **Ndoano Kitanzi kuzamisha/Kuzika** (the hooks and bait are placed on the river bottom using heavy objects usually pieces of bricks/stones) | June-Dec, weak | Main river close to river bank | 12 | 32.9 | 2.5 |
| **Ndanga** fishing trap | Bi seasonal | Small rivers when water is flooding in or out | 12 | 22.1 | 12.6 |
| **Tangati** fishing trap | All year | Small rivers when water is flooding in or out | 8 | 9.3 | 2.1 |
| **Mgonyo** fishing trap | All year | Swamps and small streams | 11 | 31.4 | 0.2 |
| **Dema** fishing trap | May-Dec | Main river when water is low | 3 | 3.9 | 0.1 |
| **Livaghaya** basket fishing trap | Jun-Dec | Swamps and small streams | 2 | 1.4 | 0.0 |
| **Lilimbo** fishing trap | Jun-Dec | Small rivers | 1 | 3.6 | 0.1 |
| **Swagila** fishing trap | Jan-July | Small rivers | 1 | 1.4 | 0.0 |
| **Kijimba** fishing trap | Sep-Dec | Small rivers | 1 | 4.3 | 0.0 |
| **Lipupu** method – use of spears/tools to hit fish | Dec-Feb | As water starts to enter floodplains | 10 | 42.2 | 0.0 |

| Description | Season | Habitat | No of villages | % of hh | Relative importance (%) |
|---|---|---|---|---|---|
| **Mtupa/Mjamba/Kidua** method – use of poisons to render fish unconscious/dead | Jun-Dec | Swamps when water is low | 5 | 4.3 | 0.0 |
| **Kabali** method – fishing by swimming to the bottom of the river and catching fish (found hiding in rock) using own hands | Sep-Oct | Main river when water is low | 1 | 0.7 | 0.0 |
| Total | | | | | 100.2 |

Different techniques are carried out in different habitats, including within the main river, small rivers or river channels, oxbows, swamps, flood plains and in deep water or shallow water, water that is rising or receding, and water with grass. Similarly, some activities are carried out all year round, whilst others are much more seasonal and tied to particular hydrological conditions that occur at specific times of the year. In general, those techniques carried out all year tend to be rated as being more important and more frequent than the more seasonal techniques. Some techniques are carried out by men, others by women and children. There was also marked variation in scores for different techniques from one village to the next.

The most frequently reported methods were using gill nets (kutega, n=13 villages), weighted nets (ndatula) and mosquito nets or kutanda (both n=11), the three hook and bait techniques (n=12-14 villages each), ndanga, mgonyo and tangati fish traps (n=12, 11 and 8 villages respectively), and the use of spears (lipupu, n=10). The other 11 techniques were reported from 1-6 villages each.

The most commonly used techniques, in terms of numbers of participants, were gill nets (51.4%), ndoano kitanzi kuning'iniza (don't touch) hook and bait (48.6%), lipupu use of spears (42.2%), ndoano mshipi hook and bait (36.1%), ndoano kitanzi kuzamisha hook and bait on river bottom (32.9%), ndatula weighted nets and mgonyo fish traps (both 31.4%).

Collectively, the use of fishing nets were rated as being the most important technique (total of 64.6%), followed by use of hooks and bait (20.5%), and then traps (15.0%). The two most important individual techniques were gill nets (30.9%) and casting weighted nets (30.5%), followed by ndanga fish traps (12.6%).

Participants from the four fishing camps identified 12 fishing methods, of which six involved the use of nets, four hooks with bait and two fishing traps (ndanga and dema). The most frequently reported techniques were fishing by casting weighted nets (ndatula) and gill nets (both used by a mean of 91.3% fishermen), the various hook and bait techniques (range from 53.3% to 43.8%), followed by mkoko nets (27.5%), kimea nets (21.3%) and ndanga fish traps (17.5%). In terms of relative importance the key techniques were ndatula weighted nets (47.0%), gill nets (23.5%), one of the hook and bait methods (ndoano kitanzi kuzika, 11.1%), then gudusi fishing nets (9.7% - nets placed across the river from one side to the other).

According to HHQ respondents, the three most common forms of fishing gear reported by both village and fish camp respondents and across both high and low seasons were ndatula fishing nets (casting with weights), ndoano kitzani hook and bait and plank boats/canoes, used by 66.4 to 85.9% of fishermen, 63.6 to 79.3% and 62.6 to 69.6%, respectively, and where the lower values are consistently from village respondents in the low season and the highest responses from fish camps also in the low season. More techniques were recorded from villages (high season n=14 and low season n=15) than from the fish camps (both seasons, n=9). Fishermen in villages use several net and trapping techniques, as well as poisons and spears, that were not reported by fish camp

respondents. For both villages and fish camps the differences between high and low seasons were relatively minor.

Overall, a total of 58.7% of HHQ respondents reported using fishing nets, varying from 55.0% in fishing camps to 62.7% in villages. Roughly two thirds of village respondents and half of fish camp respondents reported the use of fish hooks.

These results are consistent with earlier studies which similarly found the main fishing methods to be nets, hooks (longlines strung across the river), traps, scoop nets, cast nest and spears (Utzinger and Charlwood 1996, Jenkins et al. 2000). Smaller water ways, during falling water levels, are traditionally blocked with bamboo weirs with basket traps in the opening (Fig. 9).

**Figure 9: Wicker weir across a small tributary into the Ulanga River - during falling water levels basket traps will be fitted in the openings in the weir. (Photo by Chloé Salmon).**

The most comprehensive of the previous surveys was that of Frontiers/SEE carried out from October 1999 to September 2000 (Jenkins et al. 2000). In this study gill nets were found to be the most common type of fishing gear and were used for 77% of all catches, with the rest obtained from lines and traps. Scoop nets were not used at the regularly monitored camps, but were observed in other areas. Fishing with nets, lines and traps usually occurred in the main river. Fishermen often placed their nets and lines across the width of the river, but also sometimes placed their gear along the river margin, although this was a more common occurrence for lines (62%) than nets (35%). The majority of all fishing activity was concentrated on the bottom, with only a few midwater or surface catches.

## 8.4 Mesh sizes

Jenkins et al. (2000) reported the use of a variety of mesh sizes of nets, with three sizes accounting for 71% of the catches. Three-inch mesh was used for 15% of catches, 3.5 inch for 38% of catches and four inches on 18% of catches. All nets were white in colour and varied in length from 90m to 500m. Thus, compared with other African fisheries, the mesh sizes used around the period of investigation (2000) were relatively large and probably all within legal limits. The high frequency of relatively large mesh sizes used in a virtually non-managed fishery indicates a relatively low fishing pressure (Jul-Larsen et al. 2003). In comparison, nearly 90% of the mesh sizes used in the Bangweulu floodplain fishery of Northern Zambia were 2 inch or less (Kolding et al. 2003).

In the present HHQ survey, of those individuals who use fishing nets, overall, 65.4% of respondents reported using fish nets between 3.5 and 4.5 inches in mesh size, varying from a mean of 60.6% for villages to 70.5% for the fish camps. Roughly 20% of participants reported using smaller mesh sizes predominantly in the 2.5-3.5 inch category (12.1%).

# 9 ILLEGAL GEAR AND FISHING METHODS

Several of the fishing techniques and gear used are illegal, including the use of mosquito nets and other nets with mesh size smaller than three inches (kokora), as well as the pumunda netting technique and all use of poisons. Pumunda netting involves covering an area of water and grass with fine meshed nets then cutting all the grass so enabling the fishermen to pull out everything covered by the net, including small fishes and their eggs and other aquatic organisms (Fig. 10).

The majority of HHQ respondents admitted that some people do use illegal fishing gears, ranging from about 75% of respondents for villages to 85% for fish camps. When asked to estimate the proportions of fishermen using illegal fishing nets, about 35% of village respondents and 40% of fish camp respondents estimated that illegal gear is being used by more than 50% of fishermen, with a further 25% and 15%, respectively, saying that they were not able to estimate.

**Figure 10. Pumunda fishing (left) and mosqioto net fishing (right) in Kilombero. (Photos by Chloé Salmon and Giuseppe Daconto).**

Results of the PRA study also suggest an increase in illegal fishing activities. It thus appears that the fishing pattern has slightly shifted to smaller mesh sizes since the 2000 Frontiers/SEE survey.

However, a small sample of fish catches collected during the present survey (Table 4) indicated that although small mesh sizes are used, the majority of fish are still being caught in mesh sizes greater than three inches (the minimum legal mesh size).

**Table 4: Distribution of number of fish caught by length (cm) and gillnet mesh sizes (mesh sizes under 3 inches (marked in yellow) are technically illegal). (Source: Fish catch survey).**

| | Mesh size (inches) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Length (cm) | 1 | 1.25 | 1.5 | 1.75 | 2.2 | 2.5 | 3 | 3.5 | 4 | 4.5 | 5 | Total |
| 10-20 | 5 | 4 | 1 | | 2 | 1 | 12 | 9 | | | | 34 |
| 20-30 | | | | 1 | 2 | 11 | 14 | 48 | 1 | | 2 | 79 |
| 30-40 | | | | | | 1 | 16 | 12 | 1 | | 3 | 33 |
| 40-50 | | | | | | | 1 | 3 | 1 | 6 | | 11 |
| 50-60 | | | | | | | | 1 | 2 | 1 | | 4 |
| Total | 5 | 4 | 1 | 1 | 4 | 13 | 43 | 73 | 5 | 7 | 5 | 161 |
| % No | 3.1 | 2.5 | 0.6 | 0.6 | 2.5 | 8.1 | 26.7 | 45.3 | 3.1 | 4.3 | 3.1 | 100 |
| # set | 1 | 2 | 1 | 1 | 3 | 5 | 5 | 13 | 5 | 1 | 4 | 41 |
| No/set | 5 | 2 | 1 | 1 | 1.3 | 2.6 | 8.6 | 5.6 | 1 | 7 | 1.3 | 3.9 |
| Length(cm)/NO | 14.7 | 16.1 | 11.6 | 22.4 | 20.2 | 25.2 | 26.6 | 26.5 | 42.3 | 47 | 31.6 | 27.1 |

# 10 FISH SPECIES AND CATCH COMPOSITION

A cumulated total of 49 fish species have been recorded from the system (Appendix 2), but only around a third of these (15-20) are targeted and commercially important (Figs. 11 and 12). Most of the species are common to all rivers in the Rufiji Basin system, but two species (*Citharinus congicus* and *Alestes stuhlmanni*) are only found in the Kilombero River and further downstream in the Rufiji River (Eccles 1992). Across all villages, PRA participants identified a total of 38 fish species; these were rated in terms of abundance, importance for food and importance for sales. Nine species were recorded from all 14 villages and nine from only one village; the other 20 species being recorded from between one to thirteen villages.

Fourteen species were scored at 10% or more in terms of abundance, importance for food and importance for selling in one or more villages; these included all species prominent in terms of either relative abundance, or importance for food or selling, and collectively accounted for the bulk of the overall respective importance scores (95.0%, 96.6% and 92.9%, Table 5).

Kambale and Perege were both abundant (44.7% and 11.0%, respectively) and rated as most important in terms of food (28.1% and 16.5%) and income (18.5% and 19.2%). Dagaa (small fish) were considered abundant (13.7%) and relatively important for food (5.6%) but not for income. Lwepe was relatively abundant (2.8%) but not important in terms of either food or for income. On the other hand Kitoga, Njege, Mgundu, Bula, and Sulusulu were all considered important for both food and income but of low abundance.

There have been a few previous attempts to describe the species composition of the Kilombero fishery. According to the most comprehensive study (Jenkins et al. 2000), the most important commercial fish are tilapia *Oreochromis* species (Perege), catfish *Clarius* (Kampale), *Schilbe* (Bula) and *Bagrus* (Kitoga), tiger fish *Hydrocynus* (Njege), *Distichodus* (Ndungu), *Mormyrus* (Sulusulu), *Citharinus* (Mbala) and *Alestes* (Mgundu), (Fig. 11). Previous work by Bailey (1969), RBSP (1981) and Utzinger and Charlwood (1996) reported results largely consistent with those of Jenkins et al. (2000), and the latest report by Msangameno and Mangora (2016) from 2007 is also in overall agreement with the previous surveys in terms of catch compositions.

**Table 5: Main fish species in terms of relative abundance and importance for food and for selling. (Source: PRA study).**

| Species | Relative abundance (%) | Relative importance for food (%) | Relative importance for income (%) |
|---|---|---|---|
| Kambale | 44.7 | 28.1 | 18.5 |
| Dagaa | 13.7 | 5.6 | |
| Perege | 11.0 | 16.5 | 19.2 |
| Ndipi | 5.7 | 6.3 | |
| Ngogo | 5.4 | 5.1 | 2.7 |
| Benasongo | 5.0 | 4.2 | |
| Njuju/Mbewe | 4.4 | 2.9 | 5.6 |
| Lwepe | 2.8 | | |
| Ndungu/Ndunguwila | 2.4 | 5.1 | 10.2 |
| Kitoga | | 10.5 | 18.1 |
| Njege | | 3.9 | 5.3 |

| | | | |
|---|---|---|---|
| Mgundu | | 3.0 | 6.8 |
| Bula | | 2.7 | 4.0 |
| Sulusulu | | 2.5 | 2.6 |
| **Total** | **95.0** | **96.6** | **92.9** |

During the present study, a limited one week pilot sample of 229 fish were measured by sizes, identified by species and the gears they were caught in was recorded (Table 6). The composition seems to follow the same pattern as previously recorded.

**Table 6: Number of fish recorded by species and fishing gear used. (Source: fish catch survey).**

| Species | Fishing nets | Hooks and bait | Dema traps | Total | Mean length(cm) |
|---|---|---|---|---|---|
| Mjongwa | | 1 | | 1 | 63 |
| Kitoga | 17 | 29 | | 46 | 44 |
| Njege | 1 | 1 | | 2 | 43 |
| Ndunguwila | 4 | | | 4 | 40 |
| Kambale | 36 | 28 | | 64 | 39 |
| Jualajuala | 1 | | | 1 | 29 |
| Sulusulu | 12 | | | 12 | 29 |
| Mtuku | 1 | | | 1 | 28 |
| Ngogo | 3 | | 4 | 7 | 27 |
| Bula | 17 | | | 17 | 26 |
| Ndungu | 15 | 5 | | 20 | 24 |
| Perege | 41 | | | 41 | 23 |
| Mbala | 2 | | | 2 | 17 |
| Ndipi | 6 | | | 6 | 16 |
| Mbewe | 2 | | | 2 | 14 |
| Njuju | 3 | | | 3 | 12 |
| Total | 161 | 64 | 4 | 229 | 33 |

During the 1999-2000 survey by Frontiers/SEE a much larger sample consisting in total of 17,437 fish were measured weighing a total of 5,916 kg. This gives an average of around 300 grams per individual fish, which is quite large in comparison with other floodplain fisheries, such as for example Bangweulu (Kolding et al. 2003). However, comparing the two surveys (with the caveat that the present survey was reasonably representative) then the findings indicates that neither the overall species composition, nor the average size of the fish caught (Table 7, Fig. 13) has changed significantly during the reported span of time. However, to fully sustain this statement a renewed survey comprising sizes of fish caught and corresponding fishing gears used would be necessary.

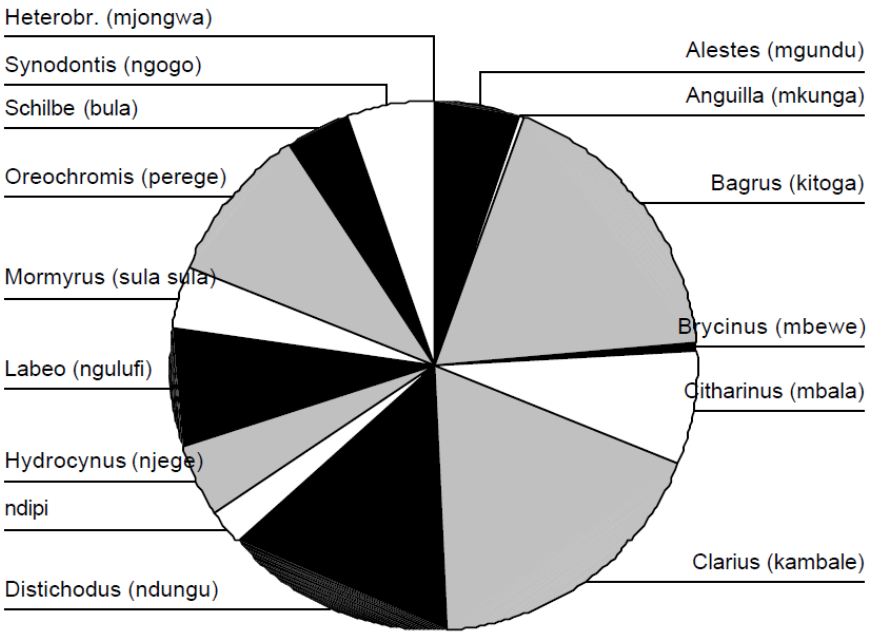


**Figure 11: Composition of total catch weight for fish on the Kilombero River, Tanzania from the period October 1999 to September 2000. (Source: Jenkins et al. 2000).**

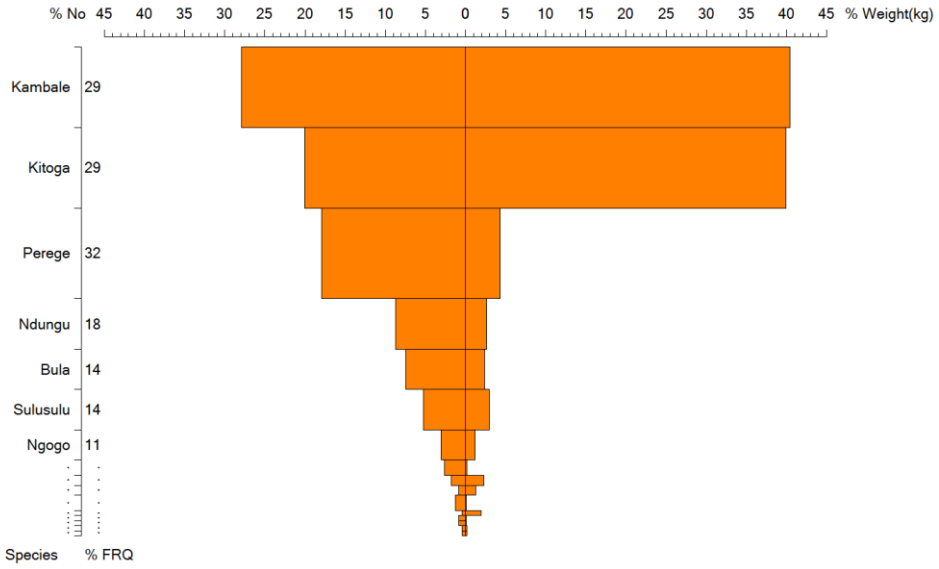


**Figure 12. Relative species composition (%number, % weight and % frequency of occurrence) of the fish recorded during the present survey. (Source: fish survey).**

**Table 7: Mean length, standard error (SE) and sample sizes (n) of fish caught using different gear types on the Kilombero River, Tanzania, from the period October 1999 to September 2000. (Source: Jenkins et al., 2000).**

| | Feb-Mar | | | May-Jun | | | Jul-Aug | | | Nov-Dec | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | n | Mean | SE | n | mean | SE | n | Mean | SE | n | mean | SE | n |
| *Bagrus* (kitoga) | 31 | 51.4 | 5.7 | 300 | 46.0 | 0.7 | 157 | 43.0 | 1.1 | 277 | 43.4 | 0.6 | 765 |
| *Citharinus* (mbala) | 35 | 27.2 | 0.8 | 1,548 | 18.8 | 0.1 | 1,110 | 15.6 | 0.1 | 30 | 12.6 | 0.1 | 2723 |
| *Clarius* (kambale) | 66 | 53.8 | 1.7 | 594 | 45.9 | 0.7 | 97 | 50.3 | 1.5 | 220 | 47.9 | 0.9 | 977 |
| *Distichodus* (ndungu) | 522 | 29.5 | 0.2 | 190 | 29.2 | 0.2 | 161 | 34.1 | 0.3 | 361 | 31.5 | 0.9 | 1234 |
| *Alestes* (mgundu) | 79 | 35.6 | 0.6 | 250 | 23.4 | 1.1 | 332 | 12.9 | 0.2 | 98 | 30.1 | 1.3 | 759 |
| *Anguilla* (mkunga) | 1 | 101.0 | - | 2 | 82.5 | 2.5 | 0 | - | - | 1 | 86 | - | 4 |
| *Brycinus* (mbewe) | 1 | 15.0 | - | 505 | 13.4 | 0.2 | 23 | 12.1 | 0.9 | 11 | 19 | 3.8 | 540 |
| Ndipi (see table x) | 231 | 12.5 | 0.4 | 3 | 13.3 | 0.3 | 472 | 9.7 | 10.6 | 706 | 10.6 | 0.2 | 1412 |
| *Hydrocynus* (njege) | 11 | 36.5 | 1.3 | 404 | 27.2 | 0.9 | 150 | 27.2 | 1.8 | 38 | 30.6 | 2.5 | 603 |
| *Labeo* (ngulufi) | 158 | 38.9 | 0.5 | 181 | 31.3 | 0.6 | 25 | 21.5 | 1 | 91 | 31.9 | 0.9 | 455 |
| *Mormyrus* (sura sura) | 4 | 34.3 | 3.3 | 201 | 25.1 | 1.4 | 153 | 30.2 | 0.6 | 617 | 22.5 | 0.6 | 975 |
| *Oreochromis* (perege) | 30 | 26.2 | 0.9 | 143 | 21.0 | 0.4 | 508 | 19.3 | 0.2 | 2,070 | 19.6 | 0.1 | 2751 |
| *Schilbe* (bula) | 67 | 30.9 | 0.4 | 1,243 | 19.2 | 0.1 | 359 | 21.9 | 0.2 | 56 | 23.2 | 1.2 | 1725 |
| *Synodontis* (ngogo) | 369 | 20.1 | 0.2 | 1,808 | 17.0 | 0.1 | 35 | 18.2 | 0.7 | 302 | 16.9 | 0.2 | 2514 |
| Total/mean | 1605 | 36.6 | | 7372 | 29.5 | | 3582 | 24.3 | | 4878 | 30.4 | | 17437 |

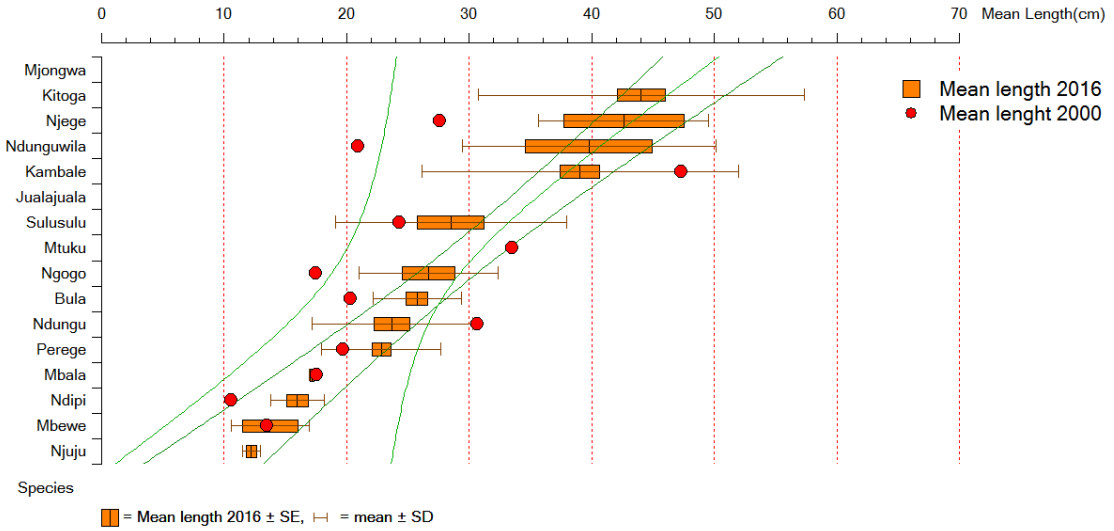


**Figure 13: Comparison of mean fish sizes between the 2000 Frontiers/SEE survey and the present fish survey. There are no clear significant differences in mean size. (Source: Jenkins et al. 2000 and Fish survey).**

# 11 FISH CATCHES, SALES, CONSUMPTION AND SPOILAGE

Data on volumes of fish catches, fish sales, consumption and spoilage were obtained from HHQ respondents (Table 8).

## 11.1 Fish catches

Reported weekly catches of large fish for the high season by fishermen in villages (574 large fish) and fish camps (1,260) were roughly five and seven times greater respectively than low season catches (115 and 172 large fish, respectively); and for both seasons weekly catches of large fish per fishermen in fish camps were larger than those from villages (high season roughly double 1,260 versus 574 large fish and low season 1.5 times 172 versus 115 large fish).

For small fish, reported weekly catches were 24.1 cups and 14.8 cups per fishermen in villages in high and low seasons respectively, and in fish camps were 109.8 and 39.1 cups respectively. As compared to large fish, the seasonal differences are slightly less marked for both villages (1.6 times) and fish camps (2.8 times), whilst the differences between villages and fish camps are more marked (fish camps 4.6 times higher in high season and 2.6 times higher in high season).

**Table 8: Weekly numbers of large fish and cups of small fish caught, sold, eaten and spoiled during the high and low seasons in villages and fish camps. (Source: HHQ survey).**

| Factor | Villages (n=150) | Fish camps (n=160) | Total (n=310) | Villages (n=150) | Fish camps (n=160) | Total (n=310) |
|---|---|---|---|---|---|---|
| | High season | | | Low season | | |
| **FISH CATCHES** | | | | | | |
| Large fish | 574 | 1260 | 901 | 115 | 172 | 142 |
| Small fish | 24.1 | 109.8 | 64.7 | 14.8 | 39.1 | 26.3 |
| **FISH SALES** | | | | | | |
| Large fish | 502 | 693 | 592 | 93 | 161 | 175 |
| Small fish | 15.1 | 122.0 | 65.5 | 10.3 | 36.7 | 22.7 |
| **FISH CONSUMED** | | | | | | |
| Large fish | 22 | 15 | 19 | 8 | 10 | 9 |
| Small fish | 3.1 | 1.6 | 2.4 | 1.9 | 2.1 | 2.0 |
| **FISH SPOILED** | | | | | | |
| Large fish | 17 | 3 | 14 | 4 | 0 | 3 |
| Small fish | 4.2 | 1.4 | 2.9 | 1.3 | 0.1 | 0.8 |

## 11.2 Fish Sales

Reported weekly sales of large fish were 502 and 93 per fishermen in villages in high and low seasons, respectively, and in fish camps were 693 and 161 respectively. As compared to catches of large fish, for villages this suggests that fishermen were selling 87.4% of their weekly catch in the high season and 80.9% in the low season and, for fish camps only 55.0% in the high season and 93.6% in the low season.

For small fish, reported weekly sales were 15.1 and 10.3 cups per fishermen in villages in high and low seasons respectively, and in fish camps were 122.0 and 36.7 cups respectively. As compared to catches of small fish, for villages this suggests that fishermen were selling 62.5% of their weekly catch in the high season and 66.7% in the low season and, for fish camps 110% in the high season (i.e. estimated weekly sales were higher than estimated weekly catches) and 94.6% in the low season.

## 11.3 Consumption and spoilage

HHQ respondents in villages reported eating a mean of 22 large fish per week in the high season and 8 in the low season. Corresponding figures for fishermen in fish camps were 15 large fish in the high season and 10 in the low season. Concerning small fish, fishermen in villages reported eating a mean of 3.1 cups per week in the high season and dropping to 1.9 cups in the low season,

whereas for fishermen in fish camps the mean values were 1.6 cups in the high season and 2.1 in the low season.

In comparison to catches, for large fish, fishermen in villages consumed 3.8% of their estimated catch in the high season and 7.3% in the low season; corresponding figures for fishermen in villages were 1.2% in the high season and 5.7% in the low season. For small fish, fishermen in villages consumed 12.9% of their estimated catch in the high season and 12.8% in the low season; corresponding figures for fishermen in fish camps were 1.5% and 5.4%.

For both large and small fish, reported spoilage of fish was higher in the high season than the low season for fishermen in both villages and fish camps. Fishermen in villages consistently reported higher levels of spoilage than those in fish camps for both large fish (villages 17.3 per week in high season and 3.7 in low season versus fish camps 9.2 in high season and 1.3 in low season) and small fish (villages 4.2 cups per week in high season and 1.3 in low season versus fish camps 1.4 cups per week high season and 0.1 low season).

Comparing spoilage to consumption, estimated levels of spoilage are consistently lower than for consumption other than for spoilage of small fish for fishermen in villages in the high season (spoilage of 4.2 cups per week versus consumption of 3.1 cups per week). Overall spoilage of large fish varied from 0.7% (fish camps, high season to ) to 3.2% (villages, low season), and for small fish from 0.1% (fish camps low season to 17.4% (villages, high season).

# 12 FISH CONSUMPTION

## 12.1 Frequency of consumption

According to HHQ respondents, mean frequencies of eating large fish in villages in high and low season were 5.3 and 4.0 times per week and for fish camps 4.9 and 3.9 times per week; corresponding figures for small fish in villages in high and low seasons were 1.1 and 0.8 times per week and for fish camps 0.5 and 0.6 times per week (Fig. 14, Table 9). People in villages and fish camps thus eat large fish more frequently than small fish; (range of 3.9 to 5.3 times per week for large fish versus range of 0.5 to 1.1 times per week for small fish), and reported frequencies were usually slightly higher in villages than in fish camps, and higher in the high season than the low season.

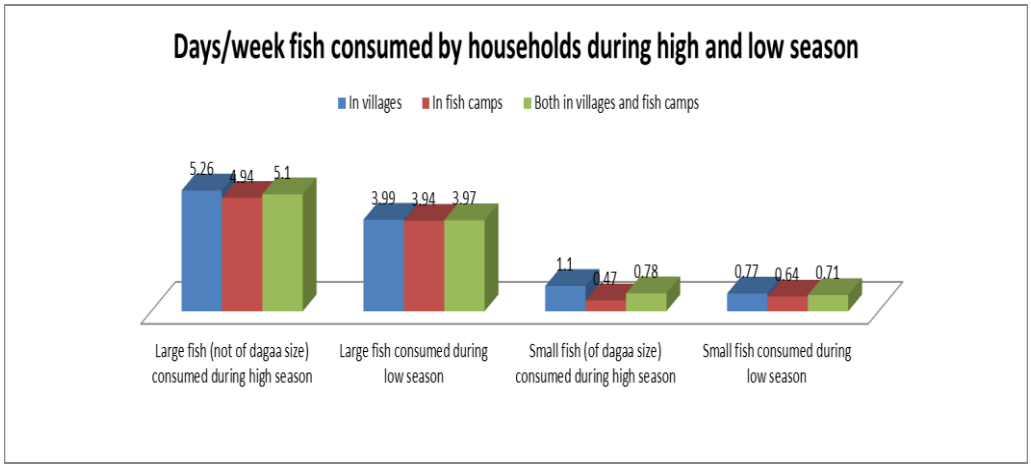


**Figure 14: Days per week fish is consumed by households during high and low seasons. (Source: HHQ survey).**

**Table 9: Frequency of fish consumption during high and low seasons in villages and fish camps (number of days fish is consumed per week). (Source: HHQ survey).**

| Factor | Villages (n=150) | | Fish camps (n=160) | | Total (n=310) | |
|---|---|---|---|---|---|---|
| | Mean | Std. Error | Mean | Std. Error | Mean | Std. Error |
| Large fish high season | 5.26 | 0.168 | 4.94 | 0.143 | 5.1 | 0.11 |
| Large fish low season | 3.99 | 0.184 | 3.94 | 0.173 | 3.97 | 0.126 |
| Small fish high season | 1.1 | 0.176 | 0.47 | 0.111 | 0.78 | 0.105 |
| Small fish low season | 0.77 | 0.131 | 0.64 | 0.111 | 0.71 | 0.086 |

## 12.2 Volumes of consumption

Volumes of consumption are reported in the previous section. Weekly consumption of large fish is roughly double during the high season (overall 18.3 versus 9.1) than low season, whereas consumption of small fish is more or less constant across seasons (overall means of 2.4 versus 2.0 cups) (Fig. 15). In villages, weekly consumption of large fish in the high season was markedly higher than in fish camps (22 large fish versus 15) but similar in the low season (8 versus 10). Similarly, the consumption of small fish is higher in villages than fish camps in the high season but lower in the low season (high season 3.1 cups versus 1.6 and low season 1.9 cups versus 2.1).

## 12.3 Sources of fish for consumption

For village respondents, in the high season 75.0% of fish consumed was obtained directly through fishing, 17.6% through purchase, 6.1% through both fishing and purchase and 1.4% through other means. For fish camp respondents half obtained fish directly by fishing (51.6%) and most of the remainder by purchase (44.0%), with the balance being through both forms (4.4%).

Fish purchased for consumption were obtained from fishermen in fish camps, traders within village markets and traders within district markets. Patterns of access varied between villages and fish camps, but within both villages and fish camps were similar from the high season to low season. Thus in villages most people obtain their fish from traders within village markets (high season 51.5% and low season 60.0%), followed by fishermen in fish camps (high season 39.4% and low season 34.0%), with the balance coming from traders in district markets. For fish camps the major source of fish is from fishermen in fish camps (high season 65.3% and low season 60.3%) and the balance from traders in village markets (34.7% and 39.7%).

## 12.4 Prices of purchased fish

For both large and small fish, reported purchase prices were higher in villages than fish camps and higher in the low season than high season. Respective figures (TZS) for large fish in villages were 3,332 in the high season and 4,604 in the low season, and for fish camps were 2,936 high season and 4,419 low season, and per cup of small fish in villages were 1,309 and 2,201 in the high and low season and in fish camps 818 and 940, respectively.

## 12.5 Fish consumption in relation to other foods

HHQ respondents were asked to rank the different types of food they consume on a scale of 1 to 5 (whereby 1=least consumed and 5=most consumed). For respondents in both villages and fish camps fish was the most frequently eaten food (overall score of 4.5 points), followed by cultivated vegetables (3.7 points), natural vegetables (2.7 points), chicken (2.2 points) and finally beef (1.9 points) (Fig. 15).

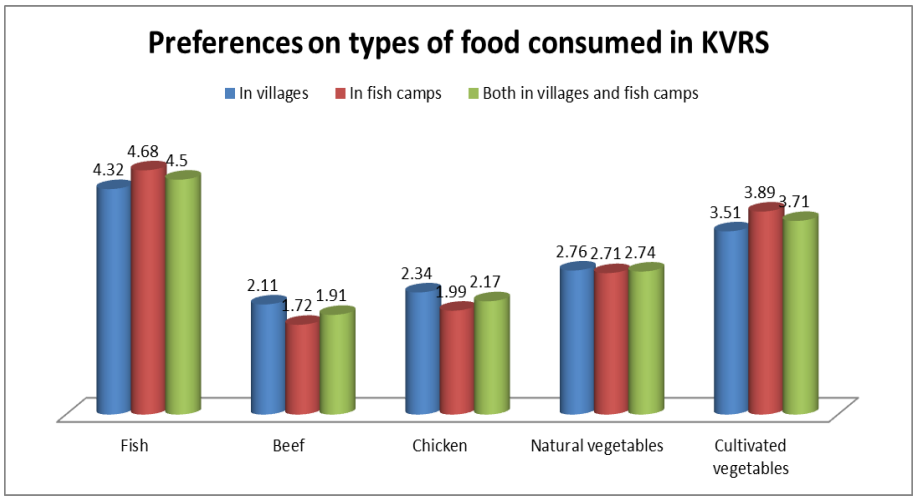


**Figure 15: Preferences on types of food consumed. (Source: HHQ survey).**

# 13 MARKETING OF FISH

According to PRA participants, the most common sites of marketing are at landing sites or fish camps (n=13, other than Mgugwe) and taking fish to and moving around villages (n=14). At the landing sites or fish camps there are traders waiting to purchase fish, but the prices they offer are usually lower than those obtainable in villages or urban centres. For example at the fish camp fish may be sold for TZ 500 but in the village the price will be TZ 1,500. So often fishermen will sell to traders at landing sites or at the fishing camps (n= 13 villages, other than Mgugwe). However, when a fisherman wants to get a better price than that offerred at the fish camp he will take the fish to the village (n=14 villages) or to town (urban centres within Kilombero Valley such as Ifakara, Malinyi, Mlimba and Mahnege) (n=9 villages). During the rainy season fishermen will use bicycles and in the dry season may use either bicycles or motorcycles to move their fish. It is easy to reach customers by going around the village and to sell all the fish in a short time. Sometimes the fisherman has special customers in the village.

Some traders sell fish at kiosks in villages (n=5 villages), this being done when the fish trader has other activities at home, and also may be selling other goods in the kiosk. This is done in small places that are not recognised as market places or centres in the village. Respondents from Mgugwe noted that some traders target village gatherings such as bars or churches, whereby it is easy to reach many customers at one point and to sell fish in a short period of time.

Respondents from four villages reported moving fish out to external markets, for example by train to Mbeya, Dar es Salaam, Songea and Tunduma; by vehicle to Morogoro, Mang'ula, and Dar es Salaam; or motorcycles to Iringa. Respondents from Kivukoni reported making contracts with fish traders who then move them out to external markets, as described above. Respondents from two villages reported selling fish to creditors who had outlayed either cash or equipment to fishermen to enable them to fish. Working with creditors occurs when a fishermen need to purchase gear for his work, or when he needs some income to survive, but the price obtained is usually low.

In the urban centres traders come from various centres to buy fish, such as from Dar es Salaam, Mbeya, Tunduma, Songea and Iringa. Sometimes this is processed fish (by smoking) as the processed fish can keep for longer such that it can be taken by traders to more distant external markets. Making contracts is the simplest way to sell fish, but the price is generally not so good.

PRA village participants were asked to identify specific selling points for fish and to score them in terms of importance. The number of selling point per village varied from one for Mgugwe to 24 for Kivukoni. Overall a total of 71 selling points were identified. The most frequently mentioned

localities were Dar es Salaam (n=9 villages), Mbeya, Morogoro and Songea (n=7 each), Ifakara and Mahenge (n=6 each), Ruaha (n=5), Lupilo (n=4) and Iringa, Mlimba and Sofi (n=3 each).

In terms of relative importance, within village markets were identified as being most important for four villages (Mgugwe, Chita, Misegese and Njiwa); markets in other villages for five villages (Mbingu for Mofu, DC camp for Kivukoni, Tanga for Ngoheranga, Itete for Njiwa, and Mtimbira for Tanga); district urban centres for six villages (Ifakara for Namawala and Mofu; Malinyi for Biro and Tanga; Mahenge for Namhanga and Mlimba for Ngalimila); and outside of Kilombero for three villages (Dar es Salaam for Igota and Lukolongo and Mbeya for Lukolongo).

# 14 FISH PROCESSING

**Frequency**

Based on HHQ responses, a total of 28.0% of respondents in villages process fish and this rises to 40.6% in fish camps (Table 10).

**Experience**

In villages, 50.0% of fishermen have been processing fish for more than 10 years, with 40.5% less than five years and 4.8% less than one year. Comparable figures for fishermen in fish camps were 40.6% greater than 10 years, 46.9% less than five years and 14.1% less than one year. This suggests that the number of new people starting to get involved in fish processing is more prevalent in fish camps than in villages.

**Source of fish**

Roughly two thirds of fishermen in village obtain fish for processing by catching them themselves (68.4% in high season and 66.7% in the low season), with the balance being purchased from fishermen at fish camps. In fishing camps the position is reversed with three quarters of respondents purchasing fish (high season 75.5% and low season 74.5%), with the balance being caught by the fishermen.

**Prices for purchased fish**

Prices paid for purchasing large fish for processing were lower in villages than fishing camps and were lower in the high season than the low season. Reported prices (TZS) for villages were 2,301 in the high season and 2,611 in the low season, and for fish camps 2,796 in the high season rising to 3,952 in the low season.

**Volumes processed**

Fishermen in fish camps processed more large fish than those in villages and more in the high season than the low season. Mean numbers of large fish processed in villages were 407 in the high season and 114 in the wet season, and for fish camps, 633 and 301 respectively. Corresponding figures for small fish were in villages 28.7 cups per week in the high season and 19.9 in the low season, and for fishermen in fish camps 50.0 and 82.4 cups, respectively, here interestingly showing an increase during the low season.

**Methods of processing**

The predominant method of processing in both villages and particularly fish camps is by smoking, accounting for 82.9% of processed fish in villages and 98.0% in fish camps respectively. The balance is preserved through frying. Reported figures were stable across high and low seasons.

**Costs of smoking fish**

The major costs of smoking fish in villages were for firewood, followed by transport, particularly by motorbikes. In fish camps the major costs were for transport (by motor bikes and trucks), followed

by firewood. In general firewood costs were higher in villages than fish camps and the reverse for transport costs. During the high season costs were generally higher than during the low season, presumably due to processing higher volumes of fish in the high season.

### Markets for processed fish

For fishermen in villages, local markets in villages were the most important accounting for 71.4% of sales of processed fish in the high season and 82.4% in the low season, with the balance being sold in fish camps (11.4% and 8.8% respectively), urban centres in the districts (8.6% and 2.9%) and to external markets (5.7% and 5.9%). For the fishing camps external markets are more important accounting for 40.4% of fish in the high season and 33.3% in the low season, with roughly another third of fish going to village markets (28.9% and 33.3%). Urban markets in districts are also important (19.2% and 27.1%), with only small amounts being sold in fish camps (11.5% and 6.3%).

The main external markets were Dar es Salaam, Kilosa, Mbeya, Morogoro, Songea, as well as the district centres of Kilombero and Mahenge.

### Buyers of fish

For fishermen in villages, the major markets for processed fish were within villages, primarily households (76.5% high season and 81.8% low season), plus village traders (14.7% and 9.1%). District and external traders account for the balance of 8.8% and 9.1% in high and low seasons respectively.

The situation was quite different in fish camps. Village households were still important (42.3% high season and 49.0% low season), plus village traders (13.5% and 14.3%), but with a significant proportion of the processed fish going to external traders (34.5% and 28.6%) and the balance to district traders (9.6% and 8.2%).

### Consumption and sales of processed fish

Very little of the fish that is processed is consumed in the household, either of large fish or small fish, for large fish ranging overall from six to nine fish per week and for small fish from 0.2 to 1.1 cups per week.

Sales of processed fish follow the same general pattern as for production, in that fishermen in fish camps processed and sold more large fish than those in villages, and more in the high season than the low season. In most cases estimated levels of sales were greater than production.

**Table 10: Fish processing in villages and fish camps. (Source: HHQ survey).**

| Factor | Villages (%) | Fish camps (%) |
|---|---|---|
| **Involvement in fish processing** | | |
| Involved | 28.00 | 40.62 |
| Not involved | 72.00 | 59.38 |
| Total | 100.00 | 100 |
| **Experience in fish processing** | | |
| Less than 1 year | 4.76 | 14.06 |
| 1-5 years | 35.72 | 32.82 |
| 6-10 years | 9.52 | 12.5 |
| More than 10 years | 50 | 40.62 |
| Total | 100 | 100 |

| Factor | Villages (%) | Fish camps (%) |
|---|---|---|
| **Means of getting fish – high season** | | |
| Fish by myself (own means of fishing) | 68.42 | 24.53 |
| Purchase from fishermen at fish camp | 31.58 | 75.47 |
| Total | 100.00 | 100.00 |
| **Means of getting fish – low season** | | |
| Fish by myself (own means of fishing) | 66.67 | 25.49 |
| Purchase from fishermen at fish camp | 30.55 | 74.51 |
| Other means | 2.78 | 0.00 |
| Total | 100.00 | 100.00 |
| **Methods of processing – high season** | | |
| Smoking | 82.86 | 98.04 |
| Frying | 17.14 | 1.96 |
| Total | 100.00 | 100.00 |
| **Methods of processing – low season** | | |
| Smoking | 82.86 | 98.04 |
| Frying | 17.14 | 1.96 |
| Total | 100.00 | 100.00 |
| **Market location for processed fish – high season** | | |
| At fish camps | 11.43 | 11.54 |
| Within villages at fish markets centres | 71.43 | 28.85 |
| Fish market in urban centres within the District | 8.57 | 19.23 |
| Outside the District | 5.71 | 40.38 |
| Others | 2.86 | 0.00 |
| Total | 100.00 | 100.00 |
| **Market location for processed fish – low season** | | |
| At fish camps | 8.83 | 6.25 |
| Within villages at fish markets centres | 82.35 | 33.33 |
| Fish market in urban centres within the District | 2.94 | 27.09 |
| Outside the District | 5.88 | 33.33 |
| Total | 100.00 | 100.00 |
| **Buyers of processed fish – high season** | | |
| Households in villages | 76.47 | 42.31 |
| Villages fish traders | 14.71 | 13.46 |
| Fish traders from within the District | 5.88 | 9.62 |
| Fish traders from outside the District | 2.94 | 34.61 |
| Total | 100.00 | 100.00 |
| **Buyers of processed fish – low season** | | |

| Factor | Villages (%) | Fish camps (%) |
|---|---|---|
| Households in villages | 81.82 | 48.98 |
| Villages fish traders | 9.09 | 14.29 |
| Fish traders from within the District | 6.06 | 8.16 |
| Fish traders from outside the District | 3.03 | 28.57 |
| Total | 100.00 | 100.00 |

# 15 FISH TRADING

Fish are traded both as fresh fish and in the form of processed fish with fresh fish accounting for the bulk of trade.

**Experience**

In general respondents in villages have longer experience of trading than those in fish camps with 60.5% having been involved for >10 years in villages as compared to 35.9% in fish camps. Similarly, the portions in villages with less than 5 years and less than 1 years experience were 28.9% and 2.6% as compared to respective figures for fish camps of 43.4% and 11.3%.

**Source of fish**

In villages fresh fish for trading purposes is obtained from either own fishing (56.8% high season and 62.9% low season) or from fishermen in fish camps (43.2% high season and 37.1% low season). In fish camps the situation is quite different with the bulk of the fish coming from fishermen in fish camps (89.1% both seasons) and the balance from own fishing.

The pattern for processed fish is similar with the major sources for village traders being own fishing and for traders in fishing camps being purchases from fishermen in fishing camps.

**Markets for fish**

For villages, the major market for fresh fish is within villages, followed by fish camps, and in the low season also external markets. For traders in fish camps their major markets are buyers in fish camps, in village markets, and external markets.

For processed fish in villages, the major market is in villages, whereas for fish camp traders the main buyers are from external markets followed by village markets.

These patterns are much the same from the high to low season.

**Buyers of fish**

For fresh fish the main buyers are households in villages and village traders, whereas for fish camps the main buyers in the high season are district traders followed by village households, plus village traders and external traders, and in the low season village households and external traders.

**Volumes and prices**

Trade is dominated by large fresh fish, with only minimal quantities of either large processed fish or small fish being traded. Volumes in villages are higher than at fish camps (high season 1,624 versus 634 fish and low season 5,926 versus 293 fish), possibly because prices realized in villages are higher than those in fish camps (TZS – high season 3,028 versus 2,329 and low season 2,952 versus 2,789).

# 16 SEASONALITY

Like all floodplains fishing activities and catches in Kilombero can be expected to fluctuate seasonally, with the highest catch rates normally being recorded during the receding water period when fish are increasingly aggregated and forced back into the main channel and permanent pools. However, Jenkins et al. (2000), reported total catch to be greatest in the wet season (April-May) and lowest in the dry season (July-December).

In this study PRA participants were asked to rate fish catches, levels of consumption and sales of fish and fish prices as low, medium or high on a monthly basis throughout the year. For fish catches the high period was May, June, July and the low period from January to March; April was medium and also August to December (Fig. 16).

Eating of fish showed the same general trend, being highest for May, June and July (6.2-6.8 times per week) and lowest for February and March (1.9-2.2 times per week) and intermediate for the other intervening months (2.9-4.6 times per week). Mgugwe (maximum of 3 times per week) and Misegese (maximum of five times per week) are the two villages for which fish is never eaten seven times per week, throughout the year.

Fish sales followed the same pattern being highest in May, June, July, and in some villages extending into August, and being lowest for January, February and March, and intermediate for the intervening months of April and August to December.

Fish prices were slightly more divergent and showed an inverse trend to catches. Lowest prices were obtained during May, June, July and for some villages also August, when supply of fish is greatest. Prices rise to moderate for the following period August, September, October and November. For the remaining months of December to April, prices are generally moderate to high, but with some villages in each category in each month.

Fish catches start to rise in December and January i.e. during the first rains when water starts to enter the flood plain. As water enters the flood plain fishing methods such as lipupu are applied, while fish traps such as mgonyo, tangati and dema are used in small water streams taking water to the flood plain.

Thereafter, during February and March, water levels on the flood plain are high, such that some of the fish camps close to the Kilombero River are submerged, and therefore fishermen (particularly those who stay at fish camp all year round) move to other fish camps in upland areas where they can continue to fish. At this time (February- March) seasonal fishermen (those staying in fish camps for a season) are typically busy working on their crop farms (particularly weeding) in the villages, while fishermen who do not stay in fish camps (i.e. fish and stay in households in the villages) are also working on their crop farms, as this is their main occupation and usually they fish mainly to get fish to suffice for food for their households *("Kitoweo")* and not for selling. Again most of the fishermen in the valley do not have adequate fishing gear to work in the difficult fishing environment when water levels are high. High flooding levels in the valley plain for some of the areas (such as in Mofu, Biro or Ngalimila villages) is one of the key difficulties. As such during February to March fish catch is low.

However, when water recedes from the flood plain back to the main river during April and May, fish catches rise as fishermen, in particular seasonal fishermen (who have temporarily stopped crop farming work) and fishermen who stay in fish camp all year round, can now go fishing to get fish mainly for selling. At this time different fishing traps such as mgonyo, tangati and dema can be used. Fish catches peak during June and start to fall in July and August as water levels falls.

In September to November water levels are low and fish catches decrease because seasonal fishermen stop fishing and move from fish camps back to the villages for harvesting their crops in

their farms. In fish camps mainly fishermen who stay in camps all year round continue to fish and stay at the fish camps. Fish consumption and selling is of high level when fish catches are high between April and August and of low level when fish catches are low in February to March and September to November. Fish catches are of medium level during December to January. However, when fish catches are high during April to August fish price is low; and fish price is high during September to November and February to March when fish catches are low.

The implication is that if management of fisheries in the valley is intended at impoving livelihoods of fishermen, then facilities for fish storage and processing could be made available to cater for the high fish catches during April to August. This would improve the fishermens capacity to bargain and sell fish at a competitive price even at a much later time in the year.

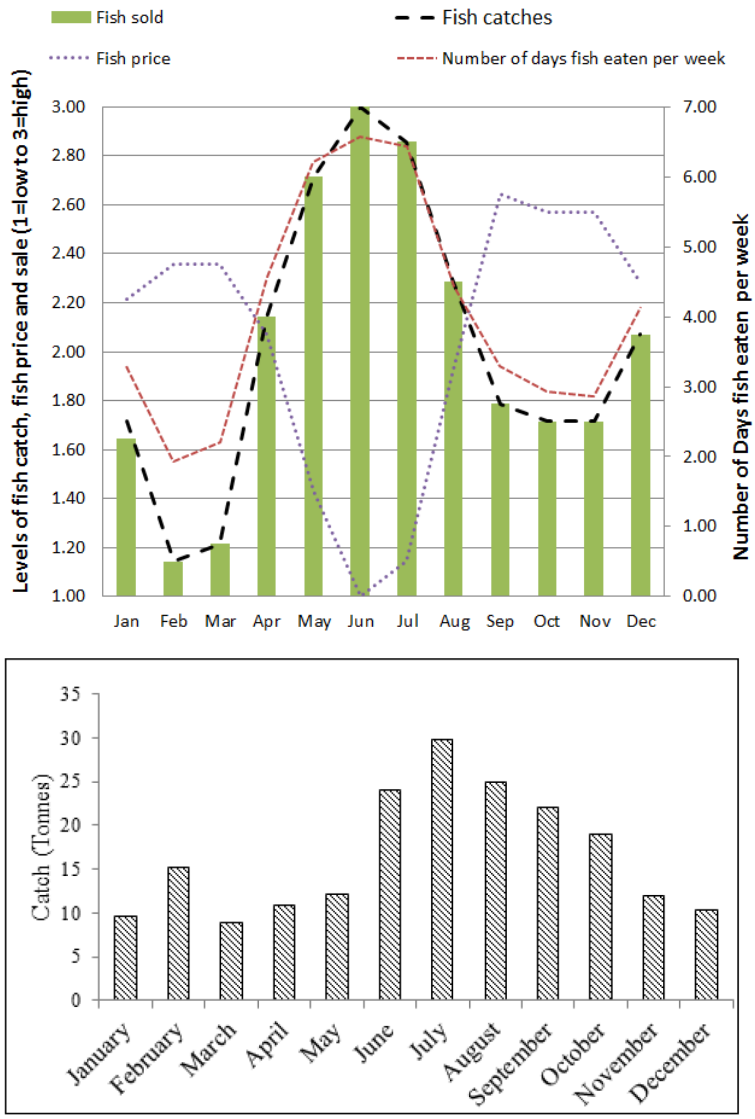


**Figure 16: Top panel. Monthly fish catches, sales, prices and consumption of fish. (Source: PRA survey). Bottom panel. Average monthly fish catch in the Kilombero River basin, 1999-2004. (Source: Msangameno and Mangora 2016).**

# 17 VALUE CHAIN ANALYSIS

The fish value chain in the Kilombero Valley includes fishermen, fish processors, fish traders and consumers (Table 11). The total value of fish production within the Kilombero Valley was estimated based on the total number of households, the percentage of households involved in fishing, mean annual catches of fish and mean prices of fish; the estimated annual amount was 541 billion TZS (Appendix 1).

Marketing margin analysis was used to evaluate the economics of fish marketing in terms of profitability and viability. Marketing margin is equivalent to the ratio of consumer price to the difference between the consumer price and producer price. In our case the producer price is the mean price of fishes in the camps and the consumers are traders and processors.

The analysis revealed that fisheries activities in KVRS appeared to be profitable. Estimated gross profits for fishermen were 14.5 million TZS, for fish processors 44.7 million TZS and for fish traders 28.7 million TZS (although note that these do not equate to collected incomes).

**Table 11: Summary of the fish value chain.**

| Actors/Location | Households in villages/urban areas | Individuals at fish camps |
|---|---|---|
| **Fishermen** | 1. Households in villages | 1. At fish camps |
| **Fish Processors** | 1. Bars<br>2. Restaurants<br>(i.e. processors at urban market centres) | 1. Fish processors at fish camps<br>- Fish processors<br>• From within Kilombero<br>• Outsiders |
| **Fish Traders** | 1. Fish retailers at urban market centres<br>2. Fish wholesalers at urban market centres | 1. Fish traders at fish camps<br>-Fish wholesalers<br>• From within Kilombero<br>• Outsiders |
| **Fish Consumers** | 1. Bars<br>2. Restaurants<br>3. Households in study villages | 1. Individuals fish consumers at fish camps |

Gross Profit Margins (GPM) for fishermen and fish processors were comparable (92.0% and 91.5% respectively, whereas that of fish traders was the highest (95.51 %). This implies that a larger portion of revenue gained by fish traders is converted to profit as compared to revenue gained by fishermen and fish processors.

Although fishermen in villages had greater gross profits than fishermen in fish camps (14.4 versus 12.5 million TZS), in terms of GPM that of fishermen in fish camps was marginally greater than that of fishermen in villages (88.9% versus 86.1%).

Comparisons of mean prices attained by producers, processors and traders indicate that the marketing of fishes in the study area was profitable, with market margins being higher for fish processors than fish traders (72-80% in villages and fish camps respectively, versus 54-67%).

# 18 MANAGEMENT OF FISHING ACTIVITIES

Information on the control of fisheries was provided by PRA participants. Fisheries control was mainly implemented by fisheries officers and other districts officials including Ward Executive Officers in the KVRS. Their role was to provide fishing licenses and fish business licenses and to undertake patrols to prevent illegal fishing activities. This was reported in all study villages. However, fisheries control was also being done by a Network of Water Resource Users of the Kihansi Sub-basin (JUWAMAKI- Jumuiya ya Watumia Maji Bonde Dogo la Mto Kihansi) as revealed by respondents in Mgugwe village and Game Officers as reported by respondents in Mlimba Division. Also relevant are Game Scouts from the Ministry of Natural Resources and Tourism, whose role is to protect natural resources in the KGCA, including stopping fishing at some fishing grounds such as Ndolo swamp in Ngalimila, as it is considered to be inside the KGCA; and patrolling to stop illegal fishing activities such as fishing without having a fishing license. Staff from Kilombero North Safaris (KNS) (previously known as MIOMBO) a hunting company operating in KGCA also participate in controlling fishing activities within their concession area. In Namhanga village, it was revealed that a traditional leader known as Mbuyi existed since 1919 till before the year 2000. The role of the traditional leader on fisheries control was to lead ritual ceremonies to protect fishermen from being attacked by crocodiles or lions in the wilderness. It was also prohibited to process fish (by smoking) particularly Catfish (Kambale) while at fish camp. The belief was that by doing it (i.e. smoking Kambale in fish camp) one would attract lions to the fish camp, and which may come to attack fishermen in the fish camp. However, such taboos are currently violated by fishermen.

According to PRA participants, in terms of control of fishing activities, the most commonly recognized institutions were District Councils (n=13 villages), followed by village governments (8 villages plus Ward government in one village). Other supporting institutions mentioned in one or two villages each were BMU, JUWAMAKI, KGCA, ILUMA WMA and traditional leaders.

District Councils were reported to be represented by Fisheries Officers (at District or Division levels), or BMUs, and to be responsible for providing fishing licenses and fishing business licenses, registration of fishing boats and patrolling to prevent illegal fishing activities.

Village governments were said to act through village leaders, Village Natural Resource Committees, Village Environmental Committees and Village Game Scouts. Their role was perceived to be:

- Responsible for protection of natural resources forests, wildlife and fisheries,
- Patrolling to stop illegal fishing activities including stopping fishing without fishing licenses,
- To inspect fishing nets used by fishermen to ensure they don't use fishing nets with small mesh size, and
- To stop the fishing of small fish.

From the HHQ study, the great majority of respondents in both villages (c. 88%) and fish camps (c. 95%) acknowledged the existence of rules and regulations relating to fishing activities. The most frequently acknowledged regulations were that certain fishing activities are illegal (75.2% of overall respondents), that fishermen must possess a license (69.4%) and that the catching of small fish is prohibited (34.2%). Results obtained from villages and fish camp respondents were largely consistent.

Roughly 80% of respondents in both villages and fish camps claimed to obey these regulations, with less than 10% in each saying no, and the balance being ascribed to respondents not involved in fishing activities (roughly 12% and 17% in villages and fish camps respectively).

For those who do not follow regulations, the principal reason given was because it is difficult to get fish, with just a few respondents saying that they do not have or cannot afford a fishing license.

When phrased differently the majority of respondents reported that some people do use illegal fishing gears, ranging from c. 75% for villages to 85% for fish camps. When asked to estimate the proportions of fishermen using illegal fishing nets, about 35% of village respondents and 40% of fish camp respondents estimated that illegal gear is being used by more than 50% of fishermen, with a further 25% and 15%, respectively, saying that they were not able to estimate.

HHQ respondents were further questioned about their perceptions of fisheries regulations. These results suggest general endorsement for retaining the existing status quo. Most respondents did not agree that there should be less people fishing (villages = 52.5% and fish camps 72.1%); strongly supported stronger regulation and enforcement of existing rules (villages = 87.9% and fish camps 87.7%), including the fact that some fishing methods should be prohibited (villages 83.7% and fish camps 84.4%), and that existing prohibited measures should be maintained (villages 62.4% and fish camps 70.4%). They also supported the strengthening of regulations to improve infrastructure at landing places (villages 89.9% and fish camps 87.6%).

The main types of fishing methods that respondents felt should be prohibited were kokoro (use of small mesh nets – 32.2% of 276 responses), pumunda (22.8%) and poisons (21.0%), followed by use of mosquito nets (6.2%), blocking of rivers (5.8%), all illegal methods (4.0%), use of spears (3.6%), kamatinginyo (small mesh net 1” by 1” – 1.8%) and others (2.6%).

# 19 DIFFICULTIES AND CONFLICTS

## 19.1 Difficulties faced by fishermen

In all, PRA participants identified a total of 15 difficulties across all 14 villages. The most frequently mentioned one was the threat of crocodiles and hippos (n=10 villages); followed by degradation or destruction of fishing grounds by cattle (n=8 villages); increased difficulty in obtaining fish and poor fishing gear (both n=7 villages); then harsh treatment by fisheries officials (n=4 villages) and the fact that some rivers and swamps are drying out (n=3 villages). The other nine difficulties were identified from only one or two villages each. These generally related to restricted access to some sites, difficulties in getting fish to markets; restrictions on cutting trees to make canoes; restrictions on fish net sizes, high costs of getting licenses; use of destructive fishing techniques (pumunda); lack of extension services; low fish prices and accidents due to strong water currents.

In terms of importance, negative impacts by cattle was seen as being the most important difficulty accouting for 36.7% of the overall relative importance. This was followed by harsh treatment by fisheries officials (12.1%), increased difficulty in getting fish 11.5%, poor fishing gear (11.2%) and dangers posed by large animals (9.3%).

Other factors given a relatively high importance score in a single village were poor access to fish markets due to poor road infrastructure (Kivukoni 96.1%); fishermen are prohibited to fish at Mnyera River even though they have fishing license (Ngoheranga 94.6%); restrictions against using trees from natural forests to construct fishing boats (Lukolongo 55.6%); and some rivers and swamps (Mabwawa) are drying out (Lukolongo 13.9%).

Suggested solution to these constraints included:

- Government should provide loans to fishermen to enable them to buy better fishing gear.
- Government should provide permits to enable the harvesting of hippos and crocodiles.
- Strengthen the capacity of JUWAMAKI to reduce illegal fishing activities and destruction of water bodies.
- Improve collaboration between government and communities in controlling fishing activities.
- Land use plans should be developed to set aside areas for grazing and areas for fishing and these should be enforced.
- Government should improve control of illegal fishing activities.

- Government should improve roads to enable better access to markets.
- Government should build places for marketing fish in villages.
- Government should construct roads to fishcamps.
- Taking cattle to fishing grounds for grazing or watering should be prohibited.
- Cattle should be kept in designated grazing areas and their numbers should be reduced.
- Fishermen should be given licenses to harvest large trees (for making canoes).
- Teak plantations should be placed far away from fishing grounds.
- Fisheries officers should visit fishermen to provide advice and solve problems that they face.
- The process of obtaining a fishing license should be facilitated.
- Illegal fishing activities should be stopped.
- Use of smaller mesh nets should be permitted.
- Government should provide awareness to fishermen on their rights to fish in concession areas and of the responsibilities of hunting companies.
- Fishermen should form cooperatives to enable collective marketing.

One of the main problems raised during KIIs was the lack of cooperation and mutual understanding between fishers and fisheries officers. The fishers claim that some officers are highly corrupt, and that the issuing of licences/permits is not straight forward since the officers fail to understand their needs. Everybody is supposed to get a licence once in a fish camp, even the people who provide supporting services such as food and those who attend to the families of the fishermen livingly permanently in the camps. This imposes a high cost to the fishers especially those who are permanent. When the fisheries officers were contacted during the key informant interviews, they explained that the fishers use such claims to shield their illegal activities, because it is difficult to establish who is truly just a supporter and thus should not pay for a permit. According to the officers, the licensing procedure is open and any member is free to get a permit at the reasonable price of TZS 40,000 per year. The fishers also complained of some untrustworthy officers using third party agents (militias) to raid their goods (fishes) wherever they come to the camps. The raided fishes are then sold back to the fishers and they are forced to buy from the officers. The fishers also reported experiencing problems of illegal fishers who normally are not registered in the camps. The fishers claim to be helpless, since they feel they do not have enough powers to stop these fishers from fishing when some of them are partnering with some of the fisheries officers.

Such actions indicate that there is a need to establish monitoring systems through which fishers will be able to report the culprits, such that their rights can be protected. There is also a need to train fisheries officers on the importance of good customary care to the fishers such that they would be able to better cooperate in managing the resources. Better management would ensure greater efficiency and also increase welfare in the communities. Despite such claims, the fishers still want fisheries officers to be involved in management activities. The fishers agree that if they are to work in collaboration with the officers, they will benefit from their activities since the officers have tools to enforce fishing rules.

Apart from the issue of corruption and mistrust between the officers, fishers also cited a problem of environmental degradation which they claim affects the availability of fish. They feel that pastoralists and crop farmers are destroying their fishing grounds through their livestock and farming practices.

## 19.2 Forms of conflicts

A total of 16 forms of general conflict were identified across all 14 villages by PRA participants. The most frequently mentioned forms were between fishermen and pastoralists due to livestock grazing along river banks (n=12 villages) and conflicts between crop farmers and pastoralists due to destruction of crops by cattle (n=11 villages). These were generally rated as being the most important forms of conflict, accounting for 40.7% and 30.9% of the mean overall importance, respectively. Other conflicts with a relatively high rating in one or two villages were conflict between fishermen and regulatory authorities regarding access to certain fishing grounds (Tanga 89.7% and Ngoheranga 87.9%); conflicts between regulatory authorities and farmers relating to

cultivation within the KGCA (Ngalamila 99.0%) and conflicts between fishermen and fisheries officers (Chita 90.1%).

Other less frequently identified and less important forms of conflict (<1% of overall mean importance) included conflicts over village boundaries; conflict between fishermen due to theft; conflicts between fishermen and traders regarding fish prices; conflicts between villages and the KGCA over village boundaries; conflicts between fishermen over the use of the destructive pumunda fishing technique, and conflicts between fishermen and crop farmers.

Suggested potential solutions to conflicts included:

- Prevent livestock from grazing along river banks and in natural water bodies such as oxbow lakes.
- Develop land use plans to designate separate areas for grazing cattle and for fishing.
- Government should intervene and improve control of grazing by cattle.
- Government should improve control of fishing activities to ensure sustainability.
- Need to construct water points for cattle that are far away from fishing grounds.
- Village land taken by KGCA should be returned to the villages.
- Government should intervene to protect farmers from loss of crops to cattle.
- Fishermen should have access to loans to purchase fishing gear.
- Government should ensure the reduction of cattle numbers.
- Grazing areas are few and government should reduce the number of cattle based on the available grazing areas.
- Government should ensure that land use plans are enforced.
- Government should regulate the price of fish to ensure good prices to fishermen.
- Government should intervene to allow fishermen to fish in concession areas.
- Awareness should be provided to all fisheries stakeholders to improve control of fishing activities.
- Villagers should be involved in identifying and setting village boundaries with KGCA.
- Government should resolve the conflicts over village boundaries.
- Increased effort should be made to stop illegal fishing activities such as Pumunda for the benefit of all stakeholders.
- District boundaries should be identified and made clear.

# 20 TRENDS

PRA participants and HHQ respondents were asked their opinions on specific trends relating to the Kilombero fishery. Note that these trends are based on individual perceptions of the situation and that there is always likely to be an inverse correlation between individual output and total output in a fishery with increased number of participants. This is discussed in more detail in Section 21 below.

**Number of fishers**

The number of fishers was generally perceived to be increasing (n=10 villages), but four villages (Mgugwe, Lukolongo, Tanga and Biro) reported a decrease as some people shift to cultivation instead; due to the destruction of fishing grounds caused by high numbers of cattle, and due to ongoing harrassement and harsh treatment by fisheries officials. Reasons for increasing numbers of fishermen were thatfishing offers a key and dependable employment opportunity;it is not easy to find other employment;and that nowadays even women go to the river to buy fish for business and women also are engaged directly in fishing usually using old mosquito nets.

**Proportion of households fishing**

The same four villages of Mgugwe, Lukolongo, Tanga and Biro predicted a future decline in the proportion of households fishing (the variety of economic activities have increased such as cultivation with cattle and also selling crops such that people do not need to depend on fishing so much; and declining availability of fish), while the remaining ten villages reported that the proportion

of households fishing had increased to present and was expected to continue doing so. This was related to population increase and the lack of alternative employment opportunities.

**Types of groups involved in fishing**

The majority of villages (n=11) did not expect any change in the types of groups fishing, two villages predicted a decrease (Mgugwe and Lukolongo) and one an increase(Namawala). Respondents from Mgugwe predicted a decrease due to strengthened control of illegal fishing activities and raised awareness, and for Lukolongo as government is discouraging people from staying in the fish camps. Most villages did not anticipate any changes since no changes were expected in terms of fishing gear, and no support was anticipated from government for improving gear, and fishing is based on traditions and so will not change.

**Types of fishing gear**

These will stay the same (n=7 villages) or increase (n=5 villages), with just two villages (Namawala and Lukolongo ) predicting a decrease on the basis that trees for making canoes are no longer available as harvesting is prohibited; and because ndaga traps may not be available in the future as these are made by experts who are mainly elderly people, and the young people do not make them any more. Those predicting increase argued that illegal fishing was increasing and new forms of illegal activities are continually emerging, e.g. Makokora was not there in the past.

**Sizes of mesh used**

Participants in most villages noted a general decline in mesh sizes and expected this to continue in the future. The exceptions were increasing for Mofu due to enhanced prohibitions on the use of small net sizes, and staying the same for Mgugwe (we do not use nets) and Ngalimila (due to controls on small mesh sizes). Explanations given for decreasing net sizes were increasing difficulties in obtaining fish such that fishermen must use smaller mesh nets to get fish; decreasing availability of large fish, and an increase in illegal fishing activities, particularly the use of small mesh sizes (less than 3.5 inches).

**Volumes of fish catches**

Volume of individual fish catches were widely perceived to have decreased to present and were expected to continue doing so into the future (n=13 villages), other than for Mgugwe, where volumes were perceived to have declined to present but were predicted to increase again due to enhanced enforcement activities. Reasons given for perceived declining catches were due to increased difficulty in finding fish; increasing numbers of fishermen, increased use of illegal activities; destruction of fish breeding sites by cattle; fish swamps drying out; and potential fishing areas being occupied by investors.

The large majority of HHQ respondents from both villages and fish camps were similarly of the opinion that fishing activities had declined over the past five years (81.9% and 86.0%) with only 8.0% of village respondents and 9.1% perceiving an improvement, and with the balance perceiving no change.

Declining individual catch rates were primarily ascribed to an increase in illegal fishing activities (52.3% of 279 responses), followed by environmental destruction due to the influx of pastoralists and their cattle (19.4%). Other less frequent explanations included declining abundance/fewer fish (10.4%) and increased numbers of fishermen (5.7%), collectively accounting for 16.1% of overall responses; climate change and decreased levels of water (6.1%), and problems with fishing gear (old/inadequate or expensive, 1.8%). Additional occasional responses were due to farming activities alongside rivers, increased use of pesticides on farms, the blocking of small rivers, more crocodiles, fish are now smaller, increased regulations and due to the Kihansi power plant.

**Size of fish caught**

The size of fish being caught was generally perceived to be decreasing (n=11 villages), with no change in one village (Ngalamila) and declines in the past to present but with increases predicted

for the future in two villages (Mgugwe and Lukolongo) due to enforcement activities. Reasons put forward for declining fish sizes were due to increased numbers of fishermen, increasing use of illegal fishing techniques such as Kakoro and Pumunda; environmental destruction of swamps by cattle; increasing use of small mesh nets; and increased fishing pressure.

**Number of fish species eaten and sold**

The number of fish species being both eaten and sold was generally perceived to have declined (n=9 villages) or remained constant (n=5 villages). Reasons offerred for these declines were increased difficulty in finding fish, destruction of fish breeding sites, increased use of illegal fishing techniques, and the fact that some species not often obtained nowadays.

**Fish processing**

Roughly half of HHQ respondents considered fish processing to have declined over the last five years (43.9% villages and 54.8% in fish camps), with the remaining half being split roughly equally between staying the same (26.8% in villages and 24.2% in fish camps) and improving (29.3% in villages and 21.0% in fish camps). Increases were mainly ascribed to positive economic benefits which enable people to meet their household needs (55.2% of 29 responses), followed by more or better ways of processing fish or improved ability to process fish (24.1%), and more people processing fish (13.8%). The dominant explanation for no change was that the methods of processing had stayed the same and there had been no changes in technology. The main reason for perceived declines were due to reduced availability of fish (62.0% of 50 responses), difficulties/high cost of accessing firewood (12.0%), and due to health problems arising from exposure to smoke (8.0%). Other infrequent responses were due to limited capital, increased competition, increased preference for fresh fish, the economic downturn and increased theft in fish camps.

**Volume of fish sales**

Volumes of fish sales were perceived as declining in 11 villages, increasing in two and with a mixed trend in Ngoheranga (before there was no market, so increased to present, but in future as fish become less available the volume of sales will decline again). Increases were ascribed to increasing prices (Namawala) and increased demand due to increased population and more fishermen (Ngalimila). Decreases were put down to more fishermen; increased illegal activities; decreasing fish availability due to destruction of fish breeding sites and some fishermen shifting to farming.

**Fish trading**

Opinions among HHQ respondents on the trend on fish trading activities over the last five years were divided. In villages 42.3% of respondents perceived an improvement and 45.7% a decline, with the remaining 11.4% stating no change; corresponding figures for fish camps were similar but slightly more positive with 51.9% improving, 36.5% declining and 11.5% no change.

Improvements were mainly considered due to the livelihood benefits obtained through trading (52.4% of 42 responses), followed by demographic factors (more people, more buyers, more consumers = 16.7%), and higher prices and growth of working capital (both 9.5%). Other occasional responses were improvements in communications, transport and access, more fish, more experience and easier to get permits. Decreases were predominantly explained by decreasing fish catches or availability (51.5% of 33 responses), followed by less profit and capital and capacity to purchase fish (24.2%), as well as increased competition (12.1%), and higher prices and levies (together 12.1%).

**How often fish is eaten**

Frequency of eating fish was consistently perceived to have declined to present and was expected to continue to do so into the future. Reasons for this were due to: increased difficulty in finding fish, illegal fishing activities destroying fish breeding sites; more people fishing; population growth; destruction of breeding sites by cattle; shift to farming activities; less fish but more consumers.

**Consumption of fish**

Two thirds (65.3%) of HHQ village respondents perceived a decline in consumption of fish over the last five years, 21.3% no change and 13.3% an increase. Results from fish camps were more positive with roughly equal numbers perceiving increase and decreases (36.3% and 38.8% respectively) and the remaining quarter (25.0%) no change.

The most common reason for increasing consumption was due to improved availability of fish (44.4% of 81 responses), coupled with lower prices/better affordability (28.4%) and the fact that fish are cheaper than chicken or beef (23.5%). Decreases were predominantly prescribed to lower fish catches and availability of fish (73.0% of 178 responses). Other reasons included that prices of fish were now too high, coupled with high costs of living (19.1%), and the fact that some people were now selling more of their catches than before (5.1%). Four respondents mentioned a shift in dietary preferences away from fish towards chicken and beef.

The general concerns raised among the communities during the PRA and HHQ surveys were:

1. Catches or availability of fish are declining
2. Fish sizes are getting smaller and some species getting rarer
3. Increased use of illegal gears

These indicators, however, are ambiguous in terms of the status of the fishery as will be elaborated below (Section 21). Basically, we are still in a situation where the overall fishing pressure and potential productivity of the Kilombero fishery is largely unknown.

# 21 ASSESSMENT OF THE FISHERY

Fishing has always been one of the main economic activities in the Valley, and catches are sold and marketed both locally and as far away as Zambia, Dar es Salaam, Morogoro and Mbeya (Beck 1964, WWF 1992). At present around 60% of the catches are consumed inside the Valley and 40%, with a total estimated value of the order of 240 billion TZS, are exported (Appendix 1). However, despite its huge economic importance, there is only scant and highly varied information on the fishery in the Kilombero Valley. Estimates of catch and effort are vaguely documented, and most likely unreliable and inaccurate given the variance and inconsistency. The only reported number of fishers is around 25,000 (Mwalyosi 1990), but this figure must have increased since then. Using the 2012 census of 148,126 total households in the Valley, of which 52% (77,800) are involved in fishing (Appendix 1), the total number of fishers or part-time fishers is presently at least 50,000.

Total annual yield figures are also highly divergent from 830 tonnes in 1986 (Vanden Bossche and Bernasceck 1990), to between 9,500-12,000 tonnes in the late 1980s (WWF 1992, Jenkins et al. 2000, USAID-EFA 2015). These figures stand in sharp contrast to the reported average catches from 1985 to 2004, which shows a decrease from 350 to 200 tonnes over the same period (Fig.17). However, these official records are most likely severe underestimates of both the actual yields and the potential sustainable yields. From the households surveys the median annual number of fish units (individual large fish and cups of small fish) caught per household was 2,263 (Appendix 1). With an assumed mean weight of 150 grams per fish unit, and multiplying with the numbers of households fishing, the estimated total annual catch is presently around 25,000 metric tonnes.

WWF (1992) reported an average annual fish productivity of 30 kg/ha/yr for Kilombero, and listed the reproductive part of the floodplain to be around 376,000 ha. This resulted in a total annual production of around 11,000 tonnes, with a corresponding yield of 5,500 tonnes annually (50% of production). According to WWF (1992), FAO had previously estimated the total annual production to 14,000 tonnes, indicating that 7,000 tonnes could be harvested. These figures, however, appear overly conservative in retrospect. The average annual sustainable yield of fish from African

floodplains is usually substantially higher around 100-150 kg/ha (Marshall and Maes 1994, Kolding and van Zwieten 2006), and multiplying with the approximately 400,000 ha of inundated area in the Kilombero floodplain this would be equivalent to 40-60,000 tonnes per year. Welcomme (1975) estimated the average yield of African floodplains to be 50 kg/ha which would be equivalent to some 20,000 tonnes per year. This is around 3 times higher than the estimated sustainable yield (MSY) of 7,000 tonnes per year (WWF 1992, Jenkins et al. 2000) and slightly lower than the present yield estimate of 25,000 tonnes per year. However, it was stated that the fishery resources of Kilombero were still very under-developed (WWF 1992), and also emphasized that more accurate information on this crucial aspect was needed.

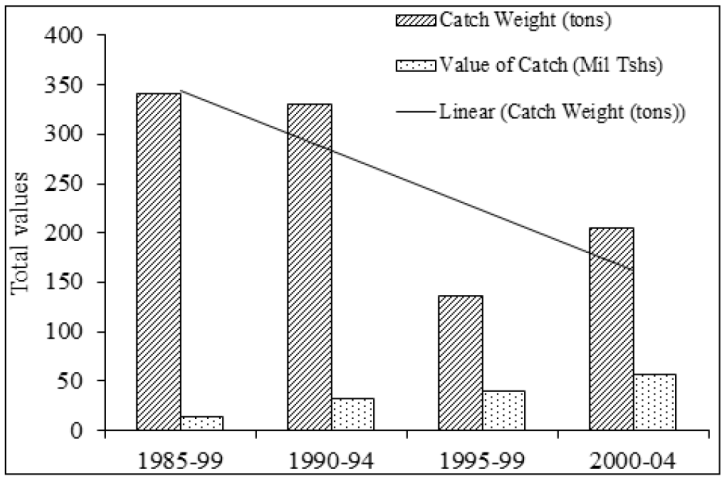


**Figure 17: Average fish catches in the Kilombero River for five year periods from1985-2004 and their corresponding value in TZS (Source: Kilombero District Fisheries Office, after Msangameno and Mangora 2016).**

## 21.1 Fish prices across species

From the data collected during the present study it appears that all fish species have more or less the same economic value from a unit volume point of view. Big fish are sold individually, and smaller fish are bundled together into “sales units” with numbers increasing proportionally to the decrease in size. This results in “sales unit” having approximately the same volume, and the same price across all species (Fig. 18).

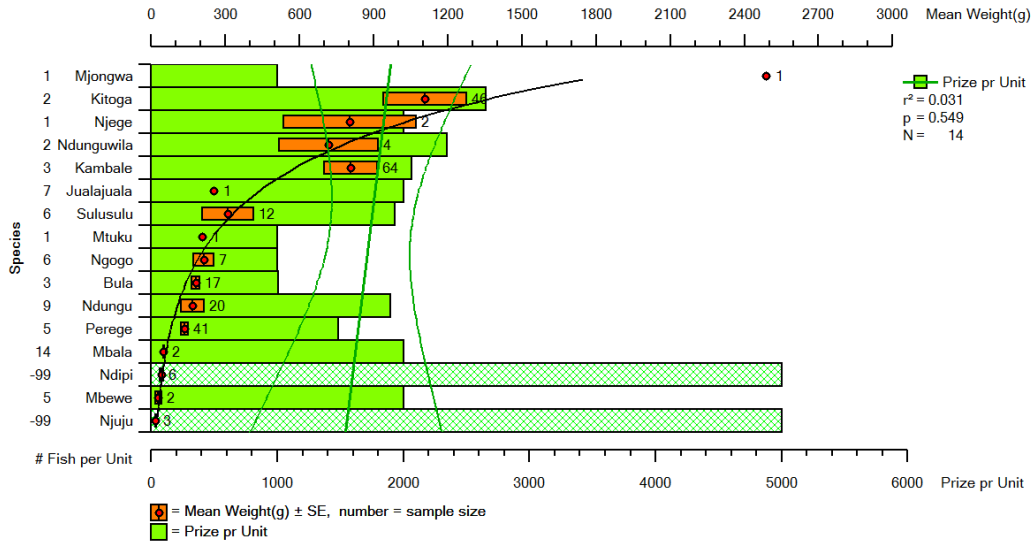


**Figure 18: Comparison of fish size (weight, orange bars) and the price per ‘weight unit’ (green bars) of the fish caught and sold in the Kilombero fishery during the 2016**

**KILORWEMP socio-economic survey. Fish are bundled according to size, which gives an overall**

From a management point of view, this fact is very interesting as it ensures that all fish in the ecosystem has economic value, and that the fishing effort therefore will be distributed and diversified across many species and sizes in proportion to their abundance. In terms of the ecosystem approach to fisheries such a fishing pattern will result in a 'balanced harvest', which recent research has shown to give the highest yields, while also the best way of maintaining the structure and internal functions of the ecosystem (Garcia et al. 2012, Kolding and van Zwieten 2014, Kolding et al 2016, Plank et al. 2016).

# 22 DISCUSSION

## 22.1 Decrease in fish catches

A decrease in catches, whether observed or inferred from interviews, (as the present PRA and KII survey), together with the observation of unrestricted entry (open access), are among the primary justification for concerns of overfishing and call for governance interventions (Kolding et al. 2014). Nearly every document or investigation focusing on the need for management or conservation action uses the omnipresent 'decrease in stocks' or 'decline in the fisheries' as first, and often only argument. The question, however, is whether this indicator refers to the catch of individual fishers (i.e. catch/fisher/day) or to that of the fishery as a whole. A bit of theory follows.

As a fishery develops and effort expands on a given population, the biomass of fish will necessarily decline as removals increase. Fish density will decrease proportionally and individual fishers will correspondingly experience a reduction in their individual catch rates, unless they fish harder and/or adapt their fishing strategies. Usually, fishers can only observe the change in their own daily catch (or that of their peers), but will rarely be able to perceive – or appreciate - that of the accumulated catch of the whole fishery in a region. In that sense a fisher, in an expanding fishery, lives in general in a world of ever declining personal catch rates unless he innovates constantly (shifting places, gears and targets) to try and maintain his take-home lot. Therefore, when asked, he will usually state that "*there is less fish than before*".

However, the individual catch decline (CPUE or density) for each resource component is not only expected as removals increase, it is also an initial prerequisite for increasing stock productivity (net added annual biomass) and thereby generating a sustainable yield. Indeed, according to general production theory it is appropriate to bring the stock sizes down to around half their virgin (unfished) level in order to maximize the sustainable yield.

Only a decrease in *total* catches without a decrease in effort is a possible indicator of overfishing. However, in Kilombero like most small-scale fisheries, with their multitude of landing sites and informal character, representative long-term series of total catches statistics are invariably missing Thus, using a "decline in catches" as an indicator of the status of the stocks may be misleading or even incorrect without specifying whether this concerns the total or each individual's catches. Unfortunately, this distinction is very seldom made in most documents or literature and can lead to serious misinterpretations of the situation. This distinction must be kept in mind when interpreting the respondents answers to general trends in the fishery in Section 19 above.

## 22.2 Decrease in size of fish caught

The second most common indicator of unsustainable fishing is the observation of a decrease of large-sized fish, or a decrease in the mean size of the fish in the catch (as also observed in the present survey). Such changes should, however, be used with great caution as a resource health indicator, as they are highly dependent on fishing strategies, markets, and prevailing management

paradigm. For many small-scale fisheries, gear and mesh regulations are often the only regulations in place (like in Kilombero), and unselective methods or indiscriminate fishing are by default considered synonymous with destructive or unsustainable fishing (Kolding and van Zwieten, 2011). Non-selective fishing methods are therefore usually banned, and minimum landing sizes or minimum mesh sizes are promoted to protect small sizes. However, when fishing selectively removes the largest sizes of the population, reducing lifespan, it should not be a surprise that a decrease in mean size is observed. It is a great paradox in fisheries governance that the perfectly normal expected result of fishing within legal requirements is used as a diagnostic of unsustainability and depletion. A decrease in sizes is, just as a decrease in catch rates, not a sign of overfishing; it may only be a sign of fishing activity taking place.

It is also informative to observe that in many small-scale fisheries, including Kilombero, fishers do not comply with gear and size regulations because they do not agree with their alleged benefits. Fishers know by experience that the highest catches by volume are obtained by targeting juvenile fish or small species located in the lower part of the trophic food chain. This contradiction between theory and practice (as so clearly illustrated in Kilombero) explains why co-management initiatives, which are often implemented only as a way to better enforce conventional regulations, and in particular mesh regulation, as in many parts of Africa, fail (Jul-Larsen et al., 2003).

A greater paradox, however, is that those small-scale fishers that either defy the selectivity regulations, or are left alone without outside interventions, often develop a fishing pattern which, by continuous trial and error, is finely adapted to match the productivity of individual stocks. In African lakes such a fishing pattern resulted in a fish community structure that did not deviate significantly from the species and size-structure of an unfished situation, while returning significantly higher sustainable yields than in areas managed in a more conventional way (Jul-Larsen et al., 2003; Kolding and van Zwieten, 2011; Law et al., 2012). Unfortunately, the standard response from managers or agencies (and even fishers themselves) to this sort of opportunistic adaptive fishing is renewed calls for compliance and enforcement of the conventional paradigm. Thus, the preferred fishing practises versus legal frameworks may easily become not only an irresolvable tug-of-war, as seen often when fishers are resisting the implementation of gear regulations, but also a futile debate as seen from the perspective of ecosystem conservation (Misund et al., 2002; Kolding and van Zwieten, 2011). Sadly, these on-going conflicts have contributed to the general public image of these fishers to be unruly members of the society on the road to self-destruction, and are perceived as just another example of the general governance failure which permeates the view of global fisheries (Kolding et al. 2014).

# 23 THE ECOSYSTEM APPROACH TO FISHERIES AND CO-MANAGEMENT

The current emphasis within fisheries management is focused on two main theoretical concepts: The so-called ‘Ecosystem Approach to Fisheries’ (EAF, FAO (2003)) and co-management, which is predominantly implemented in East Africa through so-called ‘Beach Management Units’ (BMUs). Both of these concepts are strategic goals and activities and within KILORWEMP. Unbeknown to most, however, there are serious potential conflicts and mismatches in the current practical implementation of the ideas.

The reason is basically that the current fisheries legislation, which is seen as a fundamental prerequisite for BMU guidelines, is not aligned and in accordance with EAF. The two concepts therefore become mutually conflicting and undermine and impede each other. In addition, the current fisheries legislation aiming at protecting young fish is at odds with most traditional fishing practices, and therefore not obeyed to by most fishers. We found the same situation and conflicts in Kilombero where most of the current management activities is based on two major responsibilities carried by the fisheries officers (Appendix 1): i) the issuing of fishing licenses, which in principle is free to all who pays the necessary fee, and ii) the patrolling to fish camps to enforce regulations and prevent illegal fishing practices. Enforcement, however, has proven difficult, which is actually the reason that co-management has been suggested as a solution. The biggest problem,

however, of the current management practices is that on the one hand the fishery is open to anybody who pays the licence, and on the other nobody is allowed to fish the most productive part of the ecosystem, namely the small fish. It is like inviting everybody to a party and preventing the guests of enjoying all the available food. Thus, instead of controlling 'how much to fish' (effort control), then all the present focus is on 'how to fish' (gear control).

So we are in a situation where the answer to a problem is not only in conflict with the traditional practice, but also with the overall goal of EAF. These persistent conflicts between fisheries managers and fisheries practitioners are universal across Africa and co-management has not solved the problem. The accumulated experience with BMU's have therefore overall been disappointing and for the most part created unnecessary miseries for both parties of the agreement. Below follows an elucidation of the conflicts, their origin and how they interact.

## 23.1 Fisheries management

The basic objective of fisheries management is to control the amount of fish that can be caught sustainably from a renewable resource – a stock or a fish community. In this context, sustainable means that a fishery can be carried out for a long time, indefinitely, without hampering the reproductive capacity of the resource. Sustainability is usually combined with a measure of optimisation, such as maximizing the sustainable catch (e.g. MSY) or the economic revenue (e.g. MEY). Keeping the stocks at a level that can produce the maximum sustainable yield (MSY) is an old established fishery objective in international conventions (UNCLOS 1982; WSSD 2002).

More recently, however, the ecosystem perspective, in the form of the so-called Ecosystem Approach to Fisheries (EAF), has gained focus in the sustainability debate. According to CBD (1998) a key feature of the ecosystem approach includes conservation of the ecosystem structure and functioning. Thus, the objective of optimising certain outputs must be combined with minimizing the impact on the ecosystem (Kolding et al. 2015a). "How much" can be removed (the yield) is dependent on the regenerative capacity and "How" this should be harvested (the fishing pattern) depends on the combination of fishing gears and their probabilities of capture (see below). Thus, in terms of management, there are only two direct controls available; either control the "How much" or the "How". As the regulation of fishing effort (numbers of fishers = 'how much') is difficult to implement in Africa for socio-political reasons, the fishery regulations in most African fisheries consist of technical measures (how to fish), such as minimum legal mesh sizes to prevent fishing on small juveniles and the condemnation of unselective fishing gears such as beach seines, or closing areas such as breeding grounds (Kolding and van Zwieten 2011).

## 23.2 Fisheries legislation

In Kilombero fishing and farming (agro-fishing), and sometimes also fishing and pastoralism, are often integrated activities for food security, like many places elsewhere all over Africa. However, the governance, policies and management of these combined socio-economic activities are mostly segregated (Kolding et al. 2016). Inland fisheries are usually located under the same administrative umbrella as wildlife, tourism or game departments in most (land-locked) African countries, and therefore more considered a hunting activity than a stable food supplier. Food production, on the other hand is under the responsibility of the Ministries of agriculture. The reason for this political separation is difficult to pin down, but appears to be partly historical and mainly inherited from Colonial administration (Malasha 2003). Much of the fisheries legislation in Anglophone Africa can be traced back to British game legislation, where hunting and angling were seen as a gentleman sport with the important principle of 'giving the game a fair chance' (Malasha 2003). This attitude has important implications for fishing methods that are seen as 'herding', 'indiscriminate', and 'unselective' and considered particularly unethical when immature individuals are targeted.

In addition, during the last decade of the Colonial period, a new fisheries theory was developed in the UK, which rapidly became the doctrine of modern rational fisheries management (Kolding and van Zwieten 2011). The theory (Beverton and Holt 1957) stipulated minimum size limits on exploited species in order to maximize yields, and the principle was soon exported to the colonies (Beverton

1959), resulting in widespread mesh-size regulations and the condemnation of catching small and immature fish (Kolding and van Zwieten 2011). Traditionally, however, African fishers have always targeted all sizes of fish (see Fig. 18) as there is no selective preference for large sizes as in Europe.

## 23.3 Fisheries practice

A general feature of African small-scale fisheries is the so-called 'fishing down' process (Welcomme 1999), which also results in catching small fish. This process is based on the serial reduction in the sizes of individual fish and fish species as fishing pressure increases, by a corresponding successive reduction in mesh sizes, and diversification of fishing gears and methods. The same development has been observed in Kilombero (Monson 2012). The process is induced by the inevitable decline in individual catch rates as the number of people fishing increases with general population increase (Jul-Larsen et al. 2003, Kolding et al. 2014, Section 11). The individual decline, however, is accompanied by a corresponding rise in the total catch from the combined fishery as smaller, faster growing, more productive species and sizes replace larger, slower growing, less productive ones. In addition, as many fish eating predators are among the larger species, the reduction of these will boost the abundance of species and sizes lower in the food chain.

There is now strong evidence that targeting small fish will give much higher yields than targeting only large fish as the regulations dictate (Law et al. 2012, Kolding et al. 2015a,b, 2016). Unfortunately, however, the general process of 'fishing down' is interpreted as a sign of a deteriorating and unsustainable situation (a typical statement is "the fish are getting less and smaller", see section 11), with the added complication that an increasing number of fishing methods become technically illegal as they target smaller and smaller fish. The fishing down process therefore causes increasing conflicts between fishers and managers (Misund et al. 2002) and a snowballing perception (e.g. Monson 2012, Msangameno and Mangora 2016) that the fisheries are 'doomed' and fishers are destroying their own resources in line with 'The tragedy of the commons' doctrine (Kolding and Zwieten 2011, Welcomme and Lymer 2012).

## 23.4 Food security and nutrition

However, in contrast to general perceptions of being an undesirable symptom, the ubiquitous fishing down process is not only a rational response of the fishers (Plank et al. 2016), but also a precondition for maximizing food production while maintaining the health and structure of the fished ecosystem (Kolding and van Zwieten 2014). Thus, in spite of rules and regulations, the overall result of these ongoing processes that are observed in almost every system including Kilombero, is that African inland fisheries are increasingly providing large amounts of small fish (sizes and species), which from a nutritional point of view is highly beneficial (Kawarazuka and Béné 2011, Beveridge et al. 2013, Longley et al. 2014).

It is also highly advantageous from an ecological point of view as catching small fish in proportion to their productivity conserves the aquatic ecosystem structure (Law et al. 2012, Kolding and van Zwieten, 2014), as well as maintains the terrestrial ecosystem by reducing the cutting of firewood necessary for smoking and preserving large fish. Still, most management effort at present seems oriented at constraining fishing, particularly on small juvenile fish through the enforcement of outdated regulations, instead of studying and understanding the dynamics of local fishing patterns, and quantifying their importance for nutrition and impact on the ecosystem.

## 23.5 The management paradox

If African fishers had followed the current regulations, and only fished selectively on the legal large fish sizes, there would inevitably be a concomitant decrease in catch rates and in the average size of fish caught. It is therefore a great paradox in fisheries governance that the predictable result of fishing within legal requirements (a decrease in mean size and abundance) is simultaneously used as a diagnostic of unsustainability, irresponsibility and depletion (Kolding et al. 2014).

Together, this calls for a revaluation of the current legislation and a need for a paradigm shift in management (Mosepele 2014, Kolding et al. 2015). However, the political and governance division between fishing as a hunting activity in the wild and farming as a domestic food supplier may not only prevent such changes, but also help to explain the negative perceptions and recurrent management problems that African inland fisheries suffer from.

## 23.6 Co-management and BMUs

Instead of recognizing that the legislative framework is outdated and needs informed revision (Mosepele 2014), the suggested solution to the omnipresent 'fishing down' problem and ensuing increase in illegal fishing methods is the optimistic idea that co-management will make the fishers law abiding and responsible citizens. Fisheries co-management is in principle an arrangement in which responsibilities and obligations for sustainable fisheries management are negotiated, agreed, shared and delegated between government, fishers, and other interest groups and stakeholders (Pomeroy and Rivera-Guieb, 2006).

The primary vehicle for co-management and co-responsibility is the establishment of Beach Management Units (BMUs), which are local fisheries management bodies. In Tanzania, BMUs were first introduced from around 2000, under the Lake Victoria Fisheries Research Project (Geheb 2000, Medard 2002, Kolding et al. 2015) and Operational Guidelines were developed (Ogwang et al., 2004), which have later been copied and used elsewhere in the country (e.g. Duvail et al. 2016). BMUs are incorporated into the village government and are a sub-committee under the village committee for surveillance and security (Medard 2015). The BMU has to prepare a 'surveillance programme', and has a jurisdiction which typically corresponds to the area understood to be the village's land and its waters.

From the Governments perspective, their primary duties are to take over the work of the fisheries officers to curb fishing illegalities in the fishing communities by enforcing the National Fisheries Act and its various supplements. BMUs are expected to generate lists providing details about all the fishers on the landing site: their boats, fishing licenses and fishing gear. Unlicensed fishermen are supposed to get their licenses, while prohibited gears are supposed to be surrendered to the relevant authorities. The BMU is supposed to maintain a daily record that summarises 'all illegal activities'. At the end of the month, the records are supposed to be submitted to the ward extension fisheries staff, who summarise the reports of all BMUs in their wards, and then pass the report on to the district fisheries officer and so on up the chain of command. According to Tanzania's Fisheries Regulations (URT, 2009), then "every fisher shall abide by the bylaws and conditions set by the BMUs in their respective areas". Immigrant fishers and non-citizens shall *not* be allowed to be 'members' of a BMU. The BMU officers must be resident on a beach or landing site and shall be 'ardent conservators of fishery resources' (Medard 2015), and should be able to work on a voluntary basis, be honest and truthful, and may be a member of a Tanzanian local vigilante group ('*sungusungu*').

## 23.7 The BMU experience

Nearly two decades after the first introductions in Lake Victoria, the ideas behind BMUs and the accumulated experiences are still both remarkable and confusing (Kateka 2010, Medard 2015, Duvail et al. 2016). A central tenet of any successful co-managerial regime is the devolution of powers. However, the simple decentralisation (or rather passing down) of the national legislative tools from fisheries officers to fishing communities does not represent the devolution of powers. Many fisheries co-management arrangements in Africa, Tanzania included, are so-called 'consultative', which means that mechanisms exist for government to consult with fishers but all decisions are in practice taken by government, and partnerships therefore tend to be unequal (Njaya, 2007). It is therefore questionable if a consultative partnership can expect the consulted part to voluntarily implement non-negotiated decisions when these are not agreed upon. The persistent power inequality and subsequent failure is also the general experience accumulated so far. According to Medard (2015) the major problems include reliance on donor project funds (like KILORWEMP), lack of power transfer from the state and involvement in corruption, which they learn from their seniors (the fisheries officers).

BMUs have limited motivation, resources and capacity to plan and run local activities and have no power or incentives to counteract activities which circumvent government regulations. In reality BMUs have only resulted in moving the conflicts closer into the communities, which has exacerbated the likelihood of retaliatory violence. In Lake Victoria, some BMU members have been injured, while others have lost their lives without compensation, while combating fishing illegalities. Similar incidents of violence have been reported from lower Rufiji (Duvail et al. 2016). This has resulted in the majority of BMU members are protecting their personal interests and the interests of their community members - to fish and use any gear - as long as they get fish for food and money. They also link with officials to maintain their position and become entangled in corrupt networks (Medard 2015).

While the national or regional management institutions see the BMU's primarily as their new implementation tools for centrally decided harmonized regulations, the fishers see them as fora for solving local problems and conflicts, and particularly as instruments for reducing conflicts, theft, securing access to shared fishing grounds, fair and transparent price and enumeration systems, access to markets and government financing and lending schemes, and not least the curbing of corruption (Medard 2010, 2015). The priorities of the communities are to solve their day to day problems including poverty, livelihoods and health related issues and not just to address top-down decided control measures in the fishery that they do not necessarily believe in or agree with (Kateka, 2010).

## 23.8 The need for reassessment of assumptions

In Tanzania, like most African inland fisheries (Nielsen and Hara, 2003; Nielsen et al., 2004), the ongoing conflicts between the harmonized gazetted regulations on fishing gears and legal fish sizes, and the fishers compliance have until now not been solved by the introduction of co-management. On the contrary, the use of illegal fishing methods such as monofilament gillnets, beach seines, under-sized mesh nets and fish driving (*Katuli*) are generally increasing. These methods are efficient and widely accepted by fishers (Medard and Ngupula 2007, Okware 2009, Kateka, 2010, Kolding et al. 2016) and the implied negative effects causing their prohibition have never been empirically documented (Misund et al. 2002, Kolding and Zwieten 2014).

The result, however, of the persistent resistance among the fishers to curb illegal activities, combined with increasing media broadcasted fears of imminent stock collapses, is increasing frustration among the managers. In Lake Victoria, the ensuing demands for increased government enforcement, and even military interventions, are a strong indication of the void that still exists between the top and the bottom in the envisaged co-management structure. The result is that the mutual trust and respect, on which co-management hinges, deteriorates and destroys the arrangement.

So, far the co-management processes are still a centrally controlled exercise where local communities are not involved in (co)determining the objectives of the fishery, but are essentially expected to implement the existing regulations by self-policing (Abila et al. 2000, Geheb 2000, Medard and Geheb 2000, Duvail et al. 2016). It appears that the underlying assumptions for implementing co-management, i.e. a mutual common comprehension of problems and measures, may not have been properly tested from the outset. According to Kateka (2010), the state has never tried to understand why illegal fishing is protected instead of being fought at community level. Instead, management has continued to be formulated at the national level and is heavily influenced by the markets, the international development agenda, and the global management discourses (Kolding and van Zwieten 2011).

The biggest paradox, however, is that the 'fishing down' process with an increasingly diversified spread of the fishing pressure (mainly by increasing use of illegal gears) across the whole fishing community, is actually the best way to achieve the overall goals of maximizing yields (MSY), while maintain the structure and functions of the ecosystems as required by the EAF (Kolding et al. 2015b).

# 24 SUMMARY AND OVERALL CONCLUSIONS

There are three main dimensions to the fisheries sector and management in Kilombero: the **environment,** the **fish** and the **people**.

## 24.1 The environment

The central part of Kilombero Valley and KGCA, the seasonally inundated floodplain, is still in a reasonably undisturbed state and healthy condition with respect to the fishery.

Fish production in a floodplain is dictated by the hydrological flow regime, and the maintenance of the fishery therefore hinges on the water. The water flow into the valley, and the GCA, is dependent on several factors outside Kilombero: Climate change, and human water interventions from run-off (deforestation), barrages, reservoirs, hydro-electrical dams and irrigations schemes. Each of these factors alone or in combination will affect the hydrological flow, and any factor that reduces the seasonal flood pulse will have a negative effect on the fish production. Fish production is directly correlated with the peak of the flow.

All these factors, however, are outside the valley itself, so their management depends on external activities that are outside the scope of this review. It should be kept in mind, though, that changes in these external factors are probably much more important than changes inside the GCA.

## 24.2 The fish

At present there are little reasons to be worried about the fish. As long as the floodplain functions naturally, there will be fish, although as the number of fishers increase, the individual catch rates will simultaneously decrease as observed by the respondents in the PRA surveys. From the limited data we have been able to collect there are no visible signs of overfishing.

The fishery is a seasonal multi-gear, multi-species fishery, where the constellation of gears used and fish species targeted will change according to the hydrological regime. In this respect, the Kilombero is no different from any other floodplain fishery in Africa. The fishers are experienced, from generations of accumulated knowledge they know exactly what they are doing, and when to fish where and how.

It appears that all fish species have more or less the same economic value from a unit volume point of view. Big fish are sold individually, and smaller fish are bundled by numbers with numbers increasing proportionally to the decrease in size. In the end, a “sales unit” has approximately the same volume, and the same price. This will ensure that the whole spectrum of fish and sizes will be targeted according to their relative abundance, which from an ecological point of view is ideal. In other words, there are no strong size or species preferences.

However, this also means that the fishers should be allowed to use a wide variety of gears and mesh sizes, in order to catch the same wide variety in species and sizes. This, however, is in conflict with the gazetted size-selective regulations. Although they exist in the legislation, recent research shows that they have no ecological or economic justifications, and will be impossible to enforce without massive effort. Fisheries managers have tried size related restrictions for 40 years without success, which is one of the reasons for attempting co-management. On the other hand, if they are also the main impediment for successful co-management. The fishers will not obey, and there is an increasing amount of scientific literature that challenges the rationale of the traditional size regulations in fisheries. The fishery in Kilombero, is still at a technical level where it will not be possible to overfish the stocks.

The standard globally ubiquitous indicators of increasing fishing pressure are i) increasing total catches (up to a point), ii) decreasing individual catches, and iii) changed species composition and decreasing sizes of the fish caught. None of these indicators are easily diagnosed in the Kilombero fishery due to scattered, incomplete and inconsistent information. While the official annual catches records from Kilombero indicate a decreasing trend (Fig. 17, in contrast to expectations from growing effort), other sources (WWF 1992, Jenkins et al. 2000, USAID-EFA 2015) report a likely

increase over time. The fishers themselves report decreasing catches, but this is individual catch rates which are to be expected and would be consistent with increasing fishing effort (numbers of fishers).

However, there are no clear indications that neither the overall species composition, nor the average sizes of fish caught has changed significantly. Thus, taken together there are no clear solid signs of a fishery that is deteriorating or in a bad shape. In addition, although the catch statistics are most likely considerably underestimated, there are no immediate signs that the fishery has reached it limits. Assuming that Kilombero is not significantly different from other similar floodplain fisheries in Africa, and that it covers an area of 400,000-626,500 ha during high water, then a realistic potential yield of 100 kg/ha, would be equivalent to around 30-60,000 tonnes per year (depending on the amplitude of the annual flow). There is thus quite a span from the present recorded catch to the potential limit, which supports the previous notion (WWF 1992) that the fishery is not yet fully developed. To achieve this, however, depends strongly on the continued preservation of the natural flood pulse through the systems every year.

The fish species in Kilombero are for the most part quite common and are found in other similar floodplain fisheries in Africa, which means that we have a fairly good understanding of the dynamics, the biology of the fish, and their reproductive potential. The most important driver for the biology is the hydrology, and as long as the natural cycles are maintained, then the fishery will be reasonably robust to exploitation. Floodplain species are generally adapted to highly varying seasonal and inter-annual environmental conditions with ensuing boom and bust scenarios, which means that they are adapted to rapidly respond and bounce back from adverse periods, as long as the overall habitat is not destroyed or significantly altered.

## 24.3 The people

Fishing is clearly an important cultural and economic livelihood activity in Kilombero, with a long history and tradition. The biggest remaining question in terms of a fisheries management plan for Kilombero is how do we reconcile the environment (the GCA) with the activities of the people? What should be the status of the fishers inside the GCA and what should be allowed? Are they allowed to settle permanently in the camps? Are they allowed develop (modernize) the business? Building infrastructure such as cooling/drying facilities, storage, roads? And everything that follows, or should the camps be considered as temporary and the fishery a seasonal migratory activity? Should there be gazetted fishing areas and no-take zones?

Thus, the central issue in terms of management is the fishing camps inside the GCA as they are the hubs and the basis of the industry. If we want to manage the camps, we need to set some objectives? The whole thing hinges on how to reconcile a protected wildlife area with an economic business called fishing (which may shelter some kind of poaching too). In the end it will all depend on what the people (the users) and the government (the owners) will agree on, and how power is distributed. The obvious solution is of course co-management, but unfortunately there are few, if any, examples of successful co-management in Africa (see Section 22).

So far the establishment of BMUs has delivered little in terms of co-management, and the main reason is a lack of mutual understanding of priorities among the parties. For the fishers the main challenges that the communities prioritise are to solve their day to day problems including poverty, livelihoods and health related issues and not so much to address top-down decided control measures in the fishery that they do not always believe in or agree with. All over Africa, the use of illegal fishing methods such as monofilament gillnets, beach seines, under-sized mesh nets and fish driving are still very common. These methods are efficient, often traditional, and widely accepted by fishers and the implied negative effects causing their prohibition have never been empirically documented (most are inherited from Colonial times).

Thus, if top-down regulations and enforcement are not understood, accepted and supported by the fishers there is a high risk that the mutual trust and cooperation, on which co-management hinges, will deteriorate. It appears that the underlying assumptions for implementing co-

management, i.e. a mutual common comprehension of problems and measures, may not have been properly tested from the outset. Management regulations (bylaws) have been formulated at the national level and are copy-pasted into the different fisheries without much attention to the particular needs or priorities of the fishing communities. If they are to be introduced in Kilombero, then quite a lot of work is needed to produce the adequate bylaws, and the Government must be prepared to abandon some of the conventional gear regulations, unless they have been proven to cause damage. There are no short cuts, or one-size-fits-all solutions.

# 25 RECOMMENDATIONS

The present diagnosis has shown and argued that the general problems in the management of the Kilombero fishery are:

1. The absence of updated reliable information on the fishery in terms of status, total production and value. This is critical because the general impression is that of a degraded and overexploited fishery that is employing increasingly illegal methods, while the current observations may be just normal and expected signs of fishing under increased effort.
2. The failure of state management capacity and recognition that the overall goals of an ecosystem approach to fisheries (EAF) and high sustainable yields (MSY) are irreconcilable under the present legislation framework that prevents a balanced and diversified fishing pattern, and
3. The lack of locally adapted and functional co-management arrangements between the state and the fishing communities inside the GCA, which ultimately depends on a common mutual understanding of the fishers behaviour under growing fishing pressure, and the recognition of the State that the present legislation is in need of revision towards controlling effort instead of controlling methods.

It is furthermore assumed that fishing will continue to be a legally accepted activity inside the GCA, and that the fishery will be part of the general management plan to be elaborated for the area.

It has been argued that the present constraints for establishing a functional co-management structure is an institutional and conceptual gap between the fulfilment of livelihood objectives and fisheries management objectives with an overemphasis on outdated biological sciences ideas and an underestimation of the knowledge and abilities of the fishing communities to ‘self-manage’. However, it should also be recognised that the ability and motivation of the fishing communities to ‘self manage’ depends on the amount of power to exert control that will be given to the communities.

In order to bridge this gap in mutual understanding and to facilitate the transfer of participatory regulatory power to the fishing communities, there are two main recommendations:

**Establishment of a long-term, fisherman based monitoring system**

The monitoring of the fishery should be strengthened so that some basic statistics on catch rates, species composition and fishing methods are available on a regular basis (at the moment we are groping in the blind). The most cost efficient way is to have a system where the fishermen participate in the recording of data (a system that Department of Fisheries is already promoting).In the initial stages this may need external supervision and monitoring.

**Revision of BMU management approach to allow true cooperative management and self-regulation**

‘Self-monitoring’ – and ultimately management when/where needed- requires an organisational setup that can handle it, and the most logic would be the establishment of Beach Management Units (BMU’s).

However, the present BMU structure as implemented in Tanzania through uniform guidelines is largely failing (as is evidenced from elsewhere) because it is based on incorrect assumptions about what is the best way to achieve an ecosystem approach to fisheries, and incorrect assumptions on what regulations the fishermen will understand, accept and agree to from a livelihood perspective. The fisheries legislation is based on an old theory that has outlived itself, and therefore needs revision as well as local adaptation to different kind of ecosystems.

The road to such policy revision is long and requires an informed and validated basis to build on, which again necessitates a number of pilot studies that can provide the needed knowledge. Kilombero could be one such case study as the fishery in many ways is starting from scratch in terms of both knowledge (lack of data) and management.

It is therefore recommended to initiate a process of establishing a 'modified' BMU structure, where the main focus will not be primarily on upholding the present legislation, but where the fishers will participate in gradually building up a set of regulations and bylaws that they agree with and therefore will adhere to, but which are flexible and can be adjusted as experience build up. The condition, however, will be a commitment to participate in the continued data collection needed to make such regulations on an informed basis. The present management focus is on controlling 'how to fish' (gear- and mesh regulations) instead of controlling 'how much to fish' (effort control). It is now becoming increasingly clear that gear- and mesh regulations are obsolete under EAF, and will be increasingly violated by the fishers under increasing effort. Overfishing is a result of too many people fishing, rather than how the individual people fish. Management focus must therefore be shifted so that the BMUs are given the authority to decide on whom and how many should be allowed to fish in each area, rather than obliged to control and report how people are fishing.

It should also be noted that similar experimental management models are tried and tested in other similar ecosystems, as for example in the Bangweulu swamps, Zambia, where African Parks are trying to negotiate and implement mutually agreed management structures https://www.african-parks.org/the-parks/bangweulu. It would therefore be recommended that KILORWEMP consults with African Parks and perhaps make a visit to Bangweulu for inspiration and exchange of ideas.

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# APPENDIX 1. VALUE CHAIN ANALYSIS

The value chain analysis for fisheries was conducted at different chain nodes within the study area after Sturgeon's (2001) definition, which defines value chain as being three dimensional, namely organizational, spatial and the type of actors involved (i.e. production actors). Since the author suggests from organizational aspects, that value chains can be both complex and dynamic or simple, depending on their sustained supply of variety of critical inputs, this study chose a simple organization just to get an insight into how the fish trade operates and how it affects the management of the ecosystem. The objective was to get information that can be used to improve the management of the fish trade. Consequently, the study mapped the chains from the primary production level (fish camps), to the processing and trading centres that exist within the fish camps and those at village markets in the KVRS, and so in terms of space the chain was limited to the three districts where the wetlands are located (Table 12). The chains outside the KVRS were not studied although the outside markets to where Kilombero fishes go were identified. Because of the unspecialised mode of fish trade and unspecified fish products in terms of size and qualities (value added or raw) in the study area, it was difficult to collect reliable data which could have brought confident estimates of market margins to see who benefits from the trade. The study went as far as calculating the market margins instead of limiting its findings to the gross profit margins. The gross profit margins only give an indication of how the trade is performing but unless a lot of assumptions made are justified cannot provide the exact profits accrued from the trade. The marketing margins provide the extent to which each stakeholder benefits from the trade. However, since the data was collected based on respondents memory whereby they seldom keep records, the estimate made through this study is of low confidence. Nevertheless, the study can be used to draft the management options since the findings give insights as to how the trade operates, indicating whether the trade is profitable or operating with negative margins i.e. losses.

**Table 12: Illustration of the fisheries value chain in KVRS.**

| Actors/Location | Households in Villages/urban areas | Individuals at Fish camps |
|---|---|---|
| **Fishermen** | 1. Households in villages | 1. At fish camps |
| **Fish Processors** | 1. Bars<br>2. Restaurants<br>(i.e. processors at urban market centres) | 1. Fish processors at fish camps<br>- Fish processors<br>• From within Kilombero<br>• Outsiders |
| **Fish Traders** | 1. Fish retailers at urban market centres<br>2. Fish wholesalers at urban market centres | 1. Fish traders at fish camps<br>-Fish wholesalers<br>• From within Kilombero<br>• Outsiders |
| **Fish Consumers** | 1. Bars<br>2. Restaurants<br>3. Households in study villages | 1. Individuals fish consumers at fish camp |

**Gross profit margin analysis**

Fisheries activities in KVRS involved actors such as fishermen, fish processors and fish traders. These actors participate in the value chain of fisheries through their enterprise activities. By using Gross Profit Margin analysis it was possible to determine which actor in the chain benefits most from the fisheries resource. As such in the fisheries diagnostic study it was useful to understand the Gross Profit Margin (GPM) for each actor in the fisheries value chain. The GPM was calculated as described in equations 1 and 2.

$$Grossprofitmargin = \left(\frac{Grossprofit}{Sales}\right) \times 100 \quad (1)$$

Whereby:-

$$\text{Gross profit} = \text{Sales} - \text{Costs of Goods Sold (CoGS)} \quad (2)$$

**Fish production value in Kilombero Valley**

Total value of fish produced was calculated as presented in equation 3.

$$TVFP = MFC \times FP \times THH \times \%HHF \quad (3)$$

Whereby:-

TVFP =Total value of fish produced per year

MFC = Median fish catch per household per year (= 2,263 fish units)

FP = Fish price (= 3,886 TZS for large fish and 532 TZS for cups of small fish)

THH = Total number of HHs in Kilombero Valley (census 2012 = 148,126)

% HHF = Percentage of HHs involved in fishing in KV (= 52.5%)

## Fisheries production value

**Elaboration on equation 3:**

*To obtain median fish catch per household per year (MFC):*

Duration (time) spent by a household in fishing (in weeks per year) was first calculated and then multiplied by mean fish catch per household per week (Annex 1, question 39). This was done for both high and low seasons.

The procedure was that by using data collected during the questionnaire survey mean number of months per year that fishing was done by a household for both high and low seasons was calculated. For that case, number of month fishing was done by a household during high season and number of months fishing was done by a household during low season was obtained. Again, mean number of weeks per month that fishing was done by a household during high and low seasons was calculated. Therefore, mean number of weeks per month a household fished during high season and mean number of weeks per month a household fished during low season was obtained. Then, mean number of months per year that fishing was done by a household was multiplied by mean number of weeks per month that fishing was done by a household to get mean number of weeks per year that fishing was done by a household during both high and low seasons. For that case, total number of weeks per year that fishing was done by a household was obtained as a summation of mean number of weeks per year that fishing was done by a household during high season and mean number of weeks per year that fishing was done by a household during low season.

Then, the result on total number of weeks per year that fishing was done by a household was multiplied by median number of fish caught by a household per week during high and low seasons in a year. Then, total number of fish caught by a household per year was obtained as a summation of fish catch by a household during high season and fish catch

by a household during low season. This was done for both large fish (i.e. not of dagaa size) and small fish (i.e. of dagaa size).

Thereafter, to obtain the economic value of fish caught per household per year, the total number of fish caught by a household per year was multiplied by mean price of fresh fish. This was done for both large fresh fish (where mean price of large fresh fish was used in the equation) and small fresh fish (where mean price of a cup of small fresh fish was used in the equation). The results were presented in TZS/HH/Year from both large fish (i.e. not of dagaa size) and small fish (i.e. of dagaa size).

The number of households in Kilombero Valley (considering Kilombero, Ulanga and Malinyi Districts) was obtained from the 2012 population and housing census (URT 2013). This number of households in Kilombero Valley was multiplied by the percentage (%) of fishermans' households obtained from the fisheries diagnosis in Kilombero Valley to get the number of fishermans' households in the Kilombero Valley. Again, percentage (%) of households which had members who were both fishermen and crop farmers as obtained in the fisheries diagnostic studies was multiplied by the number of households in Kilombero Valley (as per the 2012 population and housing census) to get number of households in Kilombero Valley which had members who were both fishermen and crop farmers. So, the total number of households involved in fishing was a summation of number of fishermens' households in Kilombero Valley and number of households with members who were both fishermen and crop farmers.

Finally, the total value of fish produced (TVFP) was obtained by multiplying economic value of fish caught per household per year with total number of households involved in fishing in Kilombero Valley (Table 13).

**Table 13: Estimate of total gross value of the Kilombero fishery.**

| **Production- Fish catch per year (High and low seasons)** | **Median/ Mean** | **Std Error** |
|---|---|---|
| Number of large fish caught per household per year | 240 | |
| Number of cups of small fish collected per household per year | 50 | |
| **Price of fish** | | |
| Large fresh fish (TZS) | 3,886.00 | 474.741 |
| Cup of small fresh fish (TZS) | 445.65 | 304.947 |
| **Mean value per HH per year (TZS)** | | |
| Large fresh fish | 6,723,052 | |
| Cup of small fresh fish | 237,308 | |
| **Total** | **6,960,360** | **179.19** |
| **% of HHs involved in fishing in the KV** | | |
| As fishermen | 43.23 | |
| As both fishermen and crop farmer | 9.30 | |
| **Total** | **52.53** | |
| **Total HHs in the KV (Census 2012)** | | |
| Number of HHs in Kilombero Districts (Census 2012) | 94,258.00 | |
| Number of HHs in Ulanga/Malinyi districts (Census 2012) | 53,868.00 | |
| **Total number of HHs** | **148,126.00** | |
| HH fishing in KV | 64,034.87 | |
| HH practising both fishing and crop farming in KV | 13,775.72 | |
| **Total HHs involved in fishing in KV** | **77,810.59** | |

| | | |
|---|---|---|
| **Total value of fish produced in KV per year (TZS)** | **TZS 541,589,701,281 = TZS 541 billion** | |

## Marketing Margins analysis

Marketing margin analysis was used to evaluate the economics of fishes marketing in terms of profitability and viability. Marketing margin is equivalent to the ratio of consumer price to the difference between the consumer price and producer price. In our case the producer price is the mean price of fishes in the camps and the consumers are traders and processors (Kainga, 2013).

## Value chains analysis in the study area

The analysis revealed that fisheries activities in KVRS appeared to be profitable. In particular, fish processors had a higher gross profit than fish traders and fishermen. The gross profit for processors was about 1.5 times that of traders and 3 times that of fishermen (Table 14 and Figure 19).

**Table 14: Gross Profits from fish business gained by fishermen, fish processors and traders.**

| Actors | Gross Profit (TZS) |
|---|---|
| Fishermen (Villages & Fishcamps) | 14,487,288.47 |
| Processors | 44,656,691.96 |
| Traders | 28,658,814.64 |

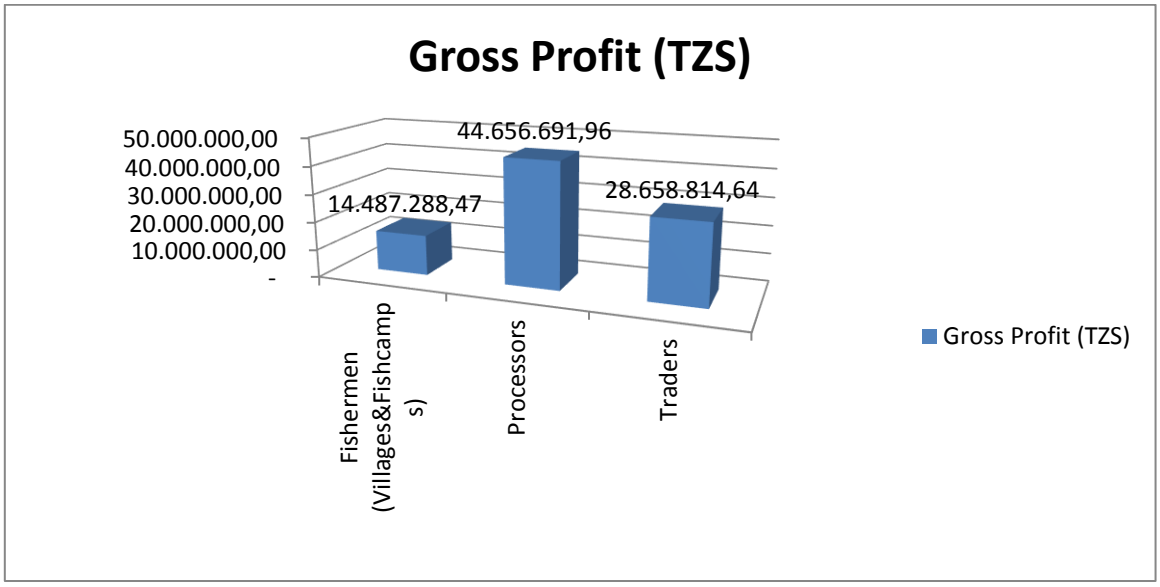


**Figure 19: Gross Profits from fish business gained by fishermen, fish processors and traders.**

Gross profit margin (GPM) for fishermen (92.0%) and fish processors (91.5%) were comparable whereas that of fish traders was the highest (95.5 %) (Table 15, Fig 20). It could therefore imply that a larger portion of revenue gained by fish traders is converted to profit as compared to revenue gained by fishermen and fish processors.

**Table 15: Gross Profit Margin gained by fishermen, fish processors and fish traders.**

| Actors | Gross Profit Margin (%) |
|---|---|
| Fishermen (Villages&Fishcamps) | 91.96 |
| Processors | 91.54 |
| Traders | 95.51 |

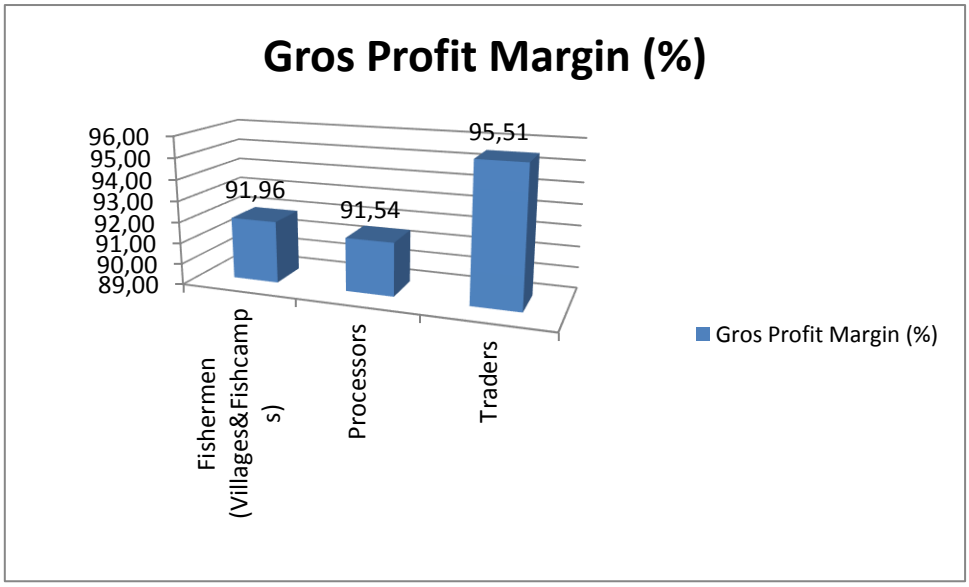


**Figure 20: Gross Profit Margin from fish business gained by fishermen, fish processors and traders.**

Fishermen in villages had greater gross profits than fishermen in fish camps (Table 16, Fig. 21). However Gross Profit Margin for fishermen in fish camps was greater than that of fishermen in villages (Table 17, Fig. 22). This could mean that there is larger portion of revenue obtained by fishermen in fish camps which is converted to profit than by fishermen in villages.

**Table 16: Gross Profit from fish business gained by fishermen in villages and in fish camps.**

| **Actors** | **Gross Profit (TZS)** |
|---|---|
| Fishermen in villages | 14,429,931.22 |
| Fishermen in fish camps | 12,481,566.76 |

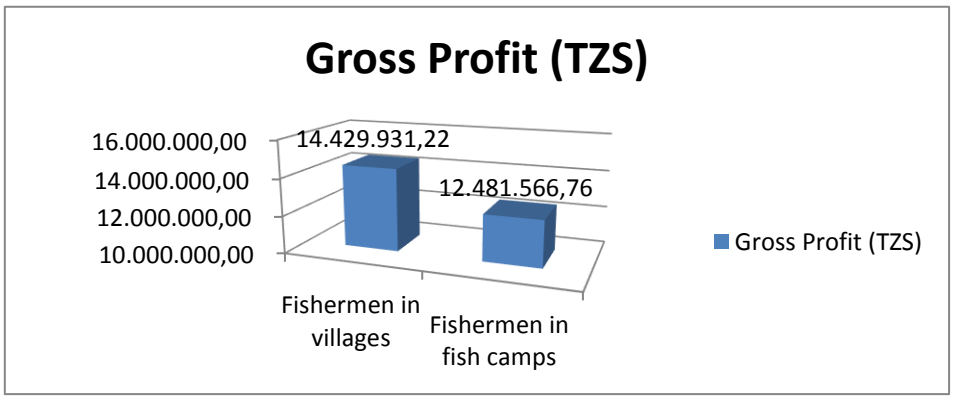


**Figure 21: Gross Profit from fish business gained by fishermen in villages and in fish-camps.**

**Table 17: Gross Profit Margin (GPM) from fish business gained by fishermen in villages and in fish camps.**

| Actors | Gross Profit Margin (TZS) |
|---|---|
| Fishermen in villages | 86.12 |
| Fishermen in fish camps | 88.85 |

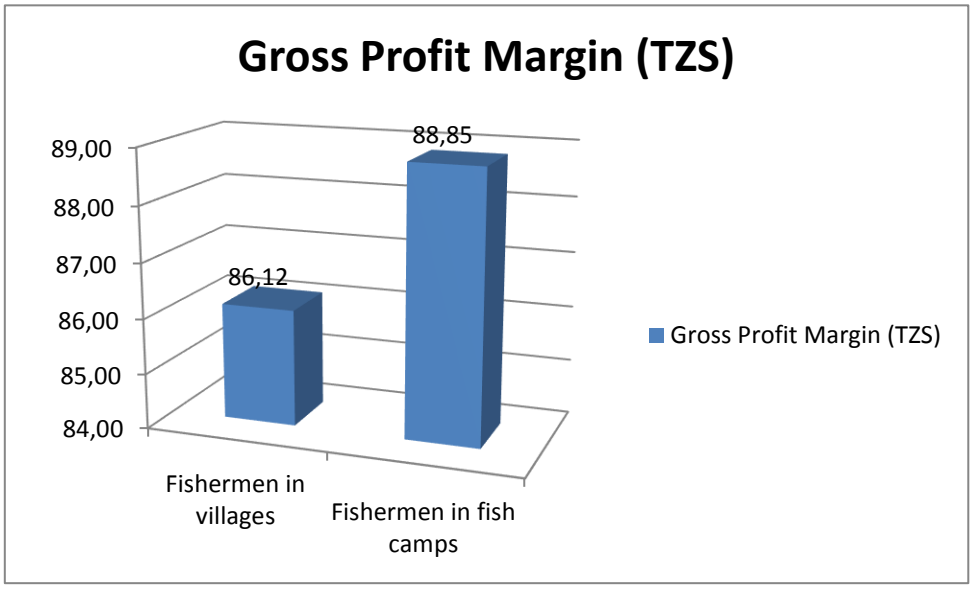


**Figure 22: Gross Profit Margin (GPM) from fish business gained by fishermen in villages and in fish-camps.**

### Market Margins

The result showed that marketing of fishes in the study area was profitable following the mean prices of producers and consumers as summarised in Table 18. The calculated Market Margins indicate that the fish processors get higher share of value for the traded fish as compared to traders i.e. 72-80% as compared to 54-67% (Table 19).

**Table 18: Fish prices at different chain nodes.**

| Stakeholders | Large fishes selling prices in the villages | | Selling prices in the fish camps | | |
|---|---|---|---|---|---|
| | Mean | Std error | Mean | Std error | |
| Fishermen | 4,508.83 | 600.55 | 3,197.18 | 287.67 | 3,853.01 |
| Traders | 16,066.67 | 5,076.09 | | | |
| Processors | 9,730.77 | 1,847.09 | | | |

**Table 19: Fish Market Margins.**

| Margin prices | Marketing Margins (MM%) | |
|---|---|---|
| | In Villages | In Fish camps |
| Fishermen Selling Price[1] | - | - |
| Fish processor Selling Price[2] | 72 | 80 |
| Fish Traders Selling Price [3] | 54 | 67 |

[1] The calculation is based on (Fishermen Selling Price-Fishing Cost per fish)* 100

[2](Fish Processor Selling Price-Fisher man Selling Price)* 100

[3](Fish Traders Selling Price-Fisher man Selling Price)* 100

# APPENDIX 2. LIST OF FISH SPECIES RECORDED FROM THE KILOMBERO FLOODPLAIN

| | Family | Species name | Local Name | Size | Observed/cited by |
|---|---|---|---|---|---|
| 1 | Cyprinidae | Barbus macrolepis | Nguyu | small | 2, 5, 6, 7, & 8 |
| 2 | | Barbus lumiensis | Dagaa | small | 4 |
| 3 | | Barbus paludinosus | Dagaa | small | 8 |
| 4 | | Barbus autaenia | Dagaa | small | 8 |
| 5 | | Barbus jacksonii | Dagaa | small | 8 |
| 6 | | Barbus kerstenii | Dagaa | small | 8 |
| 7 | | Labeo coubie | Ngurufi | large | 4, 5, 7 & 8 |
| 8 | | Labeo cylindricus | Ngurufi | large | 8 |
| 9 | | Labeo congoro | Mtuku | large | 1, 2, 3 ,4, 5, 6, 7 & 8 |
| 10 | | Neobola sp. | | small | 8 |
| 11 | Oreochromis | Oreochromis urolepis | Perege | medium | 1, 2, 3, 4 & 7 |
| 12 | | Oreochromis niloticus | Perege | large | 5, 6 & 8 |
| 13 | | Oreochromis mossambicus | Perege | medium | 8 |
| 14 | | Astatotilapia calliptera | Furu/Dagaa | small | 8 |
| 15 | Mormyridae | Mormyrus longirostris | Surusuru | large | 1, 2, 4, 5 & 7 |
| 16 | | Mormyrus kannume | Surusuru | large | 5 |
| 17 | | Petrocephalus catostoma | Ndipi | small | 2, 3 & 8 |
| 18 | | Petrocephalus steindachneri | Ndipi | small | 5, 6 , 7 & 8 |
| 19 | | Marcusenius stanleyanus | Ndipi | small | 4 |
| 20 | | Marcusenius livingstoni | Ndipi | small | 5, 6 & 8 |
| 21 | | Marcusenius macrolepidotus | Ndipi | small | 2 & 3 |
| 22 | | Hippopotamyrus dischorhynchus | Ndipi | small | 4, 5 & 6 |
| 23 | | Hippopotamyrus grahami | Ndipi | small | 5 |
| 24 | Characidae | Hydrocynus vittatus | Njege | large | 1, 2, 3 , 5, 6, 7 & 8 |
| 25 | | Hydrocynus goliath | Njege | large | 4 |
| 26 | | Alestes stuhlmanni | Mgundu | medium | 3, 4 & 7 |
| 27 | | Alestes macrophthalmus | Mgundu | medium | 5 |
| 28 | | Brycinus imberi | Njuju | small | 8 |
| 29 | | Brycinus affinis | Njuju | small | 4, 5 & 7 |
| 30 | Petersius | Petersius conserialis | Mbewe | small | 4 |
| 31 | Mochokidae | Synodontis maculipina | Ngogo | medium | 1, 2, 3, 4, 5, 6, 7, & 8 |
| 32 | | Synodontis rufigiensis | Ngogo | medium | 5 |
| 33 | | Synodontis livingstonii | Ngogo | medium | 5 |
| 34 | | Chiloglanis deckenii | | medium | 8 |
| 35 | Schilbeidae | Eutropiellus longifilis | Bula | medium | 2, 3 & 8 |
| 36 | | Schilbe moebiusii | Bula | medium | 1, 4, 5, 6, 7 & 8 |
| 37 | Clariidae | Clarias gariepinus | Kambale | Large | 1, 2, 3, 4, 5, 6, 7 & 8 |
| 38 | | Heterobranchus longifilis | Mjongwa | large | 3 & 7 |
| 39 | Bagridae | Bagrus orientalis | Kitoga | large | 1, 2, 3, 4, 7 & 8 |
| 40 | | Bagrus docmac | Kitoga | Large | 5 & 6 |
| 41 | Distichodontidae | Distichodus pertesii** | Ndungu | Large | 2, 5, 6, 7, & 8 |
| 42 | Amphilidae | Amphilius uranoscorpus | | small | 8 |
| 43 | | Distichodus sp. | Kibenamdenge | Large | 7 |
| 44 | Kneriidae | Parakneria spekii | | small | 8 |
| 45 | Citharinidae | Citharinus congicus | Mbala | Large | 2, 3, 4, 5, 6, 7 & 8 |
| 46 | | Citharinus latus | Mbala | Large | 5 |
| 47 | Anguillidae | Anguilla nebulosa | Mkunga | Large | 4, 5, 6 & 7 |
| 48 | | Anguilla mossambica | Mkunga | Large | 8 |
| 49 | Caridea | Macrobranchium sp. | Kamba | small | 7 |
| | ** Vulnerable | | | | |
| | 1 Bailey, 1969 | | 5 Jenkins et al., 2000 | | |
| | 2 Rubada, 1981 | | 6 Benno & Tamatamah, 2005 | | |
| | 3 WWF, 1992 | | 7 KVRSP, 2009 | | |
| | 4 Utzinger & Charlwood 1996 | | 8 RBEFA, 2015 | | |