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Aspects of Seasonal and Long-term Trends in Fisheries and Livelihoods in the Kilombero River Basin, Tanzania.

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Abstract

Inland fishery resources support livelihoods of rural fishing communities, but seasonal fluctuations and long term changes of fish catches have had substantial impact on incomes and food security for such rural households. In the present study, qualitative and quantitative methods were used to assess the seasonal and long term trends in fish catches, fishing effort and livelihoods among fishing communities in the Kilombero River basin in southeastern Tanzania. Fifteen fish species were identified in the river system, with five most important (% weight) being *Clarias gariepinus*, *Bagrus docmak*, *Oreochromis sp.*, *Schilbe moebiusii* and *Hydrocynus tanzaniae.* A distinct seasonal pattern in fish catches was found, where more fish were landed in the dry months (June, July, August and September) and less during peak of the rainy season (March to May). Reduction of fishing effort, crop farming and inaccessibility of fish landing sites and market places were cited as the main reasons for decline in the fish landed during the rainy season. Analysis of fish catch data for a period preceding the study (1985-2004) showed a steady decline in catches in the basin. This was corroborated by the majority (64%) of the fishers interviewed, albeit with slightly differing opinion among villages from different parts of the river profile. The seasonal and long term decline in fish catches was observed to impact negatively the incomes of the majority of the fishing households, with such impact being felt more in the downstream villages. Several coping mechanisms by the fishing communities for long term decline in fish catches were identified, with the majority of the respondents citing gradual shift towards crop farming as the most viable option for off-setting income losses from fishing activities. Others include general livelihood diversification strategies and increased fishing effort. In this study we confirm the substantial adaptive abilities of inland fishing communities toward abating the effect of reduced fisheries incomes. We therefore propose the consideration for these long-lived livelihood adaptive systems when devising long term strategies for the management of riverine fisheries and improving rural livelihoods.

Keywords: Coping strategies, Kilombero basin, Livelihoods, Riverine fisheries, Tanzania

Introduction

Fish contribute significantly to the average animal protein consumed worldwide. For instance it is estimated that 15% of the dietary intake of animal protein of 4.3 billion people worldwide comes from fish (FAO, 2014). Inland artisanal fisheries constitute a dependable source of income for millions of

people in many low income countries (Welcomme *et al*., 2010) and provide cheap, but high quality protein, thus contributing significantly to dietary needs. Such fisheries are important in local and national economies and contribute significantly to their Gross National Products (UNEP, 2010; Welcomme *et al*., 2010). Although Tanzania has enormous marine waters under its jurisdiction, inland fisheries remain the most important source of fish, contributing about 85% of the total annual output (UNEP, 2001), and their importance to rural communities cannot be overemphasized. Most of this production comes from the country's three large lakes (Victoria, Tanganyika and Nyasa) (FAO, 2005) and fisheries in river systems have seemingly been overlooked by the fisheries management authorities.

In most tropical rivers, seasonal and long-term changes in weather patterns have increased variability in fish stocks, resulting in stochastic fluctuations in fish catches (Welcomme, 1985; Sarch and Allison, 2001). This, together with population increases, overexploitation, environmental degradation, pollution, invasive species, climate change and the diminishing of alternative income-generating activities, has reduced household incomes and worsened food security for many fishing households (Mboya, 2013; Musinguzi *et al.*, 2015). Over the years, fishing communities in tropical river basins, as in many other rural settings, have evolved mechanisms to cope with such fluctuations whether predictable or stochastic (Marschke and Berkes, 2006; Morand *et al*., 2012; Musinguzi *et al.*, 2015).

Despite the role Tanzanian riverine systems play in supporting rural livelihoods such as those in the Kilombero River basin, little has been done to assess the impact of seasonal and long-term fluctuations in fish catches on the fishing communities and the mechanisms such communities cope with such changes. Although early studies (see Hopson, 1979; Bernacsek, 1981; Mapunda, 1981) provided useful baseline information on the existing environmental conditions and catches of commercially important fish species, there have been a limited number of recent studies within the Kilombero River basin on the several aspects of fisheries and livelihoods. Most of them have been short-term investigations (e.g. Utzinger and Charlwood, 1996) and do not describe annual changes associated with seasonal fluctuations. The difficulty in accessing most fishing villages in the river basin, as well as perceptions that the area was of little value for development may explain the lack of adequate research effort in the area (Rodgers, 1984). Since most people in the Kilombero River basin derive a major part of their incomes from fishing (Mwalyosi, 1990), this paper therefore describes seasonal and long term trends in fish catches and livelihoods in the basin and the mechanisms for coping with such changes.

Materials and Methods

Study area

This study was conducted in four fishing villages in the Kilombero River basin in the Kilombero District, Morogoro region, Tanzania (Figure 1) between February and September 2007. The Kilombero River rises in southwestern Tanzania on the eastern slopes of the Great East African Rift and flows northeast between the Mahenge massif and Udzungwa Mountain ranges. It joins the Great Ruaha River to form the Rufiji River which eventually pours into the Indian Ocean. The Kilombero River basin contains the largest freshwater wetland at low altitude in East Africa (Hughes and Hughes, 1992). The river is restricted to its main channel during the dry season between July and October but from March to May, the peak of rainy season, the floodplains are inundated and become large swamps extending over 4000 km^2 (Vanden Bossche and Bernacsek, 1990). The regular seasonal flooding of the wetland is of major ecological importance, maintaining high nutrient flows, habitat quality and fish productivity. The flood plains are important breeding and nursery grounds for many commercially important fish species and play a vital role in sustaining the whole of the

greater Rufiji River system further downstream (Mwalyosi, 1990).

Though flanked by a flood plain with extensive arable land for both subsistence and commercial agriculture, the Kilombero River also supports fishing activities that are of significant value to the local communities and beyond. Fishing is the single most important non-agricultural source of income for many communities in the river basin (Zehnder *et al*., 1987). It is estimated that there are 25,000 fishers within the basin, with 5-50% of men living near and within the flood plain, deriving most of their incomes from fishing (Mwalyosi, 1990).

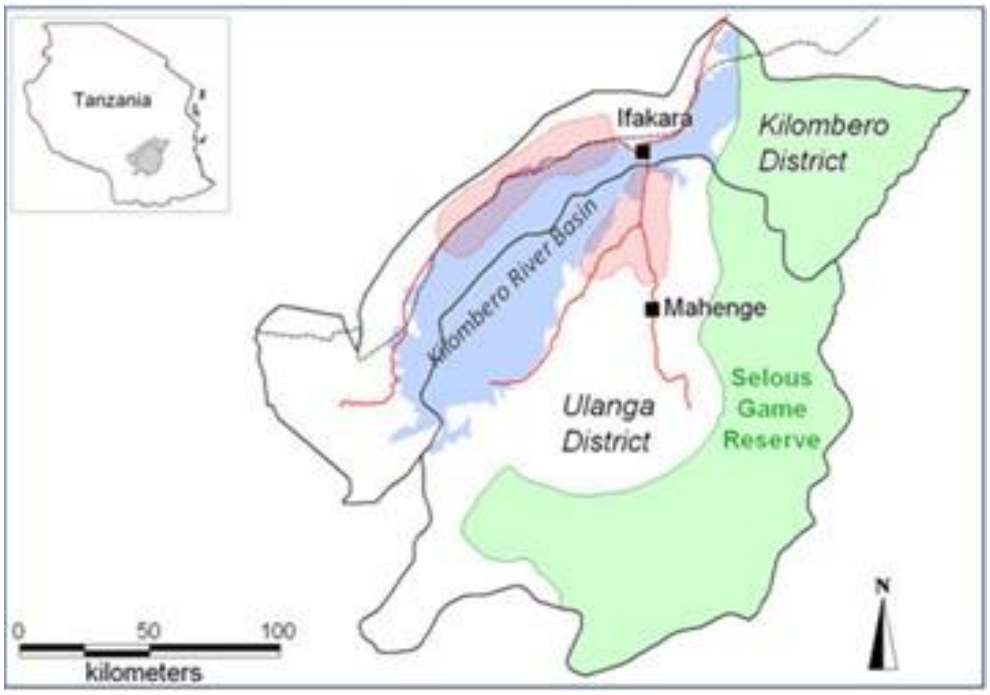

Figure 1: Map showing the Kilombero River basin in Tanzania (after Hetzel *et al*., 2006)

Field methods

Sampling for fish catches and demographic and socio-economic attributes of households was conducted in four villages, namely Lumemo, Mofu, Ikwambi and Lukolongo. The selection of these villages was based on: the extent of dependency on fishing as a source of livelihood; all-weather accessibility to the villages and their fish landing sites; and location of the villages relative to the river profile, with Lumemo and Lukolongo being the most down-stream and up-stream villages, respectively.

The quantity of fish landed and their composition was estimated at the fish landing sites (fishing camps) for five consecutive days, with catches from 10 randomly chosen fishers being used for the assessment. The species name, number and weight of the fish were recorded.

People's perceptions on seasonal and long-term trends in fish catches, incomes and coping strategies were assessed using questionnaires, key-informant interviews and participatory observations. In each village a total of 25 households were selected for the questionnaire survey, with structured and open-ended questions being put to the heads of the households. Key informant interviews were held with District Natural Resource and Fisheries Officers, Community Development Officers, and Ward and Village Executive Officers. Secondary data were obtained from reports from the District Planning Office, the

District Natural Resources Office, the District Fisheries Office, the District Community Development Office, the Ministry of Natural Resources and Tourism as well as monitoring and consultancy reports from the Kilombero Valley Integrated Environmental Management Programme (KVIEMP) and Frontier Tanzania.

Results

Demographic characteristics of the fishing households

Respondents to the questionnaire belonged to a total of nine ethnic groups with *Ndamba* being the dominant group (>80%) at Mofu and Ikwambi villages, but they made up <60% of the inhabitants at the other two villages (Table 1). The *Pogoro* made up 34% of the population at Lumemo village but <10% at any of the other villages. Ethnic diversity tended to increase in the upstream villages with Lukolongo having the most ethnically diverse fishing population. Lumemo village, although closest to the major town of Ifakara, had less diverse fishing population.

As far as household sizes are concerned, overall the fishing communities were found to have considerably large families, with over 78% of the households consisting of at least 4 inhabitants (Table 2). With the exception of Lukolongo, in the remaining villages over 30% of the households had at least 7 occupants. In terms of the level of literacy the majority of the respondents (89.1%) had a maximum of primary education (Table 3). While none of the respondents in Ikwambi village was illiterate, at least 4% of the respondents in the remaining villages received no formal education. With 12% of the respondents, Ikwambi was the villages with highest number of secondary school graduates, with Lumemo having the lowest.

Table 1: Ethnic composition (%) of the respondents (blank cells indicate zero values)

Ethnicity	Village			
	Lukolongo	Ikwambi	Mofu	Lumemo
Ndamba	56	86	96	58
Pogoro	8	-	4	34
Ndwewe	-	6	-	8
Bena	-	4	-	-
Mbunga	8	-	-	-
Nyaturu	8	-	-	-
Nyakyusa	8	4	-	-
Pare	4	-	-	-
Ngoni	8	-	-	-

Table 2: Sizes of fishing households (blank cells indicate zero values)

Household size	Percentage of respondents per village			
	Lukolongo	Ikwambi	Mofu	Lumemo
1-3	36	14	24	16
4-6	36	57	42	54
7-9	28	21	30	22
> 10	-	8	4	8

Table 3: Levels of education of the respondents (blank cells indicate zero values)

Maximum education attained	Percentage of respondents per village			
	Lukolongo	Ikwambi	Mofu	Lumemo
None	12	-	8	4
Primary	80	87	80	89
Secondary	8	13	12	7
Tertiary	-	-	-	-

Catch composition

A total of 15 fish species were identified from the fish catches (Table 4). The five most important fish species (% by weight) were *Clarias gariepinus, Bagrus docmak, Oreochromis sp., Schilbe moebiusii* and *Hydrocynus tanzaniae.* Together with *Synodontis* sp., these were cited by fishers and vendors as the most commercially important species, and thus highly valued. Fish catches in terms of both weights and species diversity tends to increase as one moves down-stream,

with the most down-stream village of Lumemo accounting for the largest part of the daily catch. Conversely, Lukolongo, the most up-stream village registered the lowest catches. Some differences in fish catch composition were also noticed among the villages. While *Clarias sp*., *Oreochromis sp.* and *Bagrus sp*. dominated catches in all the four villages, some relative contributions of other species to the daily catches varied among the villages.

Seasonal variation in fish catches

There was a distinct seasonal pattern in the fish catches which were highest in the dry months (June, July, August and September) and lowest during the peak of the rainy season from March to May (Figure 2). This seasonal trend is supported by information derived from both the focused group discussions and household questionnaire survey, where 81% of the respondents confirmed such a seasonal trend, with 51% of them regarded the dry season as the most productive period. Although some interspecific differences were cited, generally the seasonality in catches were found to affect all types of fish. Main reasons cited by the respondents for the seasonality of fish catches in the Kilombero River basin included seasonal changes in the flooding regime which caused difficulties in fishing and changes in fishing effort/intensity (Table 5).

Table 4: Percentage contributions to the average daily catches of various fish species in the Kilombero River basin.

Species	Lukolongo		Ikwambi		Mofu		Lumemo	
	% Number	% Weight	% Number	% Weight	% Number	% Weight	% Number	% Weight
Alestes stuhlmannii	2.3	2.4	7.5	6.5	-	-	2.1	7.4
Anguilla sp.	-	-	-	-	-	-	1.3	2.7
Bagrus docmak	5.9	10.9	15.0	18.7	2.3	6.7	0.5	3.0
Brycinus affinus	15.4	8.5	-	-	-	-	33.7	7.3
Citharinus latus	5.2	6.6	8.6	7.7	0.4	0.5	12.2	8.9
Clarias gariepinus	25.6	36.0	27.9	30.9	21.3	43.0	4.5	15.2
Distichodus petersii	-	-	7.5	9.5	6.0	8.1	3.3	7.5
Heterobranchus longifilis	-	-	-	-	-	-	-	0.6
Hydrocynus tanzaniae	18.4	16.1	8.0	9.4	1.8	4.4	4.6	7.1
Labeo congoro	1.6	0.9	2.7	1.3	-	-	3.3	6.2
Labeo sp.	-	-	-	-	-	-	3.3	11.0
Mormyrus longirostris	-	-	4.8	4.6	0.9	1.0	3.7	4.8
Oreochromis sp.	7.5	6.6	6.4	3.9	11.4	12.1	21.5	14.9
Schilbe moebiusii	12.5	10.0-	9.4	5.9	12.4	10.4	-	-
Synodontis sp.	5.6	1.9	2.1	1.6	43.5	13.8	5.9	3.4
Total catch	**305**	**105**	**186.5**	**207**	**2739**	**621**	**10801**	**4037**
Average daily catch	**76**	**26**	**37**	**41**	**547**	**124**	**2160**	**807**

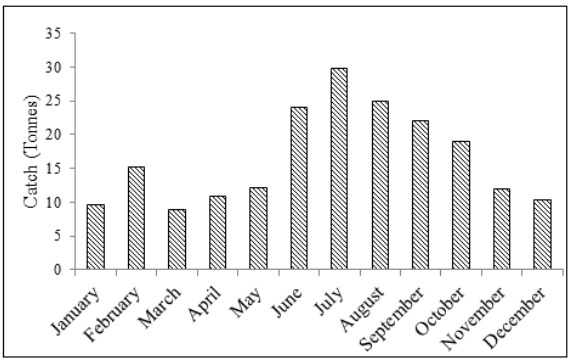

Figure 2: The average monthly fish catch in the Kilombero River basin, 1999-2004.

Table 5: Possible reasons for seasonal differences in fish catches

Perceived reason	Percentage of respondents by village			
	Lukolongo	Ikwambi	Mofu	Lumemo
Change in fishing difficulty	32.0	51.8	48.5	61.5
Change in fishing intensity	44.0	26.3	20.7	23.2
Change in patterns of fish breeding	22.5	13.2	30.8	11.5
No idea	1.5	8.7	0.0	3.8

Long term trends in fish catches in the Kilombero River basin

Long term catch data as well as the responses from the questionnaire method, focus group discussions and key informant interviews provided data on actual and perceived changes in fish catches. Figure 3 depicts fish catch data and their corresponding value for a period of 20 years (1985 to 2004), in which considerable fluctuations can be observed. There was a slight drop (3%) between the first two pentades (1985-89 and 1990-91), after which a more substantial decline was observed in the period of 1995-99 when the catches fell by 34%. Although catches slightly increased in the last pentade (2000-04), this was far below the 1990-94 levels. The values of the catches steadily increased during the 20 year period, from Tshs 13.5 million in for the first pentade to about Tshs 57 million in 2000-04. Although catch data for the subsequent pentades (2005-09 and 2010-14) were not available for analysis, declines in fish catches were evident, as this was further corroborated by the majority of the respondents (64.1%) of the questionnaire method. Differing opinion on the levels of long-term declines in fish catch was observed between the down-stream and upstream villages, with over 70% of the respondents in the villages of Mofu and Ikwambi citing greater decline in catches over the long term. This is contrary to the opinion of respondents from the most up-stream village of Lukolongo where only 44% cited such a decline.

Several factors were cited as the main cause of the continuing decline in fish catches in the Kilombero River basin, with 65% of the respondents blaming such reduction on long term changes in weather patterns. Declines in rainfall and their unpredictable timing were deemed to affect the patterns of flooding in the basin, and consequently the breeding of most species of fish. An increase in the number of fishers resulting from population growth and immigration and the increased incidences of fishing malpractices have also been cited as possible reasons. A considerable proportion of the respondents considered that the lack of alternative income-generating activities was one of the reasons why younger people were driven into fishing, which in turn was linked to a surge in illegal fishing practices, as younger fishers were considered to be more reckless. Moreover, most respondents felt that the reduced annual flooding of the river system was the main reason for a gradual increase in crop cultivation and livestock rearing adjacent to the main river channel. These activities were thought to increase soil erosion, leading to increased sedimentation of the river and thus a reduction in its depth, leading to overall declines in the fish catch and the disappearance of certain species of fish. Some respondents also associated the long-term declines in fish catches with the breaking of local traditional taboos, with rampant drunkenness, prostitution and other immoral behaviours in the fishing camps being cited as credible reasons for the long-term deterioration in fisheries productivity.

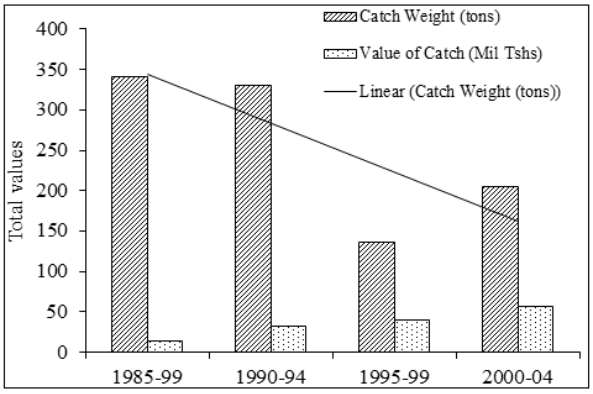

Figure 3: Average fish catches in the Kilombero river for five year periods from 1985-2004 and their corresponding value in Tshs (Source: Kilombero District Fisheries Office)

Trends in fishing intensity

It was noted that fishing intensity changed considerably from one season to the other, with 67% of the respondents acknowledging the existence of such a seasonal trend. More fishing took place during dry season, a trend confirmed by 77.4% of the respondents who cited it as their main fishing season, while 19.4% fished mostly during the wet season and 3.3% had no seasonal preference. This seasonal variation in fishing intensity applied to all villages, except for Lukolongo where a slight majority (52%)

cited no seasonal difference in the time they spent for fishing. The majority of respondents in the remaining villages cited such seasonal differences, as follows: Lumemo (73.1%), Mofu (80.8%) and Ikwambi (65.2%).

Most of the respondents (77.4%) spend at least half of the year (≥ 6 months) on fishing (Figure 4). Likewise, the most fishers were found to spend more days per week for fishing activities during such peak fishing seasons with 57.3% of them fishing on every day of the week at this time (Figure 5). In addition, most fishers spend considerable lengths of time fishing during peak fishing seasons, with almost 45% of them spending an average of eight hours per day (Figure 6) while over 70% of the respondents spend between 8-12 hours for fishing. The amount of time devoted to fishing by respondents shows how much most households in the river basin depend on fishing as a major source of their income.

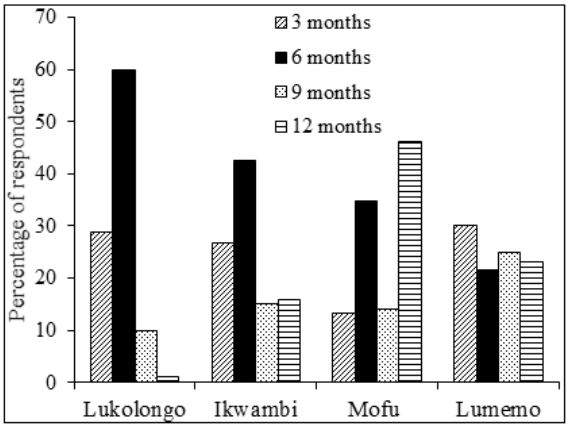

Figure 4: The number of months spent on fishing per year

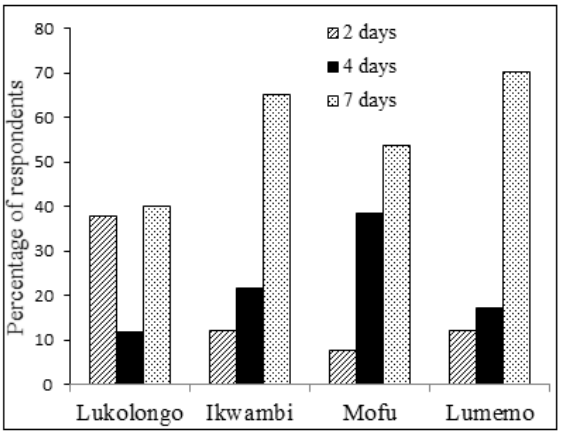

Figure 5: Number of days spent fishing per week during peak fishing season

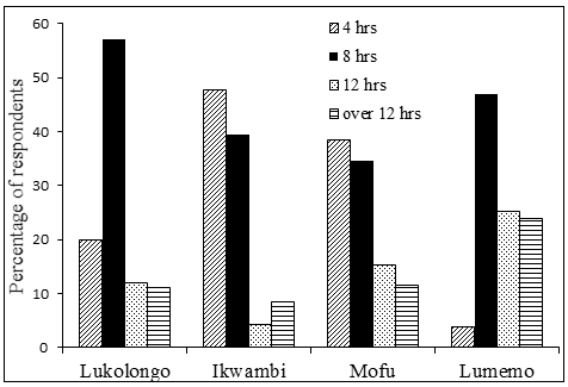

Figure 6: Number of hours spent for fishing per day during peak fishing season

Impact of seasonal and long-term declines in fisheries output on livelihoods

The seasonal and long term decline in fish catches had an impact on households' income within the Kilombero river basin and probably beyond. The majority of the respondents (68%) considered that the seasonal decline in fish catches had a negative impact on their income except at Lukolongo village, where most respondents (60%) cited no impact of such declines on incomes, over 70% of the respondents in the remaining villages were impacted by the decline. When asked to rank the severity of the impact, 41% of the affected households considered them severe, while 33.2% and 25.5% considered them mild and negligible, respectively.

Apart from the effect of seasonal fluctuations in fish catches on income, long term changes in such catches were also perceived negatively in terms of their long term impact on household incomes. Although the declines in catches corresponded with increase in their total values (Figure 3) it was not clear whether such an increase in revenues has had any impact on the well-being of the poor fishing communities in the Kilombero River basin. Nevertheless, the responses from the fishers have shown a long-term decline in the percentage contribution of fishing as a major source of household income and social wellbeing, with 63% of the fishers perceiving their incomes being progressively insufficient, unless supplemented by incomes from other non-fishing activities.

Coping mechanisms and alternative livelihood strategies

Fishing households in the Kilombero River basin have been forced to adapt to the recurrent seasonal fluctuations in the catches. They have adopted a number of short-term strategies with most (Table 6) citing crop farming as the most important supplementary activity. This activity has been crucial in ensuring that the reduced or lost incomes do not seriously affect household food security. Some respondents also considered the opposite to be true, that whenever returns from crop cultivation are reduced, fishing has proved to be an important supplementary source of income. For instance, it was noted that during the years of heavy flooding, which normally renders rice cultivation unproductive, fishing has always been a reliable source of household income.

The long term decline in fish catches has forced fishing communities in the river basin to reconsider their traditional dependency on fishing as a major source of income. A number of long term coping strategies by the communities were cited by the respondents (Table 7), with the majority choosing a gradual shift towards crop farming as a the best option to offset the continued loss of incomes from fishing. Differences were found in the levels of livelihood diversification among the villages along the river profile. For instance in the more upstream villages of Lukolongo and Ikwambi more than 70% of the fishers were willing to shift toward crop farming. This figure was relatively lower in the more downstream villages of Mofu and Lumemo.

Table 6: Short term mechanisms for coping with reduced fishing incomes

	Percentage of respondents by village			
Coping mechanism	**Lukolongo**	**Ikwambi**	**Mofu**	**Lumemo**
Crop farming	61.0	54.2	59.1	56.2
Manual labour	9.0	4.8	9.0	11.4
Animal husbandry	1.2	5.4	11.6	1.5
Food vending	1.5	2.2	1.5	4.2
Selling local brew	3.2	2.0	1.0	4.2
Other petty businesses	11.0	16.5	5.8	8.8
Increasing fishing effort	1.0	4.0	2.0	5.4
Borrowing	3.4	-		1.4
Use of personal savings	1.4	2.4	2.4	1.8
Minimizing household expenditures	5.8	8.5	5.2	5.1
No action	1.5	-	2.4	-

Table 7: Long term strategies for coping with reduced household incomes from fishing

	Percentage of respondents by village			
Coping strategy	**Lukolongo**	**Ikwambi**	**Mofu**	**Lumemo**
Gradual shift to crop farming	82.5	71.0	56.0	61.0
General livelihood diversification	5.0	12.0	38.4	25.0
Increase in fishing effort	4.8	8.7	5.6	7.0
Increase in fish price	-	-	-	7.0
No action	7.7	8.3	-	-

Discussion

Understanding the interactions between a natural resource such as a fishery, and the people who are dependent upon it is vital in ensuring the long-term sustainability of both resources and livelihoods (Allison and Ellis, 2001). More important is to understand the natural and human-induced dynamics of such resources, the impact of such changes on the livelihoods of the dependent populations, and the immediate and long-term local adaptations to such dynamics. This will provide an opportunity for devising a comprehensive approach to the sustainable management, utilization and development of the fishery resources, and hence alleviate poverty among the rural fishing communities.

Both seasonal and long-term fluctuations in fish catches were noticed in the Kilombero basin but such fluctuations in fish catches are common in most river systems. Seasonal

changes in habitat characteristics have been linked to changes in the structure of fish assemblages, including their specific composition and abundance (Meffe and Sheldon 1988; Pusey *et al*., 1993, 1998, 2000) through changes in habitat complexity brought about by changes in water depth and velocity (Felley and Felley, 1987).

In the present study, changes in fish availability and catchability were noted during wet seasons when the river widens and makes fish harder to catch. This is due either to the dispersion of fish over the flood plain or the difficulty of reaching the deeper waters of the main river stream where stocks of certain important fish species were believed to exist. On the contrary, fish were easier to catch in the dry season because they become concentrated in the receding river. Seasonal declines in fish catches in the Kilombero River can also be attributed to reduced fishing effort. Fishing intensity in terms of time invested in the fishing, type and number of fishing gear employed as well as the number of people involved in the fishing activities is a good indicator of the amount of effort exerted in harvesting the fisheries resources. It further shows whether the returns from the fishing activities are worth the investment in terms of energy, time and resources. In most of the villages studied, wet season is the crop growing season, especially in the downstream villages where rice paddy cultivation is more common. In contrast, there was little or no seasonal change in fishing effort at Lukolongo, the most up-stream of the villages, which does not experience extensive flooding during wet season. Seasonal changes in the quantity of fish landed in the basin was also attributed to the seasonal fluctuations in fish prices and thus the perceived levels of returns from the fishing activities. Increased accessibility to most landing sites during the dry season leads to increases in fish prices, since that enables more fish vendors to reach the sites and transport the fish to more lucrative markets. On the other hand flooding makes most fishing camps inaccessible during the wet season and hence little fish is exported and most is consumed locally. This leads to fall in fish prices, thus making fishing a low return activity for most fishers (e.g. Hilborn et al., 2005).

This study also revealed some linkages between ethnicity and fisheries productivity. The ethnic composition of Lukolongo village was more diverse (Table 1) and its inhabitants engage in more diverse activities than those in the ethnically homogeneous populations in the downstream villages. Here the majority *Ndamba* are traditionally fishers and thus more likely to stick to fishing throughout the year. Besides, increased incidences of fishing malpractices, which have been partly blamed by the respondents, mostly in the downstream villages, for the observed long-term declines in fish catches, have been associated with increasing multi-ethnicity among the fishing communities in recent years, with the natives blaming such malpractices on immigrant fishers.

The present study assumed rationality of the fishing communities in the Kilombero River basin in mitigating for the impact of both short and long term declines in incomes as a result of seasonal and long-term declines in fish catches. The findings from the present study agree with this hypothesis, identifying several measures undertaken by the communities to maintain their incomes and food security. The immediate response is, however, a short-term strategy for most communities as the sustainability and profitability of these alternative activities are still limited by a number of factors. Environmental degradation brought about by a changing climate, population growth and low productivity has hampered agricultural production in many rural areas of Tanzania (Madulu, 2004). Consequently, rain-fed agriculture, a relatively unreliable alternative income generating activity has evolved over a long period of time as an integral party of the socio-economic fabric of the fishing communities. It is therefore essential that any local or state-led fisheries management initiatives in the Kilombero River basin recognize the significance of these seasonal and long term fluctuations, and the nature and rationality of fisher folk's responses to them

(Sarch and Allison, 2001). National and local fisheries management authorities should not undermine these long-lived mechanisms used to both cope with the fluctuating resource base, but rather institute strategies to manage these vital resources in a way which best incorporates them.

Acknowledgments

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