African Freshwater Fisheries: What Needs to be Managed?

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Abstract

The management of African freshwater fisheries in Southern African Development Coordination (SADC) countries is discussed. Changes in catch and fishing effort in the SADC freshwater fisheries in the past 50 years, the main causes behind the patterns of change in fishing effort, the effects of fishing effort and environment on the regeneration of fish stocks, as well as existing and proposed fisheries management regulations are investigated.

Introduction

During the past decade, the debate on how to manage African freshwater fisheries, as has occurred in many fisheries worldwide, has centred on possibilities for co-management. In reaction to conventional (top-down), centralized management, an increasing number of documented cases show that locally based, access-regulating mechanisms can effectively regulate the intensity of exploitation. A clear distinction between free access and common property is now established in the literature and most people seem to think that fisheries management is best performed in a collaborative sharing of responsibilities between local people and state authorities. 'Co-management' is proposed as a way to move away from the failures of past management approaches, or simply as a way to make fisheries management cheaper, even though it is admitted that the notion is ambiguous and often difficult to define.

A characteristic that the co-management alternative continues to share with more conventional management is the fundamental assumption that fish resources are under pressure from increased fishing effort and that this represents the major challenge for the sustainability of fisheries in terms of biological and/or economic overfishing. Regulation of fishing effort therefore remains the essential means to avoid 'tragedies' and improve efficiency and peoples' living conditions. Where it differs from conventional thinking is that the promoters of collaborative management assume that once people are convinced of the positive effects of effort reduction as trends in catches and catch rates are reversed, fisheries will come to some form of self regulation.

Recently, research on other common property resources in tropical ecosystems is challenging underlying assumptions of both conventional management and co-management. Some ecologists and social scientists in the fields of pastoralism and forestry in Africa now question to what extent and how anthropogenic variables affect the regeneration of pastures and forests (see, e.g., Scoones 1995; Fairhead and Leach 1996). Abiotic variables related to climate variability and change may be much more important to the dynamics of the ecosystem. Such dynamics at least obscure the possibility to perceive trends resulting from human activity and may even outweigh anthropogenic impacts. Only to a minor extent have the same questions been raised in relation to African fisheries.

In 1997, a group of researchers, with experience in African freshwater fisheries initiated a research project entitled 'Management, co-management or no management? Major dilemmas in sustainable exploitation of freshwater fisheries in the SADC countries'. The project was funded by several sources, the principal one being the Norwegian Research Council. It ended in 2001. Researchers from Europe and the SADC countries and with backgrounds in biology and social sciences have been involved in undertaking case studies and synthesis analyses. The project has mainly focused on medium size waterbodies in Malawi, Zambia and Zimbabwe, although it also draws upon material from the other fisheries in the region. The questions addressed are:

- How have catches and fishing effort changed over the last 50 years?
- What are the main causes behind these changes?
- How does fishing effort influence the regeneration of the stocks?
- To what extent are existing and proposed management regula-

tions in fisheries consistent with the needs derived from the answers of the previous questions?

Changes in Catch and Fishing Effort in SADC Freshwater Fisheries in the Last 50 Years

Obtaining reliable catch and effort data in African small-scale fisheries is problematic. According to FAOSTAT (FAO 2000), freshwater catches in the 12 mainland SADC countries steadily increased from 168 000 t in 1961 to 598 000 t in 1986. Since then, catches have stabilized between 600 000 and 700 000 t and in 1997, it is reported to have been 635 000 t. The Democratic Republic of Congo, Malawi, Tanzania and Zambia catch more than 90% of the total freshwater landings in the region. The increases over time have resulted partly from exploitation of new water bodies, for example, Lakes Kariba and Cabora Bassa, and partly from fishing for previously untouched stocks, especially small pelagics. Fishing effort on already exploited stocks has continued to increase during the same period although this varies according to the water body. For example, in Lake Mweru, numbers of fishers have steadily increased while in the Bangweulu swamps it has probably remained fairly stable over a long time. In both the Zambian and Zimbabwean parts of Lake Kariba, fishing effort on the inshore stocks has varied considerably and is probably not much higher today than it was just after the lake was filled in the late 1950s. Intermittent lakes like Chilwa, Chiuta and Mweru Wa Ntipa also appear to be subject to considerable fluctuations in effort. In Lake Malombe, the number of fishers has steadily increased through the 1970s and 1980s, stabilized in the 1990s but seems to have decreased in recent years.

Equally, we find large differences in effort dynamics with reference to 'population-driven' and 'investment-driven' changes of fishing effort. The first concept refers to changes in the number of harvesters, while the latter relates to changes in technology, diversification of methods and/or in number of gears per unit[1]. All fisheries have elements of both types of change, but their relative importance varies considerably and in SADC freshwaters it is the population-driven changes of effort which have been the dominating characteristic during the last 50 years. This means that harvest technology and overall production costs per fishing unit in most cases have remained relatively stable, while the number of harvesters has grown or fluctuated. It is only in Lake Malombe and in some historical cases connected to the (unsuccessful) development of so-called 'modern' fisheries by foreign entrepreneurs that investment-driven changes in effort dominate. Here, it is technological change and number of gears per production unit which constitute the most important element of the effort development.

The variation in effort levels is most dramatic in fisheries dominated by population-driven changes. For instance, in Lake Kariba the number of fishers decreased by 75% in less than five years after 1963. Later, it increased by 150% in seven years during the 1980s. These fisheries are dominated by simple and capital-extensive technologies. This entails low entry fees which facilitate the mobility of people in and out of the fisheries. Economically speaking, anyone can become an independent fisher within a few years. Perhaps it is this mobility that is the reason for Pauly's argument (1994, 1997)— that the entry of people who have been marginalized in terms of other resources or occupations causes the biggest worries in African (as well as Asian and Latin American) small-scale fisheries at present. According to Pauly, the small-scale fisheries have become a "last resort" and the accumulation of destitute people in the sector ultimately leads to "Malthusian overfishing".

Our results indicate an even greater mobility. In most fisheries people not only move into fisheries, but equally move out of them as well. In the inshore fisheries of Kariba, fishers from all over the region came to establish themselves in the 1980s only to move away again at a later stage. It is also in fisheries where effort is steadily growing where people move out of the fisheries. For instance, in Mweru, more than 3 000 fishers left the fisheries in a period where the total number of producers grew by 2 300. Until now, the fisheries in SADC freshwaters have not functioned as a last resort, but as an occupation that people can join and leave whenever they judge they need to.

Causes Behind the Patterns of Change in Fishing Effort

The findings regarding effort development confront us with a series of questions related to the causes. Conventional management thinking tends to consider growth of

[1] The distinction is inspired by Brox (1990) who demonstrates very different social and economic consequences of population-driven and investment-driven growth of effort in the North Norwegian cod fisheries.

effort as inevitable and relates it to social factors such as demographic growth (population-driven) and an expanding demand for fish (investment-driven). Such explanations are problematic. It does not explain the variation over time since the demographic growth has been fairly stable in most places. Neither does it explain the differences between water bodies since there is little accordance between high demographic growth and increases in fishing effort. Finally, investment-driven growth seems to be the exception, despite a general increase in demand for fish in the whole region.

Fluctuations in population-driven changes are mainly induced by a combination of variations in ecological productivity and opportunities in other sectors. The sudden reduction in productivity after Lake Kariba was filled, combined with good opportunities in other sectors, led to the dramatic reduction of numbers of fishers after 1963. Similarly, the crisis in the Zambian economy after 1974 led many people to join the Kariba fisheries after the end of the Zimbabwean War of Independence in 1980. More than 80% of fishers who arrived in Kariba in the 1980s previously worked in the Copperbelt or in Lusaka. It was also the same crisis which in many ways led people who had lost their jobs in the Copperbelt to introduce the new fishery for chisense in Lake Mweru. There is little doubt that the SADC freshwaters serve as an important buffer or safety-valve for numerous people in times of economic distress, but entering the fisheries is not an irreversible process.

Local access-regulating mechanisms based on ethnic or community identity are found everywhere, although they may differ in effectiveness in controlling recruitment of new fishers. In Malombe, such mechanisms have, for long, excluded owners coming from outside the fishery. In Lake Kariba, it was only in the early 1960s and during the last decade that local access regulations have been effective in excluding outsiders; elsewhere they seem to have been of little relevance to exclude newcomers.

In contrast, important investment-driven changes in the form of more capital-intensive harvesting methods seem to reduce population-driven growth. In Lake Malombe, the shift from gillnets to various, much more capital-intensive seining methods, have substantially increased the entry fees into the fishery and thereby reduced the number of potential operators.

Many studies, also from outside the SADC area, indicate that the overall constraint related to more capital intensive fishing methods (and to investment-driven growth of effort) is connected to access to financial capital. No cases were found where fishing activities are in themselves sufficient to trigger further technological development based on higher levels of investment. There always seems to be a need for financial resources from outside. In Lake Mweru, the financial needs in the mpundu (*Labeo altivelis*) fishery, initiated in the early 1950s, were met by European entrepreneurs. In Lake Malombe, the need for capital to buy seines was mainly met through surpluses generated in international labor migrations. It is interesting to note how the macro-economic factors seem to affect vertical changes of effort in an opposite direction compared to population-driven changes. While improved macro-economic conditions will tend to reduce the population-driven growth by more people seeking livelihood in other sectors, it may facilitate investment-driven growth by increasing the surpluses from outside being reinvested into fisheries.

But the lack of financial resources and of investment-driven growth in the SADC freshwaters are merely a reflection of much more basic aspects in the societies and of the functioning of institutions, both at central and local level, supposed to regulate fisheries. Analytical approaches such as those developed by the new institutional economy may be very useful to understand why institutions (e.g., to cover financial needs) do not develop as easily as one could expect. But the analyses of the existing institutional landscape in SADC freshwater fisheries also demonstrate the weaknesses of this type of approach. They demonstrate how difficult it is, at the local level, to identify institutions with well-defined social rules and with underlying norms which are commonly shared. Such difficulties may be observed if we, e.g., in Malombe, study the relation between active fishers and gear owners for whom they work: it shows the complexity of what often is believed to be a straight employer/employee relationship. However, closer analysis proves that the underlying norms supposed to stabilize the relationship are far from commonly shared and that the rules therefore often emerge as ambiguous and even contradictory. The result is that the owners only control their labor with great difficulty and that fishers often feel betrayed and/or exploited by the owners. As well as controlling access to financial resources, the control and management of the labor force also seem to constitute an effective constraint for investment-driven growth in effort.

Effects of Fishing Effort and Environment on the Regeneration of Fish Stocks

Classic stock assessment models, commonly in use in many African fisheries, give a major role to fishing effort in explaining and predicting changes in the regeneration of fish stocks. However, setting limits on fishing mortality based on model-information has met with limited success. Apart from being unenforceable in many instances, a number of reasons more intrinsic to the fisheries and ecosystems contribute to this failure. In the lakes studied, environmental drivers are often more significant than effort in explaining changes in fish production. For instance, even on a highly aggregated level, variations around the trend in total catch of the SADC area are related to lake level fluctuations of the African Great Lakes. Next, total yields in these multispecies and multi-gear fisheries are surprisingly stable over a large range of effort, but with considerable changes in species and size composition, both as a result of fishing and as a result of environmentally driven processes. Many, but not all stocks appear to be highly resilient, with a large capacity to bounce back after release of pressure. Lastly, variations in effort levels are found to be to some extent a reflection of the variations in the productivity of the ecosystems, a result also found in other research (Allison and Ellis 2001).

Biological management of fish stocks has to be pragmatic and adaptive, based on knowledge of long-term system variability and the reactions of both fish and fishers on those dynamics. Three elements of the information base are needed to provide such knowledge:

(1) System variability

Long-term changes in water levels, associated with climate change, are at least as important as effort in explaining stock changes. This is immediately clear for lakes like Mweru Wa Ntipa, Chilwa/ Chiuta and Liambezi that regularly dry up completely. After refilling, fast increases in productivity take place. But such effects are not restricted to these extreme examples. In Lake Mweru, declines in total catch rates are associated with periods of extremely low water levels and catch rates stabilize, albeit at a lower level, when water levels rise again. In Lake Kariba, differences in size composition and catch rates between fished and unfished areas in the lake can be attributed to fishing. But a close relation between overall fish production and lake levels indices strongly suggests that the environment, more than the fishery, is the dominant factor affecting change, a result also found in Lake Turkana (Kolding 1995). Lastly, in Lake Tanganyika, large changes in catch rates of clupeid species over 40 years seem to be mainly environmentally driven (van Zwieten et al. 2002).

Freshwater lakes and rivers can be classified over a range from pulsed to constant environments. For any particular system, changes in water levels as the dominant environmental driver can provide a number of indices that can be related to changes in stocks. By monitoring catches, catch rates, fishing effort and water levels and evaluating their trends and variability, knowledge will accumulate on the particular behavior of a system under various conditions.

(2) Susceptibility of species to fishing

The SADC freshwaters have remarkably stable overall system yields. Underneath such apparent stability a bewildering array of changes can take place, while high variability in total yield may obscure possible trends (Fig. 1). Many examples of serious declines of single stocks can be found. Resource character plays a role here and specific life histories are particularly 'susceptible' to fishing, e.g., large, slow growing species or species with particularly vulnerable stages. For example, large predatory *Lates* species in Lake Tanganyika clearly declined as a result of fishing, while stocks of large *Barbus* species in Lake Tana, Ethiopia, are seriously endangered due to heavy fishing during spawning migrations. This, despite the overall extremely low effort levels that even decreased over the past decade (L. Nagelkerke, M. de Graaf pers. com). The more resilient a species is to increases in fishing pressure, the less relevant management becomes from a biological perspective. 'Resilient' species like tilapias have been dominant for ages in many African freshwater systems, while recent shifts towards faster growing 'highly resilient' species like freshwater herrings and small barbs species have taken place. In Lake Mweru, a fishery on clupeids (chisense, *Microthrissa moeruensis**) started in the middle of the 1980s, while in Bangweulu a similar fishery on a pelagic cyprinid started in the 1990s. In Lake Malombe, the shift towards smaller species took place after the collapse of the chambo (*Oreochromis* spp.*)* fishery, largely replacing it.

(3) Selectivity and scale of operation of fishing patterns

Small-scale fisheries, i.e., where the scale of individual day-to-day

* Valid name *Poecilothrissa moeruensis* (www.fishbase.org)

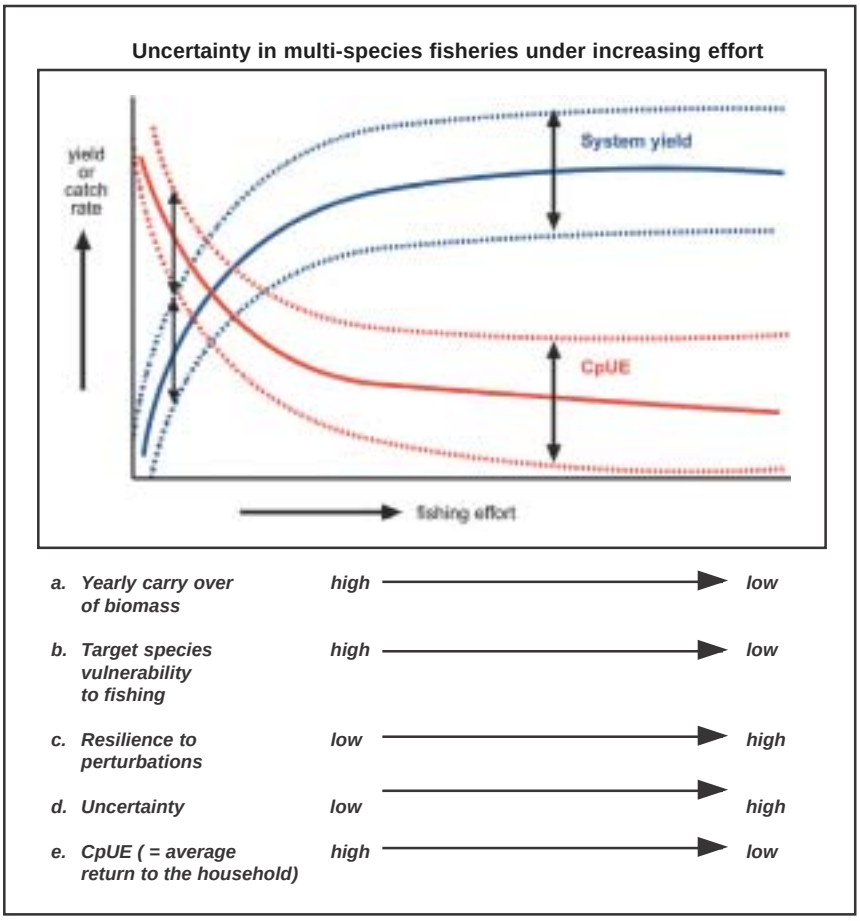

Fig. 1. Generalised development of fishing yield and catch rate of a fishery with increasing effort. The broken lines represent increasing variation around the mean yield and catch rates over time (vertical arrows). The five characteristics below the plot changing with increased effort refer to total fish biomass system (a, b and c) and to the fishery (d and e).

fishing operations is small, are able to adapt rapidly to changing circumstances. In Mweru, the drop in catches of tilapia (*Oreochromis macrochir)* and disappearance of larger size classes of species in the 1970s was followed in just a few years by a decrease in mesh size in the whole gillnet fishery. Strong year-classes formed after favorable conditions and large *O. macrochir* reappeared despite increased effort, not being caught by the dominant smaller mesh sizes, and formed the base of a renewed seine fishery. Even in this heavily fished lake, some species became exploited only very recently with, for the fishery, newly developed methods. Although invariably multispecies, many fishing methods are species selective: in Lake Bangweulu, some active methods forbidden by the formal regulations catch stocks of *Tilapia rendalli* that otherwise remain unexploited. The artisanal fishery in northern Lake Tanganyika out-competed the industrial fishery through its apparent capability to address the highly variable dynamics of the pelagic stocks (van Zwieten et al. 2002). In general, limited danger seems to exist in increased diversification of fishing patterns at small operational scales, i.e. when fishers use methods that catch the ubiquitous bucket of fish per day. By hedging the inherent variability in relative abundance of multispecies stocks, and opting to target many species simultaneously, they are developing an overall fishing pattern that could be ecosystem conserving in principle. The danger increases where instead the scale of operations override the inherent variability in stocks, in an attempt to maintain catch rates at the same level through increased gear efficiency, either arising from investments in better technology or from more intensive use of existing technology.

Conclusion

Since the beginning of the 1900s, fisheries regulations in the region are mainly related to how colonial powers and later independent states have invested in building up management systems based on accepted wisdom regarding the relationship between fishing effort and biological productivity.

However, ecological changes are quite complex and effort may be less important for the control of yields than generally anticipated. An increased perception of the natural variability in the systems with vulnerable stages during periods of low productivity and increasing uncertainty, connected to growth in effort, indicates the need for more adaptive management and dynamic 'early warning systems' - elements of which have been outlined here.

The findings that effort dynamics depend as much on the general economic and social development in the region as on the fishing economy imply a much broader focus for monitoring fisheries. Economic analyses based on how they react and respond to macro-economic changes are as important to understanding fisheries development as those based on current biological monitoring.

As long as changes in effort remain population-driven, general regulations of effort are problematic. It will be very hard to show that reduced effort leads to improvements in catch rates.

Adaptive effort reduction may nevertheless be of crucial importance, either in particularly vulnerable periods, or as a means to cope with natural variations which will occur under any type of management system. However, if effort dynamics turn to become more investment-driven, the need for regulations increases considerably. The monitoring of investment-driven changes of effort is therefore of great importance.

Any management regime is political in the sense that it includes some and excludes others from access to valuable resources - this is an ongoing struggle in all types of fisheries. It should not be too difficult to decide upon the question of whether the SADC freshwaters are to continue to serve as an economic safety-valve and a buffer for the common people of the region, or whether its fisheries should develop into more industrial enterprises (and thereby exclude many). In a situation with serious and long lasting macro-economic recessions, the buffer function must be upheld. Besides, our studies have also shown that the freshwater fisheries hardly will become a driving force in the process for much needed economic reforms.

Locally based access-regulation mechanisms already exist, and sometimes they prove to be very effective means to exclude people from the fisheries. From the perspective of keeping the fisheries open to the small-scale fishers, the great interest shown by governments and NGOs to establish local institutions that can cooperate with central authorities in managing the fisheries should be handled with some care. Rather, co-management must imply a process of mutual adaptation where local people try to coordinate existing access-regulating mechanisms (and the underlying interests they represent) and central authorities' priorities into some form of coherent system. To what extent such coordination, within short time perspectives, is possible and to what extent it will lead to more efficient use of natural resources is not evident. In any case, such attempts imply an exercise where both local populations and governments are forced into some sort of genuinely democratic process.

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