Fisheries management and uncertainty: the causes and consequences of variability in inland fisheries in Africa, with special reference to Malawi

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Abstract

Uncertainty pervades the management of fisheries. Scientific fisheries management over the last 50 years has been based on the premise that there exists an equilibrium relationship between fish production and the level of harvest that can be taken without depleting the stocks. These equilibrium 'surplus-production' and 'yield-per-recruit' models have served to establish the principle that unregulated fishing will deplete fish stocks and dissipate economic rents from the fishery, but they have been of limited applicability for practical fisheries management when their equilibrium assumptions are violated. The influence of equilibrium models has extended beyond stock assessment into management, such that many fisheries management measures are based on a 'steady-state' view of fishery resources even when most stakeholders are aware that the assumptions are untenable.

This paper makes the case that fish production in many African inland waters is driven by climate variations. For fisheries where stocks fluctuate independently of fishing effort, management for traditional sustained-yield type objectives is inappropriate. While there have been many studies attempting to elucidate the mechanisms for environmentally-induced fishery fluctuations, there have been fewer studies of the consequences of such variability for fisherfolks' livelihoods, and for the design of appropriate fishery management regimes. A study of the livelihood strategies of fisherfolk involved in the important fisheries for small pelagic species in Lake Malawi is used to make the case for management that supports opportunistic exploitation of fluctuating resources by enabling geographical and occupational mobility. Livelihood sustainability and resource conservation are best served by support for such flexible strategies. The interdependence of fishing and other sectors of the rural economy suggests that policies and development interventions aimed at raising fishermen's incomes without addressing the wider context of rural poverty are unlikely to be successful or sustainable. Species-based fisheries management and development focused on the fishing enterprise would benefit from re-conceptualisation within a broader natural resource management and rural livelihoods framework.

Introduction

Many fisheries resources fluctuate dramatically from year to year due to climactic variability (e.g. Glantz, 1992; Bakun, 1998). There has long been widespread recognition that constant catch or constant effort approaches to management, based on the paradigm of an achievable optimum sustainable yield, are inappropriate for these types of fishery (e.g. Beddington & May, 1977; Larkin, 1977).

The problem of variability in fisheries, and consequent uncertainty in future stock size estimates can be dealt with in one of two ways. Variability can be regarded as random 'noise' that obscures underlying steady-state dynamics, or its causes and patterns can be investigated, and the results of these investigations incorporated into understanding, if not predicting, future stock and harvest levels.

Although different fisheries are known to have very different patterns of catch series, there have been few attempts to classify fisheries according to extent and patterns of variability. Caddy & Gulland (1983) classified fisheries as steady, cyclical, irregular and occasional. This latter category denotes so called 'boom and bust' stocks that sustain important fisheries episodically before disappearing for decades or even for centuries. More recently, there have been attempts at formal statistical classifications of patterns of variation in catch or biomass time-series (Spencer & Collie, 1998) and to link patterns of variation with fish life-history parameters (Kawasaki, 1983). This work has interesting implications for fisheries management, as it suggests that different management targets may be appropriate for different fishery types.

Interpreting the different categories of fisheries in terms of the factors that could drive different patterns of variability (DeAngelis & Waterhouse, 1987) suggests that steady and cyclical fisheries are likely to be driven primarily by biotic interactions (e.g. stock-recruitment relationships and catch-effort relationships). Irregular and occasional stocks could be either chaotic systems driven by strong biotic interactions (feedbacks), or systems where biotic interactions are relatively unimportant, and abiotic factors are the main influence on stock dynamics. If the latter explanation for the dynamic behaviour of fluctuating stocks is accepted, management based on regulation of biotic interactions (e.g. the effect of harvesting effort on future stock size) is much less relevant.

This paper sets out to examine whether certain fisheries in Africa's Inland waters are strongly influenced by climatic fluctuations, such that the use of management based on standard equilibrium fishery models may be problematic. The paper then explores the fishery implications of climate-driven stock fluctuations, through analysis of fisherfolks' livelihood strategies in Malawi, derived from both primary fieldwork and published information.

Finally, the paper draws out some preliminary policy and management implications of these observed livelihood strategies. These implications are framed against a context where fisheries policy and management in Malawi is undergoing a transition from centralised state-led management towards community-based or co-management (Sholtz *et al*., 1998; Allison *et al.* 2001).

Africa's inland fisheries

Fish protein has made up approximately one fifth of the animal protein consumed in Africa since 1961 (FAO, 1996). However, the contribution from inland waters has risen from less than 25 per cent in 1951 to 41 per cent of domestic fish production in 1994. In absolute terms, inland fisheries production has soared from 250 000 tonnes in 1950 to almost 1 500 000 (FAO, 1996).

In recent years, Africa's inland fisheries have produced the majority of fish consumed in many African countries and almost all of that consumed in Mali, Chad and East Africa (Figure 1). Africa's inland fisheries are important not only as a source of food, but as a source of employment and income for resource poor families. They are exploited almost entirely by artisanal fishing communities in predominantly rural areas. In 1996 FAO estimated that the number of canoes operated by artisanal fishers in Africa's inland waters had increased by 40 per cent in the preceding decade and that most freshwater fisheries were intensively exploited.

" As fishing effort continues to respond to the growing demand for fish, proper inland fisheries management is becoming more and more urgent." (FAO, 1996: 10-36).

'Proper fisheries management' in this context has usually meant management for equilibrium production targets such as maximum sustainable yield, with measures to achieve these targets enforced by the State (e.g., for Lake Malawi, Tweddle & Magasa, 1989; FAO, 1993; GOM, 1999).

While fisheries management in Africa shows an increasing interest in community and co-management strategies (e.g. Normann, Nielsen & Sverdrup-Jensen, 1998), these approaches too, are often based on unjustified assumptions about static equilibria and livelihoods based entirely on fishing. These assumptions lead to uncritical promotion of territorial use rights in undifferentiated and idealised constructs of a 'community' united by fishing interests (Allison & Ellis, 2001). The assumption in both cases is that fish yields can be both optimised and stabilised by better management. This does not allow for the possibility that optimal strategies may be opportunistic and 'unstable' in the conventional sense.

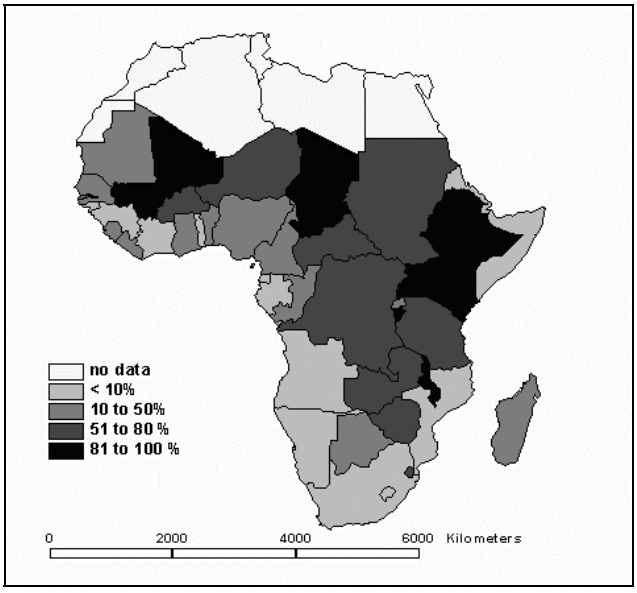


Figure 1: Inland fish production as a proportion of fish supply available per caput in sub-Saharan Africa, 1994 (Adapted from FAO, 1996).

Climate and fishery fluctuations in Africa's inland waters

Conventional fisheries management in industrialised countries over the last 40 to 50 years has been based directly, or conceptually, on the Gordon-Shaefer bioeconomic equilibrium model and its derivatives (Figure 2). This model proposes an equilibrium between catch and fishing effort, so that fishing effort can be regulated to achieve a maximum sustainable yield (F_{MSY}), maximum economic yield (F_{MEY}) and related targets. Failure to regulate fishing effort is thought to lead to a situation where fishing effort tends towards the point where economic returns from the fishery equal the costs of exploiting the resource – the 'open access equilibrium' (F_{OAE}). If signals of resource scarcity are distorted or masked by subsidies to the fishing industry (in the forms of grants for modernising fishing technology, compensation for poor fishing seasons etc), then fishing effort can even exceed the open access equilibrium, possibly leading to stock extinction.

Although the Gordon-Shaefer model provides an elegant and persuasive overview of how a fishery bioeconomic system works, it has been extensively criticised for failing to provide the basis for successful fisheries management. There are many practical difficulties with the model: it is difficult to identify the target reference points until they have been exceeded; it is difficult to dis-aggregate the models in fisheries where one stock is fished by many fleets, or one fleet fishing many stocks; and it is based on catch and effort data that are often unreliable (Hilborn & Walters, 1992). There are also the theoretical difficulties with the equilibrium assumptions, outlined in Section 2, above. All these problems have led some to question whether the model itself, as well as the fishery management systems that are built on its basis, may not be appropriate to some fisheries - particularly those that fluctuate extensively (e.g. Sarch & Allison, 2000).

How applicable are bioeconomic equilibrium (or surplus-production) models to African Inland fisheries? Three of the most important aquatic production systems in inland Africa are shallow lakes, river floodplains, and the pelagic zones of large lakes. It is also the fisheries of these systems that undergo the most pronounced climate-induced fluctuations (Kalk, McLachlan & Howard-Williams, 1979; Plisnier, 1997; Sarch & Birkett, 2000). By contrast, fisheries based on longer-lived, larger sized fish in demersal ecosystems in many of the larger and deeper African lakes seem more likely to fit with prevailing notions of equilibrium dynamics and the conventional fish stock management approaches based on them. There is a reasonable body of evidence suggesting that fisheries are significantly impacting productivity in these latter systems (reviewed in Pitcher & Hart, 1995), which is not the case for the more variable fisheries we consider in this paper.

Malawi, and the African Lakes region more generally, contain important examples of all these types of fishery system, although river floodplain fisheries are poorly documented in the region. In this paper, we use Lake Chilwa and the pelagic fisheries of Lake Tanganyika to illustrate the possible influence of climate variability of fisheries in shallow lakes and the pelagic zones of the Great Lakes, respectively.

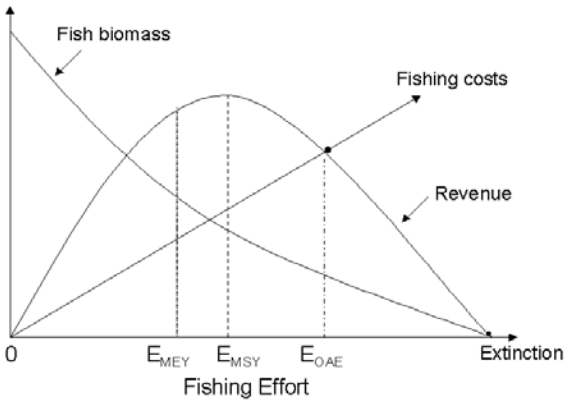


Figure 2: The Gordon-Shaefer bioeconomic equilibrium model (Gordon, 1954; Shaefer, 1954) as a basis for fisheries management.

Lake level fluctuations and fisheries at Lake Chilwa

Africa's shallow lakes are among the most productive fishery ecosystems in the tropics (Talling & Lemoalle, 1998). They are also prone to periodic lake level fluctuation, even to complete drying out in low-rainfall years. Most inland water ecosystems (with the exception of the African Great Lakes) are young, in geological and evolutionary terms, with an adaptable, resilient flora and fauna. They are, in a sense, pre-adapted to cope with a degree of human-induced change (Moss, 1992). This resilience is a feature not often emphasised in fisheries analyses, typically pre-occupied with stability as a management objective (Shepherd, 1991).

Lake Chilwa is in many ways typical of the shallower African Lakes. The Lake has recently fluctuated around 1850 km^2 including both open-water and wetland areas, is less than 3 m deep, and is subject to extreme fluctuations, including complete desiccation (Lancaster, 1979). In good years, fish catches can be as high as 25 000 tonnes (fishery statistics are rather uncertain and vary between sources) and more than 10 000 people are engaged in fishing activities. There was a major increase in fishing effort around the early 1970s, as the region became better integrated into the market economy. Minor recessions in lake level, sufficient to reduce fishing for one or two years, can be expected every six years or so (see Figure 3). Major recessions which will interfere with fishing in the open lake for 3-5 years can be expected every 60-70 years, with a possibility of an intermediate recession in 30-40 years (Lancaster, 1979). The last drying episode covered the period from late 1994 to 1996, when fishing ceased altogether. Fishing operations started again in April 1997 (GOM, 1999).

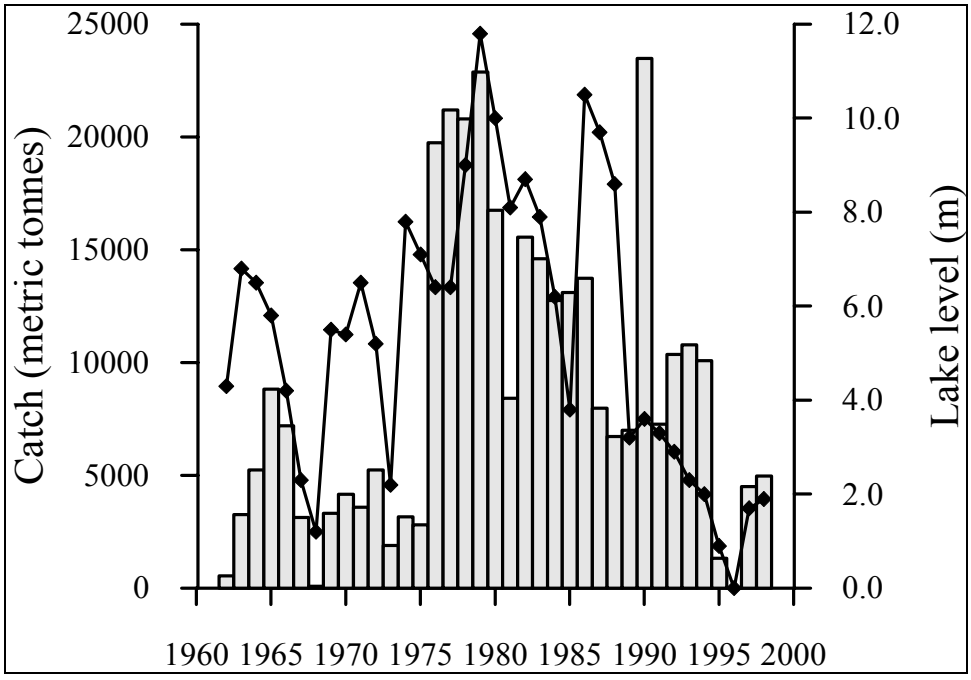


Figure 3. Catch fluctuations (shaded bars) and lake level variations in Lake Chilwa, Malawi 1962-1998. Note also that the lake gauging system was changed in 1989, and the lake level measurements from this period onwards may not be directly comparable with those in previous years (lower apparent amplitude of fluctuation). Fisheries data from Department of Fisheries, GOM (1999); Lake Level Data from Environmental Affairs Department (2000).

Climate and fisheries in the pelagic zones of the African Great Lakes

The fisheries for small pelagic fish in Africa's Great Lakes are among the most important on the continent, supplying dried fish (variously known as *kapenta, usipa, dagaa or omena* according to species and region) to markets throughout much of East and central/southern Africa. Anecdotal evidence, oral histories, ecosystem and environment studies and government fishery statistics all support the notion that of these small clupeids and cyprinids fluctuates extensively from year to year, in response to climate-driven variations in primary and secondary biological productivity (Tweddle & Lewis, 1990; Allison *et al.,* 1995; Plisnier, 1997).

An important study by Plisnier (1997) documents the relationship between fluctuations in stock size (measured by proxy as variations in commercial purse-seine CPUE) and the Southern Oscillation Index (Figure 4), demonstrating the important link between stock size and climate variations in pelagic fisheries. Evidence of climate-productivity links in Lake Malawi's pelagic fisheries are based on less extensive data, but imply a link between wind-stress, upwelling, and fish production (Tweddle & Lewis, 1990; Allison *et al*., 1995; Irvine *et al*., 2001).

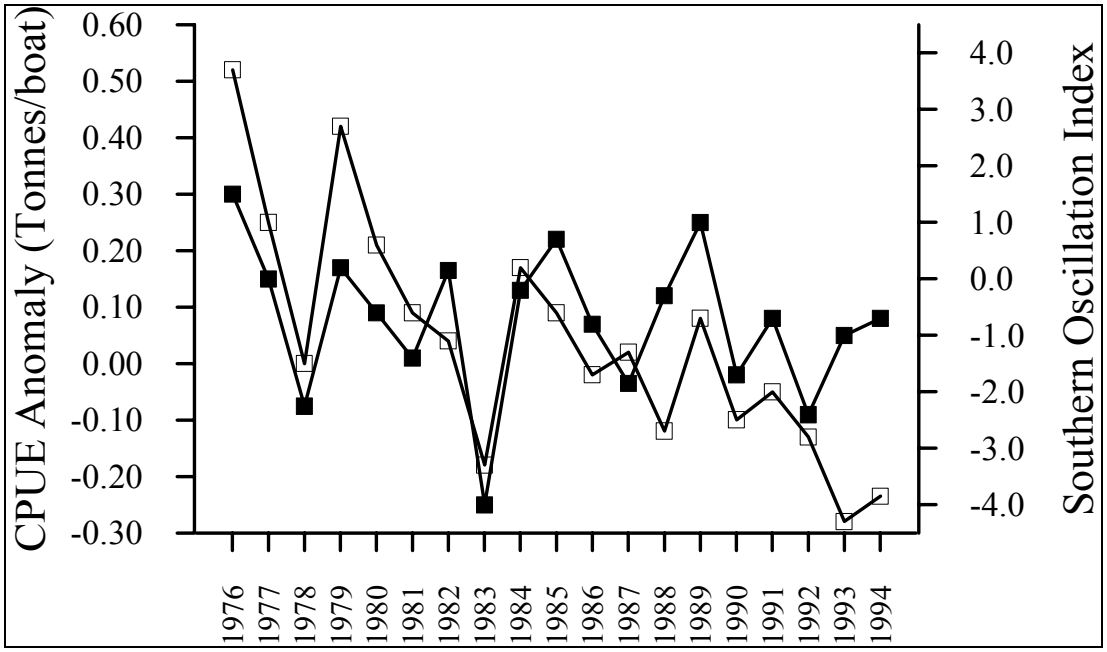


Figure 4. The relationship between stock abundance anomalies of small pelagic fish (clupeids) in Northern Lake Tanganyika (□), measured as the differences from the long-term average in Catch per unit of fishing effort by the Bujumbura-based industrial purse-seine fishery in Nov-Jan, and the Southern Oscillation Index or 'El Niño effect' (■) in the previous Feb-March. The correlation coefficient of 0.62 is highly significant. (Redrawn from Plisnier, 1997).

Given the highly variable rainfall and wind regime in sub-Saharan Africa (Conway, in press) and the evidence for existence of strong climate-fish production relationships, there is case to made for fisheries research and management agencies to incorporate fish production-climate linkages in their programmes. These could provide more relevant scientific information than the current efforts at estimating parameters for use in single-species steady-state fishery assessment models.

While there has been significant recent interest (if not formal research) in understanding the causes of variability in these fisheries, there has been little published work on the consequences of that variability for those involved in catching, processing, distribution, sale and consumption of fish. It is this gap in management-related research that we aim to address through work on the livelihood strategies of fisherfolk dependent on fluctuating resources.

The livelihoods approach and research methodology

The origins of the livelihoods approach

The livelihoods approach has its origins partly in a literature concerned with understanding the differential capability of rural families to cope with crises such as droughts, floods, or plant and animal pests and diseases. This literature focuses attention on the assets of rural people, and how different patterns of asset holding (land, stock, food stores, savings etc.) can make big differences to the ability of families to withstand shocks (Swift, 1989). This set of concerns also links to the concept of vulnerability; defined as a high degree of exposure to risk, shocks and stress and proneness to food insecurity (Chambers, 1989; Davies, 1996). Vulnerability has the dual aspect of external threats to livelihood security due to risk factors such a climate, markets or sudden disaster; and internal coping capability determined by assets, food stores, support from kin or community, or government safety net policies.

The approach also borrows ideas from an ecological literature concerned with the sustainability of ecosystems or agroecological systems (Holling, 1973; Conway, 1987). Here, sustainability is defined as "the ability of a system to maintain productivity in spite of a major disturbance, such as is caused by intensive stress or a large perturbation" (Conway, 1985). The concepts of resilience and sensitivity as livelihood attributes also originate in this context (Bayliss-Smith, 1991). Resilience refers to the ability of an ecological or livelihood system to "bounce back" from stress or shocks; while sensitivity refers to the magnitude of a system's response to an external disturbance. It follows from these ideas that the most robust livelihood system is one displaying high resilience and low sensitivity; while the most vulnerable displays low resilience and high sensitivity. These ideas are relevant to fishery-based livelihoods, as will become apparent in due course.

The concept of 'a livelihood' seeks to bring together the critical factors that affect the vulnerability or strength of individual or family survival strategies. These are thought to comprise, chiefly, the assets possessed by people, the activities in which they engage in order to generate an adequate standard of living and to satisfy other goals such as risk reduction, and the factors that facilitate or inhibit different people from gaining access to assets and activities. These considerations result in the following definition of a livelihood (Ellis, 2000, p.10):

"A livelihood comprises the assets (natural, physical, human, financial and social capital), the activities, and the access to these (mediated by institutions and social relations) that together determine the living gained by the individual or household."

The livelihoods approach is typically set out in the form of a framework that brings together the principal components that are thought to comply with the livelihoods definition, as well as demonstrating the interactions between them. There are many different diagrammatic representations of this framework (e.g. Carney, 1998; Scoones, 1998; Reardon & Vosti, 1995). Here, the framework is summarised in tabular form (Table 1).

The reference social scope of this framework is typically considered to be the extended household, including members who are away from home but send remittances back to the resident homestead. The starting point of the framework are the assets owned, controlled, claimed, or in some other means accessed by the household (column A in Table 1). The livelihoods framework recognises five main asset categories, comprising physical capital (sometimes also called produced capital or economic capital); natural capital (land, trees, fish stocks etc); human capital (people, education and health); financial capital (savings, credit); and social capital (kinship networks, associations).

Access to both assets and activities is enabled or hindered by the policy and institutional context of livelihoods, including social relations, institutions and organisations (column B). It is also affected by external factors, sometimes referred to as the vulnerability context, comprising trends and shocks that are outside the control of the household (column C). Assets permit livelihood strategies to be constructed, and these are composed of a portfolio of activities, some of which may be natural resource based and others not so (column E). Finally, this framework points to outcomes of livelihood strategies, distinguished here between livelihood security effects and environmental sustainability effects (column F).

The livelihoods of artisanal fisherfolk are readily described by this type of framework. In this instance, key assets are fishing gears (boats and nets), although many artisanal fishers may also possess land and combine fishing with farming (Bailey & Pomeroy, 1996). The policy and institutional context of artisanal fishing includes, but is not limited to, the role of state regulations and 'community' based rules that affect access to resources. Social relations can also determine who has access to fishing opportunities (e.g. the ethnicity of fishing families may differ from other families in coastal communities, and roles within fishing activities are often strongly gender-differentiated). Fishing families are no less prone than other rural dwellers to adverse events and trends, with natural fluctuations in fish stocks being especially critical for them. Finally, fishing families often engage in diverse activities in order to achieve livelihood security – an important attribute that we will return to in the context of fisheries management.

Table 1: A framework for micro policy analysis of rural livelihoods (modified from Ellis, 2000, p 30).

A	B	C	D	E	F
Livelihood platform	Access modified by	In context of	Resulting in	Composed of	With effects on
assets natural capital physical capital human capital financial capital social capital	***social relations*** gender class age ethnicity ***institutions*** rules & customs land and sea tenure markets in practice ***organisations*** associations NGOs local admin state agencies	***trends*** population migration technological change relative prices macro policy national econ trends world econ trends ***shocks*** storms recruitment failures diseases civil war	**Livelihood Strategies**	***NR based activities*** fishing cultivation (food) cultivation (non-food) livestock nonfarm NR ***non-NR based*** rural trade other services rural manufacture remittances other transfers	***livelihood security*** income level income stability seasonality degrees of risk ***env. sustainability*** soils & land quality water fish stocks forests biodiversity

Fishing livelihoods research in Malawi

The livelihoods approach is utilised in many different ways, according to the goal of the study or programme. In development practice, it is being used as a 'process' tool to enable participants in development programmes to identify key constraints and opportunities for development intervention (Ashley & Carney, 1999). In this paper, we use the livelihoods approach as a conceptual tool to interpret published literature on Lake Chilwa fisheries, and as a primary research tool to understand the livelihoods of people engaged in small-scale fishing on the shores of Lake Malawi.

Livelihoods research utilises a range of existing methodologies in the social and economic sciences, and can essentially be regarded as a framework to organise these methodologies in such a way as to reduce sectoral and disciplinary biases. The research methods used for Lake Malawi include combination of qualitative and quantitative techniques.

Assets were determined at household level by administration of questionnaires drawn from survey methods used in agricultural economics. Relatively small sample-sizes were used (typically 40 households per village) to ensure that data quality was maintained and good relationships between enumerators and respondents could be fostered. The small sample sizes also meant that each questionnaire could be verified by return visits to households if necessary. Sample selection was based on stratification following wealth ranking (based on people's self-defined criteria), to ensure that poorer households are included in the research. Based on people's own definition of wealth, three categories emerged, namely (a) the well to do (*wopeza bwino*), (b) the better off (*wopeza bwinno pang'ono*) and (c) the poor (*wosauka*). The criteria depend a lot on who has what and who does not have what. The well to do, were people that had some form of capital that enabled them to engage in some productive activities like fishing and small-scale businesses. They were said to have enough food, live in good houses, own some livestock and could afford to send their children to school. The poor were said to be lacking in most things and they did not have anything to enable them to engage in profitable productive activities. They often did not have enough food and had poor housing.

Three sites were purposely selected along the shores of Lake Malawi. The sites were Msaka in the Southern Region district of Mangochi, Lifuu in Salima (Central Region) and Tukombo in Nkhata Bay (Northern Region).

A range of qualitative tools drawn from Rapid and Participatory Rural Appraisal (RRA/PRA) and institutional analysis were used to investigate how access to assets is modified by social relations, institutions and organisations. These included wealth ranking, focus groups, key informant interviews, institutional mapping and ranking of organisations' effectiveness. Trends and shocks were analysed by documenting experiences described in focus

group discussions, the use of relevant secondary social and economic data and the analysis of the political and macro-economic context (Allison et al., 2001).

Resultant livelihood strategies were described through analysis of income sources (including gifts, remittances and exchanges) from household questionnaires, and the decision-making processes that lead to choice or adoption of these strategies were explored at both intra-household and village-level.

Although the household questionnaires can provide only a 'snapshot' of current livelihood strategies, this was complemented by qualitative investigation of dynamic change, pursued though semi-structured interviews and focus group sessions, and through documentation of individual life-stories.

Effects of chosen, or enforced, strategies on both livelihood security and environmental sustainability were investigated through existing monitoring systems, such as district and national production statistics and indicators of poverty or well-being.

The research aims to investigate institutional factors that block or enhance people's ability to pursue a sustainable livelihood so that policy and development intervention can address these constraints and opportunities.

Livelihoods analysis in Malawi – results

Lake Chilwa livelihoods

Kalk *et al.* (1979) offer an interesting insight into livelihood responses to fishery fluctuation during the 1960s and 1970s at a time of gradual transition from quasi-subsistence to a partial cash economy in this area of Malawi. This insight does not appear to have been transferred to current fishery management initiatives. The fisheries of Lake Chilwa offer an economically unstable environment, determined by the seasonal and long-term fluctuations in lake level. Yet, at high production periods, the fisheries permitted readily earned cash, with "a substantial number of men gained an income five or more times greater than that prevailing for unskilled or agricultural labour" (Chipeta, 1972). In good years, Lake Chilwa supplies almost half the total fish production in Malawi, where fish is said to supply around 70% of animal protein in the diets of 12 million people (GOM, 1999).

Fishing in Malawi is largely a business, not a subsistence activity (Ferguson *et al*., 1993). Management that constrains access to fish in productive periods constrains income-generating opportunities, denies people access to much-needed protein and serves no conservation purpose in a lake where the sustainable yield concept is obviously untenable. And yet, despite wide-spread acceptance that fisheries management, in its traditional guise of stock conservation measures, is inappropriate, there have been recent measures to introduce fishery closures to allow recovery after drying periods (even though recovery in the past has been rapid). Various gear and mesh-size restrictions have also been introduced, apparently at the behest of fishing communities around the lake, who participate in an evolving co-management scheme with the Fisheries Department (Sholtz *et al.,* 1998).

Work reviewed by Agnew (1979) and Agnew & Chipeta (1979) provide a useful baseline from which to review the likely choices available to people in the latest drying episode, and how these might have been impacted by new management initiatives. These authors summarise the short-term choices of fishermen during the lake-drying period of 1967-68 as: 1) fishing on a very much reduced scale in the remaining swamps, streams and lagoons in the Chilwa catchment, 2) transfer to nearby Lakes Malombe, Malawi or Chiuta, 3) increasing the cultivation of rice, cotton, cassava and vegetables 4) a switch over to commercial handicrafts such as plaiting carpets, 5) spending considerable time trapping birds and digging for rodents or 6) seeking employment elsewhere. These responses varied according to income status, asset profiles, ethnicity and time of residence in the area.

In the drying episode of 1968, around 200 fishermen migrated to nearby Lake Malombe, and others moved to Lake Malawi. These were among the richest fishermen, whose investment in fishing-related assets meant that they could not simply cease fishing, as could those with a lower stake in this source of livelihood. Since the introduction of community-based management in Lake Malombe and Southern Lake Malawi (Sholtz *et al.* 1998, Chirwa, 1998), the option to move fishing operations between lakes is constrained. That this may also prevent Malombe's fishermen from migrating to Chilwa in productive years, thereby relieving pressure on this intensely exploited lake, does not appear to have been explicitly considered.

The repercussions of recession in Lake Chilwa waters and consequent decline of fishing are much wider than on fishing alone. The whole of the Chilwa plains and lake must be seen as an economic network. Not only are there links between fishing and various ancillary services, but also complementary flows of income between fishing and farming. The successful fishermen had larger gardens and produced more cash crops than other fishermen (Phipps 1973). Recognition that there is an "integrated small-scale economy of farming, fishing and cattle-rearing" (Kalk, 1979; p15) does not seem to have led to any specific policy support for these diversified livelihoods. Instead, sectoral concerns for the sustainability of individual natural resource systems have prevailed, even when it is known that notions of resource sustainability are questionable. "The Chilwa fishes are clearly well fitted to persist in the unpredictable Chilwa ecosystem, provided the refugium of swamps and streams is maintained", according to Moss, (1979, p411), with Kalk (1979, p431) adding: "Man must remain as generalised in activity as the lake fauna in order to succeed in the Chilwa area".

Moss (1979) also cautions that more dangerous than overfishing in this resilient system were threats to the swamps through 'reclamation' for agriculture or perhaps as irrigation reservoirs, siltation through changes in catchment land-management, and pesticides. It is these threats that have led to recent interest in environmental management in the Chilwa wetland, and its designation as a Ramsar site. (Environmental Affairs Department, 2000).

The EAD report reiterates the perceived resilience of the system. However, in an analysis of fisheries issues (EAD, 2000, Table 5.2), the report highlights "Ignorance, Poverty, Corruption, Migratory fishermen and Lack of Resources" as barriers to sustainable utilisation of fishery resources, and recommends the implementation of "community-based natural resource management for the benefit of the local people". There is clearly some difficulty in accepting that migration may be a legitimate and sustainable strategy to maximise benefits from a fluctuating resource, a factor that needs to be taken into account in the design of any community-based management scheme.

The mobility and livelihood flexibility of the fishing families making their living on the shores of Lake Chilwa in the 1970s enabled them to respond to the extreme fluctuations observed. These were not mere 'coping strategies', but represent active opportunism – adaptations aimed at maximising the contribution of fishing to household incomes. It is not particularly useful to talk of the fish stocks as sustainable in the context of this level of 'natural' fluctuation. Around Lake Chilwa, there are large-scale shifts from fishing to farming, pastoralism and other occupations when the lake dries out (and back to fishing when it refills). Such strategies highlight the importance of enhancing or maintaining the flexibility of lakeshore livelihoods rather than constraining it with fixed fisheries production quotas, seasons or areas.

Livelihoods on the Lake Malawi shoreline

In Malawi, usipa (*Engraulicypris sardella*) is found throughout the lake, but only supports substantial fisheries in inshore areas (Thompson *et al.,* 1996; Thompson & Allison, 1997). These fisheries are mainly artisanal and carried out using chilimira seines set by two canoes or small 'plank boats'. The fishery takes place mainly at night with light attraction. There is also a substantial daytime beach-seine fishery, often for juveniles. Landings statistics are thought to be unreliable and to underestimate the true importance of the fishery, which may reach 50 000 tonnes in good years (Tweddle & Lewis, 1990). The fisheries are known to fluctuate extensively, with fishers able to identify and refer to 'good' and 'bad' years for usipa. These seem to be linked to interannual differences in productivity (Tweddle & Lewis, 1990) which in turn are generated by variations in the strength of upwelling caused by variations in wind stress (Allison *et al*., 1995).

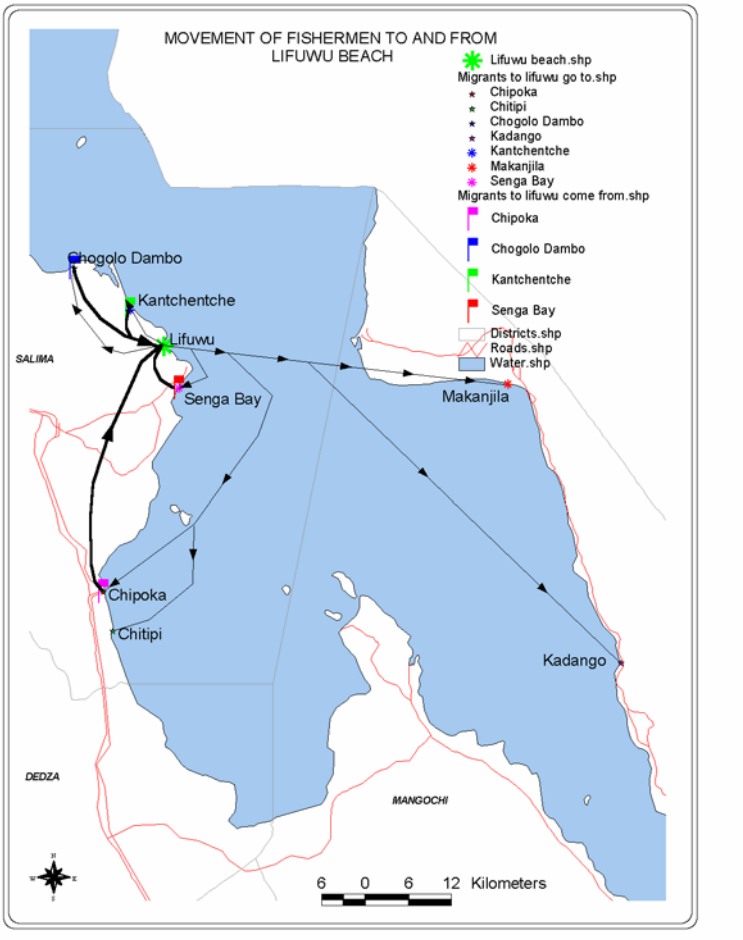
Usipa are marketed largely in sun-dried form and, together with the small pelagic species of other African lakes, contribute significantly to dietary protein throughout Central and Southern Africa. The fishery is quite seasonal, and exploitation of 'usipa' is likely to form only part of the livelihoods of those catching it. Coupled with its interannual variability, this makes this species a useful case-study of a fluctuating fishery.

Results from the survey show that livelihood diversification and mobility are key factors enabling fishers to 'track' resource fluctuations in time and space. People along the Lake diversify in a number of activities including fishing, farming and different types of small-scale businesses.

This type of movement has been adapted for sometime by fishers tracking a 'fluctuating resource'. In the case of the usipa this has led to the establishment of special relations with people in different beaches. There are two types of movements on Lake Malawi, either long-term or short term. Long-term movement refers to fishers that have moved

from their original homes and have established a permanent camp elsewhere. These often do not have access to land and thus rely solely on fish and to some extent small-scale business. With short-term movement fishers move in search of fish but operate from their original homes, only establishing temporary camps. Maintaining access to land, they are able to return to farming during poor fishing periods. The map below shows the movement of fishers around Lifuu beach in Salima District.

These strategies are well established and accepted around the Lake shore villages, where migrant fishers are seldom regarded as problematic, but are rather seen to bring benefits in the form of increased trade and economic activity in lake shore villages. Reciprocal access to fishing 'beaches' for landing catch and mending nets etc., may be more important to fishing-dependent communities than claims for territorial exclusivity of the type encouraged by efforts to promote community-based management (e.g. Sholtz *et al.* 1998). Such studies are urgently required around the other African Great Lakes, if the laudable move towards co-management is to develop models for fishery management that reinforce sustainable livelihood strategies. There is a danger that the idealised concepts of village-owned fishing grounds currently being promoted don't fit with the ecology of the fish or the livelihoods of the fishers.



Discussion

The evidence for climate-induced fluctuations in the fisheries of shallow lakes, and for small pelagic fish in the African Great Lakes indicate that the management of these stocks needs to be informed by an understanding of how fishers, distribution chains and markets cope with fluctuating supplies. Most research on fluctuating stocks has been targeted at understanding in detail the mechanisms *causing* fluctuation in stock size. This is the study of fish

recruitment processes and the environmental factors driving them (e.g. Cushing, 1996). There has been much less emphasis on the study of the *responses* of fishers to stock size fluctuations (Allison & Ellis, 2001).

Review of secondary data from the Lake Chilwa area, and preliminary analysis of primary fieldwork on the shores of Lake Malawi both reveal the importance of livelihood diversity and geographical mobility as livelihood strategies of artisanal fisherfolk. Mobility and diversity are required to sustain livelihoods when confronted with resource variability that is at least partially climate-induced. The Lake Chilwa case demonstrates that livelihood coping and optimisation strategies existed prior to introduction of both State-led and co- management systems. More recent information on the impact of fisheries management measures on livelihoods is lacking, but is currently being pursued by our research team.

The results of our research in Malawi are in accord with findings in other developing countries, where several studies have suggested that fishers cope with fluctuations through geographical and occupational mobility (Bailey, 1982; Haakonsen, 1992; Geheb & Binns, 1997; Sarch & Allison, 2000; Béné *et al.* 2000). Fisheries management strategies which focus on optimal catch rates ignore both the role which inland fisheries play in the livelihoods of many Africans and the inherent stock fluctuations which have shaped such livelihood strategies.

Proposals to manage fluctuating fisheries need to be based on a better understanding of fisherfolk's livelihood strategies. In fisheries where exploitation has little demonstrable impact on fish stocks, and productivity is closely linked with climate, it is not useful to talk about sustainable yields, or of fixed limits for fishing effort. Neither are community-based or co-managed territorial use rights, in the form of geographically fixed territories, useful for fisheries management in areas where lake or floodplain levels are highly variable, or where fishers have to track mobile pelagic resources to sustain their catch rates.

In Malawi, realisation of the importance of fisherfolk's mobility is leading to a move away from management based on beach village committees (Sholtz *et al*., 1998), towards larger spatial scales – lake management areas defined in terms of movements of range of operations of artisanal fishers, and on ecological criteria (Weyl, personal communication, 2001). The mechanisms for governance of these lake spaces are still being discussed.

It is relatively straightforward to outline what management approaches should not be taken, less easy to identify appropriate management support for sustainable livelihoods from fluctuating fisheries. While removing unnecessary impediments to sustainable opportunistic exploitation strategies is one important step, it may not be enough, given the increasing pressures on resources and livelihoods in Africa. Common property institutions that have evolved mechanisms, such as reciprocal access agreements between migrants, should be considered more appropriate than territory-based approaches as a way of implementing any effort-limitations deemed necessary. Even when embryonic and of limited functionality for resource conservation, such as in Malawi, such institutions can be built upon, rather than replaced by externally-conceived 'perfect' ones.

Formal recognition, in national policy and legislation, of the legitimacy of opportunistic livelihood strategies, coupled with active removal of barriers to mobility and livelihood diversification would seem to be appropriate policy responses at national or district level. Active support for livelihood diversification (not the same as providing incentives for people to diversify out of fishing altogether) is another management option.

The apparently greater importance of climate, relative to fishing, in driving the dynamics of fish stocks in many of Africa's shallower wetlands (Sarch & Allison, 2000) also suggests that effort could be redirected at protecting wetland functions and broader ecosystem integrity and away from trying to manage fish stocks for sustainability. Management needs to lose its preoccupation with stability and gain an increased appreciation of resilience.

'Modern' fisheries management has often consisted of setting stock conservation objectives, and then finding means of modifying fishers' behaviour or investment to fit these objectives (Mahon, 1997). This has usually meant imposing closed seasons, closed areas, size limits, gear restrictions, access or 'fishing effort' restrictions. While there has been concern for the effects of different regulatory options on fishing communities, there has usually been little systematic research on their effects on fishers livelihoods. Fisheries management is becoming more consultative, and fishing communities now have greater participation in management, sometimes through co-management arrangements (Pomeroy & Berkes, 1997). There is still little systematic discussion of the effects of different management options on livelihoods. There is a requirement for both participatory research to help to

identify acceptable management solutions to fishery problems, and further studies of livelihoods to understand how fishers cope with and react to both inherent fluctuations and changing externalities.

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