Strategy for Africa and West Asia

2002 - 2006

WorldFish
CENTER

Strategy for Africa and West Asia
2002 - 2006

formerly known as "ICLARM - The World Fish Center"

Our Commitment:
to contribute to food security and poverty eradication in developing countries.

A Way to Achieve This:
through research, partnership, capacity building and policy support, we promote sustainable development and use of living aquatic resources based on environmentally sound management.

We believe this work will be most successful when undertaken in partnership with governments and nongovernment institutions and with the participation of the users of the research results.

FIBA: Mark Edwards

Introduction

Fish is an essential food source. It supplies 25 per cent of the total animal protein in developing countries (ICLARM 1992); is the principal source of animal protein for over one billion people (Williams 1996); and provides many important nutritional and health benefits (Somerset and Bowerman 1996; FRDC 2001). Fisheries support livelihoods by providing employment and incomes to millions of people, both directly to those harvesting the fish, and indirectly to those who supply materials, and process and market the catch.

P. Dugan

Capture fisheries provide over 90 per cent of fish harvested across the region.

This global picture is reflected in Africa and West Asia where fisheries and aquaculture supply high quality food at low cost to millions of people, generate income for farming and fishing households, and play a central role in many local and national economies. Capture fisheries dominate this picture providing well over 90 per cent of fish harvested across the region (FAO 1999). But aquaculture has grown steadily in recent years with production in Egypt rising from 60 000 t in 1990 to 340 000 t in 2000 (GAFRD, 2001), and from 7 000 to over 20 000 t in Nigeria between 1990 and 1998 (FAO 1999).

Yet, despite the productivity and importance of the region's capture fisheries and the promising though slow emergence of aquaculture as a viable practice, the current regional supply of fish falls short of demand. In Africa as a whole per capita supply of fish is declining, and in some countries the average diet contained less fish protein in the 1990s than it did during the 1970s. This is the only

geographic region of the world where this has occurred. Current projections of supply and demand to the year 2020 indicate that this gap will continue to grow, even if current harvests of wild caught fish can be maintained and aquaculture continues to progress at the current rate (Ye 1999).

At present however these are fragile assumptions. There is currently widespread concern about overfishing of both marine and freshwater resources across the region, while many of the coastal and river habitats that sustain the fisheries are increasingly degraded, their water supply diminished, and pollution is increasing in both coastal and freshwater systems. Unless action is taken to address these problems the region's capture fisheries risk sustained decline. And if aquaculture is to realize its great promise and the successes of Egypt and Nigeria are to be repeated across a wider range of countries and more diverse farming systems, carefully targeted research and investment will need to be sustained over many years.

R. Brummett

In response to the growing gap between supply and demand for fish, aquaculture has grown steadily in recent years.

It is in this context that the WorldFish Center has developed the present regional Strategy for Africa and West Asia. We believe that sustained harvest of the region's capture fisheries, together with continued development of aquaculture, can provide the region with an enhanced and sustainable supply of fish protein and employment for millions of people. To achieve this, however, major investments will need to be made to ensure that the existing capture fisheries and the ecosystems that sustain them are managed appropriately, while also ensuring that future developments in aquaculture continue to learn from the lessons of the past and are pursued in ways that are technically, socially, and economically realistic.

To achieve this will require changes in policy, and increased capacity at local, national and regional levels. In turn, new policies will be developed more easily if these processes are supported by a better understanding of the social, economic and biological factors that determine sustainability of capture fisheries and aquaculture. Similarly the capacity to implement these policies will be enhanced by the development of improved management approaches for both capture fisheries and aquaculture that are technically sustainable in diverse social and economic conditions. It is hoped that the Strategy set out here will help provide this understanding.

P. Dugan

Africa and West Asia
2001-2030

Africa and West Asia include 66 countries and embrace immense physical, biological, cultural, and economic diversity. Overlaying this diversity, a complex process of social, economic, environmental, institutional and technological change is today shaping the development agenda at local, national and regional level. This process of change will ultimately play a big role in determining the future of fisheries and aquaculture in the region and their role in sustaining urban and rural food security and livelihoods. It will therefore shape the focus of the Center's work. Four features of this change process and some of the implications for fisheries and aquaculture are outlined below.

Population Growth, Poverty and Food Supply. The population of Africa and West Asia is projected to grow rapidly over the course of the next 30 years, with highest rates of growth occurring in sub-Saharan Africa (SSA) (UN 1999). From an estimated 542 million in 1995/97 the population of SSA is projected to grow to 852 million in 2015 and 1143 million in 2030. By 2030 SSA's population will still be growing at a rate of 2 per cent per annum. In West Asia and North Africa (WANA) the population is projected to increase from 361 million in 1995/97 to 517 million in 2015 and 633 million in 2030 (UN 1999).

Meeting the food and livelihood requirements of this growing population presents a significant challenge to all countries, even the oil rich states of West Asia. However in SSA, where almost no progress has been made in recent decades in raising per caput food consumption or reducing poverty, this challenge is one of massive proportions. In 1995/97 33 per cent of the population of SSA, or 185 million people, were undernourished (FAO 2000). Looking forward to 2030, FAO has concluded that even with good progress in food production in the coming years, the region could still have 15 per cent of its population undernourished in 2030 (FA0 2000). Child malnutrition is of special concern. While the number of malnourished children is projected to decline in all other major developing regions by 2020, the number in SSA is forecast to increase by about 30 per cent to reach 40 million

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Well managed fisheries and aquaculture can improve food security and support livelihoods for many millions of people.

in 2020 (Pinstrup-Andersen et al. 1999). The detrimental effect of childhood malnutrition upon people as individuals and communities lasts for at least two generations and manifests in lower life expectancy, poorer health, lower IQ, and lower economic success.

Of the 50 countries with the lowest Human Development Index (UNDP 2000), 37 are in SSA and 2 in West Asia. In those 20 countries in SSA for which data are available, an average of 45 per cent of the population live on less than US$ 1/day. In three, Mali, Nigeria and Zambia, the number exceeds 70 per cent. And in contrast to South Asia where continued relatively high GDP growth will have a

BOX 1

HIV/AIDS

HIV/AIDS is of special concern for SSA, which accounts for nine out of ten new cases of HIV infection. Eighty three percent of all AIDS deaths are in Africa, and in Botswana, Namibia, Swaziland and Namibia, 20 to 26 per cent of the population aged 15 to 49 is living with HIV or AIDS. FAO has estimated that in the 25 most-affected African countries, AIDS has killed 7 million agricultural workers and up to 25 per cent of the agricultural labour force could be lost in SSA by 2020. AIDS reduces productivity as people become ill and die and others spend time caring for the sick, mourning and attending funerals. In addition, the sale of livestock and other assets to care for the sick and pay for funerals diverts funds away from long-term development (Barnett and Rugalema 2001; FAO 2001b). There is growing evidence that fishers are a high risk group with a study in Tanzania reporting AIDS related mortality amongst fishers to be five times that amongst farmers in the same region (Ainsworth and Semai 2000). Fishers appear to be vulnerable to the same set of risk factors associated with other migrant or mobile workforces. In Namibia the growing fishing industry in Walvis Bay and Luderitz is heavily dependent on migrant labour and is cited as one of the factors facilitating the rapid spread of HIV in Namibia (UNAIDS 1999). The full implications of this phenomenon for the fishing communities and the fishery are unclear at this time. However efforts to manage the resource sustainably and enhance the benefits to fishers will need to draw upon a better understanding of these issues.

AIDS has also significantly reduced government capacity and extension services in several countries. FAO reports that in Kenya's Ministry of Agriculture, 58 per cent of all staff deaths are caused by AIDS; in Malawi's Ministry of Agriculture and Irrigation, at least 16 per cent of the staff are living with the disease; and in SSA as a whole up to 50 per cent of agricultural extension staff time was lost through HIV/AIDS (FAO 2001b). This underlines the importance of sustained investment in building capacity to manage fisheries and aquaculture, and developing new approaches to achieving this.

positive impact on poverty alleviation and increased per caput food consumption, per caput incomes in SSA are projected to grow at only 1.5 per cent per annum in the period leading to 2015. This limited average growth will be insufficient to have a significant impact on poverty and food insecurity (FAO 2000).

In West Asia and North Africa the per capita GNP of most oil exporting states is relatively high. However, for the seven poorest countries (Yemen, Iraq, Egypt, Syria, Algeria, Iran, and Jordan) per capita GNP averages US$ 1073, equivalent to US$ 2.9/day. As in SSA, there is greater absolute poverty in rural areas than in urban areas in all these countries (El Beltagy 2000).

Faced with these projections of continuing population growth, widespread and severe poverty, poor health and food insecurity, the importance of managing fisheries and aquaculture to increase food production and improve nutrition, and contribute to employment and income, is clear. Current yields of marine and inland capture fisheries need to be sustained and where possible improved, and the potential for further expansion of aquaculture developed. The full value of fisheries and aquaculture as both a direct source of food and a source of income has to be understood, and their role in rural development fostered effectively. At the same time, overfishing needs to be prevented and fish stocks restored where possible.

Changing Trade and Market Conditions. Trade liberalization combined with changing local markets will do much to shape the opportunities and constraints facing rural development over much of the region in the coming decades. They will therefore have major implications for fisheries and aquaculture.

Already 40 per cent of world fish production is traded internationally and an increasingly large share of fish exports to developed countries will be produced in developing countries in the future (FAO 1997). The implications of this trend

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The rising trade in high value species such as sea bream and sea bass is stimulating the development of coastal cage culture in Oman.

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Population growth and expansion of urban centers are projected to stimulate local markets for fish over the next 20 years.

are complex. For some high value species the rising trade is increasing opportunities for aquaculture, for example for sea bream and sea bass in Oman and other Gulf states, and shellfish in South Africa. On the other hand, the rising export trade in some species is shifting physical food resources away from the poor, and people highly dependent on fish in their diets are exposed to insecurity with regard to fish food supplies (Ahmed et al. 1999). For example in the case of Lake Victoria, Nile perch (*Lates niloticus*) are filleted for export and their skeletons processed for fish meal. Together with the use of other smaller fish in the fish meal industry, this has reduced available fish protein for communities around the Lake (Abila and Jansen 1997).

The implications of further liberalization of international trade for the region's fisheries and aquaculture development are unclear, but almost certainly very significant. In East Asia elimination or reduction of import tariffs and other barriers to trade reduced the cost of imports for fishing companies and the processing sector. This in turn made the sector more competitive in international markets. However the benefit accrued mainly to industrial and export-oriented fisheries and the intensive aquaculture sector, with small-scale fisheries and rural aquaculture seeing only marginal gains (Ahmed 1999). A similar pattern is likely in Africa and West Asia.

Population growth, and especially expansion of urban centers, is also projected to stimulate local markets, while further investment in sustainable fisheries and aquaculture for both rural and urban markets may provide an important stimulus for rural growth (Box 2). This is especially so in situations where rising urban unemployment turns people towards the rural resource base in search of income.

Even in countries with relatively high per capita GNP such as the United Arab Emirates and Oman, concerted efforts are being made to manage the aquatic resources of the country as a means of diversifying the national economy and of increasing employment opportunities. While these trends can lead to over exploitation of resources, they can also encourage improved management of capture fisheries and foster increased development of aquaculture.

BOX 2 West African Markets

In 2020 West Africa is estimated (Cour and Snrech 1999) to have a population of at least 430 million people, up from 215 million in 1998 and 85 million in 1960. This change is being accompanied by rapid urbanization: the proportion of urban dwellers rose from only 13 per cent in 1960 to 40 per cent in 1990, and at least 53 per cent of the population is projected to live in towns by 2020. However where the soil and climate are suited to farming, rural population density has also increased and is projected to continue to do so. These demographic patterns are expected to strengthen the market for agricultural products including fish.

Land and Water Management. Population growth, poverty and food insecurity will lead to increased pressures upon the natural resource base of the region in coming decades. Current patterns of land use are already leading to degradation and loss of natural resources in many countries and, combined with migration, to increased urbanization. Over the coming decades, these trends are projected to increase and lead to continuing degradation and loss of natural ecosystems.

For aquatic ecosystems these processes have had particularly serious consequences. In many African river basins forest loss is very high, reaching over 70 per cent in parts of the Congo watershed (Chapman and Chapman in press), and will dramatically affect the conditions in all major river basins in the next 20 years (IUCN 2000). Deforestation and land-use changes affect the flow and sediment loading of rivers bringing changes to the ecology, reduction in productivity, and loss of value to the people who use the rivers and associated ecosystems down-

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Changes in river flow can be particularly damaging to artisanal floodplain fisheries.

stream. For example, work by the WorldFish Center in Malawi has shown that loss of forest cover and increased sedimentation has impacted spawning migration of *Barbus spp* that are economically and nutritionally important to households in the tributary rivers of Lake Chilwa (Jamu et al. in press). Similar studies of Lake Tanganyika have shown reduced fish diversity in areas adjacent to watershed deforestation (Cohen et al. 1993).

Even where land use in river catchments has remained relatively unchanged, changes in water flow as a result of reduced rainfall, or reduced run-off because of water retention for irrigated agriculture or hydro-power, can have a potentially devastating impact on fisheries. For the River Niger, for example, the Markala and Selingue dams increase the effects of drought by further lowering the already reduced flood flows. The annual loss in catches in the inner delta of the Niger as a result of the two dams has been estimated at 5 000 t (Laë 1992). In Nigeria, construction of the Bakalori dam on the river Sokoto reduced wet season floods and led to a substantial decline in the floodplain fishery (Adams 1985).

Pollution is also a growing concern. While historically Africa and West Asia have been less affected by pollution than other continents, an FAO review of environmental issues facing fisheries and aquaculture in Africa (Remane 1997) has shown that by 1995 there were low level but widespread problems with diffuse agricultural pollution and urban pollution. Localised occasional serious cases were reported near cities and areas of industrial and mining development, notably in Cameroun and the Democratic Republic of the Congo (Welcomme in press). As urban centres grow rapidly and industrial development expands, pollution and eutrophication are projected to increase sharply across the region (IUCN 2000).

Demographic and economic forces have also led to significant loss and degradation of coastal systems. Some 37 per cent of the world's population in 1994 lived within 100 km of the coast (Cohen et al. 1997) and this figure is projected to grow (van der Heijden and van Zwol 2000). For example in West Africa much of the urban growth forecast for the coming decades will take place in the coastal belt. And while population growth will be less in North Africa and West Asia, the population there is already particularly heavily concentrated in the coastal zone. Mangroves and coral reefs, many of which play a critically important role in supporting coastal fisheries, are particularly vulnerable to coastal development. Overall some 50 per cent of the world's mangroves have been lost (Kelleher et al. 1995), while in Africa available figures from Angola, Cote d'Ivoire, Gabon, Guinea-Bissau, and Tanzania reveal a loss of between 50 to 70 per cent (WRI 2000).

If capture fisheries are to be sustained and their important contribution to food security and livelihoods is to be enhanced, the ecosystems that support these resources need to be maintained. In the face of growing pressure from diverse human sources, this will require better information on the role of these ecosystems in sustaining capture fisheries, and effective use of this information in policy processes and management systems at local, national and regional levels.

BOX 3

Climate Change

Many of the environmental pressures upon aquatic ecosystems will be exacerbated by climate change. The major effects on freshwater systems will be through changes in the hydrological cycle. Studies of the Nile and Zambezi have shown that they have a high sensitivity to climate change, with runoff projected to decrease even when precipitation increases, due to the large hydrological role played by evaporation (Watson et al. 1998; Riebsame et al. 1995).

Africa's great lakes may also be particularly sensitive to climate change. Lake Victoria rose rapidly in the early 1960s following only a few seasons with above average rainfall and has remained high since (Sene and Pinston 1994). In Lake Malawi and Lake Tanganyika that have only small outflows, minor declines in rainfall for extended periods would lead to the closure of these lakes. For both lakes there is concern that an increase of 1 to 2°C in air temperature would increase the stability of lake stratification, reduce mixing of deep nutrient-rich hypolimnotic water and nutrient depleted surface layers, and thus the production of the lake fisheries (Hecky et al. 1981,1994; Watson et al. 1998).

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Africa's great lakes may be particularly sensitive to climate change.

Environmental problems degrading the coastal zone are also projected to increase as a result of either sea-level rise or an increase in extreme weather events (IPCC 1996). The coastal regions of Africa and West Asia are all vulnerable to such changes, although the low-lying lagoon coasts of West and Central Africa, the delta of the river Nile, and the coral reefs of eastern Africa and the Red Sea and Gulf coasts are especially vulnerable.

At present, however, the precise implications of these broad and still uncertain projections for fisheries and aquaculture are unclear. Much more detailed research will be required to understand these and to identify the adaptive strategies that need to be developed and tested. For example, even with the improvements in irrigation efficiency recommended by IPCC, climatically induced reductions in in-stream flows will place even greater importance on understanding the relationship between river flow and fisheries productivity, and in developing information tools that can help improve water management decisions for fisheries.

Institutional Arrangements. Over the course of the past decade, much of the international engagement in rural development and natural resource management has been governed by the increasing profile of intergovernmental agreements and, at the other extreme, by the growing recognition of the value of decentralized management of resources. Both phenomena are of great importance for fisheries and are likely to feature strongly in the region in the coming decades.

At global level the most significant agreements are the FAO Code of Conduct for Responsible Fisheries and the Kyoto Declaration and Plan of Action on the Sustainable Contribution of Fisheries to Food Security. Both adopted in 1995, these agreements provide an internationally recognized framework for national and international action to support sustainable fisheries and aquaculture. The Code of Conduct provides a set of principles and standards for the conservation, management and development of fisheries. The Kyoto Declaration commits governments to base policies, strategies and resource management and utilization for sustainable development of the fisheries sector on the maintenance of ecological systems, use of best scientific evidence available, improvement in economic and social well-being, inter- and intra-generational equity, and application of the precautionary approach. The Plan of Action sets out an agreed list of immediate action to be taken.

While implementation of these agreements is a massive undertaking, a growing number of governments are taking action to do so. The European Union has adopted the Code, and much of the international development assistance support for fisheries is now being pursued under the framework of the Code and the Kyoto accords. This provides an important stimulus for concerted international action to address these issues.

In addition, most countries in Africa and West Asia are signatories to the Convention on Biological Diversity (CBD) and the Ramsar Convention, both of which have important provisions concerning marine and freshwater fisheries. The implications of the CBD for the marine environment have been addressed in the Jakarta Mandate which identifies five specific areas for action: (i) development and implementation of integrated marine and coastal area management; (ii) establishment and maintenance of marine protected areas; (iii) sustainable use of marine and coastal living resources; (iv) sustainable mariculture operations; and (v) control, eradication and prevention of the introduction of harmful alien species. Similarly the Ramsar Convention has provided a comprehensive set of guidelines for the assistance of Contracting Parties (Ramsar 2000). The current River Basin Initiative of the CBD and the Ramsar Convention are also of particular relevance to inland fisheries.

At the regional level, the New Partnership for Africa's Development (NEPAD) is being widely embraced as the defining framework for the continent's economic and social development, and as one that can play a major role in fostering the regional cooperation that is essential for sustainable long-term use of the region's

resources. Similarly the Southern African Development Community (SADC), the Economic Community of West African States (ECOWAS), the Gulf Cooperation Council (GCC) and other sub-regional bodies provide important frameworks for fostering collaborative management of transboundary resources. Strengthened regional cooperation enhances the prospects of a more integrated approach to water resource use and the management of coastal zones, two important frameworks within which to pursue sustainable use of fisheries. At the same time, stronger regional cooperation can foster development of markets that can help stimulate aquaculture. River and lake basin authorities, for example, for the Zambezi, or Lake Chad and Lake Victoria are also potentially important vehicles for fostering sustainable fisheries management. While historically the impact of these authorities has been limited, continuing efforts to increase their effectiveness need to be supported.

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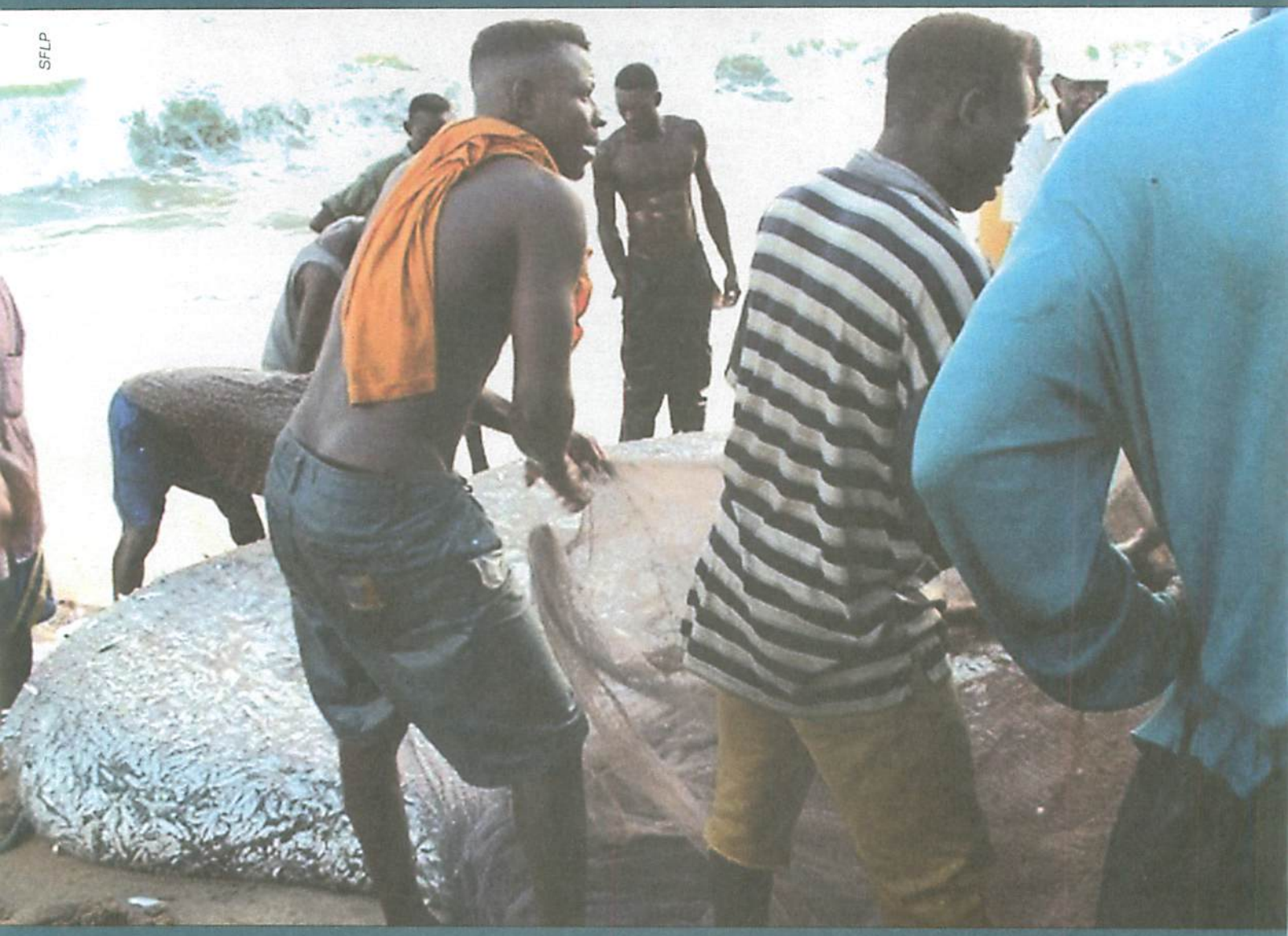
Stronger regional cooperation being fostered by NEPAD will strengthen markets for fish products.

At national and local level, the growing emphasis being placed upon decentralization, strengthened local government, and popular participation (UNDP 2000) provides an opportunity to address many of the institutional weaknesses that have contributed to overfishing. Co-management that helps foster a more equitable distribution of benefits from the fishery has considerable potential both to help regulate fishing pressure, and also to improve management of the aquatic ecosystems that sustain the fishery (Viswanathan 2002). In turn, effective engagement of local stakeholders can play a major role in fostering water allocation procedures that take account of fishery concerns. Yet, as for all of the trends described here, the ability of governments and local institutions to seize opportunities will be greatly enhanced by the availability of high quality information.

Efforts to improve fisheries management and support the development of aquaculture in Africa and West Asia need to be set within this evolving institutional context. The international policy frameworks provide important support and guidance while growing decentralization at national level provides for stronger incentives for sustainable management. High priority should be placed on providing the information that will assist local, national and regional institutions to build upon this favourable institutional environment, and design and implement policies and management measures that will foster sustainable fisheries and aquaculture.


SFLP

The Strategy 2002-2006

The issues affecting fisheries and aquaculture in Africa and West Asia over the course of the next few decades are clearly enormous. If these are to be addressed effectively, the region's fisheries managed sustainably, and the potential for aquaculture fully developed, then a wide range of institutions will need to make a major commitment to addressing them over many years. In this context, the Center's regional Strategy seeks to complement many activities already underway, notably through FAO, bilateral development assistance programs, and the NGO community, and to identify a limited number of issues where we have a particular capacity and opportunity to respond to the needs expressed. This is still an ambitious agenda however, and success will depend upon forging a wide range of partnerships within and beyond the region; and it will take time. Building upon the Center's work in the region over the past 15 years, the Strategy presented here therefore provides a framework for what is a long-term commitment.

The overall **Goal** of the Center in Africa and West Asia for the period 2002-2006 is to:

- Enhance the contribution of capture fisheries and aquaculture to rural and urban food security and livelihoods.

We will pursue this by focusing upon four aquatic production systems: rivers and floodplains, lakes and reservoirs, coastal fisheries, and aquaculture; and through a number of overarching policy studies and capacity-building activities. The three capture fishery systems identified currently dominate fish production in Africa and West Asia, while it is projected that aquaculture will expand rapidly in the next decades in response to the growing demand for fish and the livelihood opportunities that it provides. The Center will seek to generate research results that will help strengthen national and regional policies and capacity to sustain and enhance the development benefits from these capture fisheries, while identifying and designing ways to overcome technical, economic and social bottlenecks to the development of aquaculture across the region.

P. Dugan

1. RIVERS AND FLOODPLAINS

Introduction. The Nile is the Earth's longest river (6 669 km) while the Congo stretches 4 760 km and carries a volume of over 40 000 m^3/s, second only to the Amazon. Four others, the Niger, Zambezi, Okavango/Cubango and Orange have a combined main-channel length of 11 407 km (Welcomme in press). In West Asia, the Euphrates is 2 700 km long and carries an annual volume of 35 billion cm^3. These and the other major rivers of the region are fed by a multiplicity of smaller streams, together totalling some 12.8 million km in Africa alone (Welcomme 1976).

These extensive river systems sustain important fisheries, although good data are available only from the major floodplains (Table 1; Leveque

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A major portion of floodplain fisheries are harvested by small groups of fishers and individuals using small craft. These catches are generally under recorded and consequently under valued.

TABLE 1

Fisheries production from some African floodplains

Floodplain	Area (km^2)	Catch (t)	Number of Fishers	Yield (kg/ha)
Niger (Benin)	242	1 200		49.6
Niger (inner delta)	20 000	90 000	54 112	45
Niger (Nigeria)	4 600	14 340	4 600	31.2
Benoue	3 100	9 570	5 140	30.9
Pongolo	104	400		38.5
Shire (1970)	665	9 545	2 445	143.5
Shire (1975)	665	7 890	3 324	118.7
Yaérés (Cameroon)	7 000	17 500		25.0
Logomatia	600	300	70	5.0
Kafue (1970)	4 340	6 747	670	15.6
Kafue (1982)	4 754	7 400		15.6
Ouémé (1957)	1 000	10 400	25 000	104.0
Ouémé (1968)	1 000	6 500	29 800	65.0
Sénégal	5 490	30 000	10 400	54.7
Barotse	5 120	3 500	912	6.9
Cross	8 000	8 000	4 000	10.0
Nile (Sudd)	31 800	28 000		8.8

Modified after Lévêque 1999 and Welcomme 1989

P. Dugan

Dispersed across the landscape, rivers and their tributaries are widely accessible to poor households who would otherwise be without ready access to a source of animal protein.

1999; Welcomme 1989). Yields and total production estimates are comparable to lakes and reservoirs (Table 2), but the accessibility of river and floodplain fisheries is especially important. Due to their dispersed distribution across the landscape, rivers and their tributaries are widely accessible to poor households who would otherwise be without ready access to a source of animal protein. Small fish that are consumed whole with bones and organs are a particularly rich source of minerals and vitamins such as calcium, zinc and vitamin A. In areas where micronutrient deficiency is high, the easy access to river fisheries is therefore especially important for food and nutrition security (Thilsted and Roos 1999).

Partly due to their widespread distribution, river fisheries face growing pressures across the region. In most of the larger floodplains, fisheries management systems are inadequate and overfishing widespread. For example in the inner delta of the River Niger in Mali, the fishing pressure has increased markedly in the past 25 years. The number of fishers has more than doubled and individual fishing efficiency has increased due to new fishing materials and new fishing equipment (Läe et al. 1994). These pressures are exacerbated by policies promoting the development of the fishery from a subsistence activity to a market economy (Läe 1997).

At a larger scale, the lack of integrated approaches to river basin management and the lack of attention to the importance of inland fisheries in planning and development activities are major constraints to sustaining production (Svendrup-Jensen 1999). In particular, land and water management decisions at the basin level threaten the quality and quantity of water upon which the productivity of the river fishery depends. These can compound the effects of yearly variation in rainfall and the growing prospect of climate change impact on Africa's rivers.

For example, between 1969 and 1986 drought reduced the floodplain of the inner Niger delta from 20 000 km² to 5 000 km² and fish production decreased from 90 000 to 45 000 t. The Markala and Selingue dams exacerbated the effects of drought by further lowering the already reduced floods. The annual loss in total catches in the central delta attributed to the two dams has been estimated at 5 000 t (Läe 1992).

If the role of river fisheries in sustaining rural and urban food security and livelihood is to be maintained and enhanced, it is essential that effective systems of governance (UNDP 2000) are put in place at local and basin level and, *inter alia*, foster more equitable sharing of the benefits from the fishery. These will need to achieve effective engagement of all stakeholders in land and water use decisions at these different scales. In developing these governance systems, the experience of other systems that foster sustainable and equitable resource use needs to be harnessed. Many traditional systems achieved this more effectively than contemporary practices, and while these traditional systems are rarely fully applicable under today's conditions, much can be learned from them (Brehima 1998). This is particularly so in light of the processes of decentralisation that are currently being pursued across much of the region (UNDP 2000).

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The large floodplains of the Niger, Nile, Volta, Zambezi, and other major rivers sustain fisheries worth hundreds of millions of dollars each year.

To function effectively, such governance systems need to be supported by quality information. Stakeholders need in particular to have reliable estimates of the full value of the fishery resources of these rivers, and on the ways in which fish and fishermen respond to natural and artificial changes in water quality and quantity. In the absence of such data, planners tend to assume that these fisheries are insignificant, and local people and fishery departments are unable to promote their needs effectively relative to agriculture, industry and commerce (Sverdrup-Jensen 1999). Working through a viable governance system, this information can help improve management and mitigation of losses caused by external interventions such as dams.

However, only rarely is this information available. Much of the existing data is fragmentary, dispersed and dated, and there is widespread scepticism about the accuracy and relevance of current statistics, most of which are collected from a small number of monitored landing sites, an approach of limited value in assessing the importance of freshwater fisheries in the tropics (van Zalinge et al. 2000, Baran and Guttman in prep). In many freshwater fisheries actual catches are believed to be at least twice the reported figures (Welcomme in press).

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Improved understanding of the value of river fisheries provides an important step towards improved governance.

Even where data do exist catch data alone is a poor indicator of the importance of the resource for people, especially lowest income households. River fisheries are characterised by a high degree of participation, particularly of low-income groups, including women and children (Svendrup-Jensen 1999). This engagement and the high proportion of local consumption make these resources of critical value to communities, yet these parameters are not reflected in catch statistics. If fisheries governance is to be improved, it needs to be better informed by such understanding. This will in turn require wider availability of simple tools and methodologies for obtaining such information.

Water allocation and other management decisions in river basins need to be informed by information on their fisheries impact. However attempts to study this impact and develop better predictive capacity have been constrained by the limited information available. Welcomme (1976) concluded that at least 14 years of data is required to accurately predict catch from flood levels, and this is conditional upon there being no major changes to the resource base through over-fishing, environmental change and other factors. In light of the pressures upon these river systems and upon the communities who use them, this condition is rarely met today.

Recognizing these constraints, increasing attention is now being devoted to the development of new approaches to predicting the effect of changing water flows on river ecosystems and their fish populations. To date, however, the most successful methodologies for assessing environmental flows have been based primarily on temperate rivers with relatively small fish populations (see for example Brown and King 2002; Dunbar et al. 1998; and Arthington and Zalucki 1998), and now need to be adapted for use in tropical rivers where the river dynamics,

- More informed and influential engagement by fisheries stakeholders in the multiple-use management of rivers.
- River basin management and water allocation policies and processes that recognize and take account of the value of river fisheries.

Objective 3. Provide information on ways in which fish and fishers respond to natural and artificial changes in river systems as a basis for improved management and mitigation of losses caused by external intervention such as dams and water abstraction.

Outputs

- Models for assessing the impact of changes in river flow regime on fishery productivity and use.
- Impact of catchment degradation and sedimentation on fish production quantified.
- Specific recommendations on water management requirements for sustainable fisheries in up to 10 pilot river systems.

Development Impact

- Water management regimes that sustain river fisheries.
- Informed and well-targeted mitigation measures for dams and other external intervention.
- Fisheries impacts of catchment erosion and soil loss factored into land-use planning processes.
- Nutritional and income benefits of river fisheries sustained for dependent communities.

Approach. An integrated program of work will be developed to address the three research objectives. Up to 10 river systems will be identified using criteria that include: presence of institutional arrangements that provide a framework for integrated river basin management, or of work underway to develop such a framework; possibility of strengthening national and regional capacity to apply such arrangements; and possibility of collaboration with international institutions and other CGIAR centers. River systems being considered include: the Nile, Senegal, Niger, Volta, Zambezi, Limpopo, Okavango, Rufiji, the rivers of the Chad basin, and the forest rivers of southern Cameroun.

fish populations, and fishing practices are much more complex. In doing so, recent developments in fish-flow modeling (Halls et al. 2002) and multi-agent models using Bayesian networks to simulate river fisheries (Baran and Baird 2001) have considerable potential. However, the only recent work of this nature on a large river in SSA is for the Niger (Bousquet 1994), and significant investment will be required to develop similar approaches for other African river systems. Emphasis will need to be directed towards ensuring that the predictive capacity of these tools is used in a way that can inform decisions on water and land management.

Objectives, Outputs and Development Impact. The WorldFish Center's work on river and floodplain fisheries will pursue three specific objectives.

Objective 1. To identify systems of governance that enhance the contribution of riverine fisheries to food security and sustainable livelihoods, and distill reasons for their success.

Outputs

- Diverse examples of good governance for river fisheries.
- Key factors for success of these systems.
- Guidelines on systems of good governance for river fisheries.
- Guidelines on systems of river basin management that help sustain river fisheries.

Development Impact

- More widespread adoption of governance systems that enhance access to the livelihood benefits of river fisheries.
- More widespread inclusion of fisheries concerns in river basin policy and planning.
- Nutritional and income benefits of river fisheries sustained for dependent communities.

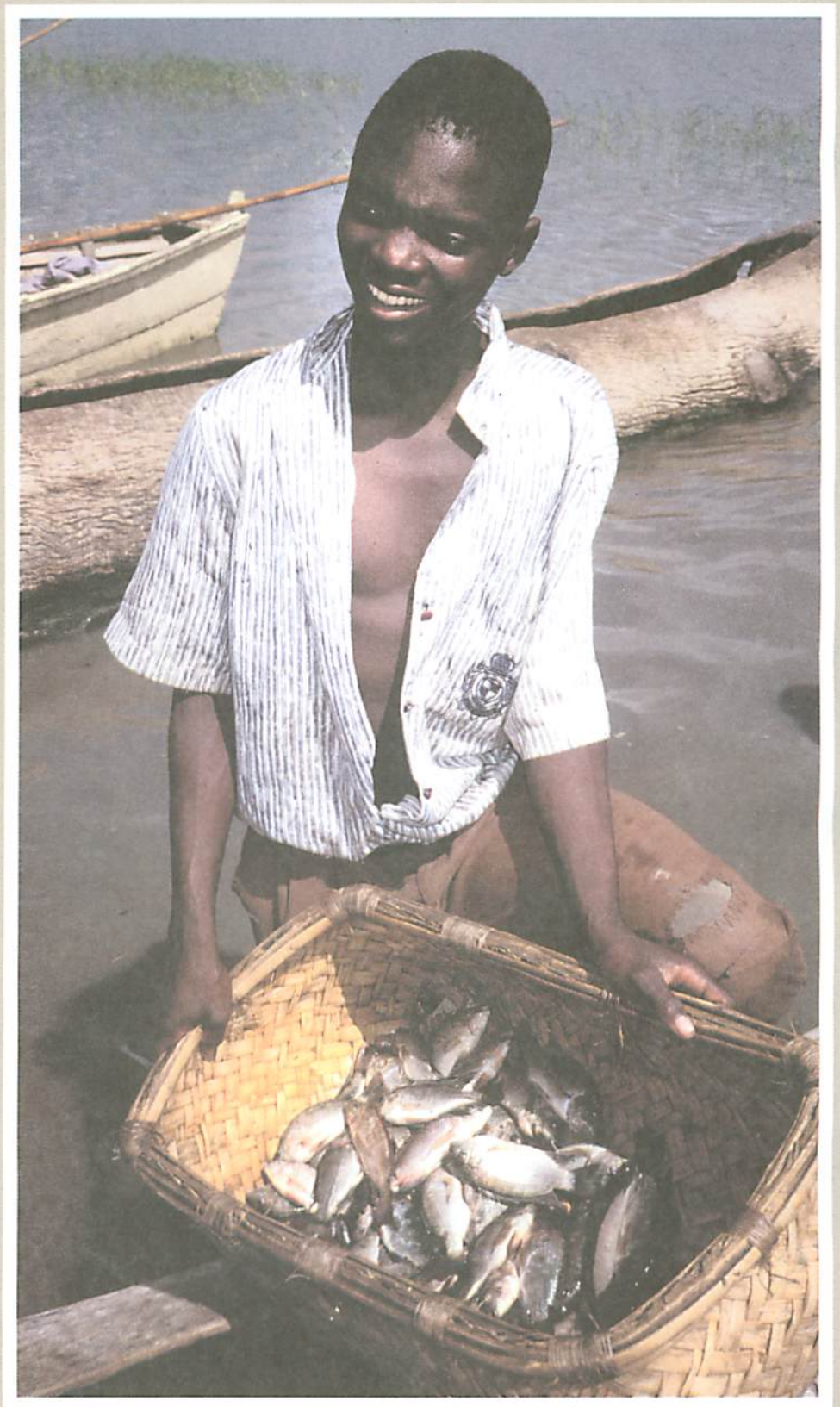
Objective 2. To acquire, interpret and supply information on the value of fisheries in support of systems of governance that enhance the contribution of riverine fisheries to food security and sustainable livelihoods.

Outputs

- Value of the fisheries of 10 river systems quantified and provided to stakeholders.
- Total value of the region's river fisheries estimated.
- Fisheries assessment capacity of national institutions strengthened.

Development Impact

- Enhanced understanding on the part of stakeholders, including local communities and governments, of the value of the fisheries resources of these rivers.



R. Brummett

2. LAKES AND RESERVOIRS

Introduction. Some of the world's oldest, largest, and deepest lakes are found in Africa. Lake Victoria with a surface area of 68 800 km² is the second largest freshwater body in the world, while Lake Tanganyika is 1 400 m deep, second globally only to Lake Baikal. They are also home to a highly diverse endemic fish fauna. Lake Tanganyika has over 300 endemic species, and Lake Malawi over 600 with 48 endemic genera (Lévêque 1997). Even smaller lakes such as Barombi Mbo and Bermin in Cameroun support important endemic fish faunas (Reid 1996). In the predominantly dry climate and desert landscape of West Asia, there are comparatively few lakes. However Turkey has over 1 million ha of natural lakes (FAO 1996) and there is a large number in Iran (Scott 1995).

All of these lake systems play a central role in the local economies of the areas where they occur. The annual harvest of fish from many African lakes is in excess of 20 000 t/year (Table 2) (Leveque 1999), and the fisheries of the largest lakes is of national and regional importance. For example, the fishery of Lake Victoria yields US$ 600 million annually in export earnings which, in turn, is estimated to represent a revenue to the lake community of US$ 240 million to US$ 480 million per annum (Ntiba et al. 2001).

D. Jamu

If lake fisheries are to continue to sustain food security and support livelihoods more effective systems of governance will be required.

Despite this importance, however, most lake fisheries face a number of growing problems. Foremost amongst these is the high fishing intensity which has led to widespread concern. For example the contribution of Nile tilapia (*Oreochromis niloticus*) to the commercial fishery on Lake George in western Uganda has fallen from 80 per cent in the early 1970s to 30 per cent in 1997 and the average size of fish caught has declined from 0.9 kg in 1950 to 0.35 kg in 1997. Nile tilapia are now maturing at a smaller size (Ntiba et al. 2001). Similarly in Lake Tanganyika a major decline in catch per unit effort has been recorded for the semi-industrial and traditional fisheries in Burundi waters. The average catch for the semi-industrial fishery in Burundi decreased from 1 173 kg/night/unit in 1983 to 150 kg/night/unit in 1993 and now appears to be unprofitable (Ntiba et al. 2001).

In Lake Victoria the situation has been complicated by the introduction of the predatory Nile Perch (*Lates niloticus*) which has been accompanied by significant change in the ecology of the lake, the fishery, and the local economy. For example, the native tilapia (*Oreochromis esculentus*) was once of great commercial importance but has now almost disappeared from the lake. Several other species have also declined in numbers and many of the endemic haplochromine cichlids are now feared to be extinct (Chapman and Chapman in press). While at first the change

in fish populations was blamed primarily on the introduction of the Nile Perch, the situation is now perceived to be much more complex (Lévêque 1997). Eutrophication is believed to have played a significant role in the decline of both *O. esculentus* and the disappearance of the cichlid species belonging to the haplochromine flock, while overfishing had already begun to affect the haplochromine stock before the introduction of *Lates* (Lévêque 1997; Welcomme 2001).

TABLE 2

Fisheries production from some African lakes and reservoirs

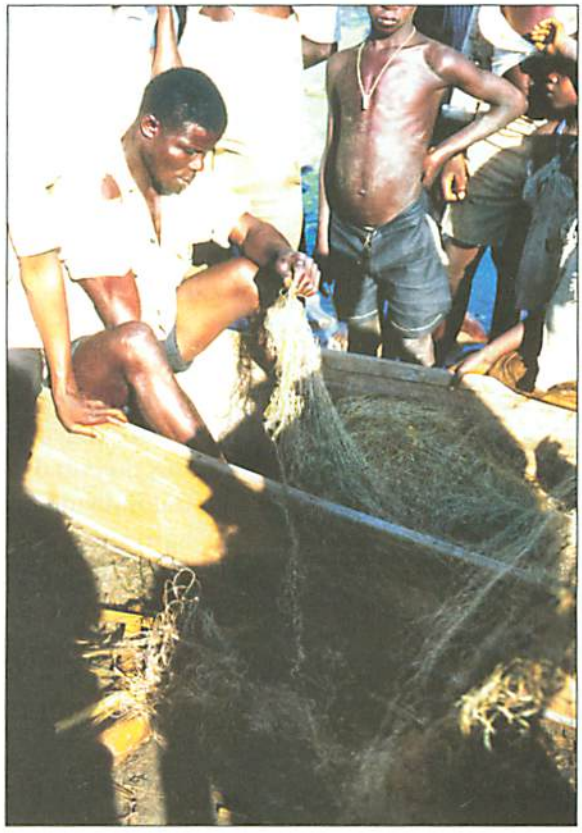
Systems	Surface (km²)	Catch (t)	Yield (kg/ha)	Period
RESERVOIRS				
Kossou	900	4 700 - 9 300	67 - 147	1972-1978
Lagdo	700	7 700 - 13 400	175 - 340	1985-1991
Maga	360	700 - 3 600		1984-1992
Manantali	500	1 500	30	1995
Sélingué	400	4 000	100	1995
Jebel Aulia	1 500	7 000 - 8 000	50	1975
Mtera	600	3 250 - 5 000	80	1986-1991
Mwadingusha	1 000	674 - 8 000	50	1953-1983
Kafue Flats	4 300	2 450 - 10 850	6 - 25	1957-1982
Kainji	1 270	4 500 - 6 000	35 - 47	1974-1978
Kariba	5 300	30 700	30 - 41	1990
Nasser	6 200	15 600 - 31 200	6 - 25	1981-1991
Volta	7 400	40 000	55	1970-1979
LAKES				
Turkana	7 560	350 - 22 000	9 - 16	1962-1988
Baringo	130	152 - 600	10 - 50	1964-1986
Naivasha	115-150	44 - 950	5 - 60	1964-1986
Albert/Mobutu	5 270	23 900	47 - 65	1989
Chilwa	750	13 700	77	1989
Chiuta	200	1 100	75	1989
Edward	2 300	14 400	61 - 70	1989
Kivu	2 370	4 600	27 - 42	1991
Malawi	30 800	69 400	35 - 45	1991
Mweru	4.650	20 200	60	1990
Tanganyika	32.900	133 900	90	1990
Victoria	68.000	562 900	29 - 59	1991

Modified after Lévêque 1999

Urbanization, agriculture and catchment degradation are the causes of eutrophication in Lake Victoria, in particular in the Winam gulf of the Kenyan sector of the lake, and in many of Africa's other lakes. For example, the slow eutrophication of Lake Kivu has been attributed to population growth, deforestation and erosion, while that in Lake Naivasha to population growth and agricultural intensification (Lévêque 1997; Harper et al. 1993). Heavy metal pollution is of less concern, but high levels have been recorded from Lake Mariut (Egypt) (Biney et al. 1992). As for rivers, long term sustainable use of lake fisheries will require significant improvements in the management of land and water use in the catchments.

The governance of lake fisheries and the distribution of the benefits they provide is a growing concern. For example, while the development of the *Lates niloticus* and *O. niloticus* fishery on Lake Victoria has grown in economic importance, so have concerns about the social impact of the fishery. The focus on exports and the recent development of the fish meal industry at the expense of fish protein supply to local communities has led to a drop in per capita protein consumption around the lake (Abila and Jansen 1997), and there is concern about overfishing of inshore fish populations which are of particular importance for small-scale fishers. And in Malawi, declining national catches and local overfishing is seen to indicate that the centralized enforcement approach to fisheries management as applied through government institutions has failed (Hara et al. 2001). To address these concerns, growing attention is being given to the potential of co-management as an alternative to centralized fisheries management.

If the role of lake fisheries in sustaining food security and livelihoods is to be maintained and enhanced, the Center believes that it is essential that effective systems of governance for fisheries are put in place at both basin and fishery level. It is particularly urgent that attention is focused upon improving the latter. To be successful, these improved systems of governance need to address biological, social and institutional aspects of the fisheries by integrating experiences of user groups with scientific advice and policy



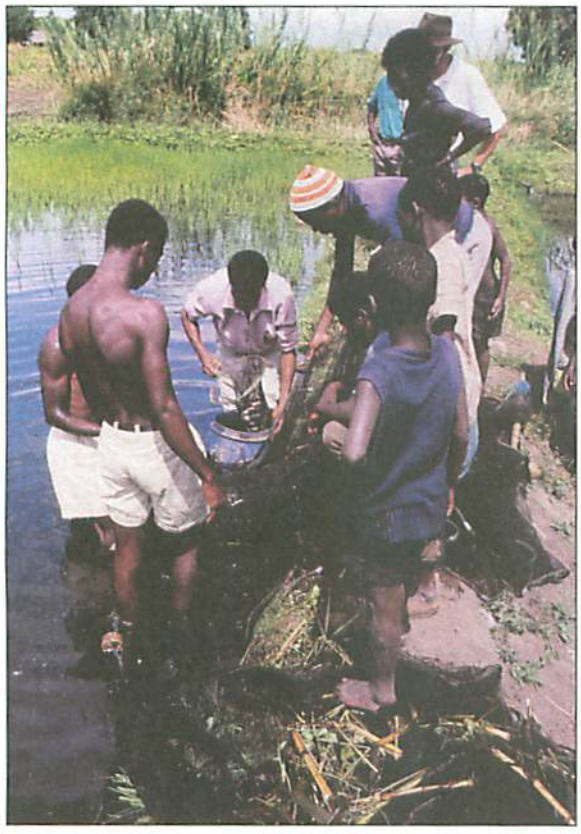
P. Dugan

Improved governance of lake fisheries needs to be informed by better information on the socio-economic importance of these resources.

considerations at the central level (Normann et al. 1998). There are few contemporary examples of such integration in African lakes, and none has yet been able to demonstrate the capacity to continue to function effectively in the face of long-term institutional and environmental change.

The development of these governance systems needs to be informed by experience that can be harnessed from other similar systems, while their implementation needs to be able to draw upon a greatly improved information base. Key issues that require improved information include: accurate stock assessments and understanding of spatio-temporal distribution and abundance; the role of inshore waters and fringing wetlands in maintaining fish species diversity and production potential; and the socio-economic importance of artisanal fisheries. Simple methodologies for obtaining such improved information need to be developed and used to inform these governance systems.

Artificial reservoirs have added significantly to the area and value of the standing surface water in the region. In Africa as a whole, there are a total of 176 large dams (each greater than 10 million cm^3), with a total impounded volume of 1 000 km^3 (Avakyan and Iakovleva 1998). These reservoirs play a significant role in the region's fisheries production with published annual harvest data ranging from 1 500 t on Manantali (Mali) to 31 000 t on Lake Nasser (Egypt), and 40 000 t on Lake Volta (Ghana). Yields are commonly around 50 kg/ha or above, and as high as 340 kg/ha in the case of Lagdo in Cameroun (Table 2) (Leveque 1999). While some of this variation is due to the natural productivity of these artificial lakes, much is due to differences in the management regime, including timing and extent of draw-down, and whether or not there has been any stocking, as for example is the case with Capenta (*Limnothrissa miodon*) in Cahora Bassa and Kariba (Marshall 1984). In addition, these figures do not consider cage culture which is now being tried and carried out on a commercial scale in a few reservoirs in Namibia and Zimbabwe, and has been tested in Lake Nasser (Egypt). However in order to fully exploit this potential, the management requirements of the individual systems need to be assessed, and agreement reached with key stakeholders on the management regime required.



R. Brummett

Management of small waterbodies can provide an important transition to aquaculture.

In addition there are many thousands of smaller dams or small waterbodies (SWBs), with the number in eastern and southern Africa alone

being estimated at between 50 000 to 100 000 (Haight 1994). Even though most of these have been built for purposes other than fisheries, are usually located in rural areas with difficult access, and though fish yield and revenue are low and government efforts are concentrated on the major fisheries, potential for improving yields exists. As efforts to improve water productivity at basin level increase in coming years, the potential of these waterbodies to provide fish and income to rural people is likely to be developed (Dugan et al. 2002). Management of SWBs also provides an important transition to aquaculture in some areas. ALCOM (Haight 1994) concluded that methods to increase production in SWBs should be tried and demonstrated including habitat and fishing gear/technique improvement, nutrient input, cage and pen culture and stocking, while regulating access and effort where fishing intensity is high.

Objectives, Outputs and Development Impact. The WorldFish Center's work on lake and reservoir fisheries will pursue four specific objectives.

Objective 1. Identify systems of governance that enhance the contribution of lake fisheries to food security and sustainable livelihoods.

Outputs

- Diverse examples of good governance of lake fisheries identified.
- Key factors for success of these systems identified.
- Guidelines on systems of good governance for lake fisheries.

Development Impact

- More widespread adoption of governance systems that enhance access to the livelihood benefits of lake fisheries.
- Nutritional and income benefits of lake fisheries sustained for dependent communities.

Objective 2. Determine the status of the region's lake and reservoir fisheries and improve the availability of existing data on fisheries productivity (past, present and potential) and management.

Outputs

- Review of the current status and future potential of the region's lake and reservoir fisheries.
- Assessment of the total current and potential value of the region's lake and reservoir fisheries.
- Critical gaps in knowledge identified.

Development Impact

- Enhanced understanding on the part of stakeholders of the value of the fisheries resources of lakes and reservoirs.
- More informed and influential engagement by fisheries stakeholders in the management of lakes and reservoirs.

Objective 3. Evaluate and identify approaches for conserving biodiversity in the region's natural lake systems.

Outputs

- Up-to-date review of the biodiversity status of the region's lakes.
- Threats to biodiversity identified.
- Successful approaches to conserve biodiversity identified.
- Guidelines on conserving lake biodiversity produced.

Development Impact

- Enhanced conservation status of the aquatic biodiversity of the region's lakes.

Objective 4. Identify options for improving fish production of lakes, reservoirs and SWBs (including pen and cage culture), in the face of competing demands for water.

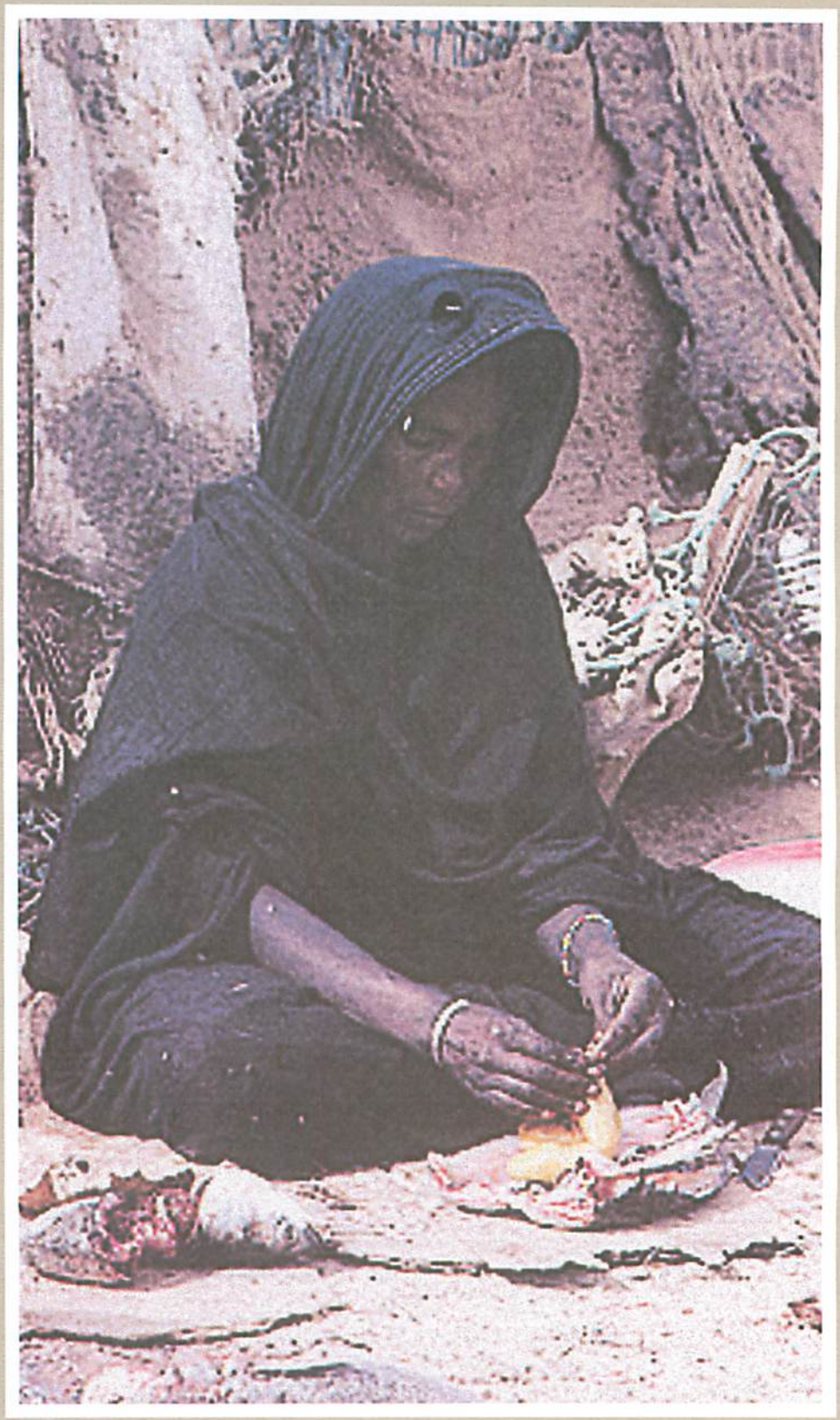
Outputs

- Review of experience in managing Africa's lakes, reservoirs and SWBs for fish production.
- Successful approaches for improving fish production from these waterbodies including institutional and technological methods.

Development Impact

- Improved management and enhanced production from the region's fisheries in lakes, reservoirs and SWBs.

Approach. In view of the commercial importance of several of Africa's lake fisheries they have received considerable research attention in recent years. To support the design of future investments in this field the Center will therefore undertake a more detailed analysis of those issues where further research will make a significant contribution to improved management. Similarly, an analysis of options for enhancing production from reservoirs and SWBs will be carried out. As this work is carried forward the Center will work with national partners to identify specific issues for collaborative research. Initial priorities include Mozambique, Malawi, Uganda, Kenya, Tanzania and Ethiopia. Work on SWBs will be considered in conjunction with work on aquaculture.



FIBA: P. Campredon

3. COASTAL FISHERIES

Introduction. The extensive marine waters of Africa and West Asia support highly productive fisheries that provide the bulk of the region's fish harvest (FAO, 1999). While the industrial fleets dominate this catch, the artisanal harvest is significant throughout the region. For example, along the Atlantic coast of West Africa the artisanal catch exceeds 1 million t (Horemans 1998), while in Mozambique the artisanal catch of 80 000 t is valued at US$ 50 million.

FIBA: J. Trotignon

Along the Atlantic coast of West Africa the artisanal catch exceeds 1 million t.

The economic and social importance of these fisheries is high. In West Africa, fisheries represent 2 to 3 per cent of GDP in most countries, rising to 10 per cent in Mauritania which has an important industrial fishery. In the coastal region from Mauritania to Angola there are estimated to be over 570 000 full-time artisanal fishers and a great many more farmers who fish part-time. In addition, some 1.8 million people are estimated to be engaged in fish processing and marketing in the same region. Fish trade is largely carried out by women (Horemans 1998). On the Indian Ocean coast of Africa, the pattern is repeated. In Mozambique the fisheries sector represents 3 per cent of GDP, but contributes some US$ 117 million to the economy. Fish exports in 1999 were valued at US$ 75 million and contributed 28 per cent of exports and 12 per cent of foreign exchange earnings. Over 80 per cent of the value of

SFLP

Processing and marketing the catch from coastal fisheries provides employment for several million.

exports is from shallow water shrimp caught on the Sofala Bank, the bulk of which is exported to the EU, Japan and South Africa. Over two thirds of the population of Mozambique live within 150 km of the coast, and thus the fisheries sector is also an important source of both animal protein and employment: some 80 000 people are employed in the sector, of which 90 per cent are artisanal fishers or those associated with the artisanal fisheries handling and distribution activities.

At present a range of social and economic processes are leading to increased dependence, and in turn pressure, upon these resources. For example, the collapse of other economic sectors combined with population increase and migration to coastal areas has led to increases in the number of coastal fishers in many parts of the region. In the face of this increased fishing pressure, traditional management systems alone rarely provide an adequate system for sustainable use of these resources, and their limitations are further constrained by the influence of the market economy and environmental degradation (Horemans 1998). In the absence of effective governance systems, this has led to a wide range of conflicts and to progressive over-exploitation of many resources.

The conflicts between artisanal coastal fisheries and industrial fishing are of particular concern, and innovative approaches for addressing these need to be developed. For example, at the northern tip of Mozambique's Sofala bank the high concentration of beach seines using fine mesh mosquito net material, combined with concern about the impact of semi-industrial and industrial trawlers fishing close to the shore, has encouraged the development of fisheries co-management. The Government has declared an experimental three-mile artisanal fisheries zone for the area and co-management committees have been established to bring together different interest groups and discuss problems such as migration, local conflicts of interest, and conflicts with trawlers, and foster more sustainable use of the fishery resource. Similarly in Guinea-Bissau, concern about the impact of semi-industrial foreign boats on the artisanal fishery of the Rio Grande de Buba has led to the development of a co-management system, and the establishment of a restricted fishing area for exclusive use by local fishers (Barros 1998; Campredon 1998; Baran and Tous 2000).

SFLP

In several countries beach seines are an important source of income. However long term sustainability will require new community based management approaches, together with livelihood diversification designed to reduce the number of fishers.

In Ghana, Togo and Benin, beach seines are used intensively with some 790 beach seine units surveyed along 550 km of coast. This intensity of use has led to growing concern that the practice is destroying fish spawning grounds and an outright ban of beach seines has already been recommended in Ghana. However each beach seine unit provides employment for some 40 to 80 people for about 8 to 10 months each year with the result that a ban will have a drastic impact on already very poor communities. New management approaches developed around Community Based Organizations are now being explored, although livelihood diversification is seen to be essential if fishing pressure is to be kept at sustainable levels (Yeboah 2002).

These successes remain very fragile, however, in view of the experimental and iterative nature of many of the approaches being pursued, and in particular because of the economic importance of the industrial and semi-industrial fishery. If these examples are to be sustained and replicated more widely, much greater investment needs to be made in demonstrating the full economic and social value of these resources, and in developing resilient co-management regimes that can adjust to changing needs and conditions. The decentralization of such management regimes, complemented by investments to reduce post harvest losses, improve access to markets, and provide micro-credit facilities to support investment, holds great promise for long-term sustainability and as a significant stimulus to rural development.

While the full development potential of coastal fisheries is untapped and the resource is therefore undervalued, the sustainability of this resource will remain vulnerable. Urban, tourist and industrial expansion have all diminished important coastal ecosystems in many parts of the region, and pollution from land-based sources, increased sedimentation and changes in river flow as a result of dams contribute to the degradation of many others. These changes can have major impact upon the coastal fisheries and the people dependent upon them, but this needs to be better understood, documented convincingly, and communicated effectively to key stakeholders if action to prevent and/or mitigate this impact is to be taken. Key conservation measures need to be identified and pursued as an integral part of future coastal zone planning and management efforts.

In the face of these pressures, institutional capacity to manage coastal fisheries as an integral part of sustainable coastal development needs to be strengthened. As argued for rivers, this needs to be underpinned by quality information on the status of the resource, its value and the pressures upon it, as well as on the governance arrangements that can foster effective stakeholder engagement.

Objectives, Outputs and Development Impact. The WorldFish Center's work on coastal fisheries will pursue three specific objectives.

Objective 1. To identify systems of governance that can foster sustainable use of coastal fisheries in the face of changing demographic, social and economic

conditions, and can enhance the contribution of these resources to food security and sustainable livelihoods.

Outputs

- Diverse examples of good governance for coastal fisheries identified.
- Key factors for success of these systems identified.
- Guidelines on systems of good governance for coastal fisheries.
- Guidelines on systems of coastal zone management that help sustain coastal fisheries.

Development Impact

- More widespread adoption of governance systems that enhance access to the livelihood benefits of coastal fisheries.
- More widespread inclusion of fisheries concerns in coastal planning processes.
- Nutritional and income benefits of coastal fisheries sustained for dependent communities.

Objective 2. To acquire, interpret and supply information on the value of fisheries in support of systems of governance that enhance the contribution of coastal fisheries to food security and sustainable livelihoods.

Outputs

- Value of the fisheries of six major coastal systems quantified and provided to stakeholders.
- Total current and prospective value of the region's coastal fisheries estimated.
- Fisheries assessment capacity of national institutions strengthened.

Development Impact

- Enhanced understanding on the part of stakeholders of the value of the fisheries resources of these coastal systems.
- More informed and influential engagement by fisheries stakeholders in the management and allocation of multi-use systems of coastal resource management.
- Coastal resource management policies and processes that recognize and take account of the value of coastal fisheries.

Objective 3. Provide information on the ways in which pressures upon the coastal zone impact coastal fisheries and identify ways to address these threats.

Outputs

- Assessment of current and potential threats to coastal fisheries.
- Action required to address those identified.

Development Impact

- Enhanced awareness of the growing threats to coastal fisheries.
- Action to address these factored into coastal zone management policies and processes.

FIBA: P. Campredon

Improved governance of coastal fisheries needs to be underpinned by quality information on the status of the resource, its value and the pressures upon it.

Approach. An integrated program of work will be developed to address the three research objectives. Up to six coastal systems will be identified using criteria that include: presence of institutional arrangements that provide a framework for coastal zone management, or of work underway to develop such a framework; possibility of strengthening national and regional capacity to apply such arrangements; possibility of collaboration with international institutions and other CGIAR centers. Coastal systems being considered include: western Indian Ocean, Bijagos archipelago and coastal rivers (Guinea-Bissau).

R. Brummett

4. AQUACULTURE

Introduction. Despite the current importance of the region's extensive capture fisheries, it is widely acknowledged that the progressive development of aquaculture is essential if the projected increase in regional demand for fish protein is to be met. In addition, there is growing regional recognition of the considerable potential of small-scale aquaculture to diversify livelihood options for poor farmers, increase income while reducing risk and vulnerability, and also to improve land and water management.

J. Thodesen

In addition to providing a reliable supply of fish and additional income, the integration of aquaculture into small scale farming systems in Malawi has increased crop production, improved overall farm profitability, hepled rehabilitate farmland and improved drought resistance.

The potential for aquaculture across the region is enormous. For SSA alone Kapetsky (1994) has estimated that 9.2 million km^2, or 31 per cent of the land area, is suitable for smallholder fish farming. If yields from recent smallholder development projects can be replicated elsewhere, only 0.5 per cent of this area would be required to produce 35 per cent of the region's increased fish requirements up to the year 2010 (Kaptesky 1995). Similarly Kapetsky's estimates suggest that there are almost 200 000 km^2 of land suitable for aquaculture in Southern Africa alone. Fish yields from integrated farms in Malawi and Zambia are typically about 1 500 kg/ha/year (Brummett and Noble, 1995; Maguswi, 1994). If this can be replicated on only 1 per cent of the almost 250 million ha identified by FAO as suitable in southern Africa, 3.75 million t of fish per year might be produced. This is four times the reported catch from all capture fisheries in the region. In addition work in Malawi has shown that while providing a reliable supply of fish and additional income, integrating aquaculture with agriculture also improves overall farm profitability, helps rehabilitate farmland, improves drought resistance, and improves farmers preparedness for crises through increased crop production (Noble 1996).

At present this potential for aquaculture remains largely untapped over much of the region. By 1999 total aquaculture production in SSA was only 117 000 t, 0.4 per cent of world production, yields in most countries remain low, commercial operations have yet to develop in many areas, and fish farmers are relatively few in number (Moehl 2001). The precise reasons for the poor adoption of aquaculture by small-scale farmers have varied from case to case, but the fundamental cause is now widely recognized to be the failure to effectively integrate aquaculture into the farm economy (Harrison et al. 1994; Stomal and Weigel 1998; Brummett and Williams 2000). This in turn is believed to be due to several factors:

- Too much emphasis on the role of central government structures, both in terms of technical support and provision of inputs, and not enough on the farmers.
- Poor understanding of the household economies and rural livelihood

strategies into which it was hoped to integrate aquaculture, and the constraints and opportunities these presented.

- Poor understanding of different household roles, and in particular the role of women.
- Poor understanding of social constraints.
- Poor assessment of markets.
- Too much emphasis on bio-technical methodologies rather than simpler but more readily adopted, and more adaptable, approaches.
- Inadequate extension.

As a result most attempts to promote the development of aquaculture have failed to recognise the real needs of the farmers, assist them in adjusting aquaculture practices to their specific contexts, and so resolve the conflicts of time and resources that have ultimately constrained the adoption of aquaculture.

Over the course of the 1990s, a number of initiatives have tried to remedy past weaknesses, in particular by placing greater emphasis on the development context (Stomal and Weigel 1998). Several of these new efforts have pursued an integrated and adaptive action-research-development approach, rather than engaging in the compartmentalized approach of pursuing research followed separately by extension that has characterized the failed efforts of the 1970s and 1980s. For example in Malawi, this integrated "action-research" approach has led to the successful adoption of small-scale pond aquaculture by a growing number of smallholder farmers as an integral part of their farming practice (Brummett and Noble 1995).

To build upon these successes and realize the region's potential, much greater investment will be required over the course of the coming decades. Approaches designed to address the constraints and failings of the past need to be developed as further experience improves understanding of the opportunities and constraints. In particular the social, economic and institutional constraints to aquaculture need to be understood, and the approaches used adjusted to address these. Detailed understanding of the socio-cultural context, together with understanding of the market forces that will determine the return to the farmer, are prerequisites for designing successful aquaculture. The roles of government, the private sector, and NGOs need to be understood and supported. In particular, the training and extension system used needs to be adapted to the dynamic environment within which aquaculture is being pursued.

Many of the farmers now engaging in fish farming in sub-Saharan Africa are women.

R. Brummett

As for most other crops, prices, demands on the farmers' time, environmental conditions and a range of other factors will vary seasonally, annually, from province to province, and in many cases from

farm to farm. This means that emphasis needs to be placed upon developing the capacity of the farmer as an entrepreneur by providing a wider suite of understanding and tools from which they can draw in order to adapt to the dynamic environment in which they are operating. The success of this approach has been demonstrated by the WorldFish Center through the use of Research and Extension Teams (RETs) in Malawi and more recently in Cameroun. However, this approach needs to be adapted to a much wider range of locations if it is to bring about the scale of change that will be needed to meet the growing demand for enhanced livelihoods and fish production from aquaculture in SSA.

In West Asia and North Africa as a whole, aquaculture is a comparatively recent development (El Gamal and Saif Abdulla 2001). The exception here is Egypt which has a long history of culturing tilapia (Bardach et al. 1972), and which is today the dominant producer of farmed fish in WANA and on the African continent. Over the course of the 1990s, however, production almost doubled in the region, with growth of 79 000 t reported in Egypt between 1989 and 1998, and of 52 000 t in Turkey in the same period. This pattern of overall growth masks reduced production of some species, for example, carp in Turkey and Egypt, and reflects in particular the substantial development of shrimp, sea bream and sea bass in appropriate coastal areas, of trout in the colder waters of Turkey, and of tilapia in earthen ponds in Egypt. The expansion of mariculture and trout culture has been in response to the market opportunities for these products and is led by the private sector. However the rapid expansion of tilapia production in Egypt is due to a combination of government policy, provision of credit facilities, and intensive research and training.

Future indications are that production from aquaculture in WANA will continue to increase but if the successes seen in recent years are to be repeated, then there will need to be sustained support. This will need to address the same range of social, economic, and institutional issues that are now being addressed in SSA and develop technical tools that are adapted to the specific biological and physical conditions of WANA. Present indications are that the evolution of aquaculture in WANA will continue to be dynamic, with production of some species meeting constraints. For example in Egypt the price of tilapia has fallen consistently over the five years between 1998 and 2002. While this is a positive development for consumers, it is straining the economic viability of some farms. New more cost-effective production techniques now need to be developed, including diversification to other species such as *Clarias gariepinus*.

P. Dugan

In Egypt the decline in price of tilapia is providing an incentive for development of more cost effective farming methods.

Across both WANA and SSA, four technical concerns emerge as being particularly important. First, as farmers begin to pursue aquaculture, and when successful intensify production, there is a critical need for high quality fingerlings at an affordable price. This has been a long-standing complaint within the region, and new approaches for addressing the problem need to be developed. Second, for those farmers seeking to increase production there is a major need for good quality low-cost feeds. At present most feeds used in semi-intensive aquaculture are dependent on imported fish meal and unfavourable exchange rates are therefore a major threat to the economic viability of many farms. New feeds using locally available inputs need to be developed. Third, as aquaculture expands and intensifies, there is a growing risk that disease will begin to impact production. This has been the history of aquaculture in other regions such as South and East Asia where disease has had a significant impact upon production and profitability. To minimise the future impact of disease in Africa and West Asia, much more needs to be done to understand the current status of fish health problems in the region, and to develop capacity to prevent these emerging to the degree that has happened in South and East Asia. Fourth, as competition for water increases, aquaculture needs to be not only cost-efficient but also water-efficient. Careful attention therefore needs to be given to developing approaches to aquaculture that can further improve water productivity at basin and farm levels.

The environmental implications of aquaculture also need to be addressed. The impact of urban development and associated pollution on aquaculture is of serious concern, as is the impact of aquaculture on natural capture fisheries. Possible loss of biodiversity as a result of escapes from aquaculture is also a major issue. There is therefore an urgent need to better understand the fish biodiversity of the region, the threats to it, and the potential impact of aquaculture.

As competition for freshwater increases aquaculture needs not only to be cost-efficient but also water-efficient.

R.Brummett

Objectives, Outputs and Development Impact.

The WorldFish Center's work on aquaculture will pursue three specific objectives.

Objective 1. Enhance the contribution of, and participation in, aquaculture through a better understanding of the adoption process.

Outputs

- Key factors fostering adoption of aquaculture identified.
- Guidance distilled on how best to address these social, economic and institutional factors in developing aquaculture.

Development Impact

- More widespread and faster adoption of aquaculture in different social, economic and institutional settings.

- Improved supply of fish to urban and rural households.
- Improved employment and income for poor rural and urban communities.

Objective 2. Enhance aquaculture productivity, including through efficient seed production and genetic enhancement.

Outputs

- Techniques for management of broodstock and pond production under different environmental, economic and social conditions.
- Simple techniques for selective breeding of tilapia and other species of value in aquaculture.
- Improved strains of tilapia.
- Improved low-cost feeds.

Development Impact

- Improved supply of fish to urban and rural households.
- Improved income to fish farmers.

Objective 3. Develop and implement methods to measure, monitor and maintain environmental integrity as aquaculture expands in the region.

Outputs

- Guidelines for sustainable aquaculture in Africa and West Asia.
- Guidelines for management of improved strains of fish in aquaculture.

Development Impact

- Sustainable benefits from aquaculture.
- Impact on other production systems and biodiversity minimized.

Approach. In order to pursue research and develop management solutions that are adapted to the diverse social, economic, institutional and environmental conditions governing the viability of aquaculture development across the region, the Center will seek to pursue the objectives set out here by working through a number of sub-regional initiatives for aquaculture research and development. Initial possibilities include Malawi/Zambia/Mozambique, South Africa, Cameroun, Ghana/Côte d'Ivoire, Nigeria, and Egypt/Jordan. Each of these sub-regional initiatives will be designed to distill learning from community-based aquaculture research and pursue further research priorities for improved technology development. The geographical focus of the initiatives will be chosen to provide a range of environmental, social and economic conditions, while also fostering links between countries with similar challenges and potential. For each sub-regional grouping, a focused program of research on technology bottlenecks/constraints will be pursued. Wherever possible, this work will be pursued through the national institutions responsible for aquaculture research and development, and with local NGOs engaged in community development.

R. Brummett

5. POLICY

Introduction. For many of the social, institutional, environmental and technological trends that will shape the future of fisheries and aquaculture in the region, much of the information that is currently available is limited in quantity and quality. In order to provide more refined guidance to the countries of the region in the development of aquaculture and fisheries, more work needs to be done to better understand these trends and their impact on fisheries and aquaculture and the communities that depend upon them for their livelihood.

P. Dugan

The future development of national and regional strategies for fisheries and aquaculture development will need to be based upon authoritative projections of the future demand, supply, and trade of fish.

Of these trends two are particularly important: the implications of current demographic and economic projections on demand for fish, and the capacity of supply to meet this demand; and the potential impact of climate change.

Over the past few decades, production, trade and consumption patterns of the world's aquatic resources have all changed dramatically. Worldwide per capita fish and seafood consumption nearly doubled from about 8 kg in the early 1950s to 14 kg in 1996, and fish exports from developing countries have surpassed many traditional export crops such as sugar, beverages and meat. According to FAO, net foreign exchange earnings from fish and seafood products in the countries of Asia, Africa and Latin America reached US$ 16.4 billion in 1996 from only US$ 5.1 billion in 1985.

However these rates of increase are not sustainable. As demand for fish has risen so has the incidence of overfishing which, compounded by increasing environmental stress in many aquatic environments, has led to the decline of fish stocks. And while the increases in aquaculture production seen over much of East, South, and Southeast Asia may be repeated elsewhere this will only be possible where the social, economic and institutional conditions are supportive, and where the right technologies are applied. In particular, the further development of national and international markets for fish and seafood products will play a major role in providing the economic context within which aquaculture can develop effectively as a profitable and productive activity.

In the face of this changing context, most countries are confronted by the need to keep their strategies for fisheries and aquaculture development under regular review, and where appropriate revise these. In doing so, each country needs to assess the long-term prospects for the fisheries sector and set their production targets and resource management plans to ensure the best possible benefits in

terms of food security, income and employment. In turn, this assessment needs to be based on authoritative projections of the future demand, supply, and trade of fish, and of the factors impacting these. These projections need to be developed for Africa and West Asia, and the national capacity to update these developed.

While the changes in supply and demand in other parts of the world provide an indicator of the changes that can be expected in Africa and West Asia, the impact of climate change is much more difficult to predict (IPCC 1996). However, there is today widespread consensus that climate change is taking place and that it will have significant long-term impacts on the natural environment and upon the lives and livelihoods of people worldwide. The precise nature of this impact will however vary from place to place and current capacity to predict the magnitude of these changes is very limited. But it is likely that climate change will bring significant changes in rainfall and temperature patterns to parts of Africa and these will impact the patterns of run-off, and thus river flow. Similarly the water dynamics of waterbodies such as lakes, reservoirs and SWBs will also be vulnerable to change. In coastal systems, there is growing evidence that coral reefs are particularly vulnerable to rising temperature and there is great concern about the future of the region's reefs. Similarly, mangroves and other coastal wetlands will be impacted by changes in sea level.

The impact of these changes is much less immediate than many of the other issues that need to be considered in the region. However wherever the opportunity arises, the Center will seek to pursue partnerships to examine and better understand these issues. It is hoped that this information will contribute to improved understanding of the impact of climate change on fish production and fishery dependent livelihoods, and to the development of appropriate mitigation strategies.

Objectives, Outputs and Development Impact. The WorldFish Center's work in these areas will therefore pursue two specific objectives.

Objective 1. Establish reliable estimates of future supply and demand for fish within the region and identify the implications for future investment in fisheries and aquaculture.

Outputs

- National and sub-regional projections for fish supply and demand.
- Analysis of implications for future investment in fisheries and aquaculture.

Development Impact

- Stronger strategic framework for future investment in fisheries and aquaculture in the region.
- Sharper research agenda in support of this strategic framework.

Objective 2. Establish reliable estimates of the impact of projected climate change on capture fisheries and aquaculture potential in the region.

Outputs

- Analyses of the impact of selected climate change scenarios on future fisheries and aquaculture production.

Development Impact

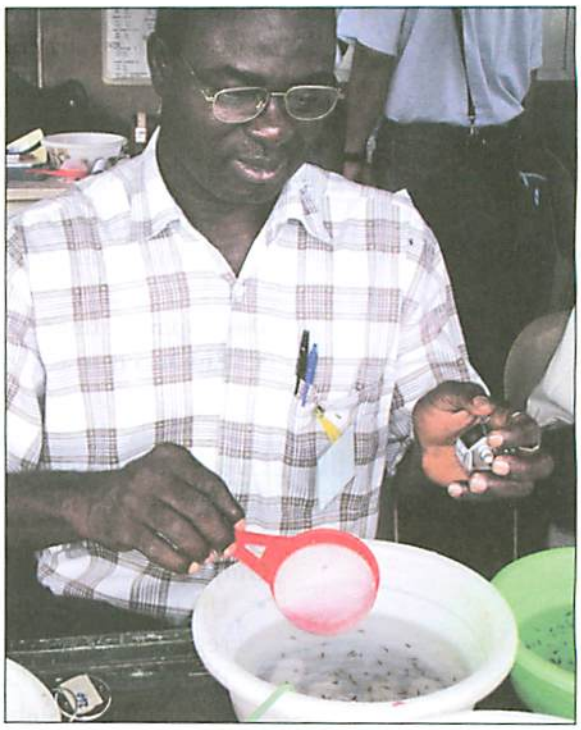
- Fisheries and aquaculture development strategies that take account of the probable impacts of climate change.

P. Dugan

6. CAPACITY

Introduction. There are few institutions in Africa and West Asia that are dedicated to research in fisheries and aquaculture. This is particularly so in SSA where economic constraints are particularly severe and most countries are facing structural adjustment, staff retrenchment and budget reductions.

Even where effective institutions do exist, considerable increase in effectiveness can be obtained by fostering exchange of experience and improved flow of information. Accordingly, the Center will work to foster capacity of national institutions to pursue research on fisheries and aquaculture across the region. This work will be adapted to the specific needs of each sub-region and country. For example in SSA a major focus will be on integrating pond aquaculture into small-holder farming systems, in North Africa on intensification of freshwater aquaculture, and in the coastal states of West Asia upon stock assessment and aquaculture. Similarly, work in SSA will give initial emphasis to rivers and floodplains and lakes and reservoirs, while more emphasis will be given in WANA to coastal systems.



J. Thodesen

The Center will give emphasis to fostering capacity of national institutions to pursue research on fisheries and aquaculture across the region.

In pursuing this work, special emphasis will be given to developing and working through regional partnerships and networks of scientists and development practitioners concerned with fisheries management and the development of aquaculture. This has been shown to be one of the most effective ways of disseminating information in an informal but highly effective and relatively fast way.

A specific effort will also be made to increase opportunities for young researchers from the region to pursue Masters, PhD and post-doctoral research as part of, or in association with, the Center's program. This is particularly important in SSA where many well-educated and influential scientists have succumbed to AIDS in recent years.

Special emphasis will also be given to improving the dissemination of information, in collaboration with FAO and other partners. At present, the libraries located at the Center's three facilities at Abbassa (Egypt), Domasi (Malawi), and Yaounde (Cameroun) are being used by a wide range of researchers, and this will increase as the program develops.

Objective, Outputs and Development Impact. The WorldFish Center's work in these areas will pursue two specific objectives.

Objective 1. Enhance the capacity of national institutions to design and carry out research that will strengthen fisheries and aquaculture management in the region.

Outputs

- Up to three training activities per year, with at least one in each sub-region.
- Up to three new PhD and three Masters students initiating training each year.
- Effective long-term partnerships established to support this training linking the WorldFish Center, national research institutions, and international partners.

Development Impact

- Enhanced research capacity of national institutions.

Objective 2. Enhance the capacity of national and regional institutions to disseminate and use the results of fisheries and aquaculture research.

Outputs

- Up to three training courses per year, with at least one in each sub-region every two years.
- Regional networks of fisheries researchers, managers and other key stakeholders established around priority issues.

Development Impact

- Enhanced capacity of national and regional institutions to foster sustainable fisheries and aquaculture.

Setting Priorities

The development of sustainable fisheries and aquaculture in Africa and West Asia over the next 30 years faces many challenges and the research agenda set out here is a large one. Considerable investment will be required over a prolonged period for this to be successful and the desired development impact achieved. The WorldFish Center will need to strengthen our own capacity, and especially that of national institutions and other partners, to pursue the work proposed.

To achieve this, priorities will need to be identified and pursued carefully. Accordingly for 2002 to 2006 the Center will focus progressively on developing activities to pursue the principal objectives identified in the Strategy and reflected in the Center's Medium-Term Plan (Table 3). Specific actions being taken to pursue these priorities at national and regional level will be set out in a series of annual operational plans.

TABLE 3 **Activities will be initiated according to the following schedule (numbers correspond to the objectives specified for each component of the strategy)**

	2002	2003	2004-2006
Rivers/Floodplains	1,2,3		
Lakes/Reservoirs		2,4	1,3
Coastal		1,2	3
Aquaculture	1,2	3	
Policy		1	2
Capacity	1,2		

Managing the Program

The regional Strategy presented here is an ambitious one. It will require a substantial increase in the WorldFish Center's investment in the region if the objectives set are to be realized. More importantly, the work described here will only result in a substantial long-term increase in capacity to manage fisheries and foster aquaculture development if it is designed and carried forward in partnership with local, national and international institutions. To help achieve this, the Center has given special emphasis to consulting with partners in the development of the Strategy and will build upon this as activities move forward. We will continue to give special attention to working with national agriculture and fisheries research and extension institutions, and appropriate advanced research institutes, non-governmental organizations, and international institutions. Wherever possible, the Center will work to build national capacity. Special attention will be given to the training opportunities that are available through the program.

The program will be coordinated from the regional research center in Egypt with specific projects managed from there, from the WorldFish Center offices in Malawi and Cameroun, and by national and regional partners. Strategic support and guidance will be provided through the WorldFish Center global programs based at HQ in Penang, Malaysia.

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