



Project Report 2012-18

Impacts of Climate Change and Variability on Fish Value Chains in Uganda

IMPACTS OF CLIMATE CHANGE AND VARIABILITY ON FISH VALUE CHAINS IN UGANDA

Key Findings

- Fish contribute significantly to Uganda's national economy and food security. Fisheries and aquaculture are vulnerable to climate change, variability, and additional non-climate related drivers of change, in particular, rapid population growth.
- Value chain analysis is a useful tool to study a sector's challenges resulting from various drivers of change, including climate. The impacts of climate change in Uganda result from an increase in mean air temperature, shifting precipitation patterns, and an increase in extreme weather events.
- The Nile perch export chain is relatively well-developed compared to the chain for domestically-consumed, lower value fish, specifically in production and processing. Mukene and Nile perch value chains differ significantly, but may be impacted by climate change and variability in similar ways related to production, processing and transport.
- Adaptation planning to decrease vulnerability within the fisheries value chain may involve supporting fishers' advocacy and safety, and developing and disseminating post-harvest handling technologies.
- Aquaculture in Uganda is promoted as a promising commercial venture to meet consumer demand for fish and support community livelihoods. However, the aquaculture value chain shows weaknesses in input supply and delivery, resulting in low productivity. A combination of climate-related threats may further weaken input supply and threaten pond productivity.
- There are many opportunities to improve input market channels, and train and support fish farmers through periods of unpredictable precipitation and/or extreme weather such as droughts and floods.
- There is an opportunity to support an enabling environment for adaptation and discourage negative informal adaptation by incorporating climate change as a cross-cutting issue within differing governance structures for fisheries and aquaculture.

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Introduction

This study examines the vulnerability of fish production in Uganda, particularly as it relates to the predicted impacts from climate change, using the concept of the value chain. The value chain approach has been recommended as a useful tool to study specific challenges facing a sector resulting from various drivers of change, including climate (MacFadyen and Allison 2009; Beveridge et al. 2011; Hall 2010). Critically, such analyses can reveal context-specific response strategies to enhance a sector (Jacinto and Pomeroy 2010). The specific purpose of the study was to identify current and potential impacts of climate change and corresponding adaptation strategies in fish value chains. The study builds upon information from earlier value chain analyses on fisheries and aquaculture production in Uganda to provide a more in-depth understanding of issues facing the fish industry, in particular, those to be incorporated in the CGIAR Research Program *Livestock and Fish*¹.

The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) in 2007 highlights the vulnerability of Africa, as a whole, to climate change and variability. Relevant current and future global climatic changes include an increase in mean air temperature, shifting precipitation patterns, and an increase in extreme weather events. The impacts of climate change and variability on inland fisheries and aquaculture production will be different (FAO 2010). Production of fish in Sub-Saharan Africa is important not only for domestic food security, but also to community livelihoods and national economies (WorldFish Center 2005). Adaptive capacity for capture fisheries and aquaculture is low, particularly in Uganda. Although the impacts of climate change and variability are difficult to determine precisely, this report seeks to explore the various impact pathways of the most relevant climatic issues on fisheries and pond aquaculture. The report focuses on (i) *Lates niloticus* (Nile perch) and (ii) *Rastrineobola argentea* (mukene²) fisheries, and (iii) on pond aquaculture of *Oreochromis niloticus* (Nile tilapia) and *Clarias gariepinus* (African catfish).

Although this report includes a discussion of Nile perch value chains, the extended chain for by-products of Nile perch processing is beyond the scope of the study³. The report is structured in four sections. Following this introduction the conceptual framework and methodology are discussed. Next, the results section provides an analysis of national vulnerability and a discussion of fisheries and aquaculture value chains, with adaptation strategies for each. The final section concludes the report.

Conceptual Framework

Value Chains

As previously stated, the fish industry in East Africa is important not only for export earnings, but also for the food and livelihood security of many households. Fisheries and aquaculture production are exposed to various facets of climate change, resulting in complex impact pathways. The degree to which those involved in fish production are affected by such changes, as well as their ability to adapt, are specific to each of the value chains evaluated in this report.

A qualitative value chain analysis is a useful method to analyze sector-specific impacts of climate change and variability. A value chain is defined as “the full range of activities which are required to bring a product or service from conception, through the different phases of production, delivery to final consumers, and final disposal after use” (Kaplinsky and Morris 2001). A value chain approach can be used to examine both micro and macro aspects, including the complex networks of production and trade comprising the fisheries and aquaculture sector.

To gain a basic understanding of each value chain, a rapid assessment was performed. This method gathers information through interviews with key representatives along the value chain, supplemented by desk research. The goal of this exercise was to determine the weakest nodes of relevant fish value chains and gain a deeper understanding of the sector’s vulnerability. In the past the value chain concept has been applied to both fisheries and aquaculture in Uganda (Fisheries: Bambona 2002; Nyeko 2004; Mugabira 2008; Pollard 2008; Kabahenda et al. 2009; Hempel 2010, Aquaculture: USAID LEAD 2009; EU 2011; Ssebisubi 2011).

¹ Additional information, including the complete research proposal, can be found at <http://www.worldfishcenter.org/our-research/cgiar-research-programs/more-meat-milk-and-fish-and-poor>

² “Mukene” is a Ugandan name for small [2-3 cm] pelagic, planktivorous fish, called ‘dagaa’ in Tanzania, and ‘omena’ in Kenya.

³ This low-value fish by-product chain is discussed in detail by Kabahenda et al. (2009).

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Governance and Value Chains

To increase the capacity of ecosystems and people to accommodate climate change, it is recommended that adaptation strategies target institution-building and rules of management (Nyeko 2004; Allison et al. 2009a). A value chain analysis is useful to illustrate and understand the existing capacities of such institutions. A value chain analysis is particularly appropriate to understand the far-reaching effects that climate change will have on aquaculture, a method of production highly dependent upon inputs such as seed, feed, and freshwater (Beveridge et al. 2011). The availability of these inputs is likely to be adversely affected by global climate change. For this reason, institutions and governance are included in this analysis of the three aforementioned value chains. Adaptation strategies are discussed as they exist throughout various institutional and governance structures, particular to Uganda's context. An analysis of the governance and institutions of value chains can explain whose actions must adapt if different outcomes are to emerge (Kaplinsky and Morris 2001).

Several modes of governance may exist within one value chain (Ponte and Gibbon 2005). Governance in value chains in developing countries often presents several additional challenges, such as large information asymmetries between producers, buyers, and consumers, opportunism and inconsistencies in transactions (Ruben et al. 2007).

Climate Change

Climate change is expected to have significant negative effects on the livelihoods of the poor in Uganda (Oxfam 2008; Hepworth and Goulden 2008; Zake 2009). Specific adaptation strategies need to both reduce these effects and provide effective options to improve livelihoods (Allison et al. 2009a). Conceptually, this report uses a vulnerability framework to discuss climate-related issues. This model is outlined below.

Vulnerability

This report analyzes existing and potential adaptation strategies to climate change for three fish value chains in Uganda. It was assembled following a review of literature on climate change adaptation, and incorporates factors from the UNFCCC's National Adaptation Programmes of Action (NAPA) (2007), and the UNDP's Adaptation Policy Frameworks. The report is structured using the vulnerability assessment framework of Allison et al. (2009b) to understand the vulnerability of fish value chains in Uganda to the key drivers of climate change. The rationale for applying such a framework to a value chain is provided. Highlighting the governance structures along a value chain illustrates which actors are undertaking current adaptation strategies, and which can undertake potential strategies in the future.

The analysis utilizes information gathered in Uganda's National Adaptation Programme of Action (2007) that outlines adaptation strategies to build capacity to react to change. Funds were issued to Uganda's Ministry of Water and Environment (MWE) to produce the 2007 report that addresses specific urgent and immediate problems faced by communities. The UNDP's Adaptation Policy Frameworks for Climate Change guidelines and relevant literature on vulnerability assessments are used to frame the analysis of climate change issues and adaptation strategies as they exist along the value chains for fisheries and aquaculture. In this way, the analysis incorporates key stakeholders and vulnerability and adaptation strategies on several scales within one sector (Winograd 2005). Uganda's NAPA, as prepared by the MWE in 2007, has already employed participatory research methods to seek out existing adaptation strategies; however, the NAPA did not conduct a rigorous vulnerability assessment, and although fisheries and aquaculture are mentioned they do not appear in priority adaptation programming (Vadacchino et al. 2011). The framework employed in this paper enables the exploration of new strategies and evaluates the capacity of institutions to implement them, specific to the fisheries and aquaculture sectors.

Climate change affecting inland fisheries and aquaculture in Uganda is separated along the value chain; how will climate change directly affect fish production in fisheries and aquaculture, and how will it affect other segments of the chain? Although the limited scope of this study made it impossible to unravel the interrelated systems and processes influencing fish production under climate change, some indirect consequences of climate change are also outlined.

Vulnerability is defined as “a combination of the extrinsic exposure of groups or individuals or ecological systems to a hazard, such as climate change, their intrinsic sensitivity to the hazard, and their lack of capacity to modify exposure to, absorb, and recover from losses stemming from the hazard, and to exploit new opportunities that arise in the process of adaptation” (Allison et al. 2009b). Based on Metzger et al.’s (2006) conceptualization, vulnerability can be expressed as a function of three factors—exposure, sensitivity and adaptive capacity, visualized below (Metzger et al. 2006; Allison et al. 2009a).

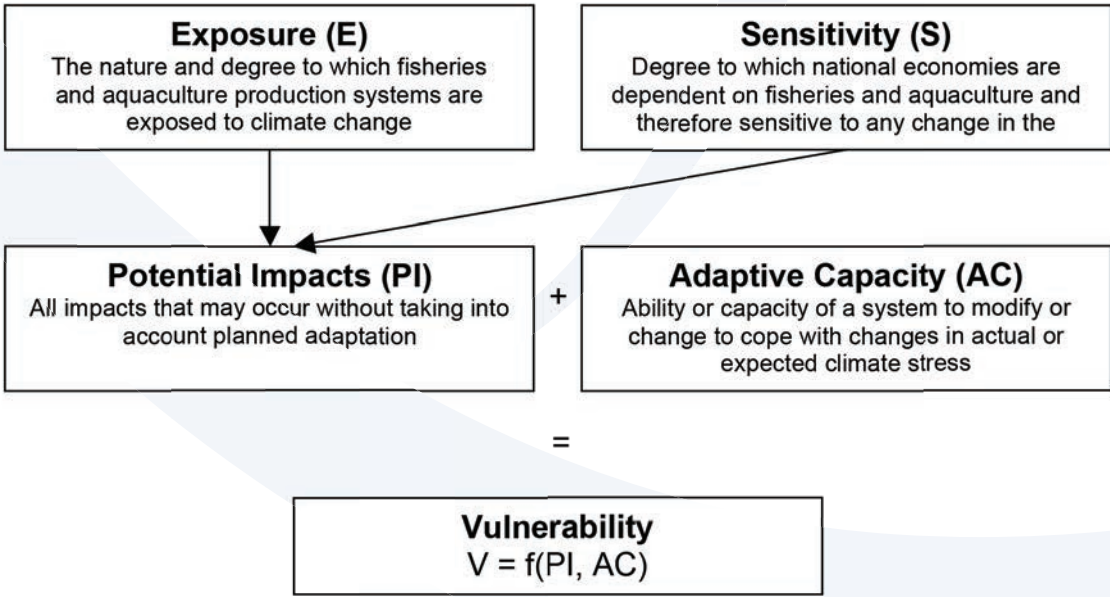


Figure 1: Conceptual Model of Vulnerability

Source: adapted from Allison et al. (2009b)

Note: In this case, the word "system" refers to the fish production sector.

The key driver of vulnerability in this system is climate change, though it is acknowledged that these value chains are simultaneously susceptible to additional drivers. In order to understand the vulnerability of this system, the impact pathways and adaptation strategies to climate change are evaluated in the following sections of the report.

Adaptation

Adaptation can be defined as a system’s ability to adapt to changes in the climate, to reduce the potential damage, to capitalize on opportunities and to cope with the consequences (Winograd 2005). Rather than prescribe adaptation strategies that address climate change alone, Hallegatte (2009) suggests implementing strategies to address greater climate uncertainty. Such adaptation strategies may be placed under the responsibility of the public or private sector.

Within fish value chains, adaptation to climate-related uncertainty may exist in several forms. Over time, resource-dependent fishing communities have been known to adapt to climate uncertainty (Sarch and Allison 2000). Often, adaptation is tactical or reactive to isolated climate events, rather than to climate change (Adger et al. 2003; Allison et al. 2009b).

The following sections outline current and expected climate changes and the resulting impacts, sensitivity in Uganda’s fishery and aquaculture communities, followed by a systematic listing of adaptation strategies designed to address the uncertainty due to climate change and variability.

Methods Used

This study incorporates information from a review of current literature on fish value chains and climate change adaptation in Uganda, supplemented with data from key informant interviews. The goal of the research was to obtain information on climate change exposure, sensitivity, and adaptive capacity of activities along the major fish value chains, and also to substantiate information gathered in the literature review.

Literature Review

The information presented here was drawn from literature assembled through an Internet search (SARNISSA and the WorldFish Center Library) together with recommendations from key researchers in fisheries and aquaculture, both locally in Uganda and internationally. It includes relevant data on the status and trends within fisheries and aquaculture and their associated institutions, and on changes in climate.

Key Informant Interviews

Semi-structured interviews were conducted with various stakeholders in fisheries and fish farming over a two month period. Interviewees are employed in the public and private sector, development institutions, and NGOs (Table 1). The interviews took place in Kampala, Jinja, and Kajjansi, and were initially facilitated by the Department of Fisheries. The content of the interview questionnaire was focused on the objectives of the study but limited by the time frame available. Qualitative data describing value chains of wild and farmed fish, as well as climate change, variability and adaptation were collected.⁴

Table 1: Number of Stakeholder Interviews Conducted

Domain	Number of Interviewees
Private Sector	5
Public Sector	10
NGO, Development Organization, Other	12
Total	27

⁴ Questionnaire developed from Snover et al. (2007).

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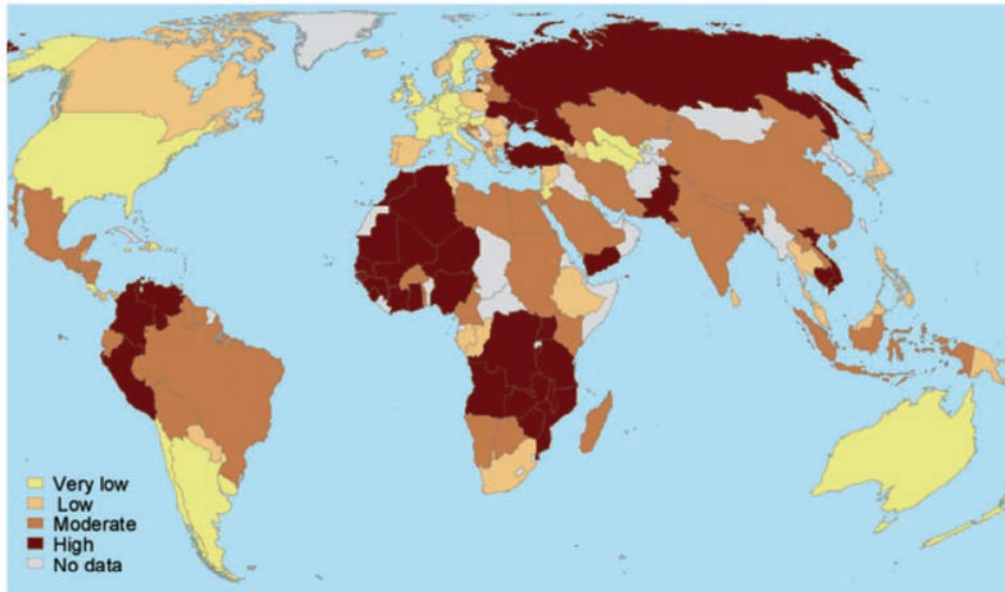


Figure 3: Vulnerability of national economies to potential climate change impacts on fisheries

Source: Allison et al. (2009b)

Exposure: Climate change in Uganda

Uganda's climate is naturally variable (Hepworth and Goulden 2008). The most widely accepted changes in climate that will impact Uganda include an increase in mean annual temperature, greater variability in precipitation but with less predictability, and an increase in extreme events.

Temperature Change

There is expected to be an increase in mean annual temperature between 0.7 °C and 1.5 °C by the 2020s, and between 1.3 °C and 4.3 °C by the 2080s. If global greenhouse gas emissions remain high then we are more likely to see temperatures at the top end of the ranges (Hepworth and Goulden 2008).

Precipitation

In addition to temperature change, a significant increase in mean annual rainfall is expected, the highest percentage increase in the 'long' rainy season in December, January and February. For a medium high emissions scenario, taking the average (median) results from different models, the increase in annual rainfall has been estimated as up to 7% by 2080, with December to February rainfall increases of 13 % by 2080 (Hepworth and Goulden 2008). Changes in rainfall seasonality are expected as well, with a shift in the 'long' rainy season (March to May), and a longer-lasting 'short' season (October to November). It is observed that rainy seasons are becoming increasingly erratic in both northern and southern parts of the country, with both wetter rainy seasons and drier dry seasons. Lake Victoria water levels are sensitive to climatic factors in the long-term. The Lake Victoria Fisheries Organization (LVFO) states that there has been a general decline in rainfall in the Lake Victoria basin from 2000–2005, contributing to a decline in lake level of 2.3 m. The issue of future access to water, especially in rural streams, must be seriously addressed (de Wit and Stankiewicz 2006).

Extreme Events

Changes in the severity and frequency of extreme events such as floods, droughts, heat waves and storms are expected, although little is known about the nature of these changes. Some models suggest that Uganda will experience a 20–30 % increase in extreme wet seasons at a medium-CO₂ emission scenario (IPCC 2007; Hepworth and Goulden 2008). Landslides in higher regions and floods in lowland areas have been particularly destructive for livelihoods, while increasing intensity of rain has caused soil erosion (MWE 2007). Such disasters can be extremely damaging to agricultural infrastructure. It is suggested that extreme events may occur 20–30 % more in the future (IPCC 2007; Hepworth and Goulden 2008).

There has been a significant increase in the occurrence of droughts in Uganda; the NAPA suggests that this can be attributed to climate change. However, this statement has been criticized; one cannot attribute this necessarily to climate change, but rather to a climatic trend (Hepworth and Goulden 2008). Regardless, a significant percentage of Uganda's population relies on water from streams that dry up during droughts (MWE 2007).

Sensitivity: Value of fish in Uganda

Contribution to Food Security

Fish contribute approximately 30–50 % of Ugandans' dietary protein (NEMA 2008; Ssebisubi 2011; Gordon and Pulis 2011). It is estimated that fish demand will grow along with population and income growth (Gordon and Pulis 2011). Fish are a standard part of the Ugandan diet, though some tribal groups have a taboo on fish consumption. The most popularly consumed fish is Nile tilapia, followed by Nile perch and the small pelagic, mukene (Ssebisubi 2011).

Contribution to Livelihoods and Economic Development

Fish are an important component of Uganda's economy. Exports of fish from Uganda have risen from 1,664 tonnes in 1990 to 24,965 tonnes in 2008, generating revenue of 124.4 USD million or 7.2 % of total exports (MAAIF 2010). It is estimated, however, that export volumes are falling (USAID LEAD 2009). Intra-regional trade is also substantial, though accurate data on this are not available. Iced and processed tilapia and Nile perch are transported to Kenya, South Sudan, Democratic Republic of Congo (DRC), Rwanda, and Tanzania, while mukene is shipped to DRC, South Sudan, Rwanda, Burundi, and Central African Republic. It is estimated that fisheries provide employment to 1.2 million Ugandans (Keizire 2006).

Adaptive capacity and non-climate related drivers of change

Uganda's food security and economy are highly dependent on rain fed agriculture. Fishing communities have limited awareness of climate change and weak adaptive capacity (Hepworth and Goulden 2008; Hepworth 2010). There is little coordination of climate-related initiatives and disaster management strategies (Environmental Alert 2010). Altogether, institutional capacity is low, lacking resources to provide sound infrastructure. Poverty levels in Uganda are high and health status weak, particularly due to a high prevalence of HIV (Allison and Seeley 2004) and other health issues such as malaria and bilharziasis (NEMA 2008).

Perhaps the most significant non climate-related driver of change in Uganda is population growth; the national population is expected to reach 50 million in 2025 (UNDESA 2010). There are also transboundary conflicts in fishing communities resulting from the expansion of the Nile perch export industry (NEMA 2008). This type of conflict is beyond the scope of current fisheries legislation. Fisheries in Uganda are considered overexploited; intense fishing pressure has resulted from increased fishing effort and illegal methods are common (NEMA 2008). Fishing areas are also sensitive environments subject to degradation. Increased settlement around water bodies has affected fish habitats and breeding grounds through eutrophication (Kolding et al. 2008). Additionally, water resources have become polluted by effluents from both industry and agriculture (NEMA 2008).

Governance under climate change in Uganda

Uganda is a signatory to various international programmes and conventions such as the UNFCCC, the Kyoto Protocol, and Reducing Emissions from Deforestation and Forest Degradation (REDD+). Uganda's National Adaptation Programme of Action (NAPA) undertook a comprehensive review of the literature on climate change, disasters, impacts and adaptation strategies, national development strategies, sectoral policies and programmes to understand the adaptive capacity to climate variability. It proposed nine adaptation programmes (worth \$38.9 M USD) but was criticized as more of a response to the UNFCCC than a response to the effects of climate change on the livelihoods of Ugandans (Hepworth and Goulden 2008).

Climate change programming is coordinated by the Ministry of Water and Environment, specifically the Department of Meteorology's (DoM) Climate Change Unit. The DoM is considered "massively overstretched, lacking both the personnel and political 'clout' required to activate an effective response" (Hepworth and Goulden 2008). Although the issue of climate change was seriously addressed by the semi-autonomous National Environmental Management Authority (NEMA), a group responsible for advising the Government of Uganda on coordination, supervision, regulation, and management of environmental issues, it remains a sectoral issue rather than a cross-cutting one (Hepworth 2010).

At the state level, development policy is led by rolling five-year National Development Plans (NDP), currently the 2010-2015. Climate change has recently become a 'development' issue through Uganda's NDP (Environmental Alert 2010); however, the NDP does not include comprehensive climate change adaptation strategies. The NDP cites limited awareness of causes, impacts and potential adaptation measures regarding climate change, and a lack of guidelines and policy for mainstreaming climate change into development policy, as constraints to the climate change adaptation programmes listed.

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There are several local and international NGOs and development organizations working on climate change adaptation in Uganda (e.g., Oxfam 2008). The perception of those interviewed is that there is little to no collaboration between these groups, and work is fragmented. The Uganda-based NGO Environmental Alert highlights a lack of research on climate change on which to base effective environmental policy and action. Although there has been significant NGO and development-related activity in Uganda on climate change (see Oxfam 2008, in particular), few actions have been implemented (Hepworth and Goulden 2008; Hepworth 2010).

There are many challenges to addressing climate change in Uganda related to improved governance. Within the government, the low level of interdepartmental communication and the limited coordination of responses to climate change poses a significant threat to comprehensive adaptation programming (Hepworth and Goulden 2008; Hepworth 2010). Uganda's approach to climate change has yielded insignificant actual results (at least this is the perception of those working in climate change in the country). Lack of coordination within and between the state, NGOs, and development institutions has led to fragmented, ineffective programming.

Fisheries in Uganda

Background

Uganda's five major lakes— Victoria, Albert, Edward, George, and Kyoga—provide the bulk of the national fish catch, with Lake Kyoga and Lake Victoria being the most productive. Lake Kyoga's catch is declining while Lake Albert's is increasing (NEMA 2008). The most common fish caught are Nile perch (primarily for export) and mukene (for domestic and some regional consumption). Formal regional exports to Rwanda, DRC and Kenya are measured at 10,000 t per year, while it is estimated that informal exports could lift this figure to 25,000 t. The majority of the informal export is transported to DRC (USAID LEAD 2009). Exports include mukene, catfish, tilapia and Nile perch by-products; most is smoked or dried.

It was estimated by Bambona (2002) that 136,000 were engaged in artisanal fishing, while 700,000 were involved in related activities such as processing, trade and boat-making. Keizire (2006) estimated that fisheries provide employment to 1.2 million Ugandans.

Common constraints in fisheries value chains are transportation, institutional frameworks for marketing, lack of capital (financial and physical) and management skills, lack of formal horizontal linkages, post-harvest losses and supply fluctuations (Odonghara et al. 2003). Ugandan fisheries are considered, by some, as unsustainable (NEMA 2006, Keizire 2006; Mugabira 2008).

Governance

Uganda's lakes are common property resources where access is governed by an institutional framework that has evolved vis-à-vis the export industry. The EU has substantial regulatory power over the Nile perch export chain to meet the demands of European consumers. They have set catch quotas and work on conservation and management of the lakes (Bolwig and Nyombi 2004; Hempel 2010; Ducker and Webber 2010).

The Department of Fisheries (under the Ministry of Agriculture, Animal Industries and Fisheries, MAAIF) is responsible for support services, policy guidelines, monitoring and evaluation of fish catches and market information of each lake's environment (Nyeko 2004; Hempel 2010). Scientific research for formulating management plans is undertaken by the Fisheries Resources Research Institute (FRRI) (Nyeko 2004). The two groups collaborate to prepare draft policies and plans for legislation.

Uganda's Fish Act of 1964 was designed to regulate fishing, fish conservation, marketing and processing. It was not amended or supplemented until the ban on Nile perch exports from Lake Victoria to the EU in the 1990s, due to health and hygiene issues. In an attempt to remedy the situation the Fish (or 'Quality Assurance') Rules of 1998 were drawn up outlining the role of inspectors, sanitary certification, hygienic conditions for landing sites, processing and transport. A Manual of Standard Operating Procedures for Fish Inspection and Quality Assurance now acts as a guide for inspectors to ensure the quality and safety of fish (Hempel 2010).

All fish export from the lake was banned in 1999 due to poor conditions at landing sites and in processing facilities, issues with health certificates, and lack of monitoring capabilities in the sector (Bambona 2002; Hempel 2010; Ducker and Webber 2010). Following the ban, underutilized fishery infrastructure and labour, paired with dwindling demand for Nile perch in the EU, led to collaboration between the EU, the Uganda

Fish Processors and Export Association (UFPEA), the Government of Uganda, and European fish importers to design a new regulatory structure that would support market flows (Hempel 2010; Ducker and Webber 2010). The Ugandan Department of Fisheries became responsible for fish safety, and 14 of 600 landing sites were EureGAP (now GLOBALGAP) certified, HACCP-accredited for export, and monitored (Hempel 2010; Ducker and Webber 2010). This certification process required fish to be tested for pesticide residues and, as a result, a local testing facility was opened (Hempel 2010; Ducker and Webber 2010).

In addition, some processors chose to privately obtain ISO 9001 certification (Hempel 2010; Ducker and Webber 2010). Voluntary Good Manufacturing Practices (GMP) were adopted by UFPEA on behalf of processors. Altogether, 11 processors became HACCP-approved to export fish (Hempel 2010; Ducker and Webber 2010). Market conditions strongly motivated the adoption of regulatory measures supporting the Nile perch value chain.

The monitoring structure at the fisher level shifted to a co-management scheme, and beach management units (BMUs) were assembled in 2003 (Nunan 2006). This scheme was considered a preferable alternative to the previous centralized model that had existed for decades prior (Odongkara 2009). Local authorities became responsible for registering boats and gear, and liaising with local government in lake management organizations (Hempel 2010; Ducker and Webber 2010). Representatives involved directly or indirectly in fisheries are elected by registered members (NEMA 2008). However, BMUs are constrained in various ways: the nature of fishing communities as transitory leads to a weak system of management; registration is often difficult and non-registration may lead to illegal practices going unnoticed; decentralized governance may foster illegal practices due to the distance from the central government; there is also a lack of knowledge of best practices within BMUs (NEMA 2008).

The National Fisheries Policy was implemented in 2004, focusing on sustainable fish management and poverty alleviation. Fish trade is a key concern, as Uganda's Poverty Eradication Action Plan promotes international trade as the main engine of growth. It was assessed by UNEP and NEMA specifically to address the links between trade, the environment and health. Although the policy and its accompanying assessment cite climatic variability as a major challenge to fish production, neither mention adaptation to climate change. The policy targets all actors along the value chains and is associated with several governing bodies in Uganda (NEMA 2006). Many institutions with an environmental mandate exist; however, enforcement is weak and effective actions are limited.

There is some vertical integration in the export chain for Nile perch; one factory owns a fleet of boats and contracts fisherfolk (Nyeko 2004). Otherwise, fisherfolk are price-takers with limited bargaining power. In fact, bargaining power is held by fish processing companies who hold their profits constant despite fluctuating export prices (Nyeko 2004). While price for Nile perch is market-determined, domestic power relations may dictate domestic and regional fish trade transactions. For instance, women processors are, in many cases, related to boat owners and/or crews (Nunan 2006). Fisheries are dominated by men; no women are involved in the catch process, but they are heavily involved in off-beach processing and trading (Nunan 2006).

Participatory research completed by Mugabira (2008) concluded that fisheries have strong (informal) horizontal linkages at the fisher level (between competitors), but poor vertical linkages in terms of trust and cooperation. Further, the fisheries researched did not have a local cooperative association for fishers to join; fisherfolk rely on informal linkages to find markets, gain information on prices, negotiate prices, and give credit (Mugabira 2008). Boat owners hold significant power in the fisheries value chain. Boat owners hire crews, and in the case of mukene fishing, female processors for in-kind payments (Legros and Masette 2010).

Nile Perch value chain

Nile perch was introduced to Lake Victoria in the 1950s to increase the productivity and commercial value of the fishery (Kambewa 2007). Although it is native only to Lake Albert (Balagadde 2003) the Nile perch is now caught from Lake Victoria, Lake Albert and Lake Kyoga. Production has been relatively consistent over time, aside from a significant dip in 1994-5, possibly due to decreased stocks and increased levels of water hyacinth.

The export market for Nile perch has now grown to more than 100 million USD per year (Nyeko 2004), making it Uganda's second most lucrative export after coffee (Bambona 2002). An illustration of the value chain for Nile perch is given in Figure 4.

The inputs involved in fisheries reflect the small-scale nature of fisheries in Uganda. It is estimated that only 15 % of boats, leased by their owners, are motorized (Bolwig and Nyombi 2004). Gear is generally artisanal: wooden boats, gill nets, and long lines, and often do not meet legal standards (Bolwig and Nyombi 2004; Marriot et al. 2004).

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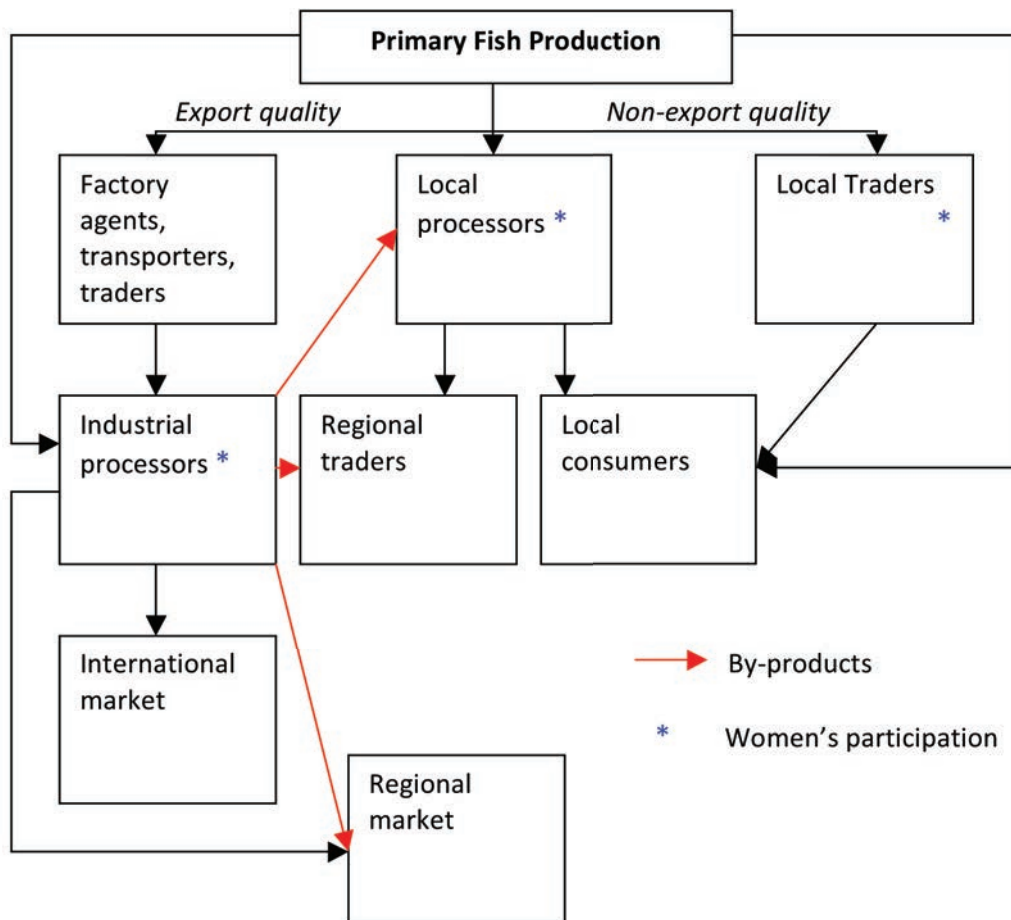


Figure 4: Nile perch supply chain in Uganda

Source: Adapted from Nyombi and Bolwig (2004)

The crews working on boats earn the least in the entire value chain (Pollard 2008).⁶ Extension services for fisheries are lacking, and fishers generally have more information on their profession than service providers.

Many fishers trade whole, ungutted perch to middlemen who use ice and insulated boats to transport the fish to processors (Bambona 2002). Cooling facilities at landing sites on Lake Victoria are few; the time required to deliver fish to land depends upon the wind, which if not favourable can lead to spoilage (Kambewa 2007). Only eight of Uganda's 600 landing sites are suitable for export (Bolwig and Nyombi 2004). At the other sites there are significant post-harvest losses; fish are landed in unhygienic conditions onto wooden platforms, stone slabs or the sand (NEMA 2008).

For the export chain, the Nile perch caught is certified by fisheries inspectors at the few gazetted landing sites along the lake shores. This high quality fish is then transported by trader-transporters to factories for processing, before being transported to Entebbe airport or the Mombasa container port (Marriot et al. 2004). Fish not meeting export standards, or caught illegally, is auctioned in batches or sold individually at these sites, or is transported by bicycle or motorbike to domestic markets (Odongkara et al. 2003; Ssebisubi 2011). In the domestic chain there are many more traders at each landing site relative to the number of fishers.

Two types of agent deal with exported perch in the EU: buying agents and selling agents (Bambona 2002). The retail chain holds the majority of market power; supermarkets are increasingly replacing fishmongers as sellers in the EU (Bambona 2002). Retailers rarely buy products directly from Ugandan processors, except when importers own processing facilities in-country (Bambona 2002).

There are currently 10 processing facilities in Uganda, each capable of processing 500 t of fish per day, and seven of these firms export fish (Nyeko 2004; Pollard 2008). Due to low catch levels, processing factories are operating at 45 % of full capacity (Pollard 2008).

⁶ Complete description and analysis of fishing activities can be found in Pollard (2008).

The majority of the catch is processed into fillets for consumption in the EU (NEMA 2008). By-products are generated at processing factories; maws are sold to international exporters, while frames⁷ are sold to local traders for domestic consumption (Pollard 2008). Women are also involved in factory processing. They carry out the skilled but tedious work of cleaning fish and removing swim bladders (specifically for Nile perch).



Above: Fort Portal. An artisanal fish processor sells smoked and fried tilapia and Nile perch in the market

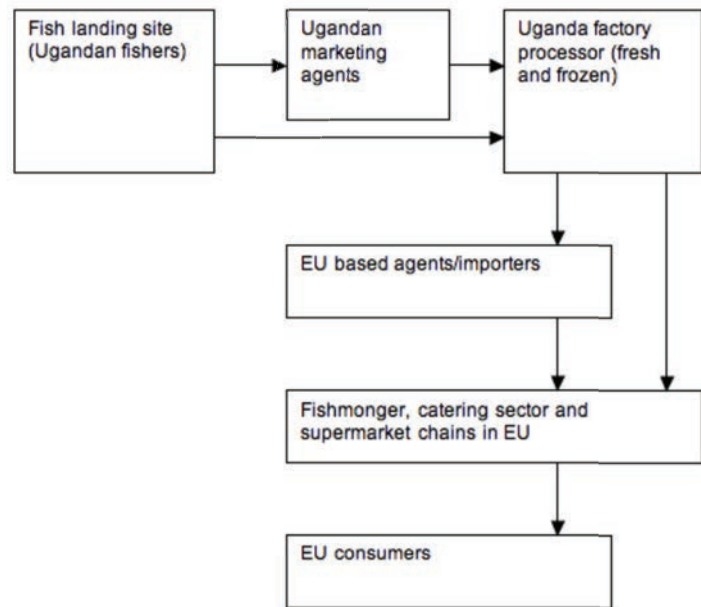


Figure 5: Major marketing channel for Nile Perch exports to Europe Source: Bambona 2002

The marketing channel depicted above indicates the path of EU-approved exported perch. However, it is simplistic and does not account for regionally and locally consumed fish that is often of lower quality, or of illegal size. Currently Nile perch is exported to the UK, Netherlands, Germany, Belgium, Australia, USA, Egypt, Israel, Hong Kong, Singapore and Japan (Bambona 2002).

Mukene value chain

Relative to the value chain for Nile perch, the chain for mukene production is less vertically integrated and requires less capital. Once considered a 'poor man's fish', mukene is increasing in popularity in diets as a source of protein, but is also a key ingredient in animal and fish feeds. It is estimated that 600,000 tonnes of mukene are caught from Lake Victoria each year (Legros and Masette 2010). Many people involved in small scale mukene fishing are migratory, and refrain from making large capital investments into fishing (Kabahenda et al. 2009).

Fishing for mukene requires few inputs, although there are various methods employed. Some fishers use simple wooden canoes, while others cast nets in shallow waters (Legros and Masette 2010).

The majority of mukene production comes from Lakes Victoria and Kyoga. Mukene represents as much as 60–70 % of the total fish catch from Lake Victoria, but only 30 % of the value (LVFO pers. comm.). As production methods are artisanal, fishers tend to gather near shorelines to fish capturing significantly smaller, juvenile fish (Legros and Masette 2010). Some fishers use a light-attraction method that is relatively new to Uganda (TECA 2012).

Upon landing, women trade fish and transfer to processing areas (Legros and Masette 2010). Traders occur at different points along the value chain; their positions can be classified as on-beach or off-beach. Off-beach

⁷ Maws are swim bladders whereas the fish frame is the main skeleton of the fish with the head and fins attached after the fillets have been removed.

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marketing, an activity dominated by women with low-startup costs, provides a significant number of purchasing households with their main source of protein (Odonhkara et al. 2003). In contrast to the Nile perch chain, there is no cold chain established for mukene; it is transported, often without refrigeration or ice, and can sit in the sun for long periods of time (USAID LEAD 2009). However, fish on the verge of spoilage is generally processed.

The great majority of processing is done by women and includes drying and salting. There are significant post-harvest losses associated with mukene, highest during the rainy seasons (Legros and Masette 2010; Finegold 2011). After processing, mukene is packed in hessian bags and transported by bicycle or hired truck to markets far from the landing sites (Ssebisubi 2011).

Mukene is sold to lower income households for consumption, and for the production of animal and fish feed (Gordon and Pulis 2011). Approximately 60–80 % of harvested mukene is used for animal feed (Finegold 2011). Markets are both local and regional. In local markets, fishmongers tend to be women (Legros and Masette 2010). Mukene consumption for dietary protein is under competition from the animal and fish feed industry; this is elaborated upon in the following sections of the report, but remains a challenge for supply of fish to low-income households.

Common non-climate related challenges can be seen along the value chains for Nile perch and mukene fisheries. Regarding inputs, some fishers use illegal gear despite efforts to regulate this through BMUs. As fish stocks decline, higher market prices may attract additional fishers to common property water resources, furthering the incentive to utilize illegal gear and maximize catch. Production is also constrained by external factors such as pollution, ongoing degradation of wetlands, and the poor health status of fishers. Post harvest losses, in the case of both Nile perch and mukene, are significant. It is estimated that 15–30 % of catch is lost due to lack of infrastructure and unsanitary handling conditions (Bolwig and Nyombi 2004; NEMA 2008). This has significant implications for domestic food security. Transport to markets is constrained by the lack of cold storage outside the export chain. Additionally, roads and transport routes are not well maintained, often impassable during rainy seasons, and travel costs can be very high due to fuel expenses.

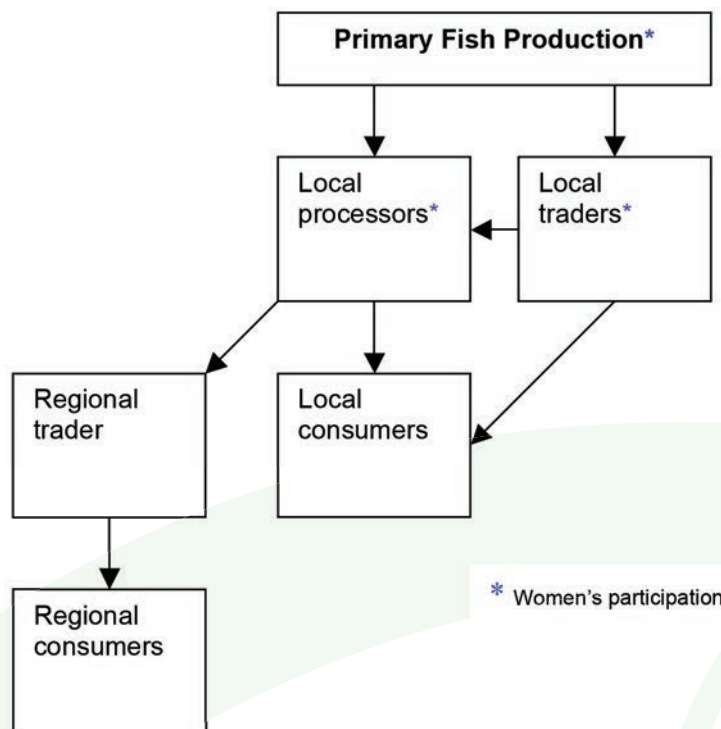


Figure 6: Mukene supply chain in Uganda



Above: Kiyindi landing site, Lake Victoria. Fish traders rest in front of a warehouse full of sacks of sun-dried mukene (*Rastrineobola Argentea*) destined for the Rwandan market. In addition to being a landing site in its own right, Kiyindi serves as a marketing hub for fish landed and processed on the islands, which is then brought to Kiyindi for onward sale and transport

Climate change — Fisheries linkages

There is a limited body of research on the impacts of climate change on fisheries with some focus on inland water bodies (Allison et al. 2005, 2009a, 2009b; Ficke et al. 2007; Daw et al. 2009) The table below was compiled through stakeholder interviews, while its structure was initially designed and used by Ficke et al. (2007).

Although Table 2 is useful to help conceptualize impact pathways for fisheries, it is impossible to isolate the impacts of specific changes in climate from climate variability and other drivers of change. Uganda's fisheries are under stress from many factors, including market pressure and fishing practices. Stakeholders involved in fisheries in Uganda generally consider the impacts of climate change and variability to be inseparable from non-climate related drivers of change. Additionally, the manifestations of climate change are highly dependent on the specific environmental and economic contexts in which they are located. Thus, a vulnerability analysis of each of Uganda's respective water bodies is warranted.

There are several factors that may arise as a result of climate change that would significantly affect the value chain for wild fish. Storms and high winds on the lakes are dangerous for fishers and result in input, infrastructure and gear destruction. Any increase in frequency or intensity would be detrimental to the fishing community.

The impacts on production resulting from climate change and variability are complex. Lake Victoria, for example, has a clear seasonality that dictates which species can be captured. It is expected that seasonality will become less predictable. There is a shortage of data on and knowledge of how primary productivity in Uganda's lakes will change over time (and the consequent impacts on secondary productivity), though shifts in distribution patterns and changes in species composition are expected. It is predicted that there will be growth in pelagic species that are smaller and more adaptable to change. Inshore waters will be affected by raised temperatures and shifting seasons; in these areas, much reproduction and juvenile growth takes place.

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Table 2: Impact pathways of climate change and variability for Uganda's fisheries sector

Point on Value Chain	Impact	Potential Outcome for Fisheries
Inputs and Services	Increased exposure of inputs (gear, boats, labour) to extreme weather, winds, and storms	Destruction of inputs and gear Increased danger to boat crew and fishers
Production	Changes in stream and groundwater temperature Change in hydrology regimes, a function of land use, precipitation, soil moisture and evapotranspiration Hydrologic variability Eutrophication Water temperature effects on limnology Increase in Ultra violet (B) rays Water loss from lentic systems; evaporation is expected to be greater than precipitation Higher growth rates Higher incidence of disease Changes in water quality	Shifts in primary production Changes in food web structure Shifts in secondary production (volume and distribution) Disease and species invasion Decreased areas to breed in shallow waters Less predictable seasonality of lakes
Trade and transport	Roads and trade routes become impassable	Lack of access to markets Changes in migratory/market routes and transport times
Processing	Processing areas hit by unpredictable rain patterns	Post harvest losses Changes in processing technologies and costs due to abundance of new species
Marketing	Supply scarcity	Price increases for available supply of fish Increased number of fishers Decreased revenues from declines in catch and/or stock abundance

Adapted from Ficke et al. (2007); WorldFish Center (2007); Daw et al. (2010) and interview data.

These changes in production may have variable outcomes on the fishing industry. Changes in species composition that show a reduction in Nile perch will impact the significant portion of Uganda's national economy stemming from its export. Decreased availability of domestically-preferred tilapia, or affordable mukene will impact national and regional food security. It is important to highlight that mukene fisheries are dominated by women's participation; any climate-related shift affecting this species will disproportionately affect the livelihoods of women.

Particularly outside of the Nile perch export chain, fishers tend target different species when stocks become low. As catches decline, fishers migrate to other areas or supplement income with non-fish related activities. Perch fishers may scale down the number of boats used when stocks are low in order to save fuel and labour costs. Male and female traders are generally more adaptable, often holding other investment strategies as catches decline. Should fishers have the means to shift industries completely, they may. However, the majority suffer through low-stock periods as they are essentially labourers contracted to obtain fish.

Although transport of fish may not be affected by marginal increases in air temperature, roads and trade routes may deteriorate in rainy seasons, and planning may be difficult as rain becomes less predictable.

Post harvest losses may also increase during intensified rainy periods, when outdoor drying of fish becomes difficult. This can be particularly devastating for mukene drying, which is done at ground-level. It is important to note that climate-related post harvest losses disproportionately affect women who are chiefly responsible for this node of the value chain.

The predicted future changes in fish production may lead to higher market sensitivity. Under sensitive market conditions, particularly when demand is unmet, fishers are more likely to use illegal gear to maintain catch volumes. The common property nature of Uganda's lakes, paired with the limited governing power of BMUs further exacerbates overexploitation.

Climate change and variability affecting agriculture will indirectly impact the value chains for Nile perch and mukene; should agriculture become less productive, farmers and surplus labour may turn to common property fisheries as an alternative livelihood strategy, increasing the pressure on fisheries.

Decentralized governance under the state is managed on a district level. Districts sharing water bodies have experienced conflict in the past, and there is little inter-district cooperation. This presents a challenge for future institutionalized adaptation along the chain.

Potential adaptation

Table 3 outlines potential adaptation strategies within the fisheries value chains for mukene and Nile perch, based on the impact pathways previously outlined. In this analysis, adaptation measures are allocated to the public or private sector as appropriate. As suggested by Macfadyen and Allison (2009), while there are many potential adaptation measures that fall to the responsibility of individuals and the private sector, there are two significant areas for the state to foster effective adaptation: creating and supporting an enabling environment for adaptation, and regulating negative informal adaptation.

Creating an enabling environment for adaptation through the Department of Fisheries can be accomplished through research and management activities. The complex interactions between climate and non-climate drivers of change and inland waters necessitate continuous public research within NaFIRRI. There is also a role for improved wetlands management in order to protect sensitive wetlands and shoreline areas. Livelihood diversification support for fishing communities promotes adaptability of the entire sector to climate change and variability (Allison et al. 2009a; Daw et al. 2009).

In order to promote adaptation at the beginning of the fish value chain, support is needed to ensure physical capital is insured against extreme weather events. The Uganda Fisheries and Fish Conservation Association (UFFCA) presently represents fisher safety and advocacy, but this organization is one-of-a-kind. Weather forecasting information could be disseminated through BMUs. Additionally, there is an opportunity for the units to provide information on quality measures, and reduce the incentive to use destructive gear through proper enforcement and by donating legal gear (Kambewa 2007).

Generally, the transport node of the value chain for many food products in Uganda would benefit from improved road infrastructure, which falls under the responsibility of the state. "Climate proofing" roads to combat unpredictable rainy seasons and extreme events would create more efficient, dependable market channels.

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Table 3: Potential adaptation within the fisheries value chain in Uganda

Point on Value Chain	Impact	Potential Adaptation Measure	Responsibility
Inputs and Services	Increased exposure of inputs (gear, boats, labour) to extreme weather, winds and storms	Insurance of physical capital equipment	Private
		Weather warning systems	Public
		Support for fishers' advocacy	Private/Community based organizations
Production	Changes in stream and groundwater temperature	Ongoing public research into climate change and variability in freshwater systems	Public
	Change in hydrology regimes, a function of land use, precipitation, soil moisture and evapotranspiration	Support for diversified livelihoods	Public/Private
	Hydrologic variability	Improved monitoring of illegal gear use	Public
	Eutrophication	Management of wetlands/lakeshore areas	Public
	Water temperature effects on limnology		
	Increase in Ultra violet (B) rays		
	Water loss from lentic systems; evaporation is expected to be greater than precipitation		
	Higher growth rates in some species		
	Higher incidence of disease		
	Water quality changes		
Trade and transport	Roads and trade routes become impassable	Infrastructure provision (e.g., roads)	Public
Processing	Processing areas hit by unpredictable rain patterns	Improved post-harvest technology (e.g. solar driers)	Private
		Training in post harvest handling suitable for migratory populations (for mukene)	Private
		Improved market information channels on consumer preferences	
Marketing	Supply scarcity	Promotion and support of cooperative groups	Public/Private

Adaptation of processing requires intervention specific to migratory populations in order to successfully decrease post harvest losses (Kabahenda et al. 2009). Supporting mukene fishing and post harvest handling will significantly benefit women fishers and traders. It is important to note that for many of these women the activities may be transitory; public or private investments into post harvest technology must take this 'employment' mobility into account. There is a role for the private sector, including cooperative groups or community-based organizations to collect and disseminate information on consumer preferences for low value fish such as mukene. This information can be provided to processors in order to maximize gains from value addition.

Uganda's fisheries are important for export earnings, domestic and regional trade, and food security. Mukene and Nile perch value chains differ significantly, but are both constrained in similar ways. There are various pathways through which climate change and climate variability impact inland waters in Uganda, and adaptation measures are warranted from both the public and private sector.

Aquaculture in Uganda

Background

There have been many studies supporting the promotion of aquaculture in Uganda (Megapesca 2006; USAID LEAD 2009; EU 2011). The Government of Uganda (GoU) introduced fish farming in the 1950s as a strategy to improve nutrition. Through the political conflict of the 1970s and 80s fish farming was largely abandoned by the state, though it was considered of some importance as a means of income generation (NEMA 2008; Isyagi et al. 2009). In accordance with the privatization and liberalization of the Ugandan economy in the 1990s, aquaculture production and support shifted toward the private sector (Isyagi et al. 2009).

Aquaculture is promoted as a promising commercial venture with 'untapped potential' for providing the supply of fish necessary to meet demand, while also providing community livelihood options (Jagger and Pender 2001; Handisyde et al. 2006). The MAAIF's 2010-2015 Development Strategy and Investment Plan states that aquaculture must shift from small-scale production for subsistence to commercial production. However, there are no proposed resources available to support this.

In 2008, the GoU estimated that there were at least 20,000 households engaged in fish farming (NEMA 2008). The Ministry of Agriculture, Animal Industries and Fisheries has identified 31 districts that are suitable for aquaculture (Figure 7). Despite this, aquaculture production in Uganda remains very low, and has been considered 'insignificant' by some key stakeholders interviewed for this study. Once heavily supported by the state through subsidies for inputs and extension, pond aquaculture is now subject to a shift toward private input and service supply. Though aquaculture is stated to have a large potential to supply fish, the majority of fish farmers do so for subsistence and little off-farm sale (KARDC, pers. comm.). Those involved in fish farming tend to engage in alternative income-generating activities such as agriculture, livestock-rearing or are employed by the state (Rutaisire et al. 2009).

Governance

Traditionally, the GoU has been heavily involved in aquaculture—in extension, policy development and previously, input supply. The Department of Fisheries' Aquaculture Unit falls under the direction of the Ministry of Agriculture, Animal Industries and Fisheries. The USAID LEAD (2009) value chain analysis describes the quality of government involvement as 'marginal'. Some stakeholders consider the production figures presented by the government to be overly ambitious. Statistics presented by the MAAIF have been questioned, and resources are lacking to collect further data on aquaculture.

The Fish (AQ) Rules, established in 2003, regulate farming practices most applicable to the commercial sector. The MAAIF's Development Strategy and Investment Plan also prescribes future commercial aquaculture activity (MAAIF 2010). Local governments are responsible for setting priorities within agriculture. Unfortunately, fish farming is often 'left behind' in such prioritization exercises, considered less important than both crops and livestock. State-led research through NARO is done by both Kajjansi Aquaculture Research and Development Centre (KARDC) and by the National Fisheries Resources Research Institute (NaFIRRI).

Prior to engaging in aquacultural production for marketing, permits must be obtained. These permits form a barrier to entering production (a full listing of these permits can be found in Ssebisubi 2011). It is common

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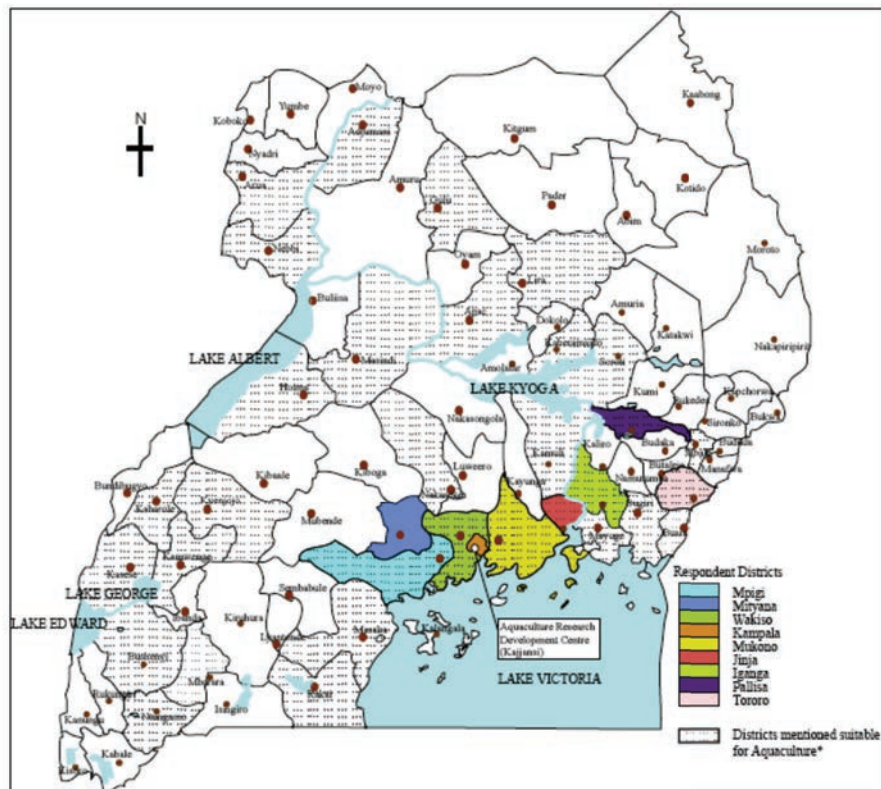


Figure 7: Districts considered 'suitable for aquaculture' in Uganda

Source: Isyagi et al. (2009)

for fish farmers to face 'informal' charges as they attempt to obtain licenses or land (EU 2011). The Uganda Revenue Authority charges taxes on farm inputs. Taxes are to be refunded, but this rarely happens. There are several development organizations implementing aquaculture programmes (ADB, USAID, NORAD, DFID, FAO, WFP, and others), however projects are often small and there is little knowledge sharing and collaboration between development groups.

Within a fish-farming household, deeply engrained gender norms dictate access to resources and control of inputs; overall, aquaculture is considered to be male-dominated. Although women participate in fish farming, men ultimately control the lucrative household assets (Rutaisire et al. 2010).

Governance of aquaculture is considered a major hindrance to a strong value chain. Weak linkages between the state and fish farmers, and development organizations and fish farmers are cited. There has been some mobilization of fish farmers through cooperative groups such as the Walimi Fish Farmers' Cooperative Society (WAFICOS), generally covering Central Uganda, and several smaller organizations in the rest of the country. Although these organizations have been successful in accessing markets for fish, they lack capacity to promote the benefits of gaining membership.

Aquaculture value chain

Stakeholders acknowledge that all inputs (feed, seed and extension) present challenges to the aquaculture value chain. Table 4 illustrates the general shift of institutional support for aquaculture from traditionally-produced feed and seed and information provided by the state, to private sector provision. The following sections describe this shift in more detail. Additional inputs for production are widely available through the private sector, or are developed locally.

Feed is of major concern to fish farmers, due to near monopolistic production and the general perception that the price is too high and unstable. Ugachick Poultry Breeders Ltd., Uganda's primary producer of feeds, runs at 50 % of its capacity to produce 600 tons of feed annually (USAID LEAD 2009). They have developed

technology for floating feed. Additional private companies are beginning to emerge, including SoN Fish Farm and Kahoorra Enterprises. SoN Fish is able to produce feed for on-site production and some external sales (USAID LEAD 2009). Kahoorra Enterprises Limited has also entered the feed market, and has proposed to significantly increase production in the near future with a new plant in the Mukono district (USAID LEAD 2009).

Table 4: Governance of aquaculture inputs, 1950-2000s

Input	1950s – 1970s	1980s – 1990s	2000s
Seed	State	State	Private-sector hatchery
Feed	Farmer	Farmer	Private sector
Extension	State	State	Private sector/state

Source: Adapted from Isyagi et al. (2009)

The instability in the price of feed is related to the variable input prices for feed production. Ugachick’s floating feeds are composed of maize, soya, and mukene. While the price for maize is known to be volatile, the price for mukene is increasing as more people consume it as a source of protein. According to private aquaculture consultants in Uganda, farmers lack knowledge on the potential benefits from applying high quality floating feeds, and instead focus on its apparently high price.

Once considered a major constraint, access to quality seed is improving. Many new private hatcheries have opened and seed is more accessible than it once was. Production of seed is generally pond-based, aside from some tank-based catfish seed production. This activity has shifted from the public sector to the private sector. Initially, the collapse of public sector seed production led to farmers using home-grown seed of poor quality. Now, increasing numbers of farmers obtain seed from private hatcheries, which are also increasing in number and reach. There are now 56 operational hatcheries in the country (Aulunier 2010).

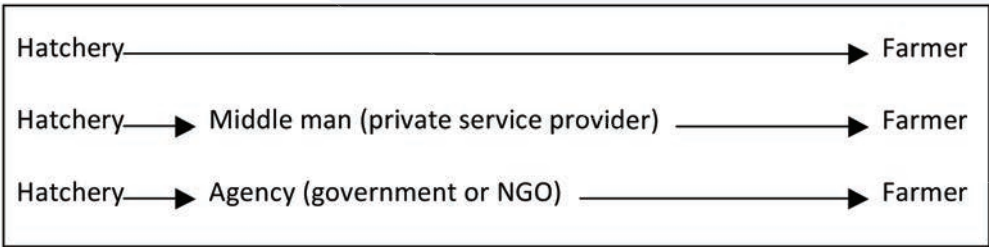


Figure 8: Seed market chain

Source: Isyagi et al. (2009)

The decentralization of extension services through the National Agricultural Advisory Services Policy (NAADS) has disadvantaged aquaculture; formerly well-supported, extension workers now lack resources once provided by the state (Isyagi et al. 2009; EU 2011). Private extension services exist, but are often of poor quality and can be expensive, particularly for small-scale fish farmers. Most extension services are provided through development projects and the private sector. Additionally, field research by Rutaisire et al. (2010) found that access to extension is significantly influenced by gender; men have easier access to information and support services for their fish farms. Further, stakeholders cite that there are weakening links between extension and research. Despite these on-going issues with extension, there are currently many new training programmes available in production technology through Makerere University and the Fisheries Training Institute.

However, the poor structure of the upstream input segment of the aquaculture value chain results in low productivity, with farms producing far below their capacity. Farmers have little knowledge of consumer preference, and generally opt to grow fish according to ease of production.

The main species farmed are African catfish (*Clarias gariepinus*) and Nile tilapia (*Oreochromis niloticus*), in ponds ranging from 100–6,000 m² (though most are approximately 500 m²) (Isyagi et al. 2009). Production is dictated by wet and dry seasons. Altogether, production levels are low though they have grown from 5,000 t/year in 2002, to approximately 50,000 t in 2008 (Ssebisubi 2011), two thirds being African catfish. It is important to note, however, that production numbers are highly contested by various groups. There is some production organization but it is limited to Uganda’s two fish farming associations: WAFICOS, and the newly-formed Uganda Fish Farmers’ Union; both groups are governed by Uganda’s national cooperative association,

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the Uganda Cooperative Alliance (UCA). Though WAFICOS has many good resources and mobilized members, it lacks expansionary capacity (EU 2011). Aside from these groups, ownership is private, foreign-owned, or managed by NARO for research purposes (Isyagi et al. 2008). It is estimated that 80–90 % of fish farmers are small-scale, and produce largely for subsistence. The margin of commercial fish farmers is small; those who produce chiefly for sale often hold secure employment elsewhere, or have retired.

Aside from fish traded through WAFICOS, cold storage is rarely used, and fish is rarely bulked. There are few middlemen involved in the trade of farmed fish, as production levels are low. While the representatives of fish farming groups seek to keep middlemen out of the value chain, there is a perception from other stakeholders that middlemen are ‘key’ to the chain as they have good knowledge of marketing opportunities, information that farmers lack (EU 2011).

Most farmed fish is sold fresh; processing is significantly under-developed for aquaculture, particularly relative to fisheries. Some local processing is done, such as drying, salting and smoking. Though processing is currently small scale, should it expand the Uganda Fish Processors and Export Association is in a good position to regulate processing quality for export (USAID LEAD 2009).

Most farmers sell fish at their own pond site; a few set up stands on the roadside or at trading centers. Some collective marketing exists for the sale of farmed fish through WAFICOS. Fish that has been processed is suitable for regional export to DRC, Kenya and Rwanda. Most catfish, on the other hand, is traded (70 %) (FAO 2010). All fish is sold for cash; contract farming does not exist. There is a general consensus that there are many marketing opportunities for farmed tilapia and catfish in both local and regional markets.

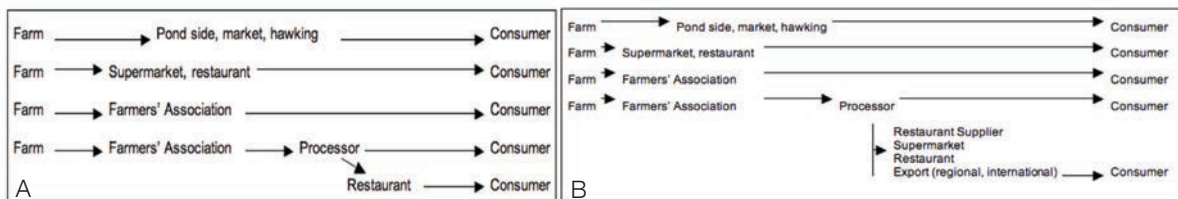


Figure 9: Market chain for (A) farmed tilapia (B) and catfish

Source: Isyagi et al. (2009)

There are several specific nodes on these aquaculture value chains that are vulnerable, as discussed above. The poor quality and inconsistent availability of inputs, specifically feed and extension, translate into a weak value chain. Governance of aquaculture has not succeeded in fostering the sectoral growth desired by the GoU and the private sector. Additionally, there is no accurate baseline data on aquaculture production. An aquaculture questionnaire has been included in the most recent census for Uganda through the Uganda Bureau of Statistics; however, various research groups criticize this questionnaire. Such groups share a concern that interventions in aquaculture are based on improper data. The next section of this report outlines the impact pathways of climate change and variability on fish farming.

Climate change – Aquaculture linkages

Aquaculture in Uganda will be exposed to the three main climatic variables discussed earlier in this report— temperature, rainfall, and extreme events. The limited body of research available on the impacts of climate change and variability on aquaculture highlights the potential challenges for feed, production, and fish farmers’ livelihoods (Handisyde et al. 2006; Allison et al. 2009a; De Silva and Soto 2009; Beveridge et al. 2011).

Climatic variables are likely to affect the inputs for feed production, both fish (in the case of Uganda, mukene), and crops (maize and soya), both directly and indirectly through increased competition for human consumption (De Silva and Soto 2009; Beveridge et al. 2011). Rising temperatures and unpredictable rainy seasons will impact crop planting and harvesting times, and may lead to higher prices. Given that the main inputs for floating fish feed also serve as food crops, decreased production resulting from climate change and variability will drive prices higher, and warrant less use of human foodstuffs for animal feed. As variable feed costs will be passed on to the fish farmer, it is necessary to understand the ways in which climate change and variability will impact production of such crops as maize and soya, in order to understand whether or not aquaculture remains economically viable. Farmers may adapt by opting for on-farm feed production, yielding low productivity. Those involved in feed development are considering alternate options for feed inputs, other than mukene.

Seed operations are expected to be better off relative to grow-out operations as most hatcheries

have a more controlled environment for production. Given the relatively higher capacity of seed producers, they may be able to engage in selective breeding for strains that are better adapted to higher temperatures, in anticipation of changes in climate. While elevated temperatures may cause increased growth rates in fish, the indirect effects of climate change may be more negative for aquaculture production (De Silva and Soto 2009). Temperature change will have an effect on the areas most suitable for production (Beveridge et al. 2011). In some cases, warming temperatures may increase production, though the extent of this benefit is unknown, and could be counteracted by increased incidence of disease (Allison et al. 2009a) Shifting and intensified precipitation may lead to flooding or dried ponds, and shorter growth seasons. In this case, seasonal planning becomes difficult. Fish farmers lack resources and information to harvest and/or pump water. There have been some efforts to provide training and extension in this area, though there is a need for it to be more frequent and inclusive.

Extreme events threaten infrastructure and can be particularly disastrous for farmers lacking insurance (Beveridge et al. 2011). In some cases, farmers informally adapt to such events by giving up fish farming entirely. In other cases, farmers benefit from undertaking training in best practices such as pond siting, construction and management.

It is expected that transport of produce will be most affected by intense rains and storms that leave transport routes impassable. As with the case of fisheries, traditional processing methods done outdoors, on the ground, are affected in rainy seasons leading to increased post harvest losses. This will only be exacerbated with less predictability and more variability in seasonal rainfall and temperature extremes.

Supply scarcity in marketing may lead to poor relationships between consumers and producers, or consumers and traders, affecting future market transactions.

Table 5: Impact pathways of climate change and variability for Uganda's aquaculture sector

Point on Value Chain	Impact	Potential Outcome for Aquaculture
Inputs and Services (Feeds)	Shifting of planting and harvesting seasons for feed input crops	Increased price of feed
	Variable feed input supplies	Decreased availability of feed
	Increased competition for feed inputs	Decreased quality of mukene as a feed input
		Decreased productivity
Production	Higher growth rates	Increased productivity
	Higher incidence of disease	Increased competition for water resources, exacerbated conflict, substitution away from aquaculture
	Changes in water quality	
	Changing growing seasons	Loss of fish stocks
	Water scarcity	
	Dried or flooded ponds	
Trade, transport	Roads and trade routes become impassable	Lack of access to markets
Processing	Local processing areas hit by unpredictable rain patterns, extreme weather events	Post harvest losses

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Potential adaptation

As with the case of fisheries, adaptation can be separated into public and private spheres of responsibility (Table 6). The privatization of input services lessens the influence of the public sector, but many opportunities to support an enabling environment for adaptation and discourage negative, informal adaptation exist.

Feed is considered a major constraint to increasing aquaculture production in Uganda, and is also particularly vulnerable to climate change and variability. Although the feed industry is privatized there is a place for both public and private research into alternative feeds through UgaChick, SoN Fish, and KARDC. For seed, KARDC or the increasing number of private hatcheries may help in selective breeding for reduced susceptibility to disease associated with stress and shifting temperatures.

Training and information on best practices falls under the responsibility of the private sector, in accordance with a shift away from publicly-funded extension. There are an increasing number of young, educated extension workers with knowledge of fish farming capable of providing information to “climate proof” production (including proper water harvesting and storage).

Similar to the market chain for fisheries production, public road infrastructure must be improved to accompany any increase in aquaculture production in order for produce to reach markets. Currently, little support is provided by the government for infrastructure repair following, or in anticipation of, extreme events such as droughts and floods.

Marketing and production would benefit from increasing support to cooperative fish farming associations, such as WAFICOS. WAFICOS does provide significant benefits; however, its ability to reach out and support additional farmers is limited. Cooperative fish farming groups can allow farmers to network, develop stronger ties to markets and share knowledge of best practices (WorldFish Center 2011). Additionally, farmers can organize cluster insurance schemes to deal with the potential impacts of extreme weather events.



Above: Rain water is harvested from papyrus roof and stored in concrete tanks for use during periods of scarcity

Table 6: Potential Adaptation within the aquaculture value chain in Uganda

Point on Value Chain	Impact	Potential Adaptation Measure	Responsibility
Inputs and Services (Feed and seed)	Shifting of planting and harvesting seasons for feed input crops	Research and development of alternative feed sources	Public/Private
	Variable feed input supplies	Sensitization of returns on investment in commercial feeds	Private
	Increased competition for feed inputs	Selective breeding for higher temperature tolerance	Public/Private
	Rise in water temperature		
Production	Higher growth rates	Increased use of feeds	Private
	Higher incidence of disease	Sensitization on climate issues and options to maintain and increase productivity	Public/Private
	Shorter growing seasons		
	Water scarcity	Improved efficiency in the use of water; training in water storage/harvesting, encourage non-consumptive water use aquaculture	Public/Private
	Dried or flooded ponds	Cluster insurance schemes	Private
Trade, transport	Roads and trade routes become impassable	Infrastructure provision (e.g., roads)	Public
Processing	Local processing areas hit by unpredictable rain patterns, extreme weather events	Extension and training in localized post-harvest handling	Private
Marketing	Supply scarcity	Promotion and support of cooperative groups	Public/Private

The impacts from climate change and variability will ultimately differ for men and women participating in aquaculture. Traditional gender norms are deeply engrained into Ugandan households including those involved in aquaculture. It is unknown how climate will disproportionately affect men and women in fish farming households.

Although aquaculture is promoted as an alternative to further overexploitation of wild fish stocks, it is not a simple industry to enter. Fish farmers are required to obtain multiple permits in order to grow fish for sale, and this regulatory framework is only expected to become more stringent if farmers begin to produce for export. Though tax exemptions are readily provided to crop farmers for inputs, the same exemptions are difficult to obtain for the inputs needed to engage in pond aquaculture. The regulatory framework must exist to promote, rather than hinder, livelihood diversification into fish farming.

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Synthesis

Based on the analysis of impact pathways and potential adaptations for fisheries and aquaculture in Uganda, it is clear that each sector faces its own difficulties. Both are exposed to climate change and variability in many ways, and are simultaneously vulnerable to non-climate-related drivers of change and their associated challenges.

The adaptation strategies included above directly involve the value chains for fisheries and aquaculture in Uganda. However, effective adaptation must also address the non-climate related drivers of change that hinder successful fish production. Several of these drivers were discussed earlier in the report. Uganda's ever-expanding population will require special attention paid to national food security and access to dietary protein, between and within households. Economic development in wetland areas, as well as pollution, threaten fisheries. Health issues within the labor force, such as HIV and water-borne diseases, limit fish production.


Institutionally, climate change is not a cross-cutting issue in Uganda. Rather, it is isolated under a single state department. Inter-departmental coordination is rare within the government. Within the Department of Fisheries, there is a lack of research integrating the impacts of climate change and variability on fish production. On a micro level, fishers and fish farmers are largely unaware of the scientific concept of climate change, though they are known to be adapting in response to extreme wet and dry seasons, or climate variability. Fisherfolk and farmers have little to no resources to effectively adapt to climate change, and there is no policy to guide adaptation specific to fish production. Following the recommendations of the FAO, it is important that national fisheries sectors be specifically incorporated into NAPAs (Vaddachino et al. 2011). Further, development interventions must take into account the sensitivity of fishing activity to climate change and variability, in order to provide sustainable assistance.

A robust vulnerability assessment is required in order to guide future adaptation within fisheries and fish farming communities. Unfortunately, the information required to guide such an assessment is lacking, particularly in the case of aquaculture. There is insufficient baseline data on fish farming to guide policy. Any further research on vulnerability of fish value chains ought to disaggregate activities and impact by gender; the current analysis is limited in this respect⁸. While gendered tasks are specific to particular nodes of the fisheries chain (see Figures 4 and 5), gender disparities for aquaculture are more related to deeply engrained gender norms. Thus, an intervention into fisheries to 'climate proof' women's activities is relatively more observable. Here, women's participation is generally limited to mukene fishing, post harvest handling and processing (both mukene and Nile perch). For aquaculture, gender disparities cannot be simply disaggregated according to nodes on the value chain. It is important to understand that any market- or asset-based intervention that is designed as a formal adaptation to climate change may disproportionately benefit men, or male-headed households. In the context of Uganda, men traditionally govern assets and monetary gains from fish production. Such information must be incorporated into programme design.

Although mobilization of fishers and fish farmers in Uganda is limited, the cooperative model provides an effective venue through which information can be shared and effective adaptation take place. For example, WAFICOS provides inclusive training to aquaculturalists on water harvesting and pond construction. The group is able to bulk produce and act as a broker, representing the collective interests of fish farmers. Stakeholders recognize the widespread benefits of WAFICOS in its cooperative efforts, but the organization is constrained by limited resources (Walakira et al. 2010). Such cooperative groups perceive the potential stresses from climate change as manageable, through education. Although UFFCA is involved in advocacy for fishing communities it acts alone, and cooperative associations for those involved in fisheries are atypical. Such bottom-up institutions are useful to disseminate information, including climate and weather patterns, to fishing groups. Alternatively, cooperative groups specifically for women can improve access to assets and achievements of rights (Weeratunge and Pant 2011).

There are important linkages between climate change and variability, its impacts on fisheries and aquaculture production that must be addressed. As climate and non climate-related drivers of change continue to impact wild fish stocks, institutions in Uganda will continue to promote aquaculture as a viable alternative to meet domestic, regional and international fish demand. As commercial aquaculture is promoted, there is a risk that capture fisheries are ignored by institutions. Given the importance of fisheries to economic livelihoods and food security, the value chain of wild fish must not be forgotten. Additionally, in order to meet the 'untapped potential' that it is expected to have, fish farming in Uganda must be supported by both public and private sectors. Effort must be put in to ensure that the aquaculture value chain is not vulnerable to climatic variables. In order to become a successful commercial venture, the value chain for aquaculture must be resilient to climate and non-climate related drivers of change.

⁸ For relevant information on gender in fisheries and aquaculture, see Weeratunge et al. (2010), WorldFish Center (2010), and Weeratunge and Pant (2011).



and droughts will become more frequent, while rainy and dry seasons will become increasingly unpredictable and intense. Given Uganda's current state of vulnerability, it is essential that programmes for adaptation are taken on by both the centralized Climate Change Unit and also in sectorally-specific ways. A vulnerability assessment can best outline specific problems facing fisheries and aquaculture, disaggregating impacts within the household and between genders.

By considering the value chains related to fish production in Uganda, this report is able to discuss context- and sector-specific adaptation strategies for products that are significant to domestic food security, livelihoods and national economic development in Uganda.

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List of abbreviations

ADB	Asian Development Bank
BMU	Beach Management Unit
CGIAR	Consultative Group on International Agricultural Research
DFID	Department for International Development
DoF	Department of Fisheries
DoM	Department of Meteorology
EC	European Commission
EU	European Union
EurepGAP	European Good Agricultural Practices
FAO	Food and Agriculture Organization
GLOBALGAP	Global Good Agricultural Practices
GoU	Government of Uganda
HACCP	Hazard Analysis and Critical Control Points
IPCC	Intergovernmental Panel on Climate Change
KARDC	Kajjansi Aquaculture Research and Development Center
MAAIF	Ministry of Agriculture, Animal Industries and Fisheries
MWE	Ministry of Water and Environment
NAADS	National Agricultural Advisory Services
NaFIRRI	National Fisheries Resources Research Institute
NAPA	National Adaptation Programmes of Action
NARO	National Agricultural Research Organization
NEMA	National Environmental Management Authority
NORAD	Norwegian Agency for Development Cooperation
SARNISSA	Sustainable Aquaculture Research Networks in Sub Saharan Africa
UCA	Uganda Cooperative Alliance
UFFCA	Uganda Fish and Fisheries Conservation Association
UFPEA	Uganda Fish Processors and Exporters Association
UNDESA	United Nations Secretariat Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
USAID LEAD	USAID Livelihoods and Enterprises for Agricultural Development
WAFICOS	Walimi Fish Farmers' Cooperative Society
WFP	World Food Programme

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