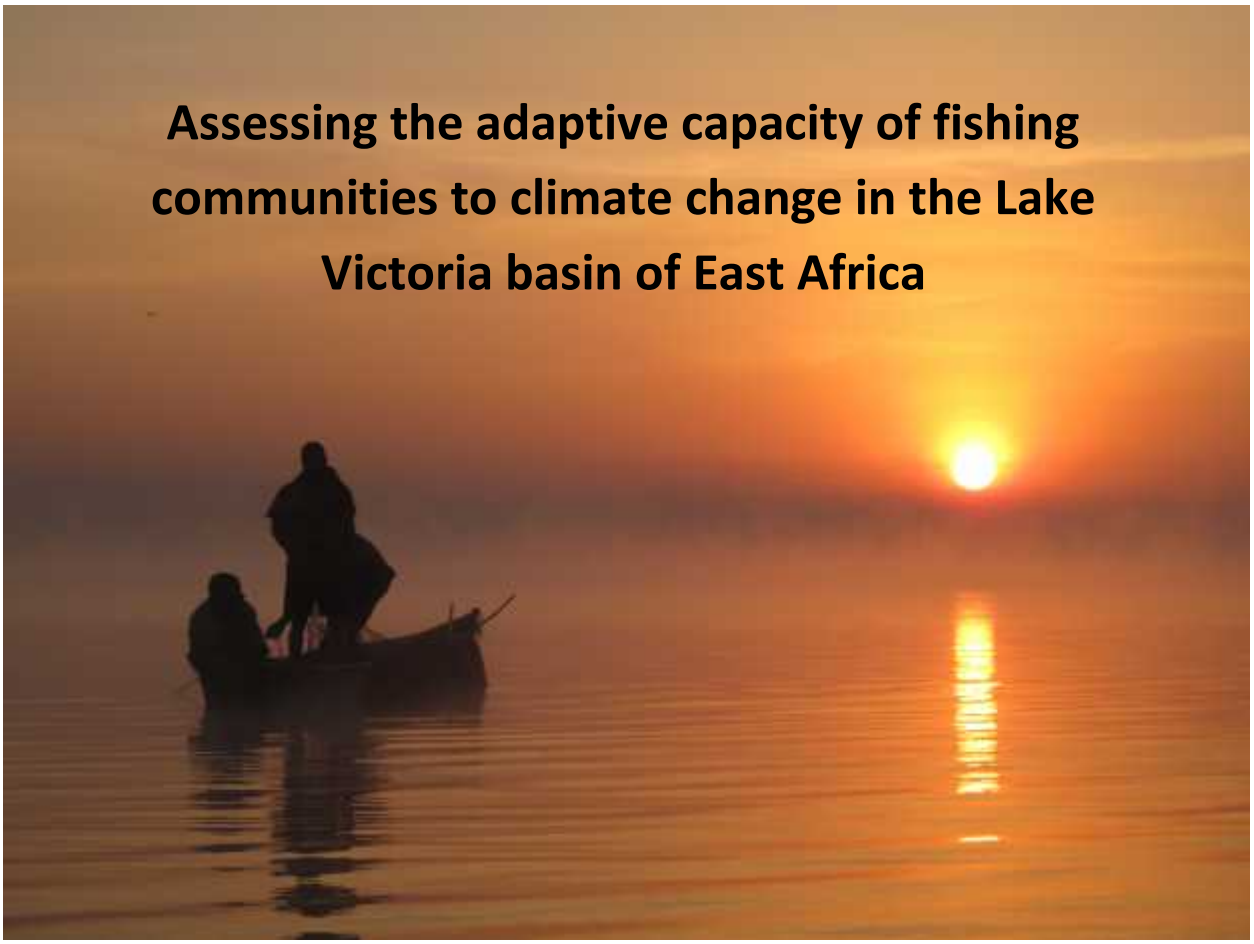
Assessing the adaptive capacity of fishing communities to climate change in the Lake Victoria basin of East Africa



This report was prepared by:

Dr. Elizabeth A. Nyboer, McGill University, Montreal, Canada

This research was done in collaboration with:

Agnes Nasuuna (NaFIRRI, Research Assistant)
John Baptist Lusala (NaFIRRI, Research Assistant)
Jackson Mutebi (Field Assistant, LNFS)
Dr. Dennis Twinomugisha (Research coordinator and driver, LNFS)
Dr. Lauren J Chapman (Research supervisor, McGill University)

We would like to acknowledge several community leaders in the various participant communities. We thank them for providing permission to work in their communities, for assisting in recruiting and organizing participants for this research, and for providing meeting spaces. In addition, we are very grateful for the valuable insights they shared as leaders in their communities. This report could not have happened without them.

Lambu
Kabuye Stephen - Beach Management Unit Secretary
Kabaja Abdu - Local Council 1
Aliganyira Julius - Assistant Fisheries Officer

Ggolo
Sophid Nalawami – Assistant Landing Site Manager
Mahmood Clinton – Landing Site Manager
Alideki Sunday – Local Council 1

Nakiga
Yiga Julius – Beach Management Unit Chairperson and Local Council 1
Gita Henry – Law Enforcement Officer

Bbaale
Sekiwunga Jude – Youth Chairman
Mutebi Jackson – Research assistant and Bbaale resident
Teopista Nakanwagi – Local Council 1

Kaziru
Mr. Matovu – Beach Management Unit Chairman

This work was funded by the International Development Research Centre (IDRC) of Canada and done in collaboration with the National Fisheries Resources Research Institute (NaFIRRI) of Uganda

SUMMARY

With climate change, weather patterns will become more variable and unpredictable. One of the most important effects of this will be an increased frequency of droughts and floods, and also changes in the timing of the rainy and dry seasons. These changes in weather can have important effects on lakes and rivers, and can change the abundance and distribution of fish. Communities that rely heavily on fisheries for their livelihoods will require adaptive strategies to adjust to these changes. In 2016, we conducted surveys and focus group discussions to ask people living in fishing communities on Lake Victoria and Lake Nabugabo what they think are the most important effects of climate change on the fishery, and on their livelihoods (income and food security). We also asked what strategies can be used to adapt to those changes, identified barriers to adaptation, and discussed different ways of overcoming those barriers. We found that climate change disrupts the livelihoods of fishers by causing unpredictable seasons, and increasing the frequency of droughts and floods. This leads to reductions in fish abundance, and also prevents diversification into other sectors such as crops or livestock. Without knowing if or when the rains will come, many fishers are hesitant to plant gardens because of the risk that the gardens will never produce crops. This leads to reductions in food security and income for many people in lakeshore communities. In addition, this causes people to rely even more heavily on the fishery, which can cause further declines in fish stocks. Survey respondents did point out several possible adaptive strategies for coping with these changes. For example, fishers suggested using farming practices that are resilient to droughts and floods, diversifying into activities that are not dependent on weather, engaging in fish farming activities, and investing in better ways of preserving and storing fish. However, they also experience barriers to accessing these adaptive practices. These include widespread poverty, lack of education, lack of access to financial support (e.g., low interest loans), lack of access to land, and weak governance structures. Useful pathways to overcome these barriers include interventions to enable livelihood diversification, improving communication and cohesion among stakeholder groups, incorporating traditional knowledge into management plans, and developing responsive and adaptive management practices.

Definitions:

Adaptive capacity: *Possible actions (adaptations) that can be done by a community that can ease negative effects, take advantage of new opportunities, and cope with consequences of an environmental disturbance (e.g., a drought or flood).*

Livelihood: *The different activities performed within a household that determine how that household makes a living. A sustainable livelihood requires access to the five capital assets:*

Financial Capital – *The income earned and economic assets owned by a household*
Social Capital – *Social resources, networks, trust relationships, community cohesion*
Natural Capital – *Access to natural resources like land, water, fish, and wildlife*
Human Capital – *Possession of skills, knowledge, abilities, good health*
Physical Capital – *Infrastructure (roads, electricity) and facilities (schools, banks, hospitals)*

Livelihood diversification: *The different ways that households can increase the number of income-earning activities practiced within a household and improve their standard of living.*

Vulnerability: *The inability to cope with the effects of climate change. In a fisheries context, a household or community is considered vulnerable if they rely on fish for the majority of their income (not diversified), if climate change is having a negative effect on their livelihood (causing reductions in income or food security), and if they do not have the ability or means to adapt (low adaptive capacity).*

INTRODUCTION

What is Climate Change?

Climate change (or global warming) is the gradual process of our planet heating up. Climate change is caused by burning fossil fuels (oil and gas), which releases harmful gasses into the atmosphere. These gasses (e.g., carbon dioxide) form a kind of invisible blanket that can trap heat from the sun and warm the earth. Other kinds of environmental destruction such as deforestation can make this problem worse. The earth has already warmed by 1°C, and is expected to increase by another 1 - 4°C over the next 50 – 100 years. Even though this might sound small, even tiny increases in temperature can have big consequences for wildlife and plants. As climate change continues, some areas of the world will get wetter, some will get drier, and weather will become more extreme and unpredictable. Climate change is a global issue, and is already having negative effects on human societies in many parts of the world. Fishing and farming communities in developing countries are among the most vulnerable because they rely on consistent weather patterns for their livelihoods.

Climate change in the Lake Victoria basin

The Lake Victoria basin is likely to experience many aspects of climate change (Goulden et al., 2013). This region has already experienced numerous droughts and floods that have caused lake levels to rise and fall dramatically and *these events are likely to become more frequent with time*. Water level changes can alter where species are found in the lake, and can cause habitat degradation. For example, when water levels drop, wetland habitats dry out and many species that require wetlands can no longer survive. In addition, water temperatures in Lake Victoria have increased by 1°C (Ogutu-Ohwayo et al., 2016). Even these small temperature increases can have negative effects on the fishes living in lakes. Some species might not be able to reproduce when it is too warm, some might escape to cooler, deeper waters where they cannot be caught, and some might not be able to survive at all. As climate change continues, *water temperatures will continue to increase* making these problems worse (Niang et al., 2014). In addition, the timing of *the rainy and dry season is likely to become less predictable*. This will mean crops will be harder to grow, and pasture for livestock may be difficult to find further contributing to challenges for food security and livelihood stability in the region.

Perch that died from elevated temperature and low oxygen

In Uganda, freshwater fisheries are very important to the economy through local markets, employment, and foreign exports. Fish provides around 30–50% of protein intake in people's diets, and fisheries provide the primary source of income for over 1 million people (Timmers, 2012). Uganda is one of the world's most vulnerable countries to the effects of climate change. This is primarily because the economy of Uganda is relies heavily on natural resources, such as fisheries and agriculture, that can be destabilized by climate change (Liu et al., 2008). As the

ecosystem changes and natural resources are no longer reliable, poverty can easily worsen. Countries like Uganda need to develop appropriate strategies for dealing with these changes.

One of the best ways to tackle these potential problems and prevent them from causing more poverty is by asking people in fishing communities several key questions:

1) What are the effects of climate change on the fishery and on your livelihood?
2) Do you have strategies to maintain your livelihood when environmental changes occur?
3) Are you focused just on fishing, or are you diversified into other activities?
4) What are barriers to maintaining your livelihood when environmental changes occur?
5) What do you think can help you overcome those barriers?

By asking these questions we hope to develop strategies that can improve the long-term outlook of the fishery and the people who rely on the fishery for their livelihoods.

METHODS

Data for this study were collected in 2016 on two lakes in the Lake Victoria basin in Uganda: Lake Victoria and Lake Nabugabo (Fig. 1). We selected five villages for this study; three on Lake Victoria (Lambu, Ggolo, and Nakiga) and two on Lake Nabugabo (Bbaale and Kaziru; Fig. 1). Landing sites were chosen to represent a broad range of population size, wealth status, fishing capacity, and degree of reliance on the fishery.

We conducted household surveys and focus group discussions at all landing sites with members of fishing communities. We also conducted one-on-one interviews with community leaders and government employees. All questions aimed to determine people's perceptions of climate change, identify effects of climate change on livelihoods, and understand how communities can best survive environmental change.

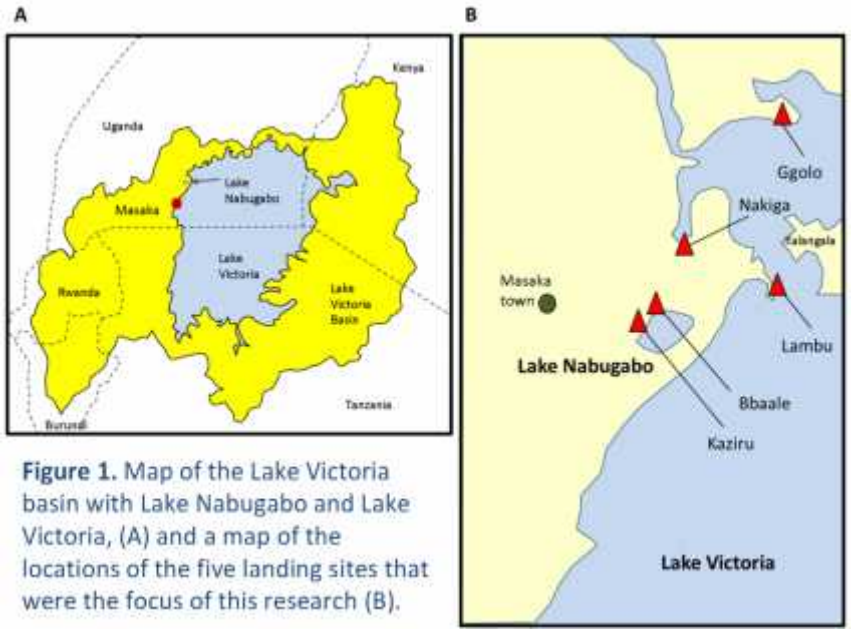


Figure 1. Map of the Lake Victoria basin with Lake Nabugabo and Lake Victoria, (A) and a map of the locations of the five landing sites that were the focus of this research (B).

Household surveys asked for information on household demographics, access to capital assets (financial, social, human, physical and natural, see *Definition*s on P. 4), livelihood diversification, perceptions of environmental change, adaptation strategies, and barriers to adaptation. We also asked whether different adaptive strategies increased or decreased income and food security to see how well different strategies work. We surveyed boat owners, male fish traders, boat crew, and female trader-processors of all ages. Focus group discussions (FGDs) were held at the same five landing. FGDs involved detailed discussions of key issues raised during surveys, especially about adaptation strategies and barriers to adaptation. In the rest of this report, we

present a summary of the responses of people from the fishing communities of Lambu, Ggolo, Nakiga, Bbaale, and Kaziru.

DATA SUMMARY

We surveyed 203 households and conducted 16 FGDs among the five focal villages. A total of 192 people participated in the FGDs. ***Landing site characteristics and the demographics of survey and focus group participants are summarized in Table 1.***

		Lake Nabugabo		Lake Victoria		
Landing site characteristics		**Bbaale**	**Kaziru**	**Nakiga**	**Ggolo**	**Lambu**
Population		180	150	200	1500	12000
Men in fishing		30	35	50	550	750
Women in fishing		4	5	12	200	300
Migrant fishers		0	3	15	100	500
Daily fish catches (kg)	Mputa	15	15	15	60	1200
	Ngege	30	5	50	10	800
	Mukene	20	0	0	500	4000
Survey respondent demographics						
Gender	Male	22	31	29	30	43
	Female	1	2	4	15	26
Involvement type	Boat owner	12	20	15	17	17
	Crew member	7	7	8	11	23
	Trader (male)	3	4	6	2	3
	Trader/Processor (female)	1	2	4	15	26
Wealth ranking	Wealthy	0	1	0	1	2
	Well off	2	1	5	4	4
	Medium	11	19	9	12	14
	Poor	10	12	15	24	40
	Very poor	0	0	4	4	9
Age	Under 20	1	0	0	0	0
	20-29	7	7	1	13	8
	30-39	12	10	13	12	27
	40-49	4	12	9	16	29
	50-59	0	2	6	3	4
	60+	0	2	4	1	1
Focus group discussion respondents						
Boat owners		16	23	15	10	12
Boat crew				11	13	14
Traders		10		10	11	10
Female trader/processors		8		12	14	13

Table 1. Landing site characteristics, demographics of people who responded to household surveys, and the number of participants in focus group discussions.

PERCEPTIONS OF CLIMATE CHANGE AND IMPACTS ON LIVELIHOODS

What are people noticing about climate change?

At all landing sites, fishers stated that extreme weather events such as droughts and floods are the most important environmental stressors to affect their households. They also stated that the number of droughts and floods had increased over the last 10 years. Most fishers stated that they could no longer predict when the rainy and dry seasons were going to start or end. Many fishers also stated that there were more unusual patterns with winds with more sudden storms arising over the lake, endangering lives, and that the directions of the winds were not following usual patterns according to the different seasons. Other important environmental changes included deforestation (especially on the Sessee Islands), cutting of the wetlands, and rapid human population growth. All of these environmental changes are understood to be decreasing fish stocks, or changing the distribution of fish populations. Fishers noticed drastic decreases in catches rates of Nile perch and Nile tilapa, and some noticed decreases in mukene as well. ***These changes are summarized in Table 2.***

Destruction of wetlands and deforestation for palm oil plntations (above).

Participants in Focus Group Discussions and surveys

Rank	Number of respondents	Environmental change	Description and effects
1	175	Increased frequency of droughts events	Dry seasons are longer, hotter, and unpredictable in timing.
			Crops fail, fish catches reduce, famine and food insecurity increase. Mukene processing is easier due to good conditions for sun-drying.
2	164	Increased frequency of flood events	Rainy seasons are shorter, but more intense, and unpredictable in timing.
			Sudden intense rains destroy crops, cause livestock disease, damage infrastructure, cause post-harvest losses (fish rot) and block transportation routes. Floods can increase catch rates.
3	146	Unpredictable timing of the rainy and dry seasons	Rainy and dry seasons do not start and end during the expected months
			Crops may not germinate well, or may be flooded and not produce.
4	117	Increased occurrence of sudden storm or wind events	Storms come up unexpectedly, winds do not blow in the expected directions
			Can cause loss of life, loss of gear, and damage to boats. Can cause changes in fish distribution and movement.
5	113	Deforestation	Large swaths of land deforested on the Ssese Islands for industrial agriculture.
			Removing natural forests makes droughts worse, and can cause reduced catches and crop failures.
6	75	Wetland destruction	Wetlands have been destroyed for agriculture, urban growth, and tourism.
			Loss of breeding ground for fishes results in fewer young fish and lower catch rates. Loss of natural filtration system increases pollution and algae growth.
7	45	Population growth	Population has grown because of high birth rates and migrants to the fishery.
			Increased competition leads to reduction in fish abundances and higher demand for fish.

Table 2. Common environmental changes that were noticed by fishers, a description of the change, and the effect of this change on fishers' livelihoods. The changes are ranked by how often they were mentioned.

How are people's livelihoods (income, food security) affected by climate change?

Overall, the effects of climate change are having a negative effect on the livelihoods of fishing communities in the Lake Victoria basin. The vast majority of participants in this study noticed decreases in income and food security when there were droughts or floods, although droughts were perceived to be worse than floods. Some participants stated that droughts and floods could sometimes provide new opportunities. ***The different positive and negative effects of droughts and floods are summarized in Table 3.***

	Floods		Droughts	
	Number of respondents	Effect	Number of respondents	Effect
Negative Effects	132	Decreased income from fisheries	142	Decreased catches
	97	Decreased catches	136	Crop failure
	96	Crop failure	110	Less fish eaten
	94	Damage to fishing infrastructure	87	Decreased income from fisheries
	63	Less fish eaten	61	Food insecurity
	53	Road blockages	34	Loss of pasture
	36	Human disease	30	Decreased fish size
	19	Fish spoilage	23	Human disease
	18	Crop disease	17	Death of livestock
	15	Water damaged houses	14	Crop disease
Positive Effects	158	Increased catches	109	Increased income from fisheries
	87	More fish eaten	41	More fish eaten
	60	Increased income from fisheries	32	Good fish processing
	42	Crops germinate well	14	Land preparation time
	9	Better pasture	12	Market for dried fish
	4	Brickmaking		

Table 3. Summary of effects of floods (in blue) and droughts (in brown) on fisher people's livelihoods. Negative effects (top) are those that DECREASED food security or income, and positive effects (bottom) are those that INCREASED food security or income.

Effects of droughts and floods at landing sites

Excessive flooding can have negative consequences for livelihoods. Stormy weather prevents fishing, and too much rain can causing crop failure (rot), road blockages, damage to infrastructure (boats, houses, roads, gear), increases in human and animal disease, and greater post-harvest losses of fish. However, when not too severe, floods can enhance catch of all fish species, both in quality (fish size) and quantity. Many people stated that mild floods can increase incomes from both fishery and non-fishery activities because fish catches are better, rains bring high quality pasture for animals, and crops germinate and grow well.

Droughts cause reductions in fish catches, crop failure, and death of livestock. This leads to reduced income and food insecurity for the majority of households. However, some participants stated that income from fisheries could increase during droughts. This was primarily female mukene traders who take advantage of the excellent conditions for

sun-drying. This can lead to better food security as dried mukene can be stored for weeks, and excess fish can be consumed within households. Others stated that times of drought can be used to prepare gardens in hopes that coming rains will provide income.

These kinds of negative effects on livelihoods will continue in the future. In order to cope with negative effects of climate change, fishers will require adaptive strategies. One of the best ways to adapt is to explore alternative livelihoods and diversify into many different areas of income-earning activities. There are also several ideas for planning ahead for environmental stressors, and mitigating effects of climate change.

ALTERNATIVE LIVELIHOODS AND DIVERSIFICATION

What are diversification options for people in fishing communities?

In the landing sites surveyed, an average household is likely to be engaged in five different livelihood activities. The different landing sites and the different groups (boat owners, boat crew, male traders and female trader-processors) had different levels of diversification (Fig. 2).

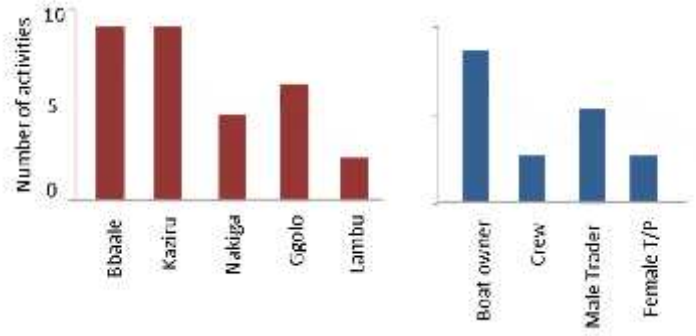


Figure 2: The average number of different livelihood activities conducted in households in each of the five landing sites surveyed (Bbaale, Kaziru, Nakiga, Ggolo, Lambu), and in each of the different stakeholder groups (boat owner, crew, male trader, female trader-processor (T/P). Longer bars indicate more diversification.

Many households (34% of those surveyed, 69 households) were not diversified outside of fishing, so even though they might engage in multiple activities within the fishery (e.g., acting as a boat crew AND as a fish trader) they do not earn income from any non-fishing activity (e.g., crops, business). To determine how to improve diversification in these communities, we compiled information about what people are ALREADY doing to diversify, and what they WISH they could be doing. ***These responses are summarized in Table 4.***

Crops and livestock were the most common non-fishing activities that people already do. The most common crops include cassava, sweet potato, maize, and beans, and the most common animals include chickens, pigs, and goats. A small proportion of respondents had diversified into non-fishery trading (e.g., coffee), service jobs (e.g., general labour, brickmaking, driving), or business (e.g., shop owner) (Table 4).

The diversification options available to fishers were often different than the options they wish to do. More people want to diversify into trade, service, or business than are currently doing so. The most common options included trading in coffee and matooke, working in another industry (e.g., construction, mechanics), and driving a taxi or boda boda. For businesses people said shops, fish farming, hair salons, small restaurants / bars, or housing rentals. For crops, many

fishers would like to diversify into high value crops such as coffee or tomatoes, and for livestock they would prefer pigs and zero-grazing cattle as these animals require little space, are easy to feed, and have good market value (Table 4). However, survey and FGD respondents also noted that crops and livestock are heavily influenced by climate change, and that they have adapted to this by planting early-maturing crops, or crops that are drought and flood-resistant, but that ideal diversification would take them outside of activities that depend on weather.

	Already doing		Wish to be doing	
Diversification category	Number of respondents	Diversification option	Number of respondents	Diversification option
Livestock	63	Chicken	29	Pigs
	63	Pigs	14	Cattle
	41	Goats	10	Chicken
	39	Cattle	10	Goats
	13	Ducks	1	Ducks
	3	Sheep		
Crops	93	Cassava	14	Maize
	90	Sweet potatoes	12	Beans
	77	Maize	7	Tomatoes
	76	Beans	6	Coffee
	42	Matooke	5	Cassava
	29	Coffee	3	Matooke
	25	Tomatoes	3	Sweet potatoes
	20	Watermelon	3	Watermelon
	11	G/nuts	2	Passion fruits
	4	Pineapple	2	Pepper
	4	Irish	1	Pineapple
	4	Pepper	1	Eggplant
	3	Passion	1	Jackfruit
	3	Trees	1	Onions
	1	Sorghum		
	1	Sugar cane		
	1	Avocado		
Trade and Service	11	General labour	12	Selling Fish
	4	Brick making	11	Coffee trade
	2	Mats	8	Boda Boda
	1	Coffee trade	7	Matooke trade
	1	Construction	6	Clothing trade
	1	Charcoal	6	Animal trade
	1	Basket weaving	5	Mechanic
	1	Jewelry/beadwork	4	Taxi
	1	Driving	2	Construction
			1	Brick making
Business	6	Shop: grocery	33	Shop
	5	Shop: household	8	Rental houses
	2	Bar	7	Fish farming
			7	Food stall/ chapatti
			5	Restaurant/bar
			4	Charcoal/Firewood
			4	Hardware shop
			4	Salaried job
			3	Hair salon

Table 4: Diversification options that fishers are ALREADY doing (in blue) and options that they WISH to be doing (in red). Options are categorized under Crops, Livestock, Trade and Service, and Business. Fishers are mostly already doing crops and livestock, but wish to be doing more trade, service, and business.

ADAPTIVE STRATEGIES, PLANNING AHEAD, COPING WITH STRESS, AND MITIGATING EFFECTS OF CLIMATE CHANGE

Examples of different ways to achieve high adaptive capacity by exploiting opportunities, diversifying livelihoods, and mitigating effects of climate change.

Above we discussed livelihood diversification options (currently practiced and desired). In this section we discuss strategies that are used in communities to adapt to stressors like droughts and floods, and whether these strategies improve livelihoods by increasing income or food security. We also look at what can be done to plan ahead for future droughts and floods, summarize how communities cope in emergency situations, and present options for what can be done to make effects of climate change less extreme. ***The kinds of activities people turned to, and whether they had positive or negative impacts on livelihoods, are summarized in Table 5.***

What are some adaptive strategies used during extreme weather events, and do they improve livelihoods?

When asked what people do to adapt to droughts and floods, a large proportion of respondents stated that they have no strategy (53% [107 households] during droughts; 37% [75 households] during floods), and simply continue 'business-as-usual'. Households that did nothing to adapt experienced decreased incomes and reduced food security. The next most common response to droughts and floods was to increase fishing pressure by working more hours or using more nets (especially during droughts). Some fishers shift to new fishing grounds, use different fishing techniques, or target different species. Unfortunately, this strategy does not improve food security or incomes. In addition, many participants mentioned that heavy fishing during low seasons is bad because fishers are likely to use illegal practices and harvest juvenile fishes.

Some people indicated that they turned to non-fishing activities to improve their livelihoods. Some activities work better during floods than during droughts. For example, crops can sometimes do better during floods (if the floods are not too heavy) because crops germinate and grow well with plenty of rain. This is especially true when people build trenches around gardens so that excess water can flow out of the garden. During droughts, people normally do not try to grow crops because they do not have irrigation facilities, and without rains crops will

fail. During droughts conditions are better for drying fish, and more people invest in this activity. However, fish are less plentiful during droughts so availability is often not high enough. And, without good storage facilities this may result in losses.

Diversifying into livestock, business, trade, and service were adaptation strategies used equally during both droughts and floods. Livestock rearing was generally perceived to improve income and food security. Participants suggested that livestock are more resilient to climatic effects than crops, except in extreme circumstances when diseases are prevalent and feeds are scarce. Those who were able to transition to non-fishery business, trade, or service reported increased income and food security, however only 14% of all households surveyed (28 households) were able to do this.

How do people plan ahead for future drought and flood events?

The majority of respondents (107 households, 53%) indicated that they had no strategy to prepare for future drought and flood events. The most common action people take to plan ahead is to plant crops; however, only a small handful (8 households) mentioned that they planted drought or flood resistant varieties, so this method for planning ahead may not be successful. A very small number of participants mentioned that they dug trenches in gardens to prepare for floods, and some said that they dug wells near their gardens to aid in irrigation. Some people planned ahead by saving money, investing in various businesses such as house rentals and shops, acquiring land, planting fruit trees, and building storage facilities for food (Table 5). Households that do these things are more protected from climate change; however, they represent a very small proportion of the population.

What are some coping strategies used in case of emergency?

Coping strategies are actions people take in emergency situations when all sources of income fail. During times when incomes are low from both fishing and non-fishing activities, respondents indicated that they coped by borrowing money or other forms of capital (e.g., seeds), selling off livestock and other assets, relying on support from the community, using up savings, or exiting the fishery to return to their home villages (Table 5). While some of these strategies are good (relying on groups, returning to home villages), some are destructive to the overall stability of the household (borrowing money, selling assets).

What can be done to mitigate effects of extreme weather events?

Mitigation strategies are actions that can be taken that will make the effects of climate change less severe. Fishers identified several key strategies including preventing destruction of forested areas and wetland habitats, and replanting or restoring habitats that have already been destroyed. They also mentioned using traditional fishing methods (allowing resting periods for the lake) and traditional farming methods (planting drought and flood resistant crops, building trenches, farming away from wetland areas, not using chemical fertilizers and pesticides).

	Action	Frequency	Effect on income and food security
Adaptive strategies	Business-as-usual	185	negative
	Turn to crops	113	positive
	Increase fishing pressure	76	no change
	Change fishing grounds	62	no change
	Turn to livestock	60	no change
	Change fishing gear	55	negative
	Turn to other business	37	positive
	Change target fish species	32	no change
	Turn to other trade / service	20	positive
	Reduce fishing time	16	negative
Planning ahead	Do nothing	107	negative
	Improve fish processing	23	positive
	Save money	15	positive
	Plant drought resistant crops	8	positive
	Plant fruit trees	8	positive
	Get education for other jobs	6	positive
	Acquire land	5	positive
	Store food	5	positive
	Invest in rentals	5	positive
	Construct house	4	positive
	Build irrigation system / dig well	4	positive
	Dig trenches around gardens	4	positive
Coping strategies	Borrow money	116	negative
	Do labour job	45	positive
	Sell livestock	42	negative
	Rely on social groups	33	positive
	Use savings	12	negative
	Do nothing	10	negative
	Sell assets	8	negative
	Return to village	5	positive
	Rely on leaders	3	positive
Mitigation	Stop deforestation	90	positive
	Protect wetlands	60	positive
	Re-plant forests	17	positive
	Restore wetlands	16	positive
	Use traditional fishing and gardening methods	14	positive

Table 5: Actions that are taken by fishers during periods of extreme weather conditions (droughts and floods) in order to improve livelihoods. Actions are split into *Adaptive strategies* that are currently used, actions taken to *Plan ahead* for future impacts of droughts and floods, *Coping strategies* that are used in case of emergency, and *Mitigation strategies* that can be used to ease future effects of droughts and floods. For every action, we indicate whether fishers perceive them to have positive or negative impacts or not change on livelihoods.

BARRIERS TO ADAPTATION AND OVERCOMING BARRIERS

What are the main barriers to adaptation?

Overall, households in the villages surveyed in this study are highly vulnerable to climate change. The different landing sites surveyed and the different groups had different levels of adaptive capacity (Fig. 3).

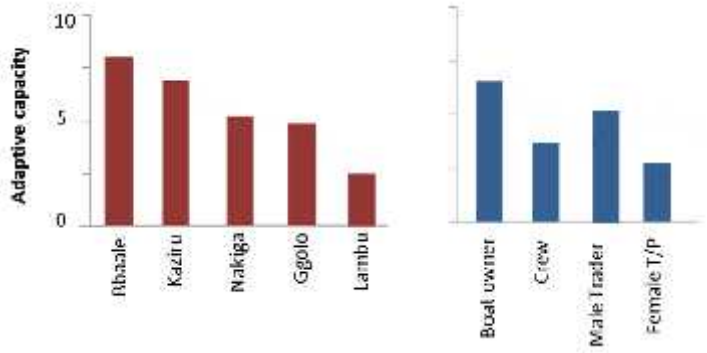


Figure 3: The average score for adaptive capacity (successful adaptation strategies) for households in each of the five landing sites surveyed (Bbaale, Kaziru, Nakiga, Ggolo, Lambu), and in each of the different stakeholder groups (boat owner, crew, male trader, female trader-processor (T/P). Longer bars mean better adaptive capacity.

Developing adaptive strategies is therefore an important challenge facing these communities. However, people in fishing communities face many barriers to adaptation. ***The main barriers mentioned by participants in this study are presented in Table 6.***

Barriers and challenges faced by the community	Number of respondents
No financial capital to start something new (poverty)	168
No access to land for crops or agriculture	65
Distrust within the community	56
No education or training for starting something new	54
Little support from the government (sense of abandonment)	46
Don't trust crops to grow	45
Pressing concerns with health, childcare, and food security	45
Population growth, migrants, and increasing competition (too easy to join)	35
Illegal fishing	32
Foreign investment developing lake	7
Poor enforcement and management (weak rules and regulations)	7
Loss of traditional knowledge	5

Table 6: The most important barriers to adaptation according to surveys and focus group discussions

Poverty represents the most important barrier to diversification for households. Impoverished households often have no choice but to alleviate immediate pressures of hunger, illness, and child care by relying solely on fishing. Often, people in these households do not have the time, financial resources, education, or training necessary to seek alternative livelihoods. In addition, many people do not know what options are available for diversification, and do not have the skills to plan a new business or activity. Households that rely only on fishing are hit very hard by climatic events such as droughts and floods, and often go into debt when weather patterns are severe. This can trap such households in poverty cycles.

Another important barrier to adaptation is lack of access to land for crop agriculture or animal rearing. Much of the land surrounding the landing sites is privately owned, so establishing plantations and gardens is not possible.

High population growth is another barrier to adaptation. Because the fishing industry is open-access, anyone can join the fishery at any time with very little investment. This has resulted in

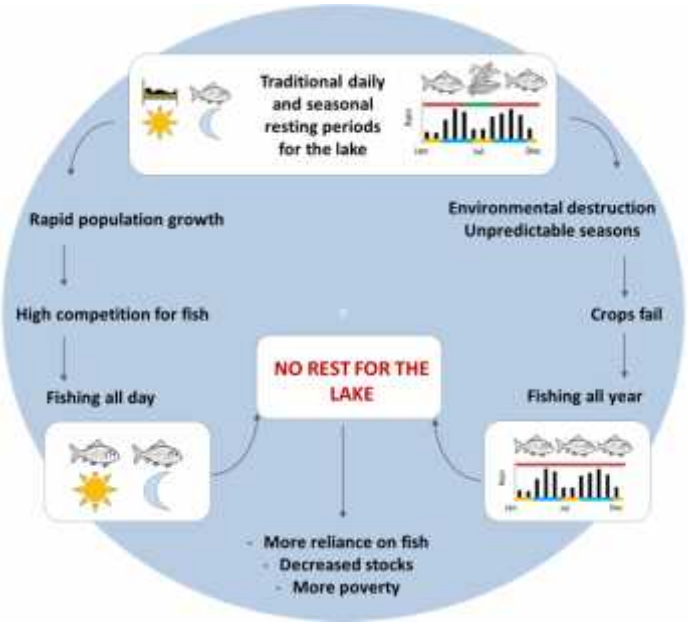


Figure 5: How social and environmental changes can combine to increase the vulnerability of fisheries.

increased immigration to the fishery. Increasing competition among fishers means that the fishery no longer experiences 'resting periods' as it did in the past when fishers were active only at night, and when fishers would leave the lake during the long dry season (June – August) when fish catches were naturally low to prepare gardens. Many older fishers stated that there was a noticeable decrease in fishery productivity as competition increased and traditional rules around 'no take' months slipped (Fig. 5).

Increasing population growth and migration of fishers can cause lack of trust within the community and within family units and can destroy attempts to diversify through thieving or dishonesty.

Unpredictable seasonal patterns is another important barrier to diversification. Many fishers find that diversifying into agriculture is risky because with unpredictable seasons they do not trust that their gardens will produce. Many people choose not to plant gardens for this reason and rely even more heavily on fishing (Fig. 5).

Finally, lack of proper enforcement and fisheries management is a barrier to sustainable livelihoods. Fishery rules are not enforced and illegal fishing is very high. This depletes the fishery and poses major challenges to livelihood stability.

How can these barriers be overcome?

Participants in the surveys and FGDs identified several areas that could improve adaptive capacity and reduce household vulnerability. Participants suggested that interventions providing low-interest credit, asset-based support, training on financial planning and diversification options, education on sustainable resource use, and sensitization to the effects of climate change would be beneficial. ***The main ways to overcome barriers are presented in Table 7.***

How to overcome barriers and challenges	Number of respondents
Improve access to low interest loans	109
Asset-based support (seeds, piglets, etc.)	68
Promote money-saving culture and training on financial management	55
Training and education for diversification	54
Sensitization to importance of diversification	50
Form groups for diversification ventures	50
Cooperation and communication among fishers and enforcers / government	49
Improve sense of community cohesion	39
Stop import manufacture of illegal gears	33
Install irrigation pumps & wells for drought, trenches to drain gardens for flood	20
Support cohesion within households	18
Improve enforcement of rules and regulations in the fishery	13
Stabilization of markets for fish, crops, and agriculture	6
Use traditional knowledge for fishing and gardening techniques	4

Table 7: Suggestions for how to overcome barriers to adaptation according to surveys and focus group discussions

Improving access to low-interest loans and asset-based support; promoting saving culture: For households in chronic poverty, it is important to develop strategies to reduce financial risks associated with diversification. This can be accomplished through education on financial planning, providing financial capital through fair loans and promoting saving culture.

Sensitization, training, and education: Some fishers, particularly youths, may not be aware of the options for diversification, nor the importance of doing so. Sensitization of young people on HOW to diversify and WHY they should diversify is very important.

Access to land and improvements in agricultural practices: Even though crops and livestock are also at risk from climate change, they can reduce vulnerability if people incorporate strategies to protect gardens from drought and floods. Opening access to land for group-based agricultural projects (e.g., coffee plantations) or livestock rearing (e.g., piggeries) can help those without land to diversify. Combining this with recommendations to build trenches around gardens, to invest in small-scale irrigation systems, to plant drought- and flood-resistant crops, and to rear livestock that are easy to maintain (e.g., pigs, zero-grazing cattle) can promote sustainable farming.

Maintaining residence in a community: A key factor contributing to a household's ability to diversify is residence time in a community. Communities such as Bbaale and Kaziru on Lake Nabugabo are more diversified because they have access to land in the village and can raise crops, poultry, and livestock (Fig. 4). On the other hand, communities with more migratory populations (e.g., Lambu) do not have this opportunity, so their incomes tend to be solely based on fishing. In addition, maintaining residence within a village increases the motivation and capacity to save money, make investments, accumulate assets (land, livestock, houses), and gain access to credit services through groups (Nunan et al., 2010).

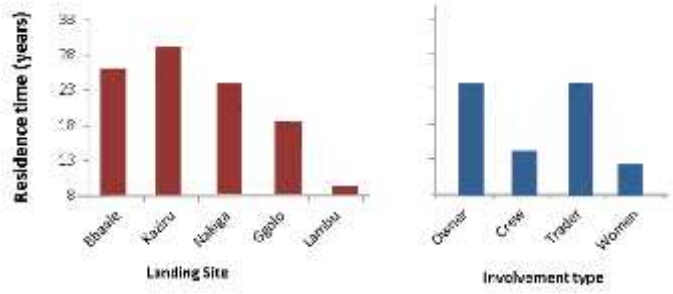


Figure 4: The average score for residence time (number of years in a village) for households in each of the five landing sites surveyed, and in each of the different stakeholder groups. Longer bars mean longer residence time.

Community trust and cohesion: Social organization allows communities to work together, and facilitate knowledge sharing. Involvement in community groups reduces risks of diversification, provides opportunities to learn new skills, and opens access to government interventions. For groups to be effective people there must be solid trust relationships within the community and the family. In the past, groups have failed because of to lack of trust, partly due to the highly migratory nature of many individuals.

Using traditional knowledge: Traditional strategies for coping with natural variation in fish abundance can inform sustainable fishing practices. In the case of Lake Victoria, traditional 'no-take' months during dry seasons allowed resting periods for the lake resulting in noticeable increases in fishery productivity (Fig. 5). In addition, using traditional farming practices can help to improve success of gardens. Older farmers suggest planting drought resistant crops (e.g., cassava, yams) around garden perimeters, building trenches and drainage systems, using natural fertilizers (e.g., chicken waste), avoiding chemical pesticides, and cultivating far away from wetlands as ways to improve farming while not hurting the lake ecosystem.

Promoting community agency through improved governance, improved enforcement: Negative interactions among governing bodies and fishing communities can undermine capacity for adaptive action. Participants indicated that poor governance is an important threat to livelihoods and spoke frequently about being forgotten by the government. Fishers stated that while they wish to maintain their fishery, the sense of not being supported led to a feeling of hopelessness. In addition, fishers perceive that environmental degradation (deforestation, wetland degradation) is due to development of the lakeshore areas by foreign businesses (e.g., palm oil plantations on Ssese Islands). These developments do not provide benefits to local communities (i.e., through job creation), and are thought to reduce the productivity of the fishery (i.e., through habitat destruction). Fishers also have the sense that the majority of profits from the fisheries sector go to foreign exporters instead of being invested back into the fishing industry. These perceptions lead to a sense of frustration and lack of motivation to care for the fishery. Improved communication among stakeholders and frequent meetings between fishers, governing bodies, and managers may help to clarify misperceptions.

CONCLUSIONS

Results from this study have shown that climate change is an important stressor in the Lake Victoria basin that is disrupting fishery productivity and livelihood stability for fishing communities. A central problem is that effects of climate change are causing declines in the availability of fish resources, and restricting access to other livelihood options at the same time. This can lead households into even higher dependence on the fishery even though stocks are

becoming less available. A key mechanism for improving adaptive capacity is livelihood diversification. Fishers in the present study had clear ideas about the types of diversification options they would like to do; however they also identified several barriers to adaptation. The main constraints include limited access to financial capital, land for agriculture, and diversification options. For households in chronic poverty, it is important to develop strategies where risks associated with diversification options are buffered. This can be accomplished through skill training, education on financial planning, and providing financial capital either through fair loans or access to credit facilities. In addition, steps should be taken to sensitize fishers to the impacts of illegal fishing and improving knowledge on diversification options. This may be particularly critical among migrant fishers who often view moving as their only option (Odongkara and Ntambi, 2007). In addition, promoting strong social cohesion within communities and forming groups can provide entry points for poor households to build diversity. Finally, improving communication among government and fishers is important for increasing motivation to protect natural resources.