Authors' response to:

Editor Decision: Publish subject to minor revisions (review by Editor) (06 Oct 2016) by Prof. Jürgen Scheffran

Comments to the Author:

The authors have addressed much of the comments of the reviewers and revised the paper accordingly, to make it more suitable for publication. In a separate note, remaining issues are highlighted that need to be addressed before publication, including a number of technical corrections.

Non-public comments to the Author:

Please address the following points and highlight with track change in the newly revised document to facilitate final review by the Editor:

- *Thank you very much for your invaluable comments. We have attached a revised version of the article including track changes.*

The emphasis on conflict has been largely abandoned, making the paper less suitable for the special issue. Some connection to climate vulnerability, adaptation and land use may still justify it. What would be interesting is how the level of conflict or non-conflict affects this connection which would strengthen the scope. A few sentences might suit.

- *We have included a few sentences within section 2.1 to strengthen the scope.*

Reviewer suggests to provide information about LCBCCAP (which has been done) and the role/connection of the authors to it (which needs short explanation).

- *We have included more information on the role of the authors in the methods section.*

Specific Comments (SC) of reviewer:

SC 2: Say what is novel about the paper, as suggested by the reviewer.

- *We included a short paragraph on page 3(112-116).*

SC 4: In response to reviewer, authors say they reflected on research ethics, but ethics could not be found in the paper. Where is ethics covered?

- *There is now more text on research ethics within the methodology section on page 13(417-422).*

SC 6 & SC 13: In the general part, the reviewer suggests to explain how the 18 participants were selected. The only explanation found was "that the respondents are not randomly selected but rather 'handpicked'."
Still it is not clear how this selection worked. More information would be useful about how data were generated, how selection and interviews worked. Which questions were asked/given to the respondents? How were the response categories created?

- *There is now more text on sampling techniques and interview process within the methodology section on page 12 and 13.*

SC 8: The title has changed but can be still improved. The term "supporting" is not explicitly used in the paper which is not really about "Living with climate change", rather about vulnerability and adaptation What about "Vulnerability to climate change and adaptation strategies of local communities in Malawi: Experiences of women fish processing groups in the Lake Chilwa Basin". The subtitle can be included or excluded.

- *Thank you, this is an appropriate title and we are gladly changed it.*

SC 9: The abstract is rather general und unspecific to the content of the paper. It should refer to the particular case of the women fish processing groups, the adaptation program and essential results.

- *The abstract is now more specific, indicating details on the adaptation programme and results.*

SC 14: In the Introduction one would expect a few more references to the state of literature (here it is only 5 references).

- *More references have been added to the introduction.*

Additional specific corrections/suggestions/comments: X(Y): means page X, line Y

- *Thank you for the specific corrections/suggestions/comments, we have tried to address all of them in an appropriate manner.*

If you have any further questions or comments, please do not hesitate to contact us. We look forward to the publication, and we believe, your comments have substantially improved the article.

Vulnerability to climate change and adaptation strategies of local communities in Malawi: Experiences of women fish processing groups in the Lake Chilwa Basin

Hanne Jørstad[1] and Christian Webersik[1]
[1] University of Agder

Abstract:

In recent years, research on climate change and human security has received much attention among policy makers and academia alike. Communities in the Global South that rely on an intact resource base and struggle with poverty, existing inequalities and historical injustices will especially be affected by predicted changes in temperature and precipitation. The objective of this article is to better understand under what conditions local communities can adapt to anticipated impacts of climate change. The empirical part of the paper answers the question to what extent local women engaged in fish processing in the Chilwa Basin in Malawi have experienced climate change and how they are affected by it. The article assesses an adaptation project designed to make ~~fish~~ ~~processing~~ women more resilient to a warmer and more variable climate. The research results shows that improving fish processing and marketing as strategies to adapt to climate change have their limitations. The study concludes that livelihood diversification can be a more effective strategy for Malawian women to adapt to a more variable and unpredictable climate rather than exclusively relying on a resource base that is threatened by climate change.

Keywords: climate change, Malawi, climate change adaptation, human security

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1 Introduction

It is a fact that anthropogenic climate change has and is going to have severe impact on developing countries, especially those with a climate-sensitive economy (DARA, 2012). Moreover, countries in the Global South struggle with poverty, horizontal inequalities, armed conflict, poor governance, and historical injustices, some of the additional compounding factors that make them vulnerable (O'Brien et al. 2000). Therefore, framing climate change impacts as a human security concern fits with the discussion on differential vulnerability, given the array of social, political, and economic factors that make people vulnerable in the first place (McDowell et al. 2016). The debate on the human security implications of climate change has gained momentum in recent years. This is due to a lively policy debate as well as to several publications in journals and books (Brzoska and Scheffran 2013; Scheffran et al. 2012, Webersik 2010). Yet, climate change impacts and their causal linkages with human security are complex and multifaceted, and research needs to address "the limits of our capacity to understand complexity" (Nicholson 2013: 158). Keeping this in mind, this research aims at contextualising climate change adaptation and its limitations in southern Malawi.

Human security is adequate in the context of climate change impacts as it includes issues pertinent to food security, public health, or any type of loss in key livelihood assets as opposed to the term security defined as freedom from physical force (Redclift and Grasso 2013). Human security acknowledges the fact that humans are both victims and agents of change. While humans are affected by climate change impacts, they are at the same time able to mitigate the drivers of climate change as well as able to adapt to real and anticipated changes (Adger et al. 2009). Countries of the Global South are typically low-income countries and are least responsible for anthropogenic climate change. Most important, given their predominantly rain-fed agriculture, a large percentage of the population economically dependent on agriculture, their low financial and institutional capacity to cope with and to withstand natural hazards, countries in the Global South are most severely affected by climate change impacts (Boko et al. 2007; Niang et al. 2014). In sum, current and future changes in temperature and precipitation

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variability, and changes in the intensity of natural hazards will most certainly affect food security, public health and agricultural productivity in low-income countries.

This reflects the notion that climate change is often seen as a 'threat multiplier' exacerbating existing tensions, such as poverty or inequalities (Hegre et al. 2016; Johnstone and Mazo 2011). Even when climate change adaptation becomes unavoidable, it needs to be sustainable. Some adaptation strategies, such as agricultural innovation in the fisheries sector as demonstrated in this article, are important in the short-term to relieve some of the pressures climate change may pose but may fail in the long-term in securing a sustainable livelihood.

The purpose of this article is to better understand human-environment interactions, bearing in mind their complexity, more specifically climate change adaptation and its limitations. By taking the example of Lake Chilwa Basin in Malawi, this article asks the following research questions: To what extent have women in Lake Chilwa Basin perceived changes in the climate, what have they experienced and how have they been affected by it? To what extent do local climate change adaptation projects increase the women's adaptive capacity? Evidence is drawn from a case study of the Lake Chilwa Basin Climate Change Adaptation Programme (LCBCCAP) and its Women Fish Processing Groups (WFPGs). Most important, this article demonstrates that some adaptation strategies have limitations and are not suited to cope with a warmer and more variable climate. Research on limitations of climate change adaptation is in its infancy, and this study contributes to this body of research with presenting novel empirical material on southern Malawi, a region that is very poor, densely populated, and prone to climate variability threatening local livelihoods. The study concludes that income diversification can build resilience to climate change.

The article is divided into a theoretical and empirical part. The theoretical part evaluates the role of climate change for human security, followed by a discussion on climate change adaptation and its limitations. The empirical part draws from a field study in Malawi, more specifically the Lake Chilwa Basin. This region is home to 1.5 million people, most of them depending on its natural resources for sustaining livelihoods. Climate variability is a perceived human security challenge among fishing

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communities in southern Malawi, hence climate change adaptation is becoming an important strategy for these communities to cope with the anticipated changes. This section sheds light on how climate change affects local fishing communities in the Basin and critically evaluates the long-term effectiveness and relevance of an adaptation project implemented in these communities.

2 Human security, climate change adaptation and its limitations

2.1 Climate change and human security

Malawi is extremely poor, with a high population growth, it is highly dependent on natural resources and is hence vulnerable to climate change. Despite existing and functioning coping mechanisms of climate variability, such as selling economic assets, agricultural diversification, and labour migration, climate change may have severe impacts on rural population and should therefore be considered as a real threat to the population's human security, including conflict (Redclift and Grasso 2013). Malawi has despite its challenging socio-economic development, impacting on both, climate change and conflict, not experienced major armed conflicts in the past decades (Hegre et al. 2016). The low levels of conflict have helped to create an enabling environment for a large number of people that depend on a fragile resource base. Local knowledge and social capital are important factors in explaining some of the coping mechanisms of the poor in Malawi, factors that could develop in peaceful periods. The absence of conflict may also help to explain that an increasing number of natural hazards have not resulted into humanitarian disasters. A study conducted by ActionAid finds that the country has already seen an increase in the number of extreme weather events in terms of floods and droughts since the 1970s till 2006 (Action Aid 2006). Sustainable adaptation strategies can therefore be seen as a means to avoid human insecurity. This article argues that global environmental change, poverty, and society must be put into context rather than purely focusing on the causal links between climate change impacts and human security. The Lake Chilwa region in southern Malawi was selected as it displays great demographic and environmental challenges, to better understand what and why some adaptation mechanisms may work or not work.

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2.2 Climate change adaptation

In the 1990s and early 2000s the climate change debate was mostly focused on how to mitigate climate change. In recent years growing attention has been given to climate change adaptation (Adger et al. 2009; Dodman and Mitlin 2011; UNFCCC 2011).

The literature provides a broad spectrum of understandings of the concept. Adaptation has its origin from natural science. The term was later adopted by anthropologists and social scientists and used in relation to human systems and human-environment systems. (Smit and Wandel 2006). Adger et al. (2003: 192) provides a useful definition and refers to climate change adaptation as "the adjustment of a system to moderate the impacts of climate change, to take advantage of new opportunities or to cope with the consequences".

Adaptation initiatives may be carried out by governments, IGOs, NGOs, CBOs or individuals and may be either an anticipatory or a reactive action. The aim of adaptation is to reduce vulnerability or ease resilience and involve changing processes or practices in social and ecological systems through reducing potential damages or engaging in new opportunities (Adger et al. 2007). Climate change adaptation rarely only focuses on factors related to climate change. Adaptation may incorporate any practices or initiatives that increase resilience to elements constituting threats to communities that may aggravate through climate change, such as poverty.

According to the Fifth Assessment Report of the IPCC (Niang et al. 2014; Boko et al. 2007) Africa is one of the most vulnerable continents to climate change due to its high exposure (e.g. heavy reliance on climate sensitive agriculture) and low adaptive capacity (e.g. poverty). Key adaptation strategies are diversification of livelihood activities, adjustment in farming operations, income generating projects, selling of labour and the move towards off-farm or non-farm livelihood incomes (Boko et al. 2007). The results of this paper suggest that these adaptation strategies are relevant also for Malawi.

2.3 Limitations of climate change adaptation

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Not all adaptation strategies are sustainable. For instance, physical adaptation strategies, such as dams to protect low-lying land from water intrusion caused by sea level rise, may require human migration and resettlement. This way, migration becomes an adaptation strategy. The debate whether migration may be an act of adaptation received attention among scholars (Tacoli 2009; Baldwin 2016; Brzoska and Frölich 2016; Black et al. 2011; McLeman and Smit 2006). Recent research in low-lying island states demonstrates that local perceptions on climate change-induced migration differ from the dominant political discourse on climate-induced migration in the same location, and that not migrating can be both, a strategy to adapt or ~~to fail to adapt~~ (Kelman et al. 2015). Though there is little evidence that environmental-induced migration has the potential to trigger violent conflict, it likely will create major challenges for hosting communities, especially in regions that are already densely populated, for example Malawi (Webersik 2012). Climate related outmigration could also change the social fabric of those communities that stay behind. With shrinking populations, markets and political institutions can get distorted making it more difficult for those left behind to adapt to climate change (Barnett 2012). In other cases, adaptation strategies that do not take into consideration the long-term impacts of climate change may prove unsustainable. Livelihood diversification is a laudable approach, however, if farming diversification activities or commercialisation of agriculture remain sensitive to climate change impacts such as unpredictable rainy seasons, the long-term adaptation effect may remain limited as the following case study in the Lake Chilwa Basin in Malawi demonstrates. Other unintended social and environmental consequences of climate change adaptation can stem from large infrastructure projects, such as dam-building for hydropower and water storage, biofuel plantations, and water relocation projects, all relevant for the African context (de Sherbinin et al. 2011). For instance, the growing number of biofuel plantations bought by foreign investors has triggered a debate on land grabbing in Africa (Matondi 2011). Most important, if people are forced to relocate due to large infrastructure projects or land-use change, their economic potential and environmental vulnerability need to be evaluated for current and future climate change impacts, as well.

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3 Explaining the context of Malawi

Malawi is one of the smaller countries in Sub-Saharan Africa, landlocked between Mozambique, Zambia and Tanzania. Nyasaland, as it was previously known, was under British rule from 1891 to 1964 when it gained its independence. After three decades of one-party rule with Hastings Banda as president, Malawi held its first multiparty elections in 1994 (CIA 2015). In contrast to the majority of the African countries, Malawi has not experienced an armed conflict after independence (Uppsala Conflict Data Programme 2012).

Malawi is one of the most densely populated countries in Africa with a population of approximately 15,380 000 on an area of 94,276 square kilometres (EAD 2010; UNDP 2012). It has a high population growth of 2.80%, according to 2008 estimates (NSO 2012). It is one of the least-developed countries (LDCs) with a gross national income (GNI) of USD 850 purchasing power parity (PPP) per capita and ranks as 171 out of 179 on UNDP's human development index (UNDP 2011). 74 per cent of Malawi's population live on less than a dollar (PPP) a day (2004 estimate) (UNSTATS 2012).

According to the Government of Malawi, the country's economy is predominantly agricultural and Malawi depends on just a few cash crops. One-third of the country's gross domestic product (GDP) comes from agriculture, forestry and fishing. Agricultural goods dominate Malawi's export commodities such as tobacco, tea and sugar. Together they constitute nearly 80 per cent of Malawi's exports.

The country is highly vulnerable to the effects of climate change and variability in the rainy season due to the country's dependency on natural resources. Changes such as rainfall onset, dry spells and distribution patterns can seriously jeopardise the country's economy (EAD 2010). Such changes also threatens the country's food security and puts further pressure on Malawi's poor as most households rely on subsistence rainfed farming for their livelihood (Kalanda-Joshua et al. 2011). Climate change may therefore threaten the majority of Malawi's population, of whom approximately 90 per cent live in rural areas (Stringer et al. 2009). Hence, future impacts of climate change and climate variability will very much depend on the adaptive ability of the rural population (Fischer et al. 2010).

3.1 Malawi and climate change

There have been some studies conducted on Malawi and climate change. ~~United Nations Development Programme's (UNDP)~~ Climate Change Country Profile concludes that Malawi is experiencing an increase in mean annual temperature. From 1960 to 2006 the mean annual temperature has increased by 0.9°C, an average rate of 0.21°C per decade (McSweeney et al. 2012). It is predicted that the temperature will continue to rise by 1.1 to 3.0°C by the 2060s and further by 1.5 to 5.0°C by the 2090s. Observations show a significant increase in the frequency of hot days and nights throughout the year, with the highest increase during the summer months (December, January and February). Vizy and colleagues moreover predict a shortening of the growing season in southern Malawi (Vizy et al. 2015).

While data on temperatures shows significant changes, long-term precipitation trends are more difficult to identify and predict.. McSweeney (et al. 2012) found no statistically significant trends in precipitation. The future predictions of annual rainfall show no substantial change but it is predicted that it will fall over a shorter period causing heavier rainfall events. It is however noted that the different models predict a wide range of possible outcomes. This is due to Malawi's geographical position, located as it is between two regions of opposing climatic response to El Niño. Eastern equatorial Africa usually receives above average rainfall during El Niño while south-eastern Africa tends to experience below average rainfall. La Niña normally cause the opposite effect (McSweeney et al. 2012).

A study conducted by the Department of Climate Change and Meteorological Services (DCCMS) in Malawi, found that there are some long-term changes in precipitation and a general decrease in precipitation is documented, but regional variations are also found. Just as UNDP, they conclude that the mean temperature in the whole country is higher than it was two decades ago with warmer winters and summers (EAD 2010). Further, when debating climate change it is often stated that extreme events will increase. The IPCC claims that there is not yet a sufficiently developed instrument to make possible conclusions about whether extreme events have increased globally and thus the IPCC can only answer to individual extreme events (IPCC 2012). For Malawi an increase in

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extreme events would mean an increase in dry spells, seasonal droughts, intense rainfall, riverine floods and flash floods (Njaya et al. 2011).

3.2 Lake Chilwa Basin and climate change

Some studies have also been conducted on climate change in the Lake Chilwa Basin. It must be noted, however, that Lake Chilwa Basin is located in a climatically unstable environment and fluctuations in rainfall and temperature have been recorded since the 1960's. It is therefore not clear if the climate is changing significantly (EAD 2000). Data ~~bes~~ however show a slight decrease in rainfall and an increase in temperature in the Lake Chilwa Basin. Statistics from the Meteorological Department show that the mean maximum temperatures in the basin have risen by approximately 1°C (EAD 2000). A decrease in precipitation since the mid-1980s has also been documented in the basin as shown in figure 1. The combined effects of higher temperatures and less rain is arguably the reason for the gradual decrease in Lake Chilwa's water level discussed in section 5.2.2 (EAD 2000) (See figure 3). ~~Scenarios of the basin vary that air temperatures in the basin will increase~~ 2.6°C to 4.7°C by 2075 while scenarios of precipitation ~~varies~~ predicts a 8.3 per cent increase to a 7 per cent decrease (EAD 2000). Moreover, local studies show that there is a chance of shorter growing seasons in the future in southern Malawi due to global warming (Cook et al. 2015), and this trend is already being experienced by the local population, as discussed in section 5.2.1.

Figure 1: Seasonal rainfall time series Zomba

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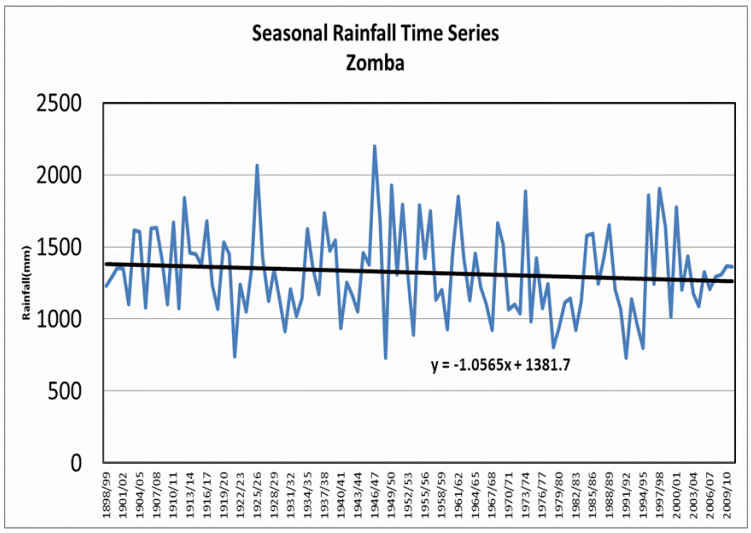

Source: Carr (2012)

4. Methodology

Given Malawi's economy is largely climate-sensitive, with a large ~~subsistence rain-fed agricultural sector,~~ climate change adaptation is paramount to ensure food security for the predominantly rural population. A qualitative research approach was chosen for the study, as it was believed that it would better equip the authors to answer the objectives and research questions of the study. The research has been conducted as a case study on the LCBCCAP and more specifically the WFPGs. The rational for choosing a case study approach is related to the benefits of being able to study the LCBCCAP and the WFPG in detail. The case study approach allows research to devote all the time and resources on one specific case and it therefore implies that the study will be more in-depth. The strength of a case study is that it does not only focus on the outcome, but also the processes. This is beneficial, as the study intends to do look at the processes involved in designing the project as well as the process of enhancing the women's adaptive capacity. The Lake Chilwa Basin was chosen, as it is predominantly rural with

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low levels of development. It is not only one of the poorest regions in the country, but arguably in all of Africa.

The empirical part of this study is based on a case study of the Lake Chilwa Basin Climate Change Adaptation Programme. LCBCCAP is a five-year joint programme (2010-2014) implemented by Leadership for Environment and Development Southern & Eastern Africa (LEAD SEA), WorldFish Centre (WFC) and Forestry Research Institute of Malawi (FRIM). The programme is funded by the Norwegian Government through the Norwegian Embassy in Malawi. LCBCCAP main objective is to secure the livelihood of the 1.5 million people living in the Lake Chilwa Basin and enhance the resilience of the natural resource base they depend on. To meet the objective, LCBCCAP develop and implement basin-wide climate change adaptation strategies and works towards increasing the capacity of communities to adopt sustainable livelihood and natural resource management practices (LEAD 2011). The programme has a number of projects in the basin and one of them is the WFPG, facilitated by WFC. The LCBCCAP was selected due to its relevance to the topic and theoretical issues of the study. The WFPG was selected on similar terms. The objective of the WFPGs is to enhance adaptive capacity through fish processing. The WFPG-project does this by 1) improving traditional methods of processing fish in order to increase quality and reduce wastage, which increases the women's income and savings, and 2) providing the WFPG members with training, such as business management, climate change, gender-issues and group dynamics. The majority of the women participating in the programme were in the fish sector prior to the project.

The research for this article adopted a qualitative methodology and the data was collected over two months from January to March 2012 by one of the authors, Hanne Jørstad. Both of the months were spent as independent researcher with LEAD in Zomba ~~he~~ coordinates the LCBCCAP. The findings are based on semi-structured interviews and focus group discussions with 18 women who were members of the three different WFPGs located in separate locations around the lake, Swang'oma, Tadala and Kachulu. Staff from the Department of Fisheries assisted in planning the meetings with the WFPGs. In addition to talking with the beneficiaries of the project interviews were also held with Leadership for Environment and Development Southern & Eastern Africa

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(LEAD SEA), WorldFish Centre (WFC) and Department of Fisheries (DoF). Apart from questions on perceptions of climate change and climate variability, such as "Do you think the climate is changing?", "Have you experienced any changes in the climate?", or "What have you experienced?", interviewees were also asked about agricultural practices to get a better understanding of the diversification of livelihood activities relevant for assessing the adaptive capacity of local communities.

The purposive sampling technique was chosen for this study in order to select respondents that are relevant for the study. The sampling technique is commonly used for qualitative research and especially small-scale projects (Bryman 2008, Denscombe 2007). Because purposive sampling is under the category of non-probability sampling it entails that the respondents are not randomly selected but rather 'handpicked'. It also implies that findings cannot be generalised to the enlarged population nor can one assume that the respondents represent the overall population (Denscombe 2007). However for this research it is not seen as necessary nor is it the intention for the research to reveal the general Malawian's experience with climate change, but rather focus on the specific case study of LCBCCAP and its women fish processing groups, how these women experience climate change and if the project increases their long-term adaptive capacity.

To gain as broad understanding of the WFPG as possible, interviews were carried out with members from all three women groups ~~as there were only three women groups~~ with eleven to fifteen members. It was further decided that it would be sufficient to have individual interviews with approximately half of the members and focus group discussions with the rest of the members from each women group.

The data collection took place over a period of two months from mid-January to mid-March, 2012. Both of the months were spent with LEAD in Zomba who coordinates the LCBCCAP. From Zomba I took several fieldtrips to the WFPG that are located in Kachulu, Swang'oma and Manguluni. A notice was sent out to the group members in advance, though it varied how many group members turned up for the interviews. The interviews were carried out at the natural settings of the respondents, meaning either at LEADs office, WFCs office or in the communities at the WFPG sites. An interpreter assisted me for the interviews with the WFPG members.

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Semi-structured interviews were used for WFPG members, LEAD and WFC and DoF. Three different interview guides were made for each group (WFPG members, LCBCCAP staff and DoF). Each interview guide consisted of between 13 to 49 questions depending on the context, with questions relevant *inter alia* for respondents' livelihoods, socio-economic factors, natural hazards, and more long-term environmental change.

All respondents participated voluntarily and were thoroughly introduced to the purpose and topic of the study. Moreover, ethical considerations, such as informed consent, do no harm, or invasion of privacy, were all reflected upon prior to collecting data, and at all times during the fieldwork. The WFPG members were thoroughly introduced to the purpose and topic of the study. Even though LEAD and WFC assisted me in field, the women understood that I did not represent these organisations. All respondents participated voluntarily and their identities are held confidential.

A local interpreter was used for all interviews with the WFPG members due to language barriers. The language barrier was a major challenge. Without any Chichewa knowledge, which is one of Malawi's official languages and one of the most dominant languages in the region, it was impossible to communicate with the women in the groups without an interpreter. This created a distance between the authors and the interviewees, which may ~~ha~~ ected the quality of the data collected.

5 Living with climate change: Experiences from Lake Chilwa Basin.

The scientific material presented above illustrates a Malawi in change. These studies are further strengthened by testimonies from local communities in the Lake Chilwa Basin. Findings from a case study of the Lake Chilwa Basin Climate Change Adaptation Programme (LCBCCAP) and its Women Fish Processing Groups (WFPGs), revealed that the women members of the groups have experienced and were impacted by changes in the climate in the Lake Chilwa Basin.

5.1 Local perceptions of climate change

For the women in the Women Fish Processing Groups (WFPG), who rely on natural resources for their food security and livelihood every day, climate change is part of the

present. The authors' study found that for the women in the WFPG climate change is already affecting their lives. Out of the eighteen women that participated in the study, all agreed that the climate is changing.

The major concern for the WFPG members is related to changes in rainfall pattern. There are two main seasons in Malawi, one dry and one wet. The rainy season normally starts in November and ends by the end of March and throughout the period they expect daily rain. The rainy season is followed by a six months long dry season with hardly any rain (Njaya et al. 2011). Any change to the start or end date of the rainy season is regarded as a change in the rainfall pattern. In addition to the start and end date of the season, the change in rainfall pattern also has to do with the frequency of rain within the rainy season.

According to the respondents, the rainy seasons had become highly unpredictable in the past four to five years as they had been delayed, inconsistent and short. The women explained they had experienced erratic ~~rain~~ unpredictable rain and there were longer drier periods within the rain season, also known as dry spells. The rainy season of 2011-2012 is a good example of the recent trend. The women expected the rain to start in October-November, but instead it started in late December and ended in February instead of March. When the rain came, it was erratic and frequently interrupted by dry spells.

Even though there is no significant reduction in the annual rainfall, unpredictable rainy seasons can be just as challenging for subsistence farmers as a reduction in rainfall. Despite the scientific evidence of significant warmer annual mean temperatures and a significant increase of hot days (McSweeny et al. 2012), the women did not put much emphasis on it when asked for specific experiences with climate change. In fact, only one woman spoke of warmer temperatures explaining that it had become increasingly difficult to work outside during the day due to higher temperatures. The woman however linked it to the fact that there are fewer trees than before due to over-exploitation of trees for firewood. Without the shade from the trees, the temperatures felt significantly warmer.

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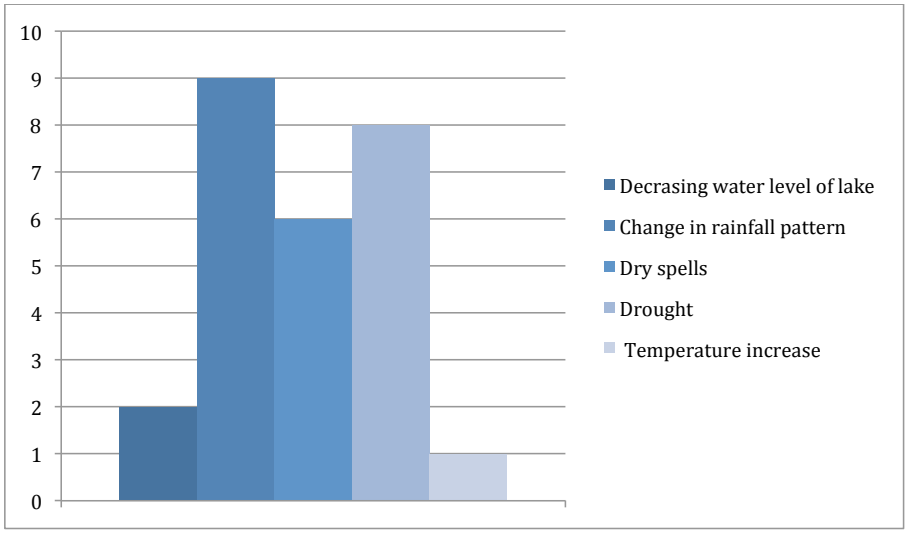
As mentioned earlier, Malawi is a country that is prone to extreme weather events such as flood and drought and since the late 1970's the country has experienced an increase of such events (Chipotha and Mphepo 2011). Out of eighteen women, eight had noticed an increase in droughts, and six women had mentioned dry spells. Floods were not mentioned, but it should be noted that the area is not prone to floods (See figure 2).

Figure 2: The respondents experience with climate change (number of respondents on y-axis)



Source: Authors research 2012.

5.2. Climate change impacts in the Lake Chilwa Basin

Our study found that the climatic changes the women experienced had a significant impact on their everyday life such as their food security, subsistence farming and livelihood. In other words, climate change exacerbates some of the most important human security issues of smallholder farmers.

5.2.1 Food security and subsistence farming

In the Lake Chilwa Basin 85 per cent of the population rely on rainfed subsistence farming for their food consumption (Njaya et al. 2011). Since it is impossible to cultivate without irrigation during the dry season, which the majority do not have access to, it is crucial that the rainy season is predictable and stable for the households to be able to cultivate sufficient amounts for the whole years. According to one of the women from Swang'oma " It is the fourth year that we have had poor harvest because of the poor rain season". A woman from the same area explains, "during the past years the rain has been unpredictable and there has been several dry spells when the rain first came. Then it has stopped before the maize matured".

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The women had tried different types of crops such as hybrid maize, groundnuts, pigeon peas and cassava, but none have produced satisfying results.

One of the main challenges for smallholder farmers in Malawi is to know when to plant. Farmers have usually relied on their local knowledge to make decisions regarding sowing (Kalanda-Joshua et al. 2011). According to the WFPG members, it used to be common to plant when the first rain came. Previously it was considered optimal as the rain usually continued to come consistently. Now they find that the rain is not as predictable as dry spells often occur right after the first rain. When a dry spell occurs the planted crops will fail to grow and consequently the households will have to replant. One of the women from Kachulu explains how the unpredictable rain is increasing their vulnerability: "This season I have planted maize three times, but every time it has withered due to lack of rain. Because of the poor rain I am becoming poorer as it is expensive to replant. I cannot afford to replant again, so I will have to purchase food instead". As a consequence of the poor and unpredictable rain season, the women are being pushed further into poverty.

Several studies have similar findings (Action Aid 2006, Nagoli 2010, Kalanda-Joshua et al. 2011). In Action Aid's (2006) study on climate change and smallholder farmers in Malawi, farmers complained about changes in the rainfall pattern ~~and higher temperatures. Changes in rainfall patterns have made it difficult to know when to plant and higher temperatures reduced the harvest~~. Climate variability is therefore making local knowledge less reliable and it is threatening their main source of knowledge (Kalanda-Joshua et al. 2011).

As a consequence of the uncertainties in the rainy season and the harvest, the women felt that they no longer could rely on subsistence farming. The majority of the women therefore cultivated less and bought bigger proportions of their food from markets. It is however viewed as a luxury that many cannot afford. The women had however been able to increase their income and savings substantially through the WFPG and were therefore capable of doing so. This may also pose a threat to sustainability of the adaptation strategy, also discussed later in this article, as women of the WFPG may

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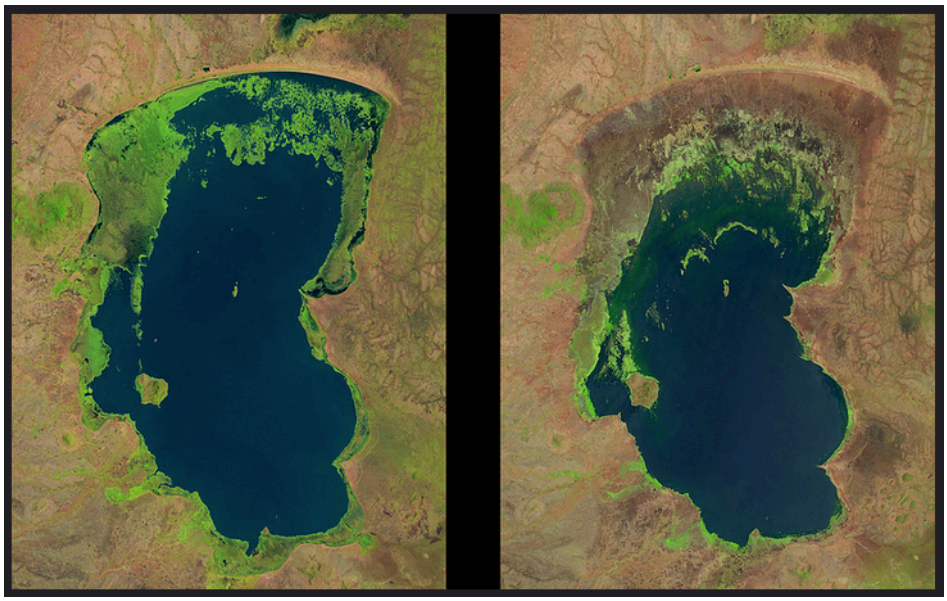
decide not to continue with subsistence farming, making them more vulnerable when the lake will dry up once again.

5.2.2. Impacts on livelihoods

The poor rain seasons and higher temperatures also had a negative effect on the women's business. With fish processing as their main income generating activity they were highly dependent on the fish stock in the lake, largely Matemba (*Barbus* spp.) and Makumba (*Oriochromis* spp.) fish (FAO 2005).

Lake Chilwa is a closed drainage lake, meaning that no water flows out of the lake. Thus, the water level is a direct result of the amount of rainfall that falls during the annual rain season and the amount of water that evaporates. Because Lake Chilwa also is shallow it is prone to drying. When it dries it takes one to two years for the lake to refill and about three to four years for the fishery to recover (Njaya 2011). One of the concerns related to climate change is that higher temperatures and a possible reduction in precipitation will cause the lake to dry up more frequently. In the past century the lake has dried nine times: 1903, 1913-1916, 1922, 1934, 1943-1949, 1967, 1973, 1975 and most recently in 1995-1996 (Chapotera 2012).

Figure 3: The Landsat images show the size of Lake Chilwa in October 1990 and November 2013 and the changes in the internationally recognised wetland areas (in bright green) surrounding the lake



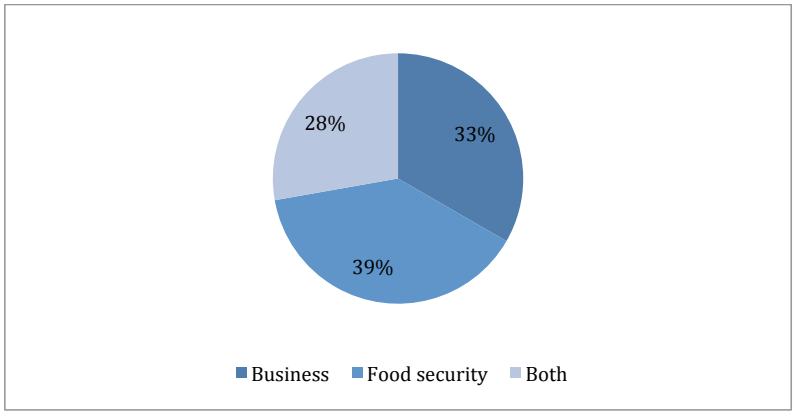
Source: USGS 2014 https://www.flickr.com/photos/usgeologicalsurvey/11963785293/in/photostream/ https://eros.usgs.gov/imagegallery/image-week-2#lake-chilwa-top

When the water level sinks the fish stock is reduced, which increases the price of the remaining catch and reduces the women's income. If the lake dries completely the women are temporary out of business for two to four years. During the data collection the women were worried that the lake would dry within 2013.The drying of the lake was considered the biggest threat posed by climate change. When asked if she considered climate change a threat, a woman from Tadala responded, "Yes, the lake will dry up and I will not have a business". Another woman from the same area expressed the same concern: "Yes, lower water level in the lake is threatening my fish business". As figure 3 demonstrates, the lake did not dry up at the end of 2013 but lost quite some wetland areas, especially in the northern part of the lake, and as a consequence, decreased in size. In 1993 and 1994 the region had similar records that caused the lake to dry the following year (Ngozo 2012).

Unpredictable rainy seasons have made subsistence farming challenging and there is a concern that Lake Chilwa will dry up more frequently. It is questionable whether or not

the changes are a result of climate change and hence a long-term trend or if it is a result of climate variability and therefore a short-term trend. Nevertheless, the WFPG members express that the changes are serious threats to the livelihood and food security of the whole Lake Chilwa Basin (See figure 4). Figure 4 shows the respondent's perception of how climate change affects their lives. Six of the respondents explained that it affected their business and another seven said it affected their crops and hence their food security. The last five respondents stated that their food security is threatened because their business has been reduced. In the figure, this response is shown as 'both'. The study therefore indicates that climate change may have effects on the most fundamental needs for the rural farmers. Such issues may further exacerbate into health issues such as malnutrition, starvation and diseases.

Figure 4: Respondents' perception of how climate change affects them



Source: Authors' research 2012.

6 Climate change adaptation, its success and limitations in Malawi

Climate variability and climate change will have serious implications for smallholder farmers in Malawi that depend on natural resources for their livelihood and food security. Adaptation programmes are developed in order to reduce the vulnerability of the poor to present and future events of environmental hazards. LCBCCAP is such a programme. While there are positive outcomes from the WFPG-project, there are also

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certain limitations that are important to recognise as these may have a significant effect on the members' ability to adapt to climate change.

The authors' study found that the members of the WFPG were satisfied with their involvement in the LCBCCAP programme, mainly due their economic betterment despite the challenging environment described above. Their income and savings had increased[1], they were no longer dependent on their own harvest for food consumption as they had enough money to purchase food (despite the poor harvests being a substantial concern), they enjoyed working in a group instead of individually and were pleased with the different training LCBCCAP offered them (See table 1 and figure 5). The programme had also managed to increase the fish value chain in the lake. Because of the new strategies that the women were using there was less waste and the women were able to produce a product with higher quality and better taste, hence they could also increase the price of the fish product. These are all positive outcomes and the LCBCCAP has in many ways contributed towards enhancing the women's financial and social position, but there are some concerns.[2]

Table 1: Respondents' income before and after joining a WFPG

[1] Data on income and savings was only available from two WFPG as the Kachulu group had not been up and running long enough for the data from their group to be relevant. It should be noted that the data on income and savings is drawn from the women's memory and thus its reliability is questionable since several of the women note that they had little knowledge of how to manage their income prior to training from the project. The information provided by the women is nonetheless a reflection of the positive impact the project has had on their income and savings.

[2] It should be noted that during the time of data collection in January 2012 the WFPG were still in the start-up phase as the groups had only been active for six to eight months and the LCBCCAP is still developing their projects as they are learning from the their experience and from the feedback given by the WFPG members.

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Respondent	Present Income (MKWA)	Previous Income (MKWA)	Difference	Increase in income
S7	3000	1000	2000	200 %
S8	5000	1250	3750	300 %
S9	2000	1500	500	33 %
S10	600	300	300	100 %
S11	2000	1000	1000	100 %
S12	2500	600	1900	317 %
T13	3000	1000	2000	200 %
T14	3000	1000	2000	200 %
T15	4000	1500	2500	167 %
T16	5000	1000	4000	400 %
T17	2000	1000	1000	100 %
T18	5000	500	4500	900 %
Mean	**3091**	**971**	**2120**	**218 %**

S: Swang'oma WFPG, T:Tandala WFPG

Source: Authors research 2012.

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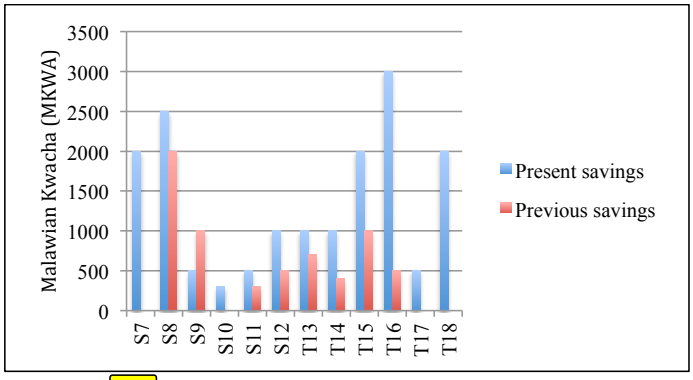
Figure 5: Respondent's savings before and after joining a WFPG



Source: Author research 2012.

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It is problematic that the women's livelihood is dependent on Lake Chilwa. In the last century the lake has dried and it is considered normal that it happens every ten to twenty years (Chapotera 2012, Njaya et al. 2009). It is therefore not a question whether the lake will dry again, but when. Further, a concern is that climate change, with higher temperatures and more unpredictable precipitation, will cause the lake to dry even more frequently. Previous experiences have proven that when the lake dries completely the whole fish sector collapses. However, according to Njaya et al. (2011) the people

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who depend on the lake are well adapted to the cycles of change. When the lake dries there are large-scale shifts from fishing to farming, pastoralism and other occupations. Migration is also common. However, migration may be problematic as it puts extra constraints on the natural resources in the area where people migrate and conflicts may arise between the locals and the migrants. This is a concern that also LCBCCAP is worried about in the Lake Chilwa district (Ngozo 2012).

Nine out of eighteen WFPG members remember the last time the lake dried in 1995/1996. Looking back at how communities and individuals were able to cope at that time gives valuable insight into people's ability to adapt to present and future climate changes. The women were asked about what they remember and how they responded to the incident. They mentioned that the fish sector collapsed and people started migrating to other areas to find work and food. They got involved with causal day labour, known as *ganyu* or utilised the empty land of the lake to cultivate vegetables. Others started processing maize flour instead of processing fish and the women were forced to walk further to fetch water.

The findings indicate that the communities struggled when Lake Chilwa dried in 1995/1996. In order to survive people engaged in alternative income generating activities or migrated to find employment and food. During a new incident, the women will most likely have to take the same measures, as their source of income will vanish. While income diversification and migration indicate that they are able to ~~cope, it~~ does not indicate that LCBCCAP has significantly increased their adaptive capacity as their reliance on the fish and farming sector still makes them highly vulnerable to future events. It can therefore be argued that LCBCCAP should bear this in mind and design adaptation strategies that are not solely dependent on a sector and a resource that is threatened by climate change like the WFPG-project is.

Livelihood diversification is recognised as an effective strategy for smallholder farmers to decrease their vulnerability towards environmental and economic shocks, and hence climate change (Simtowe 2010). Nelson et al. (2009) explain that there is a correlation between the diversity of livelihood strategies and adaptive capacity due to the possibility to substitute between alternative livelihood strategies. By having more than

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one source of income it is possible to spread the risk in case there is a poor season within one sector. A study conducted on fishermen in the basin from the 1970s identified that the wealthiest fishermen in the basin were the ones who had diversified their income (Njaya et al. 2011). LCBCCAP also view diversification as an effective adaptation strategy as they write:

> It is recognized that resilience to climate change involves household's diversifying their livelihood strategies to have options for managing drought, floods, and temperature increases. Thus, in communities throughout the Basin, the project will work to identify ways in which to diversify and enhance their livelihoods, increase productivity of ecosystems and rural incomes, and reduce vulnerability to economic and environmental shocks (LEAD et al. 2009: 15).

While most women cultivated some small plots of land for subsistence, the majority of the women however, were not diversifying their livelihood strategies to an extent that would compensate for the loss of income from fish processing and marketing. Out of eighteen women only two reported that they had another income generating activity and only one women was planning on introducing a new strategy. The two women were involved in beer brewing and boat construction and the third woman wanted to start cultivating rice. The remaining women were relying on fish processing as their source of income. Eight out of the women did however mention that they were involved with *ganyu* when facing economic difficulties. *Ganyu* refers to casual daily wage labour. It is often unskilled agricultural labour and is a common livelihood strategy in Malawi (Simtowe 2010). While it serves as a backup strategy for poor seasons, it is not a reliable source of income. Further, out of the ten women who were married, eight of the husbands were working either in the fish sector or as farmers, hence also their income was dependent on natural resources. This is problematic because the lake dries due to low precipitation over more than one year, which will also have a negative effect on the agriculture sector. Overall the study found that the WFPG members and their household had a weak income base that is highly vulnerable to climate change due to their dependence on natural resources and their low livelihood diversification (See table 2).

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Table 2: Livelihood diversification

Respondents	Wife		Husband
	Main source of income	**Other sources of income**	**Main source of income**
K1	Fish processing	Ganyu	Fish sector
K2	Fish processing	Ganyu	Farmer
K3	Fish processing		Fish sector
K4 (separated)	Fish processing	Ganyu, beer brewing	N/A
K5	Fish processing	Building boats	Fish sector
K6 (widow)	Fish processing	Ganyu	N/A
S7	Fish processing		Farmer
S8	Fish processing	Ganyu	Fish sector
S9	Fish processing		Non-NR based
S10 (widow)	Fish processing		N/A
S11	Fish processing		Fish sector
S12	Fish processing		Non-NR based
T13 (divorced)	Fish processing		N/A
T14	Fish processing		Farmer
T15 (widow)	Fish processing	Ganyu	N/A
T16 (separated)	Fish processing		N/A
T17 (widow)	Fish processing	Ganyu	N/A
T18 (separated)	Fish processing	Ganyu	N/A

K: Kachulu WFPG, S: Swang'oma WFPG, T:Tandala WFPG

Source: ~~Au~~ research 2012.

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The case study of the LCBCCAP and WFPG illustrates the importance of designing climate change adaptation strategies that take into consideration future environmental events and how the strategies will affect the beneficiaries' adaptive capacity during the event. Enhanced capacities within the fish sector will be of little value when the lake actually dries. Without an income the WFPG will be pushed further into poverty.

In order for LCBCCAP to improve the WFPG-project and further reduce the women's vulnerability towards climate variability and climate change, diversification may be a step in the right direction However, for diversification to be an effective adaptation strategy for the WFPG members it is necessary that the additional income sources do not react similar to a change in the climate as the fish sector. Finding a source of income that is not dependent on a natural resource may very well be the best option.

7 Making climate change adaptation work for vulnerable groups

The previous discussion on the success and the limitations of climate adaptation offers some practical solutions to make climate change adaptation work for vulnerable groups. Apart from diversifying income opportunities, this study offers insights into how local knowledge can enhance climate change adaptation.

The study has identified two ways, though closely linked, where LCBCCAP has utilised local knowledge. First, LCBCCAP employs local knowledge through participatory means. The findings indicate that participation was crucial for the development of the WFPG. Representative bodies were involved in identifying the WFPG as an appropriate adaptation strategy for the community. The women have further participated in analysis and their opinions have influenced the design of the project. The women have for example made suggestions to the design of the solar fish driers, which have improved the quality of the dried fish. Second, LCBCCAP adaptation is based on strategies that have proved to work elsewhere. All but one woman worked with fish processing before joining the WGPG. The traditional way of processing fish is very similar to the way the women process fish now, except they have better tools than increase the quality and value of the product. Hence, the project was rich in local content in the sense that the project was built on a local foundation.

The way in which local knowledge has been utilised has generated several benefits for both the programme and the beneficiaries. The benefits of utilising local knowledge that have been documented are increased awareness of local development issues and the local environment through dialogues with the community, by having in-depth understanding of local conditions and needs it is possible to design ~~a~~ r made adaptation programmes, which increases sustainability. Utilising local knowledge increases efficiency and cost-effectiveness, further improves communication, may reduce the chance of conflicts and enhances local empowerment.

The authors' study can therefore conclude that local knowledge can be a crucial element in enhancing climate change adaptation programmes, also for other vulnerable groups. In the case of LCBCCAP, the appropriate way of utilising local knowledge was through participatory means, and merging local practices with technical solutions.

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Utilising local knowledge is not about extracting valuable knowledge from communities and utilising it elsewhere. Though there is nothing wrong with learning from or adopting successful practices, either based on 'local knowledge' or 'scientific knowledge' it is crucial that adaptation strategies are identified together with the communities and further adapted to fit into the local context. When carried out correctly, local knowledge may indeed play a crucial role in climate change adaptation.

8 Conclusion and lessons learned

Climate change poses a significant threat to human security in Malawi, much due to the population's dependency on climate-sensitive resources for their livelihood, high poverty rates and thus limited adaptive capacity. This study presents empirical evidence of fishing communities' experiences with changing climate patterns around the Lake Chilwa Basin in Malawi and how these threaten their livelihood and subsistence farming and thus exacerbating poverty and food insecurity in the region. The changing climate is having a significant impact on smallholder farmers' human security. It is pushing the people living in the Lake Chilwa Basin further into poverty by affecting the natural resources they depend on.

The study of Women Fish Processing Groups in the Lake Chilwa Basin in Malawi demonstrates that local communities vulnerable to climate change can at least to some extent adapt to climate change impacts using low-cost strategies based on local practices. Adaptation is key, and if functioning well, it can perhaps help to avoid tensions over the loss of a natural resource base.

However, if adaptation strategies fail and local communities are forced to resettle (for instance in case Lake Chilwa is to dry up), this may pose a new challenge to a vulnerable population. In such cases the participants' adaptive capacity may in fact decrease as they have invested their time in a project that failed, pushing them further into poverty and making them more vulnerable to climate change.

The likely increase in frequency of drying of Lake Chilwa illustrates that for adaptation strategies to work in the long-term as well as the short-term, it is essential that they take into account the effect of climate change on the natural resources that the

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788 communities rely on. Adapting existing income-generation activities may prove to be
789 insufficient. Strategies that focus on reducing the overall dependency on climate-
790 sensitive natural resources by diversifying livelihoods will arguably increase the
791 communities capacity to adapt to and cope with adverse effects of climate change to a
792 greater extent. In sum, limitations and unintended consequences of climate change
793 adaptation strategies need to be taken seriously to ensure effective and lasting
794 adaptation.

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