

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

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

21
22 **Keywords:** climate change, Malawi, climate change adaptation, human security
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30 **1 Introduction**

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

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

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

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

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

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

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

94 **2 Human security, climate change adaptation and its limitations**

95 **2.1 Climate change and human security**

96 Malawi is extremely poor, with a high population growth, it is highly dependent on
97 natural resources and is hence vulnerable to climate change. Despite existing and
98 functioning coping mechanisms of climate variability, such as selling economic assets,
99 agricultural diversification, and labour migration, climate change may have severe
100 impacts on rural population and should therefore be considered as a real threat to the
101 population's human security, including conflict (Redclift and Grasso 2013). Malawi has
102 despite its challenging socio-economic development, impacting on both, climate change
103 and conflict, not experienced major armed conflicts in the past decades (Hegre et al.
104 2016). The low levels of conflict have helped to create an enabling environment for a
105 large number of people that depend on a fragile resource base. Local knowledge and
106 social capital are important factors in explaining some of the coping mechanisms of the
107 poor in Malawi, factors that could develop in peaceful periods. The absence of conflict
108 may also help to explain that an increasing number of natural hazards have not resulted
109 into humanitarian disasters. A study conducted by ActionAid finds that the country has
110 already seen an increase in the number of extreme weather events in terms of floods
111 and droughts since the 1970s till 2006 (Action Aid 2006). Sustainable adaptation
112 strategies can therefore be seen as a means to avoid human insecurity. This article
113 argues that global environmental change, poverty, and society must be put into context
114 rather than purely focusing on the causal links between climate change impacts and
115 human security. The Lake Chilwa region in southern Malawi was selected as it displays
116 great demographic and environmental challenges, to better understand what and why
117 some adaptation mechanisms may work or not work.

118 2.2 Climate change adaptation

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

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

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

138 According to the Forth and Fifth Assessment Report of the IPCC (Niang et al. 2014; Boko
139 et al. 2007) Africa is one of the most vulnerable continents to climate change due to its
140 high exposure (e.g. heavy reliance on climate sensitive agriculture) and low adaptive
141 capacity (e.g. poverty). Key adaptation strategies are diversification of livelihood
142 activities, adjustment in farming operations, income generating projects, selling of
143 labour and the move towards off-farm or non-farm livelihood incomes (Boko et al.
144 2007). The results of this paper suggest that these adaptation strategies are relevant
145 also for Malawi.

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147

148 **2.3 Limitations of climate change adaptation**

149 Not all adaptation strategies are sustainable. For instance, physical adaptation
150 strategies, such as dams to protect low-lying land from water intrusion caused by sea
151 level rise, may require human migration and resettlement. This way, migration becomes
152 an adaptation strategy. The debate whether migration may be an act of adaptation
153 received attention among scholars (Tacoli 2009; Baldwin 2016; Brzoska and Frölich
154 2016; Black et al. 2011; McLeman and Smit 2006). Recent research in low-lying island
155 states demonstrates that local perceptions on climate change-induced migration differ
156 from the dominant political discourse on climate-induced migration in the same
157 location, and that not migrating can be both, a strategy to adapt or failed adaptation
158 (Kelman et al. 2015). Though there is little evidence that environmental-induced
159 migration has the potential to trigger violent conflict, it likely will create major
160 challenges for hosting communities, especially in regions that are already densely
161 populated, for example Malawi (Webersik 2012). Climate related outmigration could
162 also change the social fabric of those communities that stay behind. With shrinking
163 populations, markets and political institutions can get distorted making it more difficult
164 for those left behind to adapt to climate change (Barnett 2012). In other cases,
165 adaptation strategies that do not take into consideration the long-term impacts of
166 climate change may prove unsustainable. Livelihood diversification is a laudable
167 approach, however, if farming diversification activities or commercialisation of
168 agriculture remain sensitive to climate change impacts such as unpredictable rainy
169 seasons, the long-term adaptation effect may remain limited as the following case study
170 in the Lake Chilwa Basin in Malawi demonstrates. Other unintended social and
171 environmental consequences of climate change adaptation can stem from large
172 infrastructure projects, such as dam-building for hydropower and water storage, biofuel
173 plantations, and water relocation projects, all relevant for the African context (de
174 Sherbinin et al. 2011). For instance, the growing number of biofuel plantations bought
175 by foreign investors has triggered a debate on land grabbing in Africa (Matondi 2011).
176 Most important, if people are forced to relocate due to large infrastructure projects or
177 land-use change, their economic potential and environmental vulnerability need to be
178 evaluated for current and future climate change impacts, as well.

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180 **3 Explaining the context of Malawi**

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

188 Malawi is one of the most densely populated countries in Africa with a population of
189 approximately 15,380 000 on an area of 94,276 square kilometres (EAD 2010; UNDP
190 2012). It has a high population growth of 2.80%, according to 2008 estimates (NSO
191 2012). It is one of the least-developed countries (LDCs) with a gross national income
192 (GNI) of USD 850 purchasing power parity (PPP) per capita and ranks as 171 out of 179
193 on UNDP's human development index (UNDP 2011). 74 per cent of Malawi's population
194 live on less than a dollar (PPP) a day (2004 estimate) (UNSTATS 2012).

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

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

210

211 **3.1 Malawi and climate change**

212 There have been some studies conducted on Malawi and climate change. [The Climate](#)
213 [Change Country Profile of the United Nations Development Programme \(UNDP\)](#)
214 concludes that Malawi is experiencing an increase in mean annual temperature. From
215 1960 to 2006 the mean annual temperature has increased by 0.9°C, an average rate of
216 0.21°C per decade (McSweeney et al. 2012). It is predicted that the temperature will
217 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.
218 Observations show a significant increase in the frequency of hot days and nights
219 throughout the year, with the highest increase during the summer months (December,
220 January and February). Vizy and colleagues moreover predict a shortening of the
221 growing season in southern Malawi (Vizy et al. 2015).

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

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

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Programme's (UNDP)

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

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246 3.2 Lake Chilwa Basin and climate change

247 Some studies have also been conducted on climate change in the Lake Chilwa Basin. It
248 must be noted, however, that Lake Chilwa Basin is located in a climatically unstable
249 environment and fluctuations in rainfall and temperature have been recorded since the
250 1960's. It is therefore not clear if the climate is changing significantly (EAD 2000). Data
251 do, however show a slight decrease in rainfall and an increase in temperature in the
252 Lake Chilwa Basin. Statistics from the Meteorological Department show that the mean
253 maximum temperatures in the basin have risen by approximately 1°C (EAD 2000). A
254 decrease in precipitation since the mid-1980s has also been documented in the basin as
255 shown in figure 1. The combined effects of higher temperatures and less rain is arguably
256 the reason for the gradual decrease in Lake Chilwa's water level discussed in section
257 5.2.2 (EAD 2000) (See figure 3). Scenarios include a variation of air temperature in the
258 basin with a range of 2.6°C to 4.7°C by 2075 while scenarios of precipitation vary from a
259 8.3 per cent increase to a 7 per cent decrease (EAD 2000). Moreover, local studies show
260 that there is a chance of shorter growing seasons in the future in southern Malawi due
261 to global warming (Cook et al. 2015), and this trend is already being experienced by the
262 local population, as discussed in section 5.2.1.

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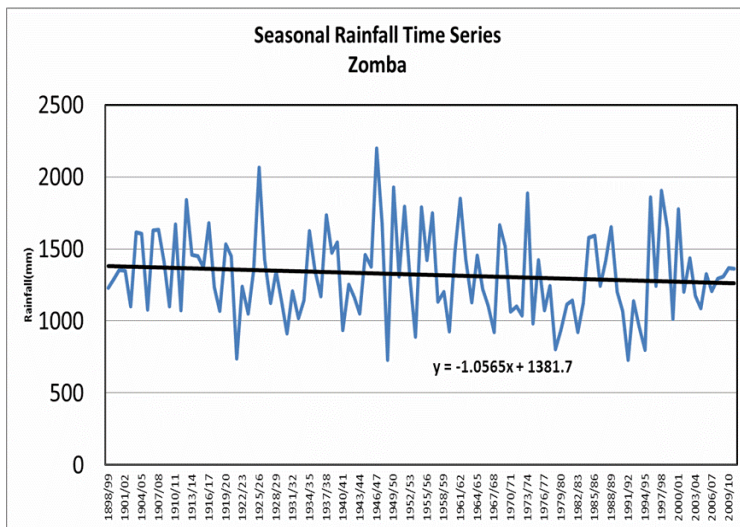
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270 **Figure 1: Seasonal rainfall time series Zomba**



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272 Source: Carr (2012)

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274 **4. Methodology**

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

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

292 The empirical part of this study is based on a case study of the Lake Chilwa Basin
293 Climate Change Adaptation Programme. LCBCCAP is a five-year joint programme
294 (2010-2014) implemented by Leadership for Environment and Development Southern
295 & Eastern Africa (LEAD SEA), WorldFish Centre (WFC) and Forestry Research Institute
296 of Malawi (FRIM). The programme is funded by the Norwegian Government through the
297 Norwegian Embassy in Malawi. LCBCCAP main objective is to secure the livelihood of
298 the 1.5 million people living in the Lake Chilwa Basin and enhance the resilience of the
299 natural resource base they depend on. To meet the objective, LCBCCAP develop and
300 implement basin-wide climate change adaptation strategies and works towards
301 increasing the capacity of communities to adopt sustainable livelihood and natural
302 resource management practices (LEAD 2011). The programme has a number of
303 projects in the basin and one of them is the WFPG, facilitated by WFC. The LCBCCAP was
304 selected due to its relevance to the topic and theoretical issues of the study. The WFPG
305 was selected on similar terms. The objective of the WFPGs is to enhance adaptive
306 capacity through fish processing. The WFPG-project does this by 1) improving
307 traditional methods of processing fish in order to increase quality and reduce wastage,
308 which increases the women's income and savings, and 2) providing the WFPG members
309 with training, such as business management, climate change, gender-issues and group
310 dynamics. The majority of the women participating in the programme were in the fish
311 sector prior to the project.

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

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

328 The purposive sampling technique was chosen for this study in order to select
329 respondents that are relevant for the study. The sampling technique is commonly used
330 for qualitative research and especially small-scale projects (Bryman 2008, Denscombe
331 2007). Because purposive sampling is under the category of non-probability sampling it
332 entails that the respondents are not randomly selected but rather ‘handpicked’. It also
333 implies that findings cannot be generalised to the enlarged population nor can one
334 assume that the respondents represent the overall population (Denscombe 2007).
335 However for this research it is not seen as necessary nor is it the intention for the
336 research to reveal the general Malawian’s experience with climate change, but rather
337 focus on the specific case study of LCBCCAP and its women fish processing groups, how
338 these women experience climate change and if the project increases their long-term
339 adaptive capacity.

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

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

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355 Semi-structured interviews were used for WFPG members, LEAD and WFC and DoF.
356 Three different interview guides were made for each group (WFPG members, LCBCCAP
357 staff and DoF). Each interview guide consisted of between 13 to 49 questions depending
358 on the context, with questions relevant *inter alia* for respondents' livelihoods, socio-
359 economic factors, natural hazards, and more long-term environmental change.
360 All respondents participated voluntarily and were thoroughly introduced to the
361 purpose and topic of the study. Moreover, ethical considerations, such as informed
362 consent, do no harm, or invasion of privacy, were all reflected upon prior to collecting
363 data, and at all times during the fieldwork. The WFPG members were thoroughly
364 introduced to the purpose and topic of the study. Even though LEAD and WFC assisted
365 me in field, the women understood that I did not represent these organisations. All
366 respondents participated voluntarily and their identities are held confidential.
367 A local interpreter was used for all interviews with the WFPG members due to language
368 barriers. The language barrier was a major challenge. Without any Chichewa knowledge,
369 which is one of Malawi's official languages and one of the most dominant languages in
370 the region, it was impossible to communicate with the women in the groups without an
371 interpreter. This created a distance between the authors and the interviewees, which
372 may have affected the quality of the data collected.

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373 **5 Living with climate change: Experiences from Lake Chilwa Basin.**

374 The scientific material presented above illustrates a Malawi in change. These studies are
375 further strengthened by testimonies from local communities in the Lake Chilwa Basin.
376 Findings from a case study of the Lake Chilwa Basin Climate Change Adaptation
377 Programme (LCBCCAP) and its Women Fish Processing Groups (WFPGs), revealed that
378 the women members of the groups have experienced and were impacted by changes in
379 the climate in the Lake Chilwa Basin.
380

381

382 **5.1 Local perceptions of climate change**

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

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

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

397 According to the respondents, the rainy seasons had become highly unpredictable in the
398 past four to five years as they had been delayed, inconsistent and short. The women
399 explained they had experienced erratic and unpredictable rain and there were longer
400 drier periods within the rain season, also known as dry spells. The rainy season of
401 2011-2012 is a good example of the recent trend. The women expected the rain to start
402 in October-November, but instead it started in late December and ended in February
403 instead of March. When the rain came, it was erratic and frequently interrupted by dry
404 spells.

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

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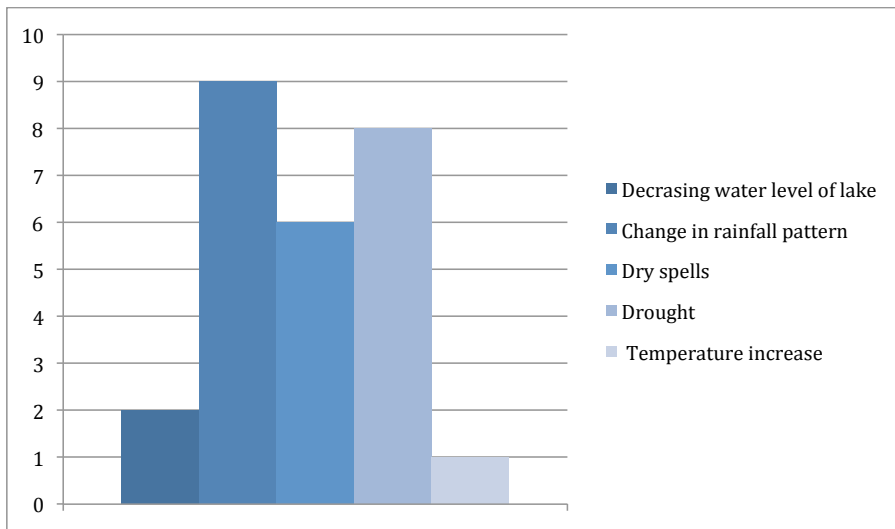
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417 As mentioned earlier, Malawi is a country that is prone to extreme weather events such
418 as flood and drought and since the late 1970's the country has experienced an increase
419 of such events (Chipotha and Mphepo 2011). Out of eighteen women,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

422

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



424

425 Source: Authors research 2012.

426

427 **5.2. Climate change impacts in the Lake Chilwa Basin**

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

432 **5.2.1 Food security and subsistence farming**

433 In the Lake Chilwa Basin 85 per cent of the population rely on rainfed subsistence
434 farming for their food consumption (Njaya et al. 2011). Since it is impossible to cultivate

435 without irrigation during the dry season, which the majority do not have access to, it is
436 crucial that the rainy season is predictable and stable for the households to be able to
437 cultivate sufficient amounts for the whole years. According to one of the women from
438 Swang'oma " It is the fourth year that we have had poor harvest because of the poor
439 rain season". A woman from the same area explains, "during the past years the rain has
440 been unpredictable and there has been several dry spells when the rain first came. Then
441 it has stopped before the maize matured".

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

444 One of the main challenges for smallholder farmers in Malawi is to know when to plant.
445 Farmers have usually relied on their local knowledge to make decisions regarding
446 sowing (Kalanda-Joshua et al. 2011). According to the WFPG members, it used to be
447 common to plant when the first rain came. Previously it was considered optimal as the
448 rain usually continued to come consistently. Now they find that the rain is not as
449 predictable as dry spells often occur right after the first rain. When a dry spell occurs
450 the planted crops will fail to grow and consequently the households will have to replant.

451 One of the women from Kachulu explains how the unpredictable rain is increasing their
452 vulnerability: "This season I have planted maize three times, but every time it has
453 withered due to lack of rain. Because of the poor rain I am becoming poorer as it is
454 expensive to replant. I cannot afford to replant again, so I will have to purchase food
455 instead". As a consequence of the poor and unpredictable rain season, the women are
456 being pushed further into poverty.

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

463 As a consequence of the uncertainties in the rainy season and the harvest, the women
464 felt that they no longer could rely on subsistence farming. The majority of the women

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Changes in rainfall patterns have made it
difficult to know when to plant and higher
temperatures reduced the harvest

470 therefore cultivated less and bought bigger proportions of their food from markets. It is
471 however viewed as a luxury that many cannot afford. The women had however been
472 able to increase their income and savings substantially through the WFPG and were
473 therefore capable of doing so. This may also pose a threat to sustainability of the
474 adaptation strategy, also discussed later in this article, as women of the WFPG may
475 decide not to continue with subsistence farming, making them more vulnerable when
476 the lake will dry up once again.

477

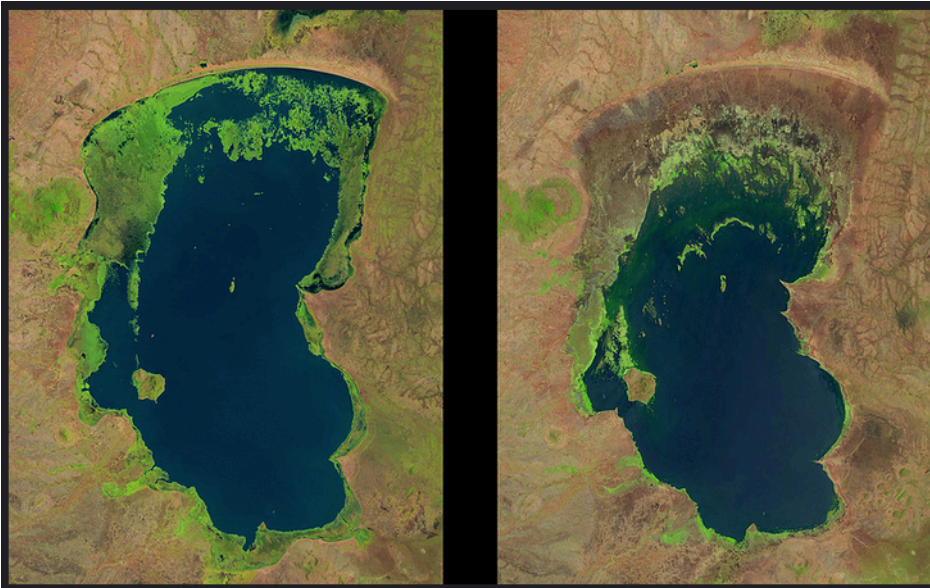
478 **5.2.2. Impacts on livelihoods**

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

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

492

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



496
497 Source: USGS 2014 <https://www.flickr.com/photos/usgeologicalsurvey/11963785293/in/photostream/>
498 <https://eros.usgs.gov/imagegallery/image-week-2#lake-chilwa-top>

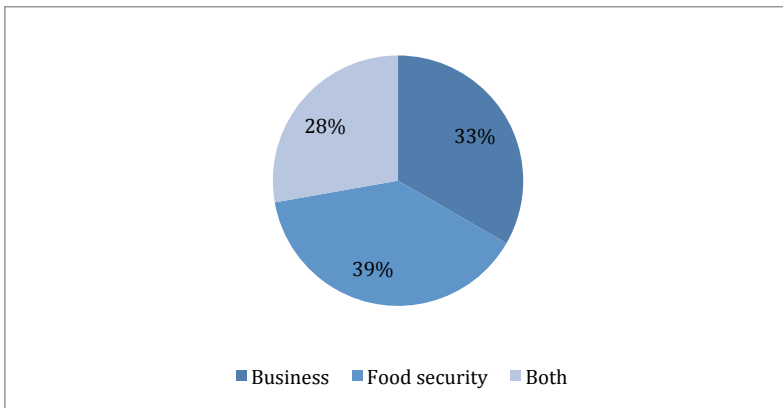
499
500 When the water level sinks the fish stock is reduced, which increases the price of the
501 remaining catch and reduces the women's income. If the lake dries completely the
502 women are temporary out of business for two to four years. During the data collection
503 the women were worried that the lake would dry within 2013. The drying of the lake
504 was considered the biggest threat posed by climate change. When asked if she
505 considered climate change a threat, a woman from Tadala responded, "Yes, the lake will
506 dry up and I will not have a business". Another woman from the same area expressed
507 the same concern: "Yes, lower water level in the lake is threatening my fish business".
508 As figure 3 demonstrates, the lake did not dry up at the end of 2013 but lost quite some
509 wetland areas, especially in the northern part of the lake, and as a consequence,

510 decreased in size. In 1993 and 1994 the region had similar records that caused the lake
511 to dry the following year (Ngozo 2012).

512 Unpredictable rainy seasons have made subsistence farming challenging and there is a
513 concern that Lake Chilwa will dry up more frequently. It is questionable whether or not
514 the changes are a result of climate change and hence a long-term trend or if it is a result
515 of climate variability and therefore a short-term trend. Nevertheless, the WFPG
516 members express that the changes are serious threats to the livelihood and food
517 security of the whole Lake Chilwa Basin (See figure 4). Figure 4 shows the respondent's
518 perception of how climate change affects their lives. Six of the respondents explained
519 that it affected their business and another seven said it affected their crops and hence
520 their food security. The last five respondents stated that their food security is
521 threatened because their business has been reduced. In the figure, this response is
522 shown as 'both'. The study therefore indicates that climate change may have effects on
523 the most fundamental needs for the rural farmers. Such issues may further exacerbate
524 into health issues such as malnutrition, starvation and diseases.

525

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



527

528 | Source: Authors' research 2012.

529 **6 Climate change adaptation, its success and limitations in Malawi**

530 Climate variability and climate change will have serious implications for smallholder
531 farmers in Malawi that depend on natural resources for their livelihood and food
532 security. Adaptation programmes are developed in order to reduce the vulnerability of
533 the poor to present and future events of environmental hazards. LCBCCAP is such a
534 programme. While there are positive outcomes from the WFPG-project, there are also
535 certain limitations that are important to recognise as these may have a significant effect
536 on the members' ability to adapt to climate change.

537

538 The authors' study found that the members of the WFPG were satisfied with their
539 involvement in the LCBCCAP programme, mainly due their economic betterment
540 despite the challenging environment described above. Their income and savings had
541 increased¹, they were no longer dependent on their own harvest for food consumption
542 as they had enough money to purchase food (despite the poor harvests being a
543 substantial concern), they enjoyed working in a group instead of individually and were
544 pleased with the different training LCBCCAP offered them (See table 1 and figure 5). The
545 programme had also managed to increase the fish value chain in the lake. Because of the
546 new strategies that the women were using there was less waste and the women were
547 able to produce a product with higher quality and better taste, hence they could also
548 increase the price of the fish product. These are all positive outcomes and the LCBCCAP
549 has in many ways contributed towards enhancing the women's financial and social
550 position, but there are some concerns.²

551

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 their experience and from the feedback given by the WFPG members.

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

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 %

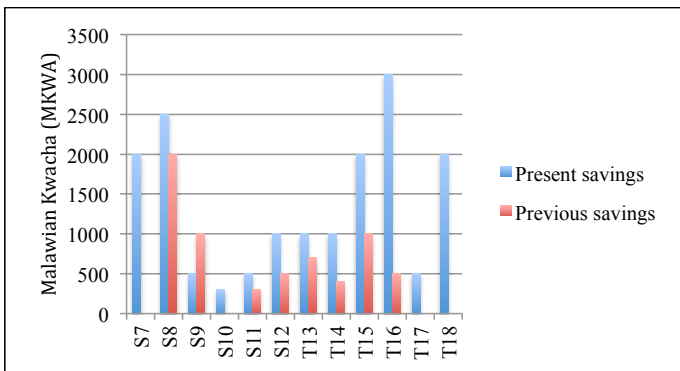
S: Swang'oma WFPG, T:Tandala WFPG

553

554 | Source: Authors' research 2012.

555

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



557

558 | Source: Authors' research 2012.

559

560 It is problematic that the women's livelihood is dependent on Lake Chilwa. In the last
 561 century the lake has dried and it is considered normal that it happens every ten to
 562 twenty years (Chapotera 2012, Njaya et al. 2009). It is therefore not a question whether

563 the lake will dry again, but when. Further, a concern is that climate change, with higher
564 temperatures and more unpredictable precipitation, will cause the lake to dry even
565 more frequently. Previous experiences have proven that when the lake dries completely
566 the whole fish sector collapses. However, according to Njaya et al. (2011) the people
567 who depend on the lake are well adapted to the cycles of change. When the lake dries
568 there are large-scale shifts from fishing to farming, pastoralism and other occupations.
569 Migration is also common. However, migration may be problematic as it puts extra
570 constraints on the natural resources in the area where people migrate and conflicts may
571 arise between the locals and the migrants. This is a concern that also LCBCCAP is
572 worried about in the Lake Chilwa district (Ngozo 2012).

573 Nine out of eighteen WFPG members remember the last time the lake dried in
574 1995/1996. Looking back at how communities and individuals were able to cope at that
575 time gives valuable insight into people's ability to adapt to present and future climate
576 changes. The women were asked about what they remember and how they responded
577 to the incident. They mentioned that the fish sector collapsed and people started
578 migrating to other areas to find work and food. They got involved with casual day
579 labour, known as *ganyu* or utilised the empty land of the lake to cultivate vegetables.
580 Others started processing maize flour instead of processing fish and the women were
581 forced to walk further to fetch water.

582 The findings indicate that the communities struggled when Lake Chilwa dried in
583 1995/1996. In order to survive people engaged in alternative income generating
584 activities or migrated to find employment and food. During a new incident, the women
585 will most likely have to take the same measures, as their source of income will vanish.
586 While income diversification and migration indicate that they are able to cope **with, this**
587 does not indicate that LCBCCAP has significantly increased their adaptive capacity as
588 their reliance on the fish and farming sector still makes them highly vulnerable to future
589 events. It can therefore be argued that LCBCCAP should bear this in mind and design
590 adaptation strategies that are not solely dependent on a sector and a resource that is
591 threatened by climate change like the WFPG-project is.

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593 Livelihood diversification is recognised as an effective strategy for smallholder farmers
594 to decrease their vulnerability towards environmental and economic shocks, and hence
595 climate change (Simtowe 2010). Nelson et al. (2009) explain that there is a correlation
596 between the diversity of livelihood strategies and adaptive capacity due to the
597 possibility to substitute between alternative livelihood strategies. By having more than
598 one source of income it is possible to spread the risk in case there is a poor season
599 within one sector. A study conducted on fishermen in the basin from the 1970s
600 identified that the wealthiest fishermen in the basin were the ones who had diversified
601 their income (Njaya et al. 2011). LCBCCAP also view diversification as an effective
602 adaptation strategy as they write:

603 It is recognized that resilience to climate change involves household's
604 diversifying their livelihood strategies to have options for managing drought,
605 floods, and temperature increases. Thus, in communities throughout the Basin,
606 the project will work to identify ways in which to diversify and enhance their
607 livelihoods, increase productivity of ecosystems and rural incomes, and reduce
608 vulnerability to economic and environmental shocks (LEAD et al. 2009: 15).
609

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

625 agriculture sector. Overall the study found that the WFPG members and their household
 626 had a weak income base that is highly vulnerable to climate change due to their
 627 dependence on natural resources and their low livelihood diversification (See table 2).

628

629 **Table 2: Livelihood diversification**

Respondents	Wife		Huband
	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

630 Source: Authors' research 2012.

631

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

637 In order for LCBCCAP to improve the WFPG-project and further reduce the women's
 638 vulnerability towards climate variability and climate change, diversification may be a

639 step in the right direction However, for diversification to be an effective adaptation
640 strategy for the WFGP members it is necessary that the additional income sources do
641 not react similar to a change in the climate as the fish sector. Finding a source of income
642 that is not dependent on a natural resource may very well be the best option.
643

644 **7 Making climate change adaptation work for vulnerable groups**

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

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

662 The way in which local knowledge has been utilised has generated several benefits for
663 both the programme and the beneficiaries. The benefits of utilising local knowledge that
664 have been documented are increased awareness of local development issues and the
665 local environment through dialogues with the community, by having in-depth
666 understanding of local conditions and needs it is possible to design tailor made
667 adaptation programmes, which increases sustainability. Utilising local knowledge

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669 increases efficiency and cost-effectiveness, further improves communication, may
670 reduce the chance of conflicts and enhances local empowerment.

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

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

681 **8 Conclusion and lessons learned**

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

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

696 However, if adaptation strategies fail and local communities are forced to resettle (for
697 instance in case Lake Chilwa is to dry up), this may pose a new challenge to a vulnerable

698 population. In such cases the participants' adaptive capacity may in fact decrease as
699 they have invested their time in a project that failed, pushing them further into poverty
700 and making them more vulnerable to climate change.

701 The likely increase in frequency of drying of Lake Chilwa illustrates that for adaptation
702 strategies to work in the long-term as well as the short-term, it is essential that they
703 take into account the effect of climate change on the natural resources that the
704 communities rely on. Adapting existing income-generation activities may prove to be
705 insufficient. Strategies that focus on reducing the overall dependency on climate-
706 sensitive natural resources by diversifying livelihoods will arguably increase the
707 communities capacity to adapt to and cope with adverse effects of climate change to a
708 greater extent. In sum, limitations and unintended consequences of climate change
709 adaptation strategies need to be taken seriously to ensure effective and lasting
710 adaptation.

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