

1 **Living with Climate Change:**
2 **Climate change adaptation through supporting women fish**
3 **processing groups in Malawi**

4
5 Hanne Jørstad¹ and Christian Webersik¹
6 ¹ University of Agder

7 **Abstract:**

8 In recent years, research on climate change and human security has received much
9 attention among policy makers and academia alike. Communities in the Global South
10 that rely on an intact resource base and struggle with poverty, existing inequalities and
11 historical injustices will especially be affected by predicted changes in temperature and
12 precipitation. The objective of this article is to better understand under what conditions
13 local communities can adapt to anticipated impacts of climate change. The empirical
14 part of the paper answers the question to what extent local communities in the Chilwa
15 Basin in Malawi have experienced climate change and how they are affected by it.
16 Further, it assesses one of Malawi's adaptation projects designed to build resilience to a
17 warmer and more variable climate, and points to some of its limitations. This research
18 shows that not all adaptation strategies are suited to cope with a warmer and more
19 variable climate, and concludes that livelihood diversification can be an effective
20 adaptation strategy.

21

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

23

24

25 Corresponding author: Christian Webersik, Department of Global Development and

26 Planning, University of Agder, christian.webersik@uia.no

27

28 **1 Introduction**

29 It is a fact that anthropogenic climate change has and is going to have severe impact on
30 developing countries, especially those with a climate-sensitive economy (DARA, 2012).
31 Moreover, countries in the global South struggle with poverty, horizontal inequalities,
32 armed conflict, poor governance, and historical injustices, some of the additional
33 compounding factors that make them vulnerable (O'Brien et al. 2000). Therefore, by
34 framing climate change impacts as a human security concern fits with the discussion on
35 differential vulnerability, given the array of social, political, and economic factors that
36 make people vulnerable in the first place. The debate on the human security
37 implications of climate change has gained momentum in recent years. This is due to a
38 lively policy debate as well as to several publications in journals and books (Brzoska
39 and Scheffran 2013; Scheffran et al. 2012, Webersik 2010). Yet, climate change impacts
40 and their causal linkages with human security are complex and multifaceted, and
41 research needs to address “the limits of our capacity to understand complexity”
42 (Nicholson 2013: 158). Keeping this in mind, this research aims at contextualising
43 climate change adaption and its limitations in southern Malawi. Climate variability is a
44 perceived human security challenge among fishing communities in southern Malawi,
45 hence climate change adaption is becoming an important strategy for these
46 communities to cope with the anticipated changes. The term human security is
47 adequate in the context of climate change impacts as it includes issues pertinent to food
48 security, public health, or any type of loss in key livelihood assets as opposed to the
49 term security defined as freedom from physical force. The term human security
50 acknowledges the fact that humans are both victims and agents of change. While
51 humans are affected by climate change impacts, they are at the same time able to
52 mitigate the drivers of climate change as well as able to adapt to real and anticipated
53 changes. Countries of the global South are typically low-income countries and are least
54 responsible for anthropogenic climate change. Yet, given their predominantly climate-
55 sensitive economies, with rain-fed agriculture dominating, a large percentage of the
56 population economically dependent on agriculture, their low financial and institutional
57 capacity to cope with and to withstand natural hazards, they are most severely affected

58 by it. Current and future changes in temperature and precipitation variability, and
59 changes in the intensity of natural hazards will most certainly affect food security,
60 public health and agricultural productivity in low-income countries.

61 This reflects the notion that climate change is a 'threat multiplier' exacerbating existing
62 tensions, such as poverty. Even when climate change adaptation becomes unavoidable,
63 it needs to be sustainable. Some adaptation strategies, such as agricultural innovation in
64 the fisheries sector as demonstrated in this article, are important in the short-term to
65 relieve some of the pressures climate change may pose but may fail in the long-term in
66 securing a sustainable livelihood.

67 The purpose of this article is to better understand human-environment interactions,
68 bearing in mind their complexity, more specifically climate change adaptation and its
69 limitations. By taking the example of Lake Chilwa Basin in Malawi, this article asks the
70 following research questions: To what extent have women in Lake Chilwa Basin
71 perceived changes in the climate, what have they experienced and how have they been
72 affected by it? To what extent do local climate change adaptation projects increase the
73 women' adaptive capacity? Evidence is drawn from a case study of the Lake Chilwa
74 Basin Climate Change Adaptation Programme (LCBCCAP) and its Women Fish
75 Processing Groups (WFPGs). Most important, this article demonstrates that some
76 adaptation strategies have limitations and are not suited to cope with a warmer and
77 more variable climate.

78 The article is divided in a theoretical and empirical part. The theoretical part evaluates
79 the role of climate change for human security, followed by a discussion on climate
80 change adaptation and its limitations. The empirical part draws from a field study in
81 Malawi, more specifically the Lake Chilwa Basin. This region is home to 1.5 million
82 people, most of them depending on its natural resources for sustaining livelihoods. This
83 section sheds light on how climate change affects local fishing communities in the Basin
84 and critically evaluates the long-term effectiveness and relevance of an adaptation
85 project implemented in these communities.

86 **2 Human security, climate change adaptation and its limitations**

87 **2.1 Climate change and human security**

88 Malawi is extremely poor, with a high population growth, it is highly dependent on
89 natural resources and is hence vulnerable to climate change. Despite existing and
90 functioning coping mechanisms of climate variability, such as selling economic assets,
91 agricultural diversification, and labour migration, climate change may have severe
92 impacts on rural population and should therefore be considered as a real threat to the
93 population's human security. A study conducted by ActionAid finds that the country has
94 already seen an increase in the number of extreme weather events in terms of floods
95 and drought since the 1970s till 2006 (Action Aid 2006). Sustainable adaptation
96 strategies can therefore be seen as a means to avoid human insecurity. This article
97 argues that global environmental change, poverty, and society must be put into context
98 rather than purely focusing on the causal links between climate change impacts and
99 human security. A region in southern Malawi was selected with great demographic and
100 environmental challenges, to better understand what and why some adaption
101 mechanisms may work or may not function..

102 **2.2 Climate change adaptation**

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

106
107 The literature provides a broad spectrum of understandings of the concept. Adaptation
108 has its origin from natural science and was later adopted by anthropologists and social
109 scientists and used in relation to human systems and human-environment systems.
110 (Smit and Wandel 2006). Adger et al. (2003: 192) provides a useful definition and refers
111 to climate change adaptation as “the adjustment of a system to moderate the impacts of
112 climate change, to take advantage of new opportunities or to cope with the
113 consequences”.

114 Adaptation initiatives may be carried out by governments, IGOs, NGOs, CBOs or
115 individuals and may be either anticipatory or a reactive action. The aim of adaptation is

116 reduced vulnerability or increased resilience and it involves changing processes or
117 practices in social and ecological systems through reducing potential damages or
118 engaging in new opportunities (Adger et al. 2007). Climate change adaptation rarely
119 only focuses on factors related to climate change. Adaptation may incorporate any
120 practices or initiatives that increase resilience to elements constituting threats to
121 communities that may aggravate through climate change, such as poverty.

122 According to the Fifth Assessment Report of the IPCC (Niang et al. 2014; Boko et al.
123 2007) Africa is one of the most vulnerable continents to climate change due to its high
124 exposure (e.g. heavy reliance on climate sensitive agriculture) and low adaptive capacity
125 (e.g. poverty). Key adaptation strategies are diversification of livelihood activities,
126 adjustment in farming operations, income generating projects, selling of labour and the
127 move towards off-farm or non-farm livelihood incomes (Boko et al. 2007). The results of
128 this paper suggest that these adaptation strategies are relevant also for Malawi.

129

130 **2.3 Limitations of climate change adaptation**

131 Not all adaptation strategies are sustainable, with limited long-term effectiveness. For
132 instance, adapting to climate change may require human migration and resettlement.
133 This debate is highly contested and received attention among scholars (Tacoli 2009;
134 Baldwin 2016; Brzoska and Frölich 2016). Recent research in low-lying island states
135 demonstrates that local perceptions on climate change-induced migration differ from
136 the dominant political discourse on climate-induced migration in the same location, and
137 that not migrating can be both, a strategy to adapt or to fail to adapt (Kelman et al.
138 2015). Though there is little evidence that environmental-induced migration has the
139 potential to trigger violent conflict, it most certainly will create major challenges for
140 hosting communities, especially in regions that are already densely populated, for
141 example Malawi (Webersik 2012). Climate related outmigration could also change the
142 social fabric of those communities that stay behind. With shrinking populations,
143 markets and political institutions can get distorted making it more difficult for those left
144 behind to adapt to climate change (Barnett 2012). In other cases, adaptation strategies
145 that do not take into consideration the long-term impacts of climate change may prove
146 unsustainable. Livelihood diversification is a laudable approach, however, if farming

147 diversification activities or commercialisation of agriculture remain climate-sensitive,
148 the long-term adaptation effect may remain limited as the following case study in the
149 Lake Chilwa Basin in Malawi demonstrates. Other unintended social and environmental
150 consequences of climate change adaptation can stem from large infrastructure projects,
151 such as dam-building for hydropower and water storage, biofuel plantations, and water
152 relocation projects, all relevant for the African context (de Sherbinin et al. 2011). For
153 instance, the growing number of biofuel plantations bought by foreign investors has
154 triggered a debate on land grabbing in Africa (Matondi 2011). Most important, if people
155 are forced to relocate due to large infrastructure projects or land-use change, their
156 economic potential and environmental vulnerability need to be evaluated for current
157 and future climate change impacts, as well.

158 **3 Explaining the context of Malawi**

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

166 Malawi is one of the most densely populated countries in Africa with a population of
167 approximately 15,380 000 on an area of 94,276 square kilometres (EAD 2010; UNDP
168 2012). It has a high population growth of 2.80%, according to 2008 estimates (NSO
169 2012). It is one of the least-developed countries (LDCs) with a gross national income
170 (GNI) of USD 850 purchasing power parity (PPP) per capita and ranks as 171 out of 179
171 on UNDP's human development index (UNDP 2011). 74 per cent of Malawi's population
172 live on less than a dollar (PPP) a day (2004 estimate) (UNSTATS 2012).

173 According to the Government of Malawi, the country's economy is predominantly
174 agricultural and Malawi depends on just a few cash crops. One-third of the country's
175 gross domestic product (GDP) comes from agriculture, forestry and fishing. Agricultural

176 goods dominate Malawi's export commodities such as tobacco, tea and sugar. Together
177 they constitute nearly 80 per cent of Malawi's exports.

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

188

189 **3.1 Malawi and climate change**

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

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

207 to experience below average rainfall. La Niña normally cause the opposite effect
208 (McSweeney et al. 2012).

209 A study conducted by the Department of Climate Change and Meteorological Services
210 (DCCMS) in Malawi, found that there are some long-term changes in precipitation and a
211 general decrease in precipitation is documented, but regional variations are also found.
212 Just as UNDP, they conclude that the mean temperature in the whole country is higher
213 than it was two decades ago with warmer winters and summers (EAD 2010). Further,
214 when debating climate change it is often stated that extreme events will increase. The
215 IPCC claims that there is not yet a sufficiently developed instrument to make possible
216 conclusions about whether extreme events have increased globally and thus they can
217 only answer to individual extreme events (IPCC 2012). For Malawi an increase in
218 extreme events would mean an increase in dry spells, seasonal droughts, intense rainfall,
219 riverine floods and flash floods (Njaya et al. 2011).

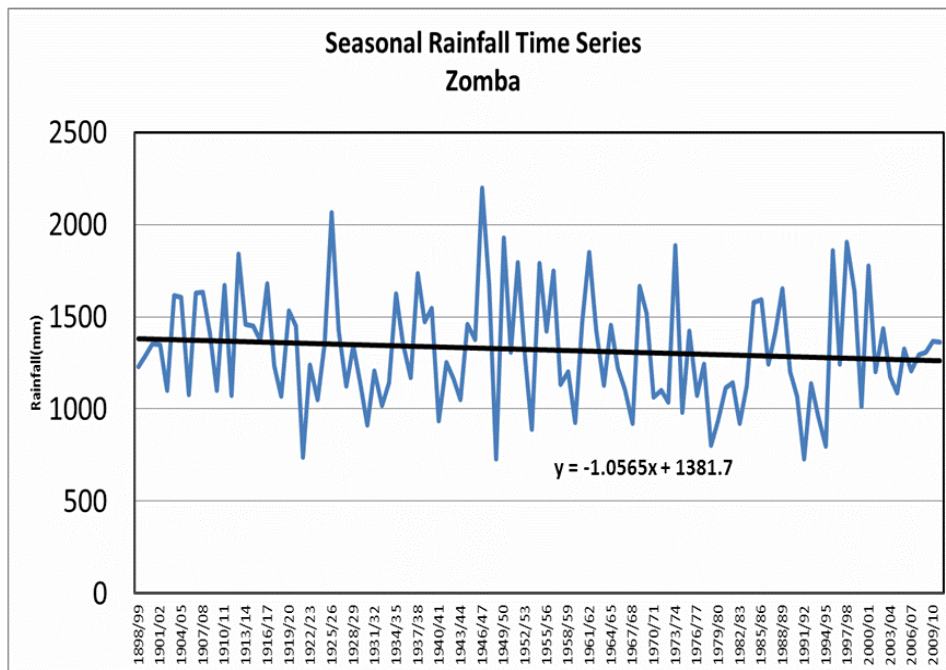
220

221 **3.1.1 Lake Chilwa Basin and climate change**

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

237

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



239
240 Source: Carr (2012)

241
242 **4. Methodology**

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

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

258 The empirical part of this study is based on a case study of the Lake Chilwa Basin
259 Climate Change Adaptation Programme. LCBCCAP is a five-year joint programme
260 (2010-2014) implemented by Leadership for Environment and Development Southern
261 & Eastern Africa (LEAD SEA), WorldFish Centre (WFC) and Forestry Research Institute
262 of Malawi (FRIM). The programme is funded by the Norwegian Government through the
263 Norwegian Embassy in Malawi. LCBCCAP main objective is to secure the livelihood of
264 the 1.5 million people living in the Lake Chilwa Basin and enhance the resilience of the
265 natural resource base they depend on. To meet the objective, LCBCCAP develop and
266 implement basin-wide climate change adaptation strategies and works towards
267 increasing the capacity of communities to adopt sustainable livelihood and natural
268 resource management practices (LEAD 2011). The programme has a number of
269 projects in the basin and one of them is the WFPG, facilitated by WFC. The objective of
270 the WFPGs is to enhance adaptive capacity through fish processing. WFPG-project does
271 this by 1) improving traditional methods of processing fish in order to increase quality
272 and reduce wastage, which increases the women's income and savings, and 2) providing
273 the WFPG members with training, such as business management, climate change,
274 gender-issues and group dynamics. The majority of the women participating in the
275 programme were in the fish sector prior to the project.

276 The research for this article adopted a qualitative methodology and the data was
277 collected over two months from January to March 2012 by one of the authors, Hanne
278 Jørstad. The findings are based on semi-structured interviews and focus group
279 discussions with 18 women who were members of the three different WFPGs located in
280 separate locations around the lake, Swang'oma, Tadala and Kachulu. In addition to
281 talking with the beneficiaries of the project interviews were also held with Leadership
282 for Environment and Development Southern and Easter Africa (LEAD), WorldFish
283 Centre (WFC) and Department of Fisheries (DoF). Apart from questions on perceptions
284 of climate change and climate variability, interviewees were also asked about
285 agricultural practices to get a better understanding of the diversification of livelihood
286 activities relevant for assessing the adaptive capacity of local communities.

287 The purposive sampling technique was chosen for this study in order to select
288 respondents that are relevant for the study. The sampling technique is commonly used
289 for qualitative research and especially small-scale projects (Bryman 2008, Denscombe
290 2007). Because purposive sampling is under the category of non-probability sampling it
291 entails that the respondents are not randomly selected but rather 'handpicked'. It also
292 implies that findings cannot be generalised to the enlarged population nor can one
293 assume that the respondents represent the overall population (Denscombe 2007).
294 However for this research it is not seen as necessary nor is it the intention for the
295 research to reveal the general Malawian's experience with climate change, but rather
296 focus on the specific case study of LCBCCAP and its women fish processing groups, how
297 these women experience climate change and if the project increases their long-term
298 adaptive capacity. To gain as broad understanding of the WFPG as possible, interviews
299 were carried out with members from all three groups. A notice was sent out to the
300 group members in advance, though it varied how many group members turned up for
301 the interviews. All respondents participated voluntarily and were thoroughly
302 introduced to the purpose and topic of the study. A local interpreter was used for all
303 interviews with the WFPG members due to language barriers.

304 **5 Living with climate change: Experiences from Lake Chilwa Basin.**

305
306 The scientific material presented above illustrates a Malawi in change. These studies are
307 further strengthened by testimonies from local communities in the Lake Chilwa Basin.
308 Findings from a case study of the Lake Chilwa Basin Climate Change Adaptation
309 Programme (LCBCCAP) and its Women Fish Processing Groups (WFPGs), revealed that
310 the women members of the groups have experienced and were impacted by changes in
311 the climate in the Lake Chilwa Basin.

312

313 **5.1 Local perceptions of climate change**

314 For the women in the Women Fish Processing Groups (WFPG), who rely on natural
315 resources for their food security and livelihood every day, climate change is part of the
316 present. The authors' study found that for the women in the WFPG climate change is

317 already affecting their lives. Out of the eighteen women that participated in the study,
318 all agreed that the climate is changing.

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

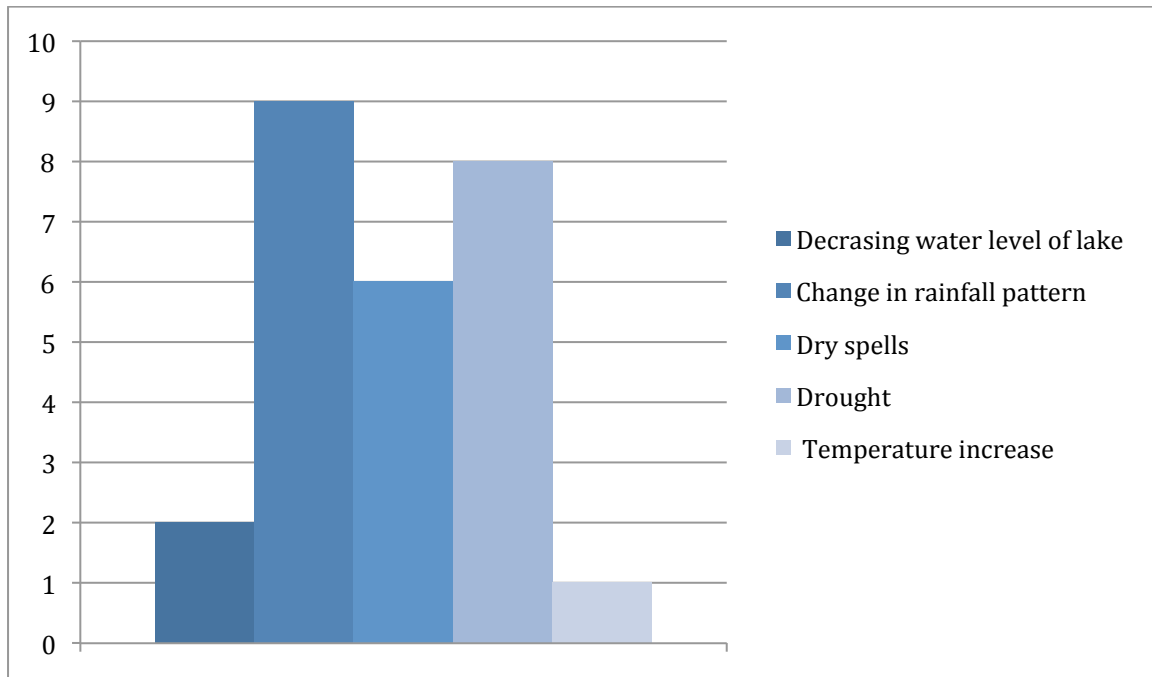
327 According to the respondents, the rainy seasons had become highly unpredictable in the
328 past four to five years as they had been delayed, inconsistent and short. The women
329 explained that they had experienced that the rain came as erratic, unpredictable rain
330 and there were longer drier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

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

345 As mentioned earlier, Malawi is a country that is prone to extreme weather events such
346 as flood and drought and since the late 1970's the country has experienced an increase

347 of such events (Chipotha and Mphepo 2011). Out of eighteen women, eight had noticed
348 an increase in droughts, and six women had mentioned dry spells. Floods were not
349 mentioned, but it should be noted that the area is not prone to floods (See figure 2).
350

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



352

353 Source: Author's research 2012.

354

355 **5.2. Climate change impacts in the Lake Chilwa Basin**

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

360 **5.2.1 Food security and subsistence farming**

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

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

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

385 Several studies have similar findings (Action Aid 2006, Nagoli 2010, Kalanda-Joshua et
386 al. 2011). In Action Aid’s (2006) study on climate change and smallholder farmers in
387 Malawi, farmers complained about changes in the rainfall pattern and higher
388 temperatures, which has made it difficult to know when to plant and additionally
389 reduced the harvest. Climate variability is therefore making local knowledge less
390 reliable and it is threatening their main source of knowledge (Kalanda-Joshua et al.
391 2011).

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

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

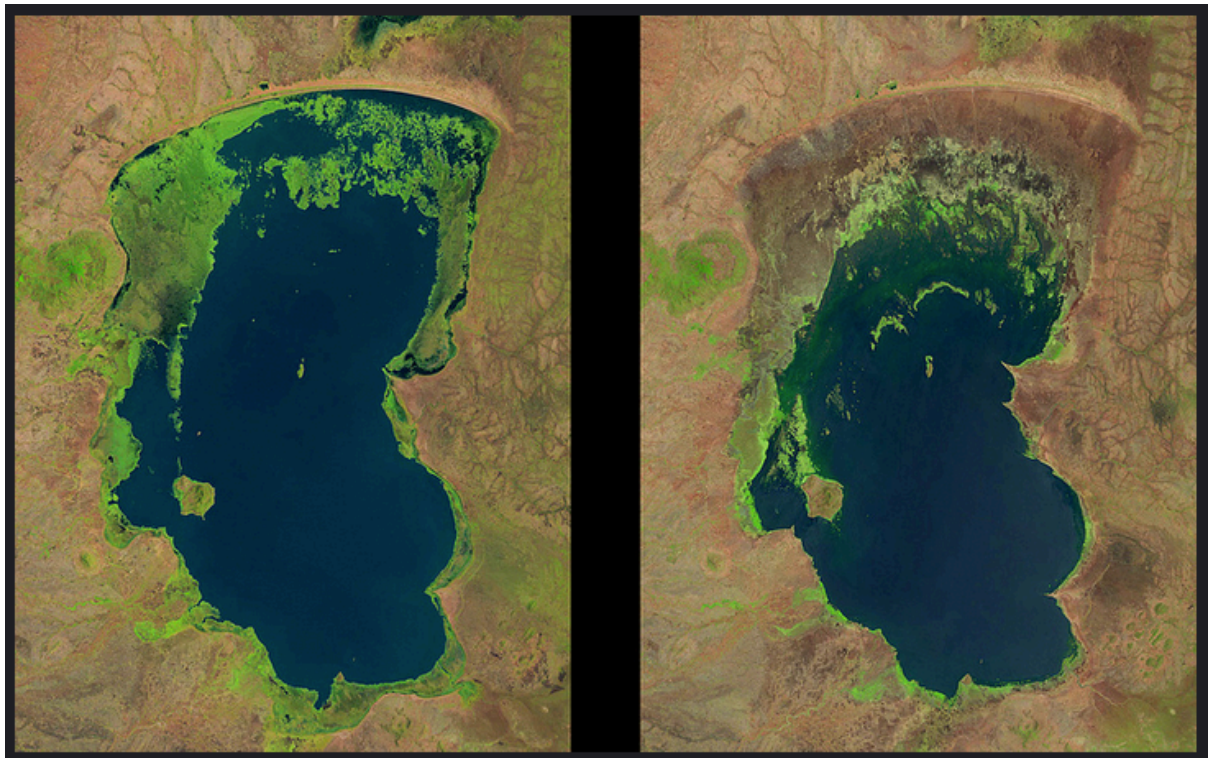
401

402 **5.2.2. Impacts on livelihoods**

403 The poor rain seasons and higher temperatures also had a negative effect on the
404 women's business. With fish processing as their main income generating activity they
405 were highly dependent on the fish stock in the lake.

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

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



418

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

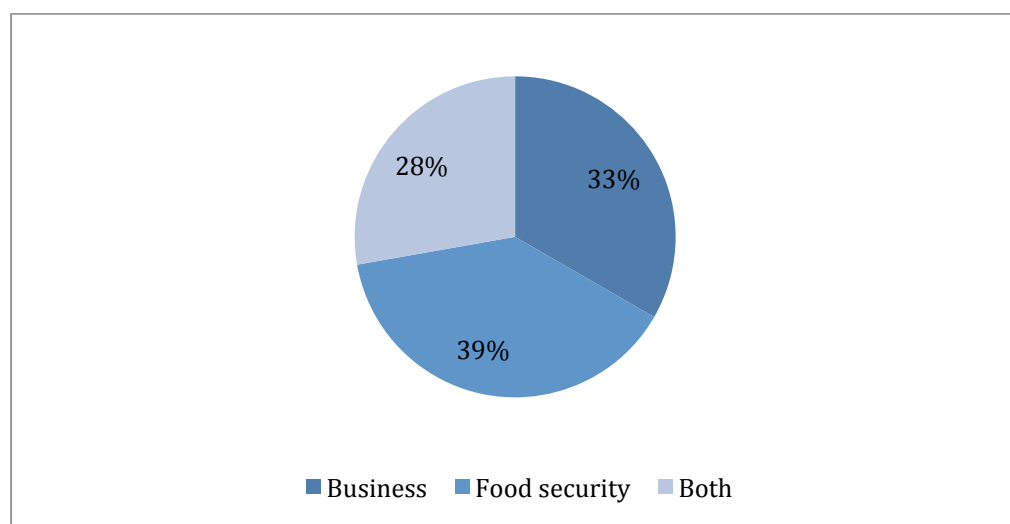
421

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

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

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

447 Figure 4: The respondents' perception of how climate change affects them



448

449 Source: Author's research 2012.

450 **6 Climate change adaptation, its success and limitations in Malawi**

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

456 there are also certain limitations that are important to recognise as these may have a
457 significant affect on the members' ability to adapt to climate change.

458

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

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

473

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 the 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 face 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.

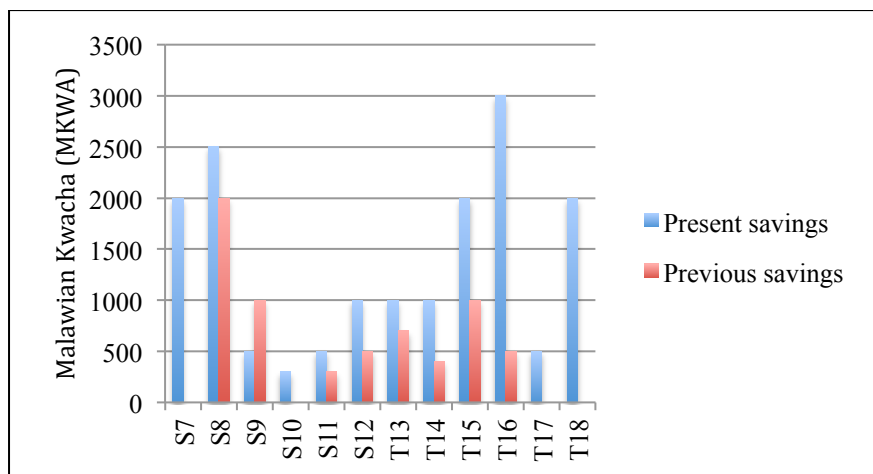
| Respondent | Present Income (MKWA) | Previous Income (MKWA) | Difference | Increase in income |
|-------------|--------------------------|---------------------------|-------------|--------------------|
| S7 | 3000 | 1000 | 2000 | 200 % |
| S8 | 5000 | 1250 | 3750 | 300 % |
| S9 | 2000 | 1500 | 500 | 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

474 Source: Author's research 2012.

475

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



477

478 Source: Author's research 2012.

479

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

487 (2011) the people who depend on the lake are well adapted to the cycles of change.
488 When the lake dries there are large-scale shifts from fishing to farming, pastoralism and
489 other occupations. Migration is also common. However, migration may be problematic
490 as it puts extra constrain on the natural resources in the area where people migrate and
491 conflicts may arise between the locals and the migrants. This is a concern that also
492 LCBCCAP is worried about in the Lake Chilwa district (Ngozo 2012).

493 Nine out of eighteen WFPG members remember the last time the lake dried in
494 1995/1996 well. Looking back at how communities and individuals were able to cope at
495 that time gives valuable insight into people's ability to adapt to present and future
496 climate changes. The women were asked about what they remember and it how they
497 responded to the incident. They mentioned that the fish sector collapsed and people
498 started migrating to other areas to find work and food. They got involved with casual
499 day labour, known as *ganyu* or utilised the empty land of the lake to cultivate vegetables.
500 Others started processing maize flour instead of processing fish and the women were
501 forced to walk further to fetch water.

502 The findings indicate that the communities struggled when Lake Chilwa dried in
503 1995/1996. In order to survive people engaged in alternative income generating
504 activities or migrated to find employment and food. During a new incident, the women
505 will most likely have to take the same measures as their source of income will vanish.
506 While it indicates that they are able to cope, it does not indicate that LCBCCAP has
507 significantly increased their adaptive capacity as their reliance on the fish and farming
508 sector still makes them highly vulnerable to future events. It can therefore be argued
509 that LCBCCAP should bear this in mind and design adaptation strategies that are not
510 solely dependent on a sector and a resource that is threatened by climate change like
511 the WFPG-project is.

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

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

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

528

529 While most women cultivated some small plots of land for subsistence, the majority of
530 the women however, were not diversifying their livelihood strategies to an extent that
531 would compensate for the loss of income from fish processing and marketing. Out of
532 eighteen women only two reported that they had another income generating activity
533 and only one women were planning on introducing a new strategy. The two women
534 were involved in beer brewing and boat construction and the third woman wanted to
535 start cultivating rice. The rest were relying on fish processing as their source of income.
536 Eight out of the women did however mention that they were involved with *ganyu* when
537 facing economic difficulties. *Ganyu* refers to casual daily wage labour. It is often
538 unskilled agricultural labour and is a common livelihood strategy in Malawi (Simtowe
539 2010). While it serves as a backup strategy for poor seasons, it is not a reliable source of
540 income. Further, out of the ten women who were married, eight of the husbands were
541 working either in the fish sector or as farmers, hence also their income was dependent
542 on natural resources. This is problematic because the lake dries due to low precipitation
543 over more than one year, which will also have a negative effect on the agriculture sector.
544 Overall the study found that the WFPG members and their household had a weak
545 income base that is highly vulnerable to climate change due to their dependence on
546 natural resources and their low livelihood diversification (See table 2).

547 **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

548 Source: Author's research 2012.

549

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

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

561

562 **7 Making climate change adaptation work for vulnerable groups**

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

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

580 The way in which local knowledge has been utilised has generated several benefits for
581 both the programme and the beneficiaries. The benefits of utilising local knowledge that
582 have been documented are increased awareness of local development issues and the
583 local environment through dialogues with the community, by having in-depth
584 understanding of local conditions and needs it is possible to design a tailor made
585 adaptation programmes, which increases sustainability. Utilising local knowledge
586 increases efficiency and it is cost-effective, it further improves communication and
587 reduces the chance of conflicts and it was found that it enhances local empowerment.

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

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

598 **8 Conclusion and lessons learned**

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

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

613 However, if adaptation strategies fail and local communities are for example forced to
614 resettle (for instance in case Lake Chilwa is to dry up), this may pose a new challenge to
615 a vulnerable population.

616 However, if adaptation strategies fail the participants' adaptive capacity may in fact
617 decrease as they have invested their time in a project that failed, pushing them further
618 into poverty and making them more vulnerable to climate change.

619 The example of Lake Chilwa and the likely increase in frequency of drying illustrates
620 that for adaptation strategies to increase the smallholder farmers' vulnerability to the

621 long-term as well as the short-term impacts of climate change, it is essential that they
622 take into account the affect of climate change on the natural resources that the
623 communities rely on. Adapting existing income-generation activities may prove to be
624 insufficient. Strategies that focus on reducing the overall dependency on climate-
625 sensitive natural resources by diversifying livelihoods will arguably increase the
626 communities capacity to adapt to and cope with adverse effects of climate change to a
627 greater extent. In sum, limitations and unintended consequences of climate change
628 adaptation strategies need to be taken seriously to ensure effective and lasting
629 adaptation.

630 **References**

- 631 Action Aid (2006). *Climate change and smallholder farmers in Malawi: Understanding*
632 *poor people's experience in climate change adaptation*, Action Aid International.
- 633 Adger, W. Neil (2003). Social Capital, Collective Action and Adaptation to Climate
634 Change, *Economic Geography*, Vol. 79, No. 4, pp. 387-404.
- 635 Adger, W. Neil, Katrina Brown, Declan Conway, Mike Hulme and Saleemul Huq (2003).
636 Adaptation to climate change in the developing world, *Progress in Development*
637 *Studies*, Vol. 3, No. 3, pp. 179-195.
- 638 Agder, W. Neil, Suraje Deesai, Marisa Goulden, Mike Hulme, Irene Lorenzoni, Donald R.
639 Nelson, Lars Otto Naess, Johanna Wolf and Anita Wreford (2009). Are there
640 social limits to adaptation to climate change?, *Climate Change*, Vol. 93, pp.335-
641 354.
- 642 Baldwin, A. (2016). Premediation and white affect: climate change and migration in
643 critical perspective. *Transactions of the Institute of British Geographers*, 41(1), 78-
644 90. doi:10.1111/tran.12106
- 645 Barnett, Jon. 2012. "On the risks of engineering mobility to reduce vulnerability to
646 climate change: insights from a small island state" In *Climate Change and Human*
647 *Mobility: Challenges to the Social Sciences*, eds. Kirsten Hastrup and Karen Fog
648 Olwig. Cambridge: Cambridge University Press.
- 649 Boko, M., I. Niang, A. Nyong, C. Vogel, A. Githeko, M. Medany, B. Osman-Elasha, R. Tabo
650 and P. Yanda (2007). Africa. *Climate Change 2007: Impacts, Adaptation and*
651 *Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report
652 of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P.
653 Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press,
654 Cambridge UK, pp. 433-467.
- 655 Brzoska, M., & Fröhlich, C. (2016). Climate change, migration and violent conflict:
656 vulnerabilities, pathways and adaptation strategies. *Migration and Development*,
657 5(2), 190-210. doi:10.1080/21632324.2015.1022973
- 658 Brzoska, M., & Scheffran, J. (2013). Climate and war: No clear-cut schism. *Nature*,
659 498(171).
- 660 Central Intelligence Agency (2015). *The world factbook: Malawi*, Central Intelligence
661 Agency, Online. Available from: [https://www.cia.gov/library/publications/the-](https://www.cia.gov/library/publications/the-world-factbook/geos/mi.html)
662 [world-factbook/geos/mi.html](https://www.cia.gov/library/publications/the-world-factbook/geos/mi.html) (Accessed 13.10.15).
- 663 Chapotera, Mphatso (2012). *Stream flow and water level monitoring report*,
664 Zomba:WorldFish Centre.
- 665 Chiotha, Sosten and Gibson Mphepo (2011). Integrating climate change adaptation in
666 farming – Building on community knowledge of flooding and drought, pp. 64-66,
667 in Bass, James L.L. Banda, Sosten Chiotha, Joseph Kalowekamo, Themba Kalua,
668 Daisy Kambalame-Kalima, Boyd Hamella, Michael Mmangisa, Gibson Mphepo,
669 Nyuma Mughogho, Dennis Mulebe, Friday Njaya, Elliot Phiri, Benon Yassin, and
670 Gil Yaron (2011). *Mainstreaming the environment in Malawi's development:*

- 671 *experience and next steps*, London: IIED.
- 672 de Sherbinin, A., M. Castro, F. Gemenne, M. M. Cernea, S. Adamo, P. M. Fearnside, G.
673 Krieger, S. Lahmani, A. Oliver-Smith, A. Pankhurst, T. Scudder, B. Singer, Y. Tan, G.
674 Wannier, P. Boncour, C. Ehrhart, G. Hugo, B. Pandey and G. Shi. 2011. "Preparing
675 for Resettlement Associated with Climate Change." *Science* 334(6055):456-457.
- 676 Dodman, David and Diana Mitlin (2011). Challenges for Community-Based Adaption,
677 *Journal of International Development*, Available through: Wiley Online Library,
678 (accessed 06.04.08).
- 679 EAD (2010). *Malawi State of Environment and Outlook: Environment for Sustainable*
680 *Economic Growth*, Lilongwe: Environmental Affairs Department.
- 681 Fisher, M., Chaudhury, M., & McCusker, B. (2010). Do Forests Help Rural Households
682 Adapt to Climate Variability? Evidence from Southern Malawi. *World*
683 *Development*, 38(9), 1241-1250.
684 [doi:http://dx.doi.org/10.1016/j.worlddev.2010.03.005](http://dx.doi.org/10.1016/j.worlddev.2010.03.005)
- 685 GoM (2010). *Statistical Yearbook: 2010*, Zomba: National Statistical Office.
- 686 Jury, M. R., and N. D. Mwafulirwa (2002). Climate variability in Malawi, part 1: Dry
687 summers, statistical associations and predictability, *Int.J. Climatol*, Vol. 22, pp.
688 1289–1302.
- 689 Kalanda-Joshua, Miriam, Cosmo Ngongondo, Lucy Chipeta and F. Mpembeka (2011).
690 Integrating indigenous knowledge with conventional science: Enhancing
691 localised climate and weather forecasts in Nessa, Mulanje, Malawi, *Physics and*
692 *chemistry of the earth*, Vol 36, pp. 996-1003.
- 693 Kelman, I., Stojanov, R., Khan, S., Gila, O. A., Duží, B., & Vikhrov, D. (2015). Viewpoint
694 paper. Islander mobilities: any change from climate change? *International*
695 *Journal of Global Warming*, 8(4), 584-602. doi:10.1504/IJGW.2015.073056
- 696 Leichenko, R. M., & O'Brien, K. L. (2008). *Environmental change and globalization :
697 double exposures*. Oxford ; New York: Oxford University Press.
- 698 Matondi, Prosper Bvumiranayi, Kjell J. Havnevik and Beyene Atakilte. 2011. Biofuels,
699 land grabbing and food security in Africa. London; New York; Uppsala: Zed
700 Books; Published in association with Nordic Africa Institute; Palgrave Macmillan
701 [distributor].
- 702 McSweeney, C., M. New and G. Lizcano (2012). *UNDP Climate Change Country Profile:
703 Malawi*, <http://country-profiles.geog.ox.ac.uk> (Accessed 13.09.11).
- 704 Nagoli, Joseph (2010). *Lake Chilwa Basin Climate Change Adaptation Programme:
705 Livelihood Analysis Report*, Zomba: WorldFish Centre.
- 706 Nelson, R, P. Kokic, S. Crimp, P. Martin, H. Meinke, S.M. Howden, P. de Voil, U. Nidumolu
707 (2009). The vulnerability of Australian rural communities to climate variability
708 and change: Part II – Integrating impacts with adaptive capacity, *Environmental*
709 *Science & Policy*, Vol. 13, pp. 18-27.

- 710 Ngozo, Claire (2012). Livelihoods drying up on Malawi's Lake Chilwa, *Inter Press Service*
 711 *News Agency* (17.08.12), [http://www.ipsnews.net/2012/08/livelihoods-drying-](http://www.ipsnews.net/2012/08/livelihoods-drying-up-on-malawis-lake-chilwa/)
 712 [up-on-malawis-lake-chilwa/](http://www.ipsnews.net/2012/08/livelihoods-drying-up-on-malawis-lake-chilwa/) (Accessed 04.09.12)
- 713 Niang, I., O.C. Ruppel, M.A. Abdrabo, A. Essel, C. Lennard, J. Padgham, and P. Urquhart,
 714 (2014). Africa. In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability.*
 715 Part B: Regional Aspects. Contribution of Working Group II to the Fifth
 716 Assessment Report of the Intergovernmental Panel on Climate Change [Barros,
 717 V.R., C.B. Field, D.J. Dokken, M.D. Mastrandrea, K.J. Mach, T.E. Bilir, M. Chatterjee,
 718 K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken,
 719 P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge,
 720 United Kingdom and New York, NY, USA, pp. 1199-1265.
- 721 Nicholson, C. T. M. (2014). Climate change and the politics of causal reasoning: the case
 722 of climate change and migration. *The Geographical Journal*, 180(2), 151-160.
 723 doi:10.1111/geoj.12062
- 724 Njaya, Friday (2011). Integrating environments in fisheries- co-management and
 725 traditional knowledge helping shift Lake Chilwa from recession to recovery, pp.
 726 58-63, in Bass, James L.L. Banda, Sosten Chiotha, Joseph Kalowekamo, Themba
 727 Kalua, Daisy Kambalame-Kalima, Boyd Hamella, Michael Mmangisa, Gibson
 728 Mphepo, Nyuma Mughogho, Dennis Mulebe, Friday Njaya, Elliot Phiri, Benon
 729 Yassin, and Gil Yaron (2011). *Mainstreaming the environment in Malawi's*
 730 *development: experience and next steps*, London: IIED.
- 731 NSO (2012). CountrySTAT: Key Indicators,
 732 <http://www.countrystat.org/mwi/cont/pages/page/indicators/en> (Accessed
 733 29.09.12)
- 734 Njaya, Friday, Katherine A. Snyder, Daniel Jamu, John Wilson, Clive Howard-Williams,
 735 Edward H. Allison and Neil L. Andrew (2011). The natural history and fisheries
 736 ecology of Lake Chilwa, southern Malawi, *Journal of Great Lakes Research*, Vol 37,
 737 pp. 15-25.
- 738 Scheffran, Jürgen, Michael Brzoska, Jasmin Kominek, P. Michael Link and Janpeter
 739 Schilling. 2012. "Climate Change and Violent Conflict." *Science* 336(869).
- 740 Simtowe, Franklin Peter (2010). Livelihoods diversification and gender in Malawi,
 741 *African Journal of Agricultural Research*, Vol. 5, No. 3, pp.204-216.
- 742 Smith, Barry and Johanna Wandel (2006). Adaption, adaptive capacity and vulnerability,
 743 *Global Environment Change*, Vol. 16, pp. 282-292.
- 744 Stringer, Lindsay C., Jen C. Dyer, Mark S. Reed, Andrew J. Dougill, Chasca Twyman and
 745 David Mkwambisi (2009). Adaptation to climate change, drought and
 746 desertification: local insight to enhance policy in southern Africa, *Environmental*
 747 *Science & Policy*.
- 748 Tacoli, C. (2009). Crisis or adaptation? Migration and climate change in a context of high
 749 mobility. *Environment and Urbanization*, 21(2), 513–525.
- 750 UNDP (2011). *Human Development Report 2011: Sustainability and Equity: A Better*
 751 *Future for All*, Hampshire: Palgrave Macmillan.

752 UNDP (2012). *Malawi: Country Profile: Human Development Indicators*,
753 <http://hdrstats.undp.org/en/countries/profiles/MWI.html> (Accessed 02.04.12).

754 UNFCCC (2011). *Report of the Conference of the Parties on its sixteenth*
755 *session, held in Cancun from 29 November to 10 December 2010*, UNFCCC,
756 <http://unfccc.int/resource/docs/2010/cop16/eng/07a01.pdf#page=4>
757 (Accessed 24.05.12).

758 UNSTATS (2012). *Millennium Development Goals Indicators*,
759 <http://mdgs.un.org/unsd/mdg/Data.aspx> (Accessed 29.09.12)

760 USGS (2014). Image of the week, Lake Chilwa, Malawi. Online. U.S. Geological Survey.
761 Available from: [https://eros.usgs.gov/imagegallery/image-week-2#lake-chilwa-](https://eros.usgs.gov/imagegallery/image-week-2#lake-chilwa-top)
762 [top](https://eros.usgs.gov/imagegallery/image-week-2#lake-chilwa-top)

763 Webersik, Christian. 2010. *Climate change and security: a gathering storm of global*
764 *challenges*. Santa Barbara, Calif.: Praeger.

765 Webersik, Christian. 2012. "Climate-Induced Migration and Conflict: What are the
766 Links?" In *Climate Change and Human Mobility: Challenges to the Social Sciences*,
767 eds. Kirsten Hastrup and Karen Fog Olwig. Cambridge: Cambridge University
768 Press.

769 Vizzy, E. K., Cook, K. H., Chiphamba, J., & McCusker, B. (2015). Projected changes in
770 Malawi's growing season. *Climate Dynamics*, 45(5), 1673-1698.
771 doi:10.1007/s00382-014-2424-x

772