german
cooperation
DEUTSCHE ZUSAMMENARBEIT

Climate Change Impacts on Human (Im-) Mobility in Sub-Saharan Africa

Recent Trends and Options for Policy Responses

Implemented by

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Climate Change Impacts on Human (Im-) Mobility in Sub-Saharan Africa

Recent Trends and Options for Policy Responses

Benjamin Schraven / Stephen Adaawen / Christina Rademacher-Schulz / Nadine Segadlo

Contents

1

Background, introduction and objectives

The African continent is largely characterised by different climatic regimes ranging from high arid to very humid conditions, which remain highly variable and unpredictable. While recurring periods of droughts and climate variability have culminated in the corresponding adaptation of environmental and social systems over the years, the continent remains vulnerable to ongoing global climatic changes. With the majority of agriculture, related rural livelihoods and economies in many parts of the continent that are highly dependent on rain-fed agriculture, it is projected that the impact of climate change in the near future will be enormous. As such, this will have dire implications for food security, health, water availability, stability and economic development for many parts of the continent.

The negative impacts of climate change and related shocks are already manifesting in West, East and Southern Africa. Whilst droughts, water scarcity and rainfall variability have, for example, consistently been pronounced in the West African Sahel, many East African countries like Kenya, Ethiopia and the Darfur region have been grappling with drought-induced famines, loss of livestock due to scarcity of water and pasture, as well as enduring farmer-herder conflicts. Aside from increasing temperatures above the global average in the Southern Africa region, the climate-dependent rural economies in most parts of the SADC region have been severely affected by climate change. In particular, big South African cities like Cape Town and Durban have in recent times been experiencing climate change-induced drought and associated water scarcity.

On the one hand, whilst the sustained mobility of people from one area to the other has traditionally been part of social organisation and experiences of people across societies in Africa, it is widely acknowledged that effects of climate change and related shocks would further induce new waves of increased migration, displacement and planned relocation with the potential to aggravate latent conflicts and the fragile security situation in certain regions of the continent. On the other hand, many vulnerable people and communities could also be "trapped" or unable to migrate as a response due to a lack of financial, social or even physical assets that may be required to facilitate movement.

Despite the relative progress in the efforts at addressing climate change impacts on human mobility at the international level, critical insights in how far and under what circumstances climate change has or will affect vulnerable populations are missing. Otherwise, likely precipitate increases in mobility patterns in East, West and Southern Africa is critical to shaping a development-oriented approach towards human mobility in the context of climate change. Yet, strategic approaches to managing migration, reducing internal displacement and as well, achieving transparent, participatory, and demand-oriented relocation are lacking.

In line with this, GIZ's Global Programme 'Human Mobility in the Context of Climate Change' (GP HMCCC), commissioned by the German Federal Ministry for Economic Cooperation and Development (BMZ), seeks to address populations severely affected by climate change across several world regions. It is envisaged that the adverse impacts of climate change will, in tandem with other intervening factors, greatly influence human mobility dynamics that have diverse implications for countries in these regions. The study will thus seek to provide an overview of three African regions focusing on three major climate change related slow- and rapid-onset phenomena: (increasing) rainfall variability, flooding and droughts (see box 1 for definitions). It will seek to highlight in how far these phenomena are increasing in frequency and strength, whilst examining the impact on human (im-) mobility.

Specifically, the study will:

1) Identify the main consequences on human (im-) mobility and its challenges for policymakers on a regional level related to these phenomena;

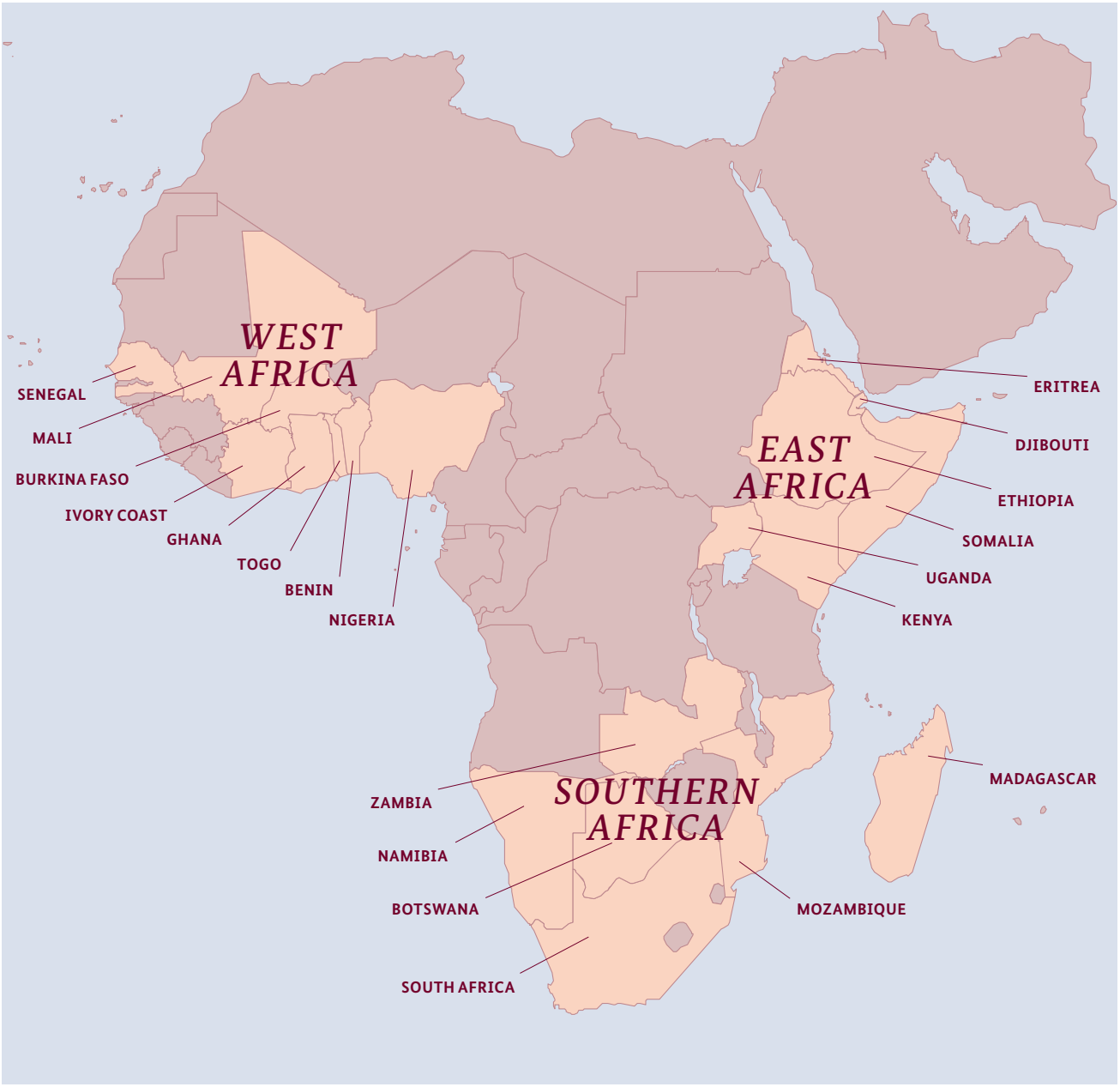
2) Map relevant development sectors in specific countries of the three regions;

3) Develop possible trajectories for development cooperation in relation to the mandate of the GP HMCCC on a regional level.

The aforementioned issues will be examined in the following countries across the three focus regions in Africa.

- **EAST AFRICA: Djibouti, Eritrea, Ethiopia, Kenya, Somalia, Uganda**
- **WEST AFRICA: Benin, Burkina Faso, Ivory Coast, Ghana, Mali, Nigeria, Senegal, Togo**
- **SOUTHERN AFRICA: Botswana, Madagascar, Mozambique, Namibia, South Africa, Zambia**

In all, the study will critically examine and engage relevant stakeholders in the various countries across the regions; whilst also developing recommendations on possible trajectories for national and regional policymakers and German development cooperation on how to address issues related to human mobility in the context of climate change.



Definitions of rainfall variability, flooding and drought

Rainfall variability refers to the degree to which rainfall amounts vary across an area or through time – in other words: rainfall variability is made up of a temporal and a spatial component. Rainfall variability is an important characteristic of the climate of an area. As such, rainfall variability does not constitute a natural or climate hazard, but an increase in rainfall variability may lead to a higher probability of water-related hazards like droughts, the drying up of water bodies or heavy rainfall events leading to flood events. These in turn may have adverse consequences for agricultural or generally natural resource-based livelihoods and human security *(Warner and Afifi, 2014)*.

A simple definition of **flooding** is: water where it is not wanted. Floods occur most commonly from heavy rainfall when natural watercourses lack the capacity to convey water. It can also result from other phenomena, particularly in coastal areas, by a storm surge associated with a tropical cyclone, a tsunami or a high tide. Dam failure, triggered by an earthquake, for instance, will lead to flooding of the downstream area, even in dry weather conditions. Various climatic and non-climatic processes can result in different types of floods: riverine floods, flash floods, urban floods, glacial lake outburst floods and coastal floods. Floods are the natural hazard with the highest frequency and the widest geographical distribution worldwide. Although most floods are small events, monster floods are not infrequent *(UNISDR 2017)*.

A **drought** is generally defined as an extended period – a season, a year, or several years – of deficient precipitation compared to the statistical multi-year average for a region that results in water shortage for some activity, group, or environmental sector. Droughts can be defined according to meteorological, agricultural, hydrological, and socio-economic criteria: Meteorologically, a drought means that precipitation patterns depart from the long-term normal; agriculturally, there is a drought when insufficient soil moisture cannot meet the needs of a particular crop at a particular time. An agricultural drought is typically an evident after a meteorological drought but before a hydrological drought. The latter means that deficiencies occur in surface and subsurface water supplies. Finally, in socio-economic terms, a drought means that human activities are affected by reduced precipitation and related water availability *(FAO 2013)*.

2

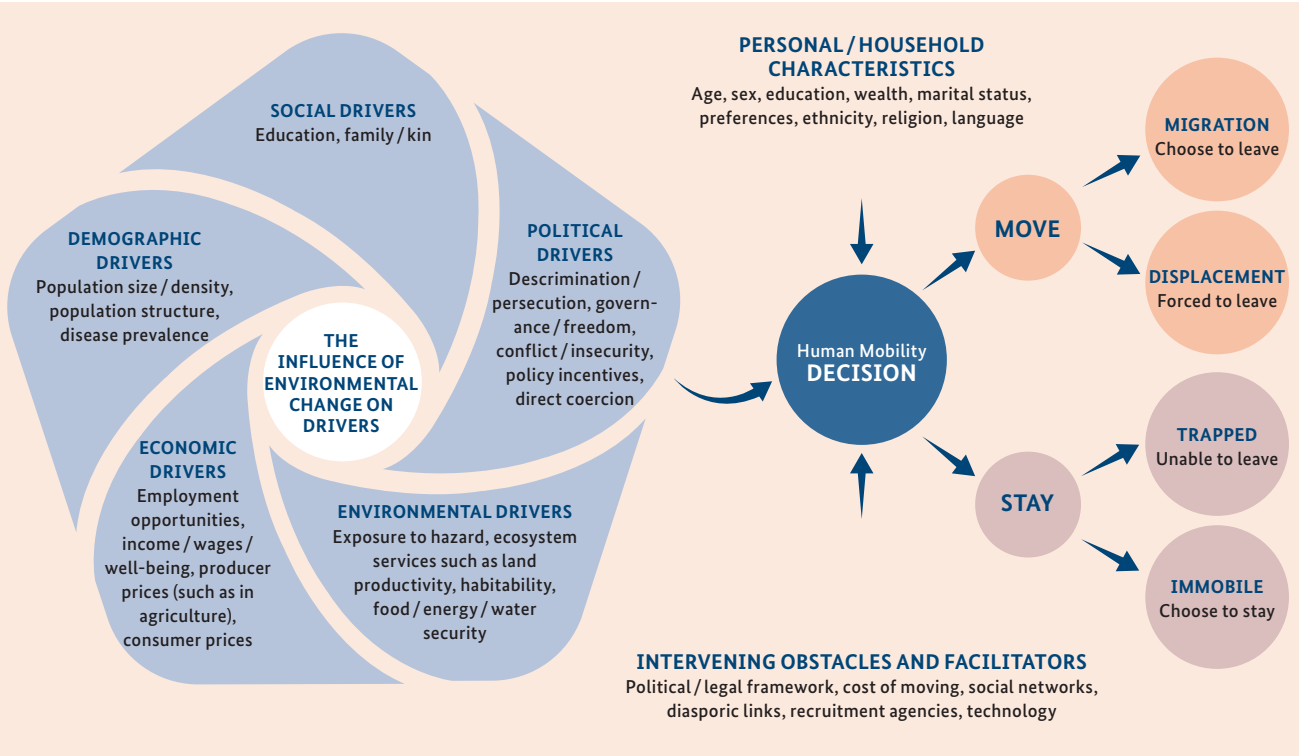
Conceptual framework and methodology

The conceptual framework shown below is, in principal, based on the Foresight Report *(Government Office for Science, 2011)*. Concretely, the human mobility decision framework is based on UN Environment *(2017: 75)*, which is an advancement of the original Foresight framework. It clearly illustrates that the decision of an individual or a family to move or stay is largely driven by a range of drivers, namely personal and household characteristics as well as intervening obstacles and facilitators. Climate change or global environmental change, being itself composed of different social, political, economic, environmental and demographic drivers, further influences the complex interactions of these drivers and can lead to different outcomes in decision-making.

An advantage of using the Foresight framework is its framing of the migration-environment nexus in terms of drivers of human mobility. It portrays human mobility (including displacement and the decision to stay or being unable to leave) as being ultimately shaped by a complexity of interrelated forces including social, economic, cultural and environmental processes. The only disadvantage of this framework may be the fact, that it does not capture measures of planned relocation due to its micro-level decision-making focus. However, as planned relocations are rather an issue of a theoretical debate in the context of climate and environmental change in Africa, this disadvantage is rather neglectable.

This study is based on an advanced literature research and analysis of relevant publications for the three different focus regions. Both, academic as well as technical literature was searched in relevant literature databases using simple key word combinations (e.g. "rain fall variability" + "Ghana"). Additionally – as far as this was possible – experts were interviewed in order to shed some light on aspects, which were not adequately covered by the literature.

Figure 1: Conceptual framework



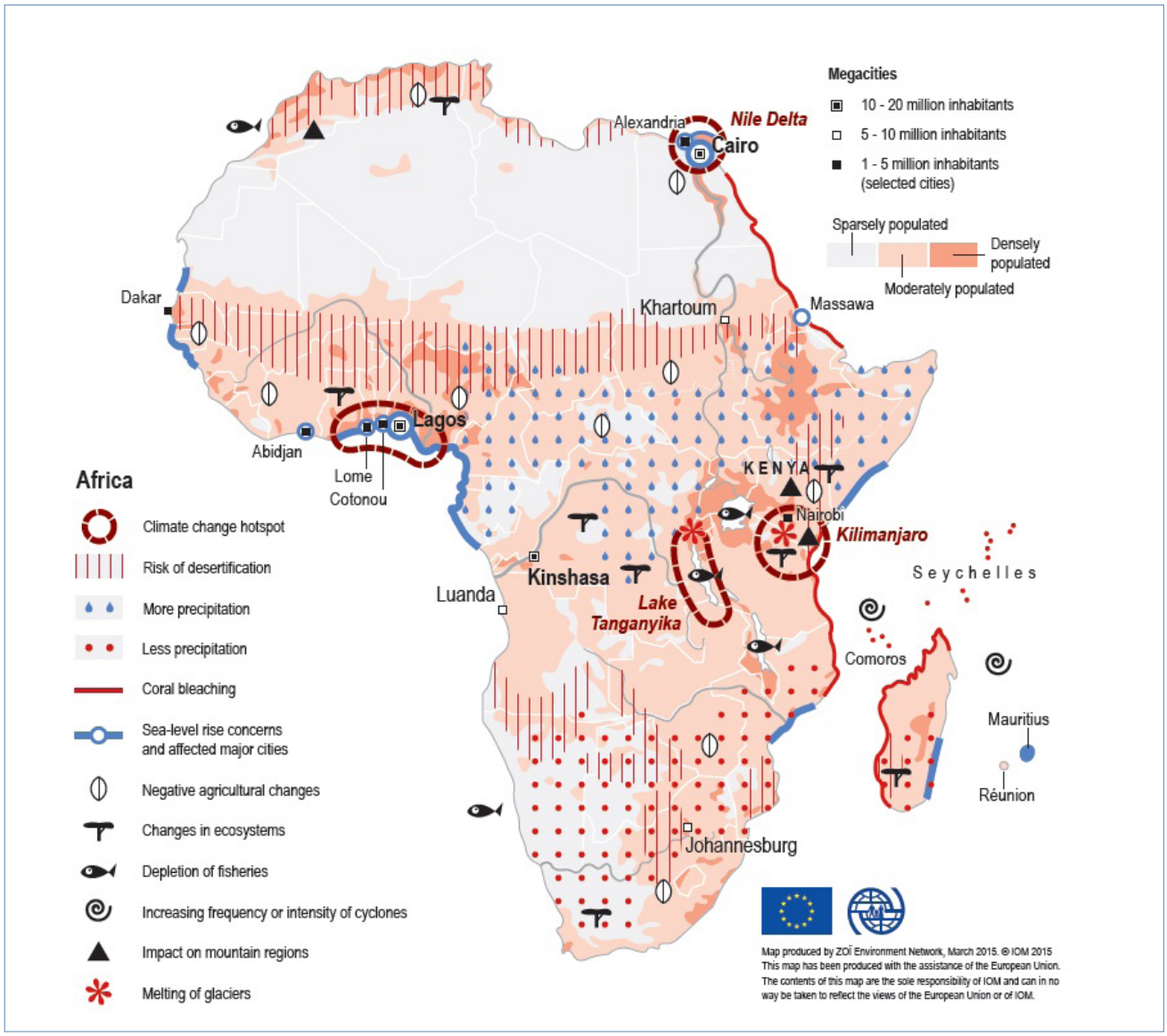
Source: UN Environment (2017): P. 75, based on Government Office for Science (2011).

3

Climate impacts and human (im-)mobility in three African regions

Climate change and its various consequences (see figure 2) is expected to affect food and water security in Sub-Saharan Africa, endangering human security and livelihoods. As precipitation patterns shift, yields from rain-fed agriculture, for instance, are predicted to fall. A further compounded stress on water resources is predicted to be intensified with escalated risks of flooding, drought and desertification. Furthermore, Africa, along with Asia, is urbanizing faster than any other continent in the world. Rapid urbanization, combined with overall population growth, pushes vulnerable populations into living in the most environmentally hazardous and densely populated areas. This apparently increases the number of people affected by natural disasters. In the following, the consequences of three selected climate change related stressors (increasing rainfall variability, floods and droughts) for human mobility are analysed for the three African focus regions.

Figure 2: Climate change impacts in Sub-Sahara Africa



Source: IOM Regional Maps on Migration, Environment and Climate Change (2015): www.environmentalmigration.iom.int/maps.

3.1 West Africa

a) Rainfall variability and mobility in West Africa

The West African region has persistently been confronted with considerable changes in its climatic and environmental conditions over the years. These changes have manifested in high annual and interdecadal rainfall variability, increasing temperatures and much more frequent and intensive slow-onset events like sea-level rise, floods and droughts *(Nicholson, 2000; Giannini et al., 2008)*. This has often translated into widespread negative effects on crop farm productivity and livestock production *(Roudier et al., 2011; Giannini et al., 2017)*. Mean annual rainfall across the region has generally ranged between 600 mm – 1600 mm in the humid tropical zones to the south and 100 mm – 200 mm in the northern fringes of the Sahel *(Brooks, 2004; Nicholson, 2005)*. However, the region has over time been marked by sustained periods of desiccation with a corresponding decline in mean annual rainfall of between 20 % – 30 % with an observed warming of between 0.3° C and 1° C *(Sylla et al., 2016)*.

While analysis of recent rainfall activity within the region suggests a recovery of rainfall across the region *(Nicholson, 2005)*, the onset of seasonal rainfall has nonetheless been increasingly unpredictable with early cessation of rainfall, as well as prolonged intra-seasonal dry spells *(Sarr, 2012; Salack et al., 2016)*. The supposed rainfall recovery is attributed to an increase in intensity relative to frequency of precipitation and hence, tends to mask the observed rainfall anomalies and variability in the region *(Giannini et al., 2013)*. Generally, the projected range of changes in precipitation over the region remains uncertain. But in drawing on Regional Climate Models (RCMs), however, it is projected that rainfall activity will remain highly variable with precipitation levels across the whole of West Africa expected to decrease between 5 % – 40 % by 2100 *(IPCC, 2013; Sylla et al., 2016)*.

High rainfall variability and the corresponding unpredictability, as well as early cessation have greatly posed threats to food security and increasingly food deficits in Sahelian countries like Mali, Senegal and Burkina Faso *(Robison and Brooks, 2010)*. As such, rainfall variability has, in tandem with other anthropogenic factors, often contributed to post-flowering water stress, intra-seasonal long dry spells, flooding of lowlands and the need for re-planting with significant negative impacts on yields *(Salack et al., 2015)*. In response, many farmers have adapted to the cultivation of high yielding and short-cycle crop varieties to enhance resilience and productivity. However, the continuous decline in yields has been more marked with climate sensitive staples like millet, sorghum and maize in both the Sudano- and Guinean-Sahelian areas of Senegal, Mali, Niger, Burkina Faso, Northern Togo and Benin *(Roudier et al., 2011; Sultan et al., 2013)*. The impact on agricultural livelihoods and yields have largely contributed to intensifying the short-term circular or seasonal migration of mostly rural farmers to urban and other rural areas, as well as cross-border mobility from the drier areas of Burkina Faso, Niger and Mali to Ivory Coast, Togo and Ghana as a coping strategy.

In **Burkina Faso**, for example, high inter-annual and seasonal rainfall variability are major factors contributing to crop failure and decline in yields of major staples like millet, sorghum, maize and the production of cotton *(Ingram et al., 2001)*. These agro-climatic dynamics have persistently posed threats to food and livelihood insecurity for the majority of rural households with many often resorting to migration as a coping or adaptation strategy *(Nielsen, 2016)*. In their study on environmental conditions and migration patterns in Burkina Faso, Henry et al. *(2004a)* pointed to a link between rainfall variability and migration or first village departure in the country. Based on their analysis, they observed that the propensity to migrate from one village to the other was higher in areas with rainfall deficits. However, males were more likely to engage in rural-rural migration on a permanent basis in the advent of poor rainfall than their female counterparts. Overall, they observed that rainfall and bad harvests tended to limit people's ability to undertake long-distance migration. While this seems to reflect that climate / environmental change could be a driver and at the same time a barrier to migration, the study acknowledged that the findings were not definitive. Nonetheless, the study highlights the role of rainfall scarcity as a catalyst to migration of people in response to changing agro-climatic conditions in the country.

Similarly, the issue of rainfall variability and declining mean of annual rainfalls have consistently presented a challenge to the rain-fed agricultural and energy sector in **Ghana** *(Owusu and Waylen, 2009)*. In particular, erratic rainfall patterns, late-onset of rainfall and frequent but

prolonged intra-seasonal dry spells have contributed to a shift in the farming season. The unpredictability of rainfall activity has created uncertainties for the majority of rural farmers in the semi-arid Savannah in the northern part of the country *(Laux et al., 2008)*. The effect of declining and seasonal rainfall distribution has continued to negatively stress crop farming and the annual decline of harvests of millet, sorghum and groundnuts in the area. Consequently, rural farm households often had to endure food shortages, economic hardship and livelihood uncertainties *(Laube et al., 2012)*. Alongside other responses to the effect of rainfall anomalies on crop production, it is observed that the majority of people tend to reinforce the somewhat established pattern of seasonal or circular migration to the wetter areas of southern Ghana *(Van der Geest, 2011; Rademacher-Schulz et al., 2014; Van der Land et al., 2018)*. However, recent empirical studies have suggested a gradual increase in the outmigration of people also in the wet farming season when rainfall and farming activities are presumably in the peak. Despite the observation, Rademacher-Schulz et al. *(2014)* have been unequivocal that timing and seasonality of rainfall was crucial to seasonal migration as a coping strategy for the rural Savannah areas of Northern Ghana.

In reference to **Mali and Senegal**, the challenge of insufficient rainfall coupled with unfavourable spatial distribution and land degradation are also major causes of crop failure and bad harvests for farmers *(Grace et al., 2018)*. With the majority of households deriving their livelihood and survival on rain-fed agricultural production, the effect of inadequate rainfall, droughts and land degradation in the face of population growth has tended to directly compromise household income and food availability *(Butt et al., 2005)*. Alongside several other coping strategies, migration is identified as an adaptive strategy employed by individuals and households in both Mali and Senegal. The phenomenon presents an income diversification mechanism and is as well, used to minimise the effect of rainfall variability on crop failures *(Hummel, 2016)*. On the part of **Togo**, the country's National Programme of Action (NAPA) on climate change has also cited changes in the onset of rainy season and poor rainfall distribution as major challenges that have led to widespread impacts on rural agriculture and households. Togo's NAPA further notes that the situation has in part led to rural-urban exodus as well as seasonal migration of farmers *(Sward and Codjoe, 2012)*. Similar observations of uneven spatial rainfall distribution and deficits, coupled with the complementary effects of increasing temperatures and land degradation, will also continue to drive both short- and long-term migration propensities in semi-arid areas of the Sahelian zone including **Northern Benin** *(Hummel et al., 2012; Sow et al., 2014; Dah-gbeto and Villamor, 2016)*, **Northern Nigeria** *(Dillon et al., 2011; Abbas, 2017)* and across many rural areas of the Sahel *(Grace et al., 2018)*.

Overall, rainfall variability as well as the associated impacts on rural livelihoods and national economies will have negative implications for food security and populations in marginal areas. Despite uncertainties with regard to future climate change in the region, the threat to food security and livelihoods will potentially intensify outmigration patterns from rural to urban areas and across borders to states in wetter regions to the south of the West African Sahel. Others may be trapped and unable to move or may not have access to remittances due to lack of capital or social networks. With no robust social protection for vulnerable populations, the situation will likely have adverse effects on rural populations and as well threaten human security and welfare in West Africa.

b) Flash floods, riverine floods and mobility in West Africa

The general impressions of climate dynamics across West Africa reflect a situation of a highly variable climatic regime marked by sustained periods of desiccation and recurrent droughts *(Brooks, 2004)*. These dynamics have often translated into periods of rainfall deficits and droughts across the region *(Dai et al., 2004)*. Yet, empirical studies have also suggested that recent years of intensive rainfall and associated flood events may have marked the beginning of a wetter and greener Sahel *(Nicholson, 2005)*. Since the 1970s, drought events have alternated with successive years of flooding in the region *(IEG/World Bank, 2010)*. But periods of heavy rainfall activity in the last 25 years (1995, 1998, 1999, 2007 and 2012) across West Africa often led to devastating episodes of both flash and riverine floods and the associated loss of lives and property, with the estimated cost of damage raking up to millions of dollars *(Tarhule, 2005; Nka, et al., 2015)*.

In the case of West Africa, the frequency and adverse impacts of floods on communities is increasingly becoming a serious challenge to governments and policymakers *(Samimi et al., 2012)*. Alongside flash and riverine

floods induced by heavy rainfall, coastal communities and major cities like Dakar, Lagos, Abidjan, Lomé and Accra are all exposed to regular inundation due to **sea-level rise and improper urban development** in face of increasing urbanisation *(Rain et al., 2011; Owusu and Nursey-Bray, 2018)*. In some coastal communities, for example, flooding by sea water due to rising sea levels has taken over living spaces with many being displaced *(Fagotto, 2016)*. As a coastal town in Ghana, Keta has been recording a sea-level rise of 3 mm / year *(Boatemaa et al., 2013)*. Due to the associated 2.66 m loss of coastline per annum due to erosion, the government initiated a sea defence project to reclaim land from the advancing shoreline. This notwithstanding, the Keta Municipality continuously experiences sea water flooding with widespread impacts on property and livelihoods. As part of a governmental resettlement programme, an appreciable proportion of households that lost their houses due to sea erosion received bungalows. Nevertheless, a pattern of short-distance migration is noticed / can be noticed in the area. According to Hillmann and Ziegelmayer *(2016)*, most of the persons who were interviewed indicated they moved primarily because the sea destroyed their houses. The effect of sea water flooding and coastal erosion was thus a major cause of high internal migration in the Keta Municipality.

In the West African region, however, there seems to be little or no policy or scientific attention on the devastative effects of floods and sea-level rise in many communities *(Tarhule, 2005)*. The seeming lack of attention may have been fuelled by general perceptions of a Sahel plagued by droughts and rainfall deficits. However, in 2007 alone, more than 500,000 people were affected by floods in the 11 West African countries of Mali, Burkina Faso, Mauritania, Niger, Ivory Coast, Senegal, Gambia, Liberia, Togo, Sierra Leone and Ghana. Similar cases of heavy rains in 2012 led to flooding and damages in Cameroon, Chad, Niger, Nigeria and Senegal. The 2012 flooding, in particular, resulted in the displacement of 2.1 million people and a loss of 363 lives and 600,000 houses in what has been described as an unprecedented natural disaster in Nigeria *(IRIN, 2013)*. Within the same period, a total of 260,000 people in Ghana, 35,000 in Burkina Faso and 20,389 in Togo were also reportedly affected. Severe floods were also recorded in both West and Central Africa in 2017. With the 2017 floods, 12 out of the 13 regions in Burkina Faso were affected with the accompanying strong winds leaving many people homeless and displaced. As a result, 30,862 people were displaced. A significant number of people (100,000) were also affected in Nigeria's Benue State, where 21 local government were completely overwhelmed with the magnitude of the inundation.

Although socio-economic and institutional challenges often serve to amplify the magnitude of impact and hence resilience in most of the affected countries in West Africa *(Owusu and Nursey-Bray, 2018)*, the advent of heavy rains and flooding have been the cause of crop destruction and food shortages in the region *(Hartill, 2008)*. The loss of livelihoods and high vulnerability, in especially marginal areas, have often resulted in economic hardship and food insecurity for most poor households and vulnerable sections of the population like women and children in the region *(Glazerbrook, 2011)*. As extensively documented by media reports and empirical research, for example, many parts of West Africa including **Northern Ghana** were affected by heavy rains and severe floods in 2007. The spatial spread and magnitude of the floods resulted in the loss of lives, destruction of property and displacement of people. Given that the flooding in Northern Ghana coincided with the lean period of the year where food stocks are normally low, many poor households experienced food shortages while many others were displaced.

The impact of the flood in both urban and rural communities was compounded with the spillage of water from the Bagre dam in Burkina Faso. The country's Ministry of Food and Agriculture (MoFA) estimated that more than 70,500 hectares food crop farmlands were destroyed. Following the damage that was recorded in the loss of farmlands (144,000 metric tonnes worth of food crops), livestock and property to the floods, coping mechanisms were overwhelmed. While assistance was extended to affected areas, most of the communities could not be accessed due to inundation and breakdown of key infrastructure like roads and bridges. As noted by Armah et al. *(2010)*, on the one hand, most affected households resorted to a variety of immediate, short- and long-term coping mechanisms. While many resigned to engaging in non-farm economic activities, selling of livestock and taking loans from social contacts to cope with losses and food shortages, many others identified outmigration and remittances as mechanisms that helped them to cope with the floods. On the other hand, some affected persons who did not have any social support or networks suffered more as compared to those who had a spread of family members in other areas. Even for those who migrated, many were found to have relocated to flood prone areas along the banks of the

Volta River thereby further exposing them to flood risks. Although some were aware of the risks of migrating, they nonetheless chose to migrate as they felt that the risks were much lower than staying in the affected areas.

In the case of **Togo**, flooding in urban and rural areas has been a regular phenomenon. However, recent experiences of heavy rains across the entire West African region have led to an increase in the frequency and devastative effects of floods. Flood events have caused deaths, displacement and the destruction of socio-ecological systems in many parts of the country. In the wake of the 2007 heavy rains and accompanying floods, more than 127,880 people were affected. Also, a total of 13,764 were displaced while many lives were reportedly lost in areas close to the Mono River basin *(Ntajal et al., 2016)*. Again in 2017, excessive rainfall in the northern parts of the country resulted in heavy discharge beyond the retention capacity of the Nangbéto hydro-electric dam. The overflow of water from the dam inundated villages bordering the Mono catchment, displacing 3,612 people. In view of the destruction and massive displacement of people, that both flash and riverine floods continue to cause across both the Savannah and coastal areas of the country, Togo has, as a matter of urgency, emphasized the need for an early warning system in its NAPA *(Sward and Codjoe, 2012)*. It is envisaged that this would greatly contribute in forestalling the damage and loss often caused by the floods.

With **Senegal**, annual flooding has also consistently been a veritable threat to people in the country. It is estimated that flooding affects about 200,000 people annually in the country. As noted by Schwarz et al. *(2018)*, flood risk is especially high in the urban coastal city of Dakar. In 2009, for example, widespread flooding in Dakar alone resulted in damages and losses of up to $ 104 million. Further / in addition, coastal erosion is a threat to almost all coastal communities in the country. The effect of strong sea waves and coastal erosion has been the cause of displacement and relocation of several coastal communities due to the advancement of shoreline and hence, gradual disappearance of communities. Aside the coastal flooding and erosion, many people in northern Senegal were also displaced and left homeless when villages including Lougdemis were completely flooded due to heavy rains in the region in 2009. In response, many of the affected communities left or were resettled in safe areas like Medina Mountaga in makeshift houses. The Senegalese authorities thus collaborate extensively with aid agencies in stepping up efforts to stem flood impacts in especially vulnerable communities along coastal regions *(Senegal NAPA, 2006)*.

In **Ivory Coast and Mali**, flooding has also been a challenge. Following torrential rains in June 2018, for example, flood water of up to 2.5 meters was recorded in the coastal city of Abidjan. Many houses were submerged, and properties destroyed. Aside from the 18 lives that were lost, many people were displaced and others forced to relocate or seek refuge with family relations. While the issues of corruption and urban development were blamed for the devastation that was recorded, the government readily recommended the evacuation of people living in flood prone areas and the destruction of structures blocking drains and waterways as measures to tackle the menace. With regard to **Bamako (Mali)**, 24 people died in floods caused by torrential rains in 2013. The burst of River Niger overflowing its banks led to the displacement of people and destruction of more than 100 houses. Similarly, the 2010 flood episode in **Benin** was considered as the worst since 1963 *(Smith, 2010)*. The severity of the flood led to the death of 56 people and rendered thousands of people (55,000) homeless. Alongside an outbreak of cholera (846 cases), a total of 680,000 people and over two-third of the country were affected *(Ibid.)*.

For the West African region, therefore, sea-water inundation and flooding due to heavy rainfall and river overflow are recurring hazards that have consistently been a challenge. While flooding has not actually been the cause of any significant mass displacement and, hence, the consideration of any planned relocation as an adaptation option for affected persons in the region, the potential of environmental and socio-economic factors in aggravating waves of migration across West Africa cannot be discounted *(Tschakert et al., 2010)*. But with ongoing global climate change predicted to greatly influence precipitation patterns in many regions across the globe, it is expected that heavy rains, run-off and sea-level rise will potentially amplify the intensity and spread of floods in West Africa. There is thus the need for integrated flood management, early warning, timely response and spatial planning to minimise the devastation often suffered by vulnerable populations.

c) Droughts and mobility in West Africa

In contrast to recent suggestions of a transition towards a wetter Sahel, following a recovery of rainfall and devastating floods across West Africa *(Nicholson, 2005)*, climate variability and severe droughts have undeniably remained enduring features of climate dynamics in the region. Indeed, the Sahelian zone has since the early 1970s been marked by long periods of desiccation *(Hulme, 2001; Brooks, 2004)*. For much of the Sahel, droughts and corresponding decline in rainfall activity have been the cause of crop failure, famines and loss of livestock especially in areas predominantly habited by pastoralists *(Dietz et al., 2001)*. Notably, the droughts in the 1970s and 1980s resulted in food shortages, deaths to both livestock and people, and the mass movement of people across the region. Recurring and devastating droughts have contributed to the loss of farmland, decline in crop yields and loss of livestock in especially dry areas of Mali, Niger, Senegal, Northern Nigeria and Burkina Faso.

In 2010, for example, a reported 10 million people were affected by hunger as a result of severe droughts across West Africa. During the period, Sahelian countries like Niger, Chad, Mali, Burkina Faso and Mauritania were the most affected when preceding rainfall anomalies and decline culminated in low crop harvests for grains. It is estimated that food production has since declined by 25 % with harvests from grains plummeting drastically to 1.4 million metric tons. Also taking the Lake Chad basin, for example, the consistent shrinking of the lake due to extended periods of drought, climate change and extensive use of water poses an existential threat to the survival of nearly 40 million people in Chad, Cameroon, Niger and Nigeria. Indeed, a variety of empirical studies on environmental conditions in West Africa have tended to suggest the compounding effects of population growth, farm expansion, loss of vegetation, water scarcity and land degradation will accelerate desertification and the outmigration of people to more resource-endowed areas (*Gautier et al., 2016; De Bruijn et al., 2005).*

Aside from the impact on food security, drought-induced water scarcity, mobility and competition in the use of scarce natural resources, as exemplified in the Lake Chad region, recurring droughts have been the major cause of farmer-herder conflicts and inter-state tensions on the use of transboundary water resources *(Brown and Crawford, 2008; Cabot, 2017)*. As the case of the Darfur conflict shows *(UNEP, 2007)*, Nett and Rüttinger *(2016)* argue that the shrinking Lake Chad could further stoke the activities of Boko Haram in the region. Over the years, Sahelian livelihoods and social systems have adapted to years of climate variability and extremes as exemplified in livelihood diversification, mobility and pastoralism. Nevertheless, the impact of drought and water scarcity on food and livestock production will not only contribute to increases in the number of internally displaced persons but also worsen the food insecurity and environmental scarcity situation in the region *(Hammer, 2004; Giannini et al., 2017)*. Moreover, with violent farmer-herder conflicts or water tensions also becoming increasingly common and widespread by the day, the tendency for these tensions to escalate or ignite latent conflicts will be great. This will invariably also have implications for the already fragile security situation and stability in the region.

As in most parts of West Africa, internal and cross-border human mobility has been an ongoing phenomenon in **Mali and Burkina Faso**. In both countries, migration has long been a livelihood strategy to cope with environmental stress. While the majority of populations thrive on the production of rain-fed grains like sorghum, maize, millet and cotton, years of debilitating droughts and unreliable rainfall have significantly affected harvests. Aside from the food crisis that hit millions of people across the Sahel, following the droughts in 1970s and 1980s, the recent drought and food shortages in 2012 which affected 19 million people in West Africa was enormous in both countries *(Pearson & Niaufre, 2013)*. In view of the fragility often associated with Sahelian environments, the gravity of the drought was more in the Sudano-Sahelian fringes of northern Burkina Faso and Mali. Considering that most vulnerable households are often limited with adaptation options, people in these drought-prone areas often resort to already established mobility patterns by migrating to other areas as a coping strategy.

Based on analysis of longitudinal migration data in **Mali**, for example, Findley *(1994)* discovered that there was no significant increase in migration with droughts. However, there was a dramatic increase in the number of women and children who migrated during the severe 1983 to 1985 droughts that hit the country. Alongside this increase, there was an observed shift to short-cycle circulation where about 64 % migrants engaged in circular migration *(Ibid.)*. Despite the acknowledgement that the link

between drought, desertification, food insecurity and mobility was not explicit, Pearson and Niaufre *(2013)* indicated that periods of extreme drought often increase the numbers of inter-regional migration in Mali. In their study, it was revealed that 42 % of households intensified seasonal migration during poor harvests, while 17 % and 13 % respectively migrated when there was crop failure and extreme climatic events like droughts. In corroborating these findings, Hummel *(2012)* also found that 40 % of people in her study area of **Bandiagara (Mali)** engaged in migration as a coping strategy to climate shocks like droughts.

Akin to observations in Mali, **Burkina Faso** also experiences a north-south internal migration pattern, as well as an intensive cross-border mobility to Ivory Coast and Ghana. However, internal migration in Burkina Faso follows a strongly rural-rural pattern. In the face of environmental deterioration and climate variability, both short- and long-term migration have been identified as a prominent off-farm coping strategy in especially the drier regions of northern Burkina Faso *(Henry et al., 2004a; Nielsen and Reenberg, 2009)*. As exemplified amongst the Rimaiibe ethnic group of Biidiin northern Burkina Faso, the effects of droughts and highly variable rainfall have contributed in further consolidating the traditional labour mobility pattern in the village. As noted by Nielsen and Reenberg *(2010)*, most young Rimaiibe migrate to other urban areas and Abidjan in response to the effects of drought and rainfall deficit on food availability. The Rimaiibe often migrate in order to work and earn money primarily for food. The case is not different in the semi-arid Sudano-Sahelian region of northern **Nigeria**. Recurring severe droughts and rainfall deficits have been veritable threats to livelihoods and stability for both farmers and herders that dominate the region. The problem of severe droughts and the associated effect on crop failure in the region, according to Abubakar and Yamusa *(2013)*, have been the cause of starvation and the disruption of economic activities especially in areas where crop farming is the main livelihood source of the people. Amidst the different adaptation options, the majority is often forced to migrate to the middle and wetter areas in the south of the country. The scramble in the use of scarce natural resources with the influx of herders have, in tandem with other socio-economic and political factors, been the main cause of violent conflicts between Fulani herders and farmers in the country *(Weiss, 2003; Okeke, 2014)*.

Whilst most affected or displaced persons are often predisposed to migrating as a coping or adaptation option, a host of complementary factors come into play to precipitate movement during periods of droughts and other environmental change-related stress. Moreover, it is equally also important to note that migration is often but one of the plethora of coping or adaptation options that vulnerable populations normally consider in coping with both slow- and rapid-onset extreme events or hazards. Climate change-induced droughts and extreme events can also lead to immobility when the affected persons become displaced or overwhelmed such that they may lack the means to undertake any movement *(Findley, 1994; Henry et al., 2004b)*. But in considering that the nature of future climatic changes may further lead to the frequency and intensity of extreme events in West Africa, there is the need for an integrated approach to water and resource management, food buffers (grain silos) and robust climate forecasts (climate-smart agriculture). This would be crucial to manage the effects of droughts and rainfall deficits on food availability, as well as on poor rural households who thrive mainly on climate-dependent agriculture. Additional strategies in the form of large-scale reforestation programmes to curtail water loss, improve soil conditions and water retention, as well as the provision of water points for pastoralists or dams to promote irrigation agriculture could be initiated to minimise the devastating effects of climate extremes. It is envisaged that these initiatives would greatly help in forestalling drought-induced food shortages and resource-use conflicts in especially marginal areas of the Sahel.

Key messages for West Africa

Climate variability is reflected in decreasing and inter-annual **rainfall variability** and increased warming. Despite suggestions of rainfall recovery in the region, the onset of rainfall has become increasingly unpredictable and erratic. The corresponding shift in the start of the wet farming season and intra-seasonal long dry spells have affected the rain dependent agricultural sector with the much more on climate sensitive major staples like millet, sorghum and maize. This poses a threat to (smallholder) farm productivity and food security in Sahelian countries like Mali, Senegal and Burkina Faso. In turn, the impact of rainfall variability on agricultural production has largely contributed to intensifying the short-term circular or seasonal migration of mostly rural farmers to urban and other rural areas, as well as from the much drier areas like Niger and Mali to Ivory Coast, Togo and Ghana as a coping strategy. Some rural households are simply trapped and unable to move or have access to remittances due to lack of capital or social network. With no robust social protection for vulnerable populations, the situation will likely have adverse effects on rural population and as well, threaten human security and welfare in West Africa.

In contrast to widespread convictions of West African Sahel marked by long periods of desiccation, the region has been marked by intensive rainfall and associated **flood events in recent times**. Frequent episodes of heavy rainfall have been the cause of devastating flash and riverine floods. Increasingly, sea water inundation and coastal erosion due to sea-level rise is increasingly submerging coastal communities and posing enormous risks to major cities like Dakar, Abidjan, Accra, Lagos or Lomé. While socio-economic and institutional challenges often serve to amplify the magnitude impact and hence resilience in most of the affected communities, the destruction of farmlands has been the cause of food shortages, food price volatility and violent protest in many countries across the region. But flooding has not caused any significant mass displacement so far. Hence, the consideration of relocation as adaptation option for affected persons, the potential of environmental and socio-economic factors in aggravating waves of migration across West Africa cannot be discounted.

In contrast to recent suggestions of a transition towards a wetter Sahel, climate variability and devastating **droughts** have remained enduring features of climate dynamics in West Africa region. Recurrent droughts have contributed to the loss of farmland, declining crop yields and loss of livestock in semi-arid areas (e.g. in Mali, Niger, Senegal). Aside from the impact on food security, drought-induced water scarcity, mobility and competition in the use of scarce natural resources (like in the Lake Chad region) has been the main cause of farmer-herder conflicts and inter-state tensions for transboundary water resources. Alongside the tendency to further accentuate already existing mobility patterns, there is also a tendency for families, which may have been overwhelmed by loss of livestock, livelihoods or lack of any institutional or social support systems, to be trapped or unable to move. The increasing violent farmer-herder conflicts or water tensions have the tendency to escalate or ignite latent conflicts with implications for the already fragile security situation and stability in the region – with an increasing likelihood of forced displacement.

3.2 East Africa

a) Rainfall variability and mobility in East Africa

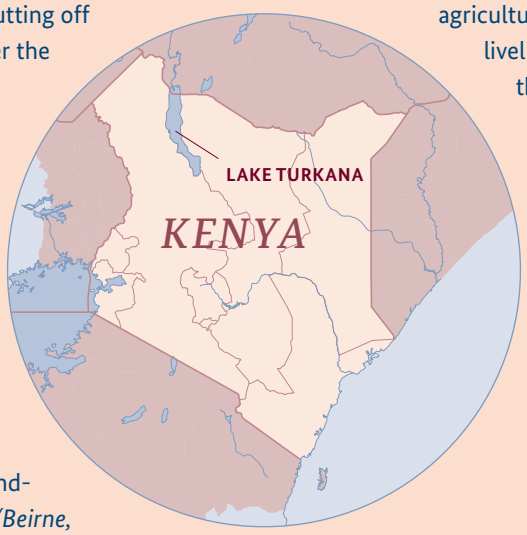
East Africa is projected to be a region that will be particularly exposed to the negative impacts of climate variability, namely rainfall variability, erratic rainfall leading to floods, temperature increase with heat waves, higher evaporation rates and an increase in droughts *(Shongwe et al., 2011)*. Agricultural production and food security particular in semi-arid regions are increasingly compromised due to higher probability of both dry spells and heavy rainfall events during the rainy season *(Huho and Mugalavai, 2010)*. In fact, many people already have low coping capacities due to high levels of poverty, fragile contexts and the existence of various violent conflicts in many parts of the region *(Collier et al., 2008)*. Also, different forms of mobility are widely used as coping and adaptation mechanisms to livelihood stressors, such as (circular) rural-urban migration and pastoralism *(Wiederkehr et al., 2018)*. As compared to West and Southern Africa, the risk of forced displacement is generally most pronounced in East Africa. Apart from the high numbers of refugees and internally displaced people due to the ongoing (politically induced) conflicts, several others have been displaced due to natural resource scarcity or natural disasters *(Afifi et al., 2012)*. Development projects such as dam constructions and the transformation of indigenous grazing and agricultural lands into plantations constitute major risk factors as well. But often these displacement risk factors are highly intertwined *(Maru, 2017)*.

Temperature increase and higher evaporation rates among others lead to the degradation of wetlands, labelled as the **"drying of lakes"**. An IPCC regional impact of climate change report stated already in 1997 that many reservoirs in Africa such as Lake Victoria are under threat. Many water bodies show a very high sensitivity to changes in runoff. The East African Rift Valley lakes are mentioned to have a delicate hydrological balance. In the last Assessment Report (IPCC AR5) from 2014, climate model projections show warming in all four seasons across Ethiopia, which may cause a higher frequency of heat waves as well as higher rates of evaporation with implications for lakes and rivers *(Conway and Schipper, 2011)*. Over East Africa, an increase in heavy precipitation is projected with high confidence *(Seneviratne et al., 2012)*. The Great Rift Valley consists of a chain of lakes, streams and wetlands with unique hydrological and ecological characteristics and an extensive biodiversity. These river and lake basins are all facing problems with diminishing water-levels. Experts found out that rising temperatures as well as more frequent and intense floods and droughts in the Rift Valley basin cause significant changes in its hydrological components and in the lakes' water balances *(Chimdesa, 2016)*. In **Ethiopia**, for example, the 12 major river basins and lakes of the Ethiopian Central Rift Valley suffer from rising pressure on its water sources. Experts relate the diminishing water tables not only to climate change, but also to human activities as well such as the overall exploitation of natural resources. The high water extraction is used for domestic supply, livestock consumption, irrigation projects, and industrial activities such as the floriculture industry, soda abstraction and fish farming. In addition, land degradation, deforestation, overgrazing, soil erosion, waste disposal and sediment loads pose threats to the water bodies. Furthermore, temperature increases and varying rainfall patterns lead to high evaporation, salination and water shortage. The same problem is found at Lake Ziway and Lake Abijata in the upper Ethiopian Rift Valley *(Climate change, overutilization dry up Ethiopian lakes, 2018; GFDRR, 2011)*.

In the case of **Lake Victoria**, being the second largest freshwater lake in the world, climate change, human activities, water extraction for hydro-power generation and a booming fish-export industry cause stress to the lake. In Uganda, conflicts over water use and access to land and fishing grounds arose and threaten local fishery-dependent communities *(Mwiturubani, 2010)*. Reuter *(2014)* even reports displacement of marginalized groups such as fisher folks at Lake Victoria in Uganda that are denied access to the lake and its fish resources. Research on the interlinkages between lake drying and human mobility is however scarce.

Special case: drying lake, dam construction and "development-induced displacement"

In Kenya, the world's largest desert lake, **Lake Turkana** suffers from falling water tables. Apart from human overexploitation and climate change, the construction of the huge Gibe III dam in neighbouring Ethiopia is a main reason for the desiccation of the lake. The water level declined significantly since 2015 when Ethiopia started filling the dam with water from the Omo River. The more than 700 kilometres long **Omo River Valley** in which the dam is situated, a World Heritage Site, is home to some 500,000 people downstream of the dam in Ethiopia and around Lake Turkana in Kenya. They practice flood-recession agriculture and pastoralism and are entirely dependent on the Omo River's natural flood cycle *(Carr, 2017)*. Cutting off inflow into Lake Turkana will lower the lake's water level, increase salinity and decrease biodiversity *(The Environmental Justice Atlas, 2017)*. According to Human Rights Watch *(2017)*, fisher folks around the lake are already reporting of reduced fish stocks.



Dam construction induces widespread displacement or forced resettlement of the surrounding (semi-)pastoralist population *(Beirne, 2014; Stevenson, 2018)*. Furthermore, the Ethiopian government leased land formally owned by the local population to foreign investors for irrigated commercial agriculture, namely sugar plantations. For its pastoralist population, the Government did set up Pastoral Community Development Projects in order to settle them in newly constructed villages without previous consultations. Conflicts between neighbouring ethnic groups arose and resistance activities to forced resettlement became widespread *(The Oakland Institute Report, 2014)*.

The massive (and mainly internal) in-migration of construction workers in the last years and migrant labourers working in the sugar plantations changed migration patterns in the region while the unemployed indigenous population is suffering from growing food insecurity *(Stevenson, 2018)*. Stevenson stresses the need for a comprehensive and well-funded livelihood reconstruction programme (2017 and 2018; *Fong, 2015*). Carr emphasizes that the transboundary livelihood systems of the region's indigenous groups depend on the access to adequate water and living resources from the Omo River or Lake Turkana. Research results reveal that dam construction and irrigated commercial agriculture are already causing massive livelihood destruction. Carr warns that continued vanishing of resources could produce a major humanitarian disaster with spiralling armed conflict *(2017: 18)*.

Despite a positive outlook of the region getting wetter due to the effects of global warming, the region is rather grappling with high climate variability, increasing temperatures and severe droughts. Following severe droughts and food shortage in Somalia and south-eastern Ethiopia *(FEWS NET, 2017)*, for example, many scientists have struggled to make sense of the climatic inconsistencies, terming the yearly drier conditions as 'the East African Climate Paradox' *(Rowell et al., 2015; Rowell and Chadwick, 2018)*. While climate change and environmental conditions have contributed to the virulence and resurgence of certain diseases in the region, the effect of rainfall variability and severe droughts have greatly threatened food security, pastoral livelihoods and are, in many cases, the underlying cause of acute conflicts, mass displacement and refugee mobility in the region *(Afifi et al., 2012; Raleigh and Kniveton, 2012)*.

In **Ethiopia**, spatial and inter-annual rainfall variability has been a feature of climate dynamics in the country. For the country, rain-fed agriculture remains an important sector of the economy. However, unfavourable rainfall variability has been a challenge to crop and livestock production, often accounting for food shortages relative to the population's growth in the country *(Ramakrishna and Demeke, 2002; Hameso, 2018)*. In the Borana area of Southern Ethiopia, a decrease in the frequency and spatial distribution of rainfall has resulted in declining crop yields, water scarcity and competition for resources between herders and farmers. Aside from conflicts emanating from competition in the use of water resources and pastureland, rainfall uncertainty and poverty has seen a drift of herders towards crop cultivation *(Tache and Oba, 2010)*. In similarity to these observations, Bewket *(2009)* also indicates that inter-annual and seasonal rainfall variability has been the cause of a slump in the production of cereals in especially the Amhara region. Although empirical studies on the question of rainfall have variously expressed reservations on the 'perceived' rainfall variability and the link to failing agriculture, it is also acknowledged that widespread food shortages has been a major precursor for an observed increase in the frequency of temporary migration (especially males) to urban and rural areas in the country as an income diversification strategy *(Kassie et al. 2013; Adimassu et al., 2014)*.

For **Kenya** also, the spatial distribution and amounts of rainfall remains key to the rain-fed agricultural sector. Nyaoro et al. *(2016)* state that weather extremes like storm surges, heat waves and too much or too little rain are a common feature of the country's climate. Kenya's recent peculiar climate conditions show greater variability than before. The authors relate the increased variability to the regional impacts of global warming. In Kenya, an increase in temperature has generally resulted in reduced precipitation, shorter rainy seasons and longer dry spells. Apart from slow-onset degradation and desertification, sudden-onset events such as flooding have increased as well. The livelihoods of both farmers and pastoralists are highly dependent on rainfall activity. However, agro-climatic conditions have been marked by increasing variability and declining rainfall totals, especially for the short rainy season *(Nicholson, 1996)*. As noted in the arid and semi-arid areas of Makindu, seasonal rainfall variability and droughts has affected agricultural livelihoods and productivity *(Van de Steeg et al., 2009)*. While scientific analyses of rainfall trends seem to refute widespread perceptions of declining rainfall across the country *(Meze-Hausken, 2004)*, declining rainfall has contributed to the increase in intensity and the tripling of distances covered in the seasonal migration of herders in search of pasture and water *(Herrero et al., 2010)*. The intensification of these sorts of already established patterns of seasonal migration and the competition for scarce resources has been the cause of widespread farmer-herder conflicts and the associated killing of livestock and displacement in the region. In times of drought, crop failure and famine, there is evidence of people moving towards forest and protected areas in search of grazing lands, harvesting forest products and benefiting from the cooler environment provided by the forest *(Gray, 2011 in: Nyaoro et al., 2016)*.

b) Flash floods, riverine floods and mobility in East Africa

In East Africa, climate dynamic remains complex and increasingly unpredictable. While climate models seem to suggest that the region will become wetter, the area is still drying out with unfavourable consequences. Despite uncertainties regarding the extent of change in rainfall patterns in the region *(Rowell and Chadwick, 2018)*, the climate dynamics of East Africa reflect alternating wet and dry conditions. In what may be seen as a discernible contradiction to the frequent episodes of devastating

droughts, the region is also plagued by devastating floods. Both flash and riverine floods have been hazards that have led to loss of lives and mass displacement of people in East Africa. The situation further contributes to the number of displaced persons circulating in the region as refugees.

A Drought Appeal for the East and Horn of Africa by IDMC *(2018)* discusses the complex interrelation between drought and flood events in Eastern Africa in recent years and its consequences. **Ethiopia**, **Kenya** and **Somalia** have been affected by drought exacerbated by El Niño since 2015. In late 2016 and 2017, more than a million people were displaced in search of food, water and livelihoods. The situation began to improve at the end of 2017, but precipitation was still erratic and below average until the onset of the first rainy season at the end of March 2018. The season started several weeks earlier than usual and changed the situation dramatically, bringing record rainfall and flooding to the whole region. **Kenya** was worst affected by the onset of rains. All 47 counties experienced flooding and more than 326,000 new displacements were recorded. In the arid northern parts of the country, people were already highly vulnerable after the drought that left more than 2.6 million people in food crisis in 2017 *(Reliefweb)*. The floods destroyed most of their remaining assets. The destruction of farmlands and high numbers of animals killed posed existential livelihood threats to pastoralists and farmers. In **Ethiopia** flooding and the ongoing drought were most severe, destroying nearly 13,000 hectares of farmland, damaged infrastructure leading to the closing of health care services and schools. The case of displacement due to heavy rains and riverine floods is most prevalent in Ethiopia *(Erena and Worku, 2018)*.

According to the country's NAPA, climate change in Ethiopia will bring changes in precipitation patterns, rainfall variability, and temperature, which could increase the frequency and occurrence of floods and droughts *(USAID Climate Change Risk Profile Ethiopia, 2016; Climate Risk and Adaptation Country Profile Ethiopia, 2011)*. Due to high rates of deforestation, land degradation, increasing climate variability, and settlement patterns, floods are occurring with greater frequency and intensity across the country. Large-scale floods occur mostly in lowland areas, whereas flash floods resulting from intense rainfall events destroy settlements in the Highlands, such as in the Rift Valley, and lead to displacement. For example, floods from Omo River in the south accounted for the loss of about 1,000 lives and the displacement of over 10,000 people when it overflowed the banks in 2006 *(Worldwatch Institute)*. Another case of flooding in the same year happened due to a burst of the Dechatu River in Ethiopia's 6th largest city of Dire Dawa that destroyed homes and left 3,000 displaced and deaths of 350 people. In their study on flash floods in Ethiopia, Billi et al. *(2015)* demonstrate that flood disasters and the toll paid in terms of human lives and loss of property show an increasing trend. Their focus is on the town of Dire Dawa that is increasingly affected by flash floods since the first decade of the 21st century. The authors conclude that the increase in extreme rains, paired by a marked change in land use is considered the main factor responsible for the increased frequency of high flash floods in the town of Dire Dawa, though increasing rainfall intensity is likely playing a more relevant role *(Billi et al., 2015)*. The capital city of Addis Ababa also experiences annual flood events, which destroy property and pose a significant threat to urban dwellers.

The Gambela region of Ethiopia, for example, has been vulnerable to risks posed by inundation from the Baro River and flash floods from heavy rains. Haile et al. *(2013)* note that 37 % of the population has suffered from flooding between 2006 and 2011. Prior to 1983, the Baro River lowlands were almost uninhabited until the Ethiopian Government resettled people from drought-prone areas in the highlands to that region. Since the construction of the villages, people have to deal with occasional extreme floods. According to Haile et al., local preventive and adaptive measures were of limited help and thus people are in need of drainage canals, dykes and flood retention basins in order to reduce their vulnerability to floods. In addition to development-induced displacement via dam construction, the impacts of floods on livelihoods and food availability have been identified as a major driver of rural-urban migration, mostly to Addis Ababa in search of waged labour *(Hunnes, 2012)*.

Uganda has also experienced an increase in the frequency and intensity of droughts and floods in recent decades. The percentage of rainfall coming in the form of heavy precipitation events is anticipated to increase, which would escalate the risk of disasters such as floods and landslides *(see USAID Climate Vulnerability Profile Uganda, 2013)*. According to the Global Facility for Disaster Reduction and Recovery (GFDRR), climate change is likely to increase average temperatures in Uganda. Rainfall variability and rising temperatures are expected to lead to higher incidences of droughts and water scarcity. Flooding presents

the largest risk, particularly in low-lying areas. Each year, floods impact nearly 50,000 people and over $62 million in gross domestic product *(GFDRR, 2017)*.

According to Parry et al. *(2012)*, **Kenya**'s exposure to climate risk is high. It is already one of the most water-scarce countries in Africa and one of the most disaster-prone countries in the world. Kenya does experience major droughts about every 10 years and moderate droughts or floods every three to four years. The authors state that the total number of climate disaster victims increased significantly in the 1990s and 2000s, partly due to population growth *(see also Nguimalet, 2018)*. Rain-fed agriculture is the mainstay of Kenya's economy, accounting for 95 % of all agricultural activities. As this type of agriculture is highly sensitive to increasing temperatures, droughts and floods leading to reduced agricultural activity could threaten the food security of the whole country even more than today *(Government of Kenya, 2012b)*.

In Kenya, displacement due to floods occurs in arid and semi-arid (ASAL) regions, the highly fertile areas of Kenya and in the major rivers and deltas lying in arid and semi-arid areas. The Tana River, for example, is regularly affected by seasonal flooding. Sometimes, seasonal flooding turns into severe floods due to heavy rainfall *(IDMC, 2014b: 13 in: Schade, 2016)*. Nyaoro et al. *(IOM / MECLEP report, 2016)* state that between 1964 and 2015 2,976,123 people were affected by floods, among them 6,200 got homeless and 1,350 persons died in the floods *(2016: 56)*. Floods in the lower Tana River basin area are modified by upstream dam management *(Schade, 2011: 36)*. Flash floods, in contrast to seasonal floods, are basically characterized by torrential rain lasting over a short duration in a relatively small area *(Government of Kenya, 2010)*. Flash floods in Kenya tend to occur in semi-arid areas, such as Turkana County. Government responses or official adaptation measures are the construction of dams, the provision of relief and temporary relocation to safer places. People use adaptation measures such as ditching channels for drainage, using borehole water for drinking and migrating *(Nguimalet, 2018)*.

c) Droughts and mobility in East Africa

Slow-onset phenomena such as droughts, desertification, and soil degradation linked to changing rainfall patterns, and the resulting scarcity of productive agricultural land is expected to be a major issue in Africa causing massive migration and displacement *(Ndaruzaniye et al., 2010)*.

As global temperatures rise, drought-induced human relocation is expected to increase. In a Drought Appeal for the East and Horn of Africa region in 2017 (April – December 2017), IOM described that Eastern Africa was facing one of the worst droughts in decades. The IOM *(2017)* advances that persistent decline in precipitation and political instability due to conflict and armed insurgency in the region had orchestrated a rapid deterioration in food security and an increase in the numbers of displaced persons. Aside the significant numbers of refugees in the region, approximately 16 million people were under threat of droughts, while the impact on livestock and crop production was going to be enormous in vulnerable countries like Ethiopia, Somalia and Kenya. As was captured at the beginning of 2017, at least 700,000 were displaced and forced to move due to severe droughts in Somalia. In contrast, a total 316,128 people in Ethiopia and 41,000 in Kenya were displaced within the same period *(IOM, 2017)*.

The drought-mobility situation in **Somalia** is, according to the IOM Regional Migrant Response Plan for the Horn of Africa and Yemen 2018 – 2020, multifaceted and complex, being characterised by internal and external displacement due to natural disasters, conflict, man-made crises and forced evictions, and irregular labour migration. As a result of the recent drought, 2.1 million people have been internally displaced and 870,895 Somalis are registered as refugees in the Horn of Africa and Yemen region.

Studies reveal that droughts are the most recurring climate hazard in **Ethiopia**, especially to pastoralists and agro-pastoralists living in drought-prone areas *(Climate Risk and Adaptation Country Profile 2011)*. Since the 1970s, experts state that the magnitude, frequency and intensity of droughts have significantly increased. The impacts of droughts are manifold, including pasture shortages, overgrazing, land degradation, decreased water availability, and livestock diseases. The results are decreased livestock productivity, crop failure in agro-pastoral areas, food insecurity, causing increased movements of people

and livestock and increased conflicts over scarce resources. According to IOM *(2017 and 2018)*, Ethiopia is facing a triple challenge of drought, food and inter-communal conflict since the beginning of 2017.

In their study of mobility patterns in drought-prone areas, for example, Ezra and Kiros *(2001)* intimate that vulnerability to food crisis had a positive effect on out-migration. In their study on the effects of drought on population mobility in the Ethiopian highlands, Gray and Mueller *(2012)* concluded that migration by men increased more than twice as much under severe droughts. This was especially the case for land-poor households. These findings imply that a multiplicity of factors such as poverty, high unemployment, land scarcity, environmental degradation, regional income disparities, and even a well-established culture of migration in origin regions act in tandem to increase migration propensity.

Djibouti shares long borders with Somalia and Ethiopia and as result faces large cross-border movements of pastoralists with their livestock during the lean season to Djibouti *(IOM 2017; 2018)*. Djibouti is expected to experience an increase in drought-induced human population and livestock movements. The Djibouti Drought Interagency Contingency Plan for 2017 is estimating between 5,000-10,000 persons, putting further pressure on the already precarious livelihoods in these areas. Due to its geographical position, Djibouti is experiencing complex, bi-directional migratory flows across the Red Sea and the Gulf of Aden. In addition to the drought problem, UNICEF reports of the tropical cyclone Sagar that hit Djibouti in May 2018, causing floods in at least 15 % of Djibouti city. The cyclone has damaged an estimated 10,000 households and infrastructure, affecting about 150,000 people.

According to GFDRR *(2017)*, droughts in **Uganda** affected close to 2.4 million people between 2004 and 2013. In addition, drought conditions in 2010 and 2011 caused an estimated loss and damage value of $ 1.2 billion, equivalent to 7.5 % of Uganda's 2010 gross domestic product. In face of ongoing climatic change and variability, droughts have continued to present serious crisis to most parts of the country. The so called "cattle-corridor" stretching from western Uganda through the central region to Teso and Karamoja in the north-east is one of the worst afflicted areas *(Egeru, 2015)*. A recent FAO Resilience Analysis Report for Karamoja *(2018)* stated that Karamoja is the poorest region in Uganda, with a poverty rate that is 3-times higher than the national average. Furthermore, a high occurrence of droughts, floods and dry spells undermine the coping capacities of most people. The region is inhabited by pastoralists and agro-pastoralists that use internal, mostly seasonal migration as an integral part of their livelihoods. New migration patterns include more minors moving to urban centres in order to make money *(Haug, 2014)*. Jordaan *(2015)* concludes in a drought risk assessment of Karamoja that most droughts experienced since 2000 are manmade and not the result of poor climatic conditions. He stresses that farmers need to better adapt and build resilience against drought by using more climate-resilient agricultural methods.

According to the Government of **Kenya**, the drought cycles have become shorter, more frequent and intense due to global climate change and environmental degradation. As the drought cycles become shorter, more and more people get affected and the impacts get even more severe *(Government of Kenya, in: Nyaoro et al., 2016)*. A MECLEP / IOM Report reveals that between 1965 and 2015, 14 droughts have occurred which affected a total number of 48,800,000 people *(2016: 60)*. Repercussions of droughts were and are widespread crop failure, acute water shortages, sharply declining terms of trade for pastoralists and declining animal productivity. This leads to an increasing food insecurity, disease outbreaks, severe malnutrition, loss of livelihoods and increased resource-based conflict as a result of displacement by community members and livestock *(IOM, 2017)*. Nyaoro et al. *(2016)* point out, that drought-related displacement is frequently associated with pastoralist displacement, which is linked to the loss of livestock, access to land, resources and markets. It may take the form of local sedentarization and rural-urban migration. Displaced pastoralists often settle along rivers, thus increasing their vulnerability to floods. Adaptation strategies used by the affected people are diversifying livelihood, such as extra-pastoralist activities, migration and temporary relocation *(Nguimalet, 2018)*.

Key message for East Africa

East Africa is a region, which is – and increasingly will be – exposed to the negative impacts of climate variability, namely an increasing **rainfall variability**, which in this geographical setting is very closely linked to a higher probability of **floods**. Immediate effects of erratic rainfalls are declines in agricultural production and decreasing food security. Many people already have low coping capacities due to high levels of poverty, fragile contexts and the existence of various violent conflicts in the region. Different forms of mobility are widely used as coping and adaptation mechanisms to these livelihood stressors, such as (circular) rural-urban migration and pastoralism. Erratic rainfall leading to floods is a phenomenon that is regularly affecting East African countries. Flash floods occur particularly after long dry spells and are limited to small areas such as parts of the East African Highlands, often destroying the livelihood base of people affected and leading to displacement. Human activities like deforestation and land degradation severely aggravate the problem, as well as the establishment of new settlements in risk-prone areas such as rivers. Seasonal, riverine floods that occur in major rivers and deltas in arid and semi-arid regions may turn into severe floods due to heavy rainfall. They are particularly affecting pastoral communities, but also the inhabitants of cities such as Addis Ababa. Adaptation measures against floods are temporary relocation, migration or the construction of drainage channels or dams.

Whereas floods usually affect specific regions only, **droughts** are affecting whole countries in the East African sub-region – and droughts are becoming more frequent. Periodic droughts lead to severe economic losses, increased food insecurity, increased resource-based conflicts and massive drought-induced displacement, particularly by pastoralists and semi-pastoralists that inhabit highly drought-prone areas. All East African countries exhibit different forms of human mobility as adaptation to a changing environment. In cases of droughts, massive displacement and searching for relief is the most common emergency reaction as a means of survival. Rural-to-urban migration is more related to general livelihood diversification, but is used in emergency cases as well.

As compared to the other two African sub-regions, the **risk of forced displacement** is generally most pronounced in East Africa: Apart from the high numbers of refugees and internally displaced due to the ongoing (politically induced) conflicts and severe (forced) displacement risks due to natural resource scarcity or natural disasters, development projects such as dam constructions and the transformation of indigenous grazing and agricultural lands into plantations constitute a major risk factor in this regard. But often these displacement risks factors are highly intertwined.

3.3 Southern Africa

a) Rainfall variability and mobility in Southern Africa

Southern Africa is mainly classified as a semi-arid region with high spatial variation in rainfall. However, climatic conditions range from arid areas in the south-west with very little rainfall to humid subtropical conditions in the northeast. Generally, most of the region experiences seasonal rainfall with the main summer rainfall season from October to March. The climate is warm with an annual average temperature mostly above 17° C *(Davis and Joubert, 2011; Spear et al., 2015)*.

The Intergovernmental Panel on Climate Change (IPCC) in its most recent report revealed that the Southern African Development Community (SADC) region has experienced a rise in average temperature over the past decades. In the same period, it has been plagued by below average rainfall, changes in onset, cessation and intensity of rainfall. Additionally, Southern Africa witnessed an increase in extreme rainfall events coupled with increasing frequency of dry spells leading to more intense droughts *(IPCC, 2014; Lesolle, 2012; Jury, 2013)*. Forecasts show that more variable rainfall and the increase in both frequency and intensity of extreme events like drought and floods can be expected in the future *(IPCC, 2014)*.

The observed and further expected downward trend in rainfall adversely affects agricultural production and the availability of water resources. Exact estimates vary but SADC itself reports that about 70 % of the region's population rely upon agriculture for their livelihood *(Lesolle, 2012)*. Thus, the agricultural sector is crucial for people's survival, especially as agriculture is mainly practiced under rain-fed conditions. With varying and decreasing annual rainfall in areas suitable for agricultural production, the length of the growing season and yield potentials are expected to diminish *(UNECA, 2015; Eriksen et al., 2008)*. This has severe impacts on maize production that is the staple food crop in Southern Africa. As maize is particularly vulnerable to climate change, a review study by Zinyengere et al. *(2013)* predicts maize yield losses in Southern Africa at mid-century to be around 18 % and around 30 % at the end of the century.

Reduced rainfall further leads to greater competition for water resources. Comparatively, Southern Africa has a great number of different water bodies and major river basins. However, decreasing rainfall is expected to lead to water shortages and reduced stream flows of Limpopo and Okavango Rivers with adverse effects on water availability for livestock production and farming activities *(IPCC, 2014; USAID, 2016b)*. Additionally, projected sea-level rise will affect low-lying coastal areas and plains where much of the fertile land for agricultural production is located *(SADC and UNEP, 2010)*.

The pattern of increasing rainfall intensity and longer dry spells can already be observed in the Limpopo Basin in **Mozambique** where the effects of alternating floods and droughts pose a significant challenge to disaster recovery *(Ndaruzaniyeet al., 2010)*. Heavy rain events have repeatedly displaced people in that region in the past *(Lumbroso et al. 2008)*. Moreover, the following extreme dry periods often hit the same vulnerable communities and pose serious threats to long-term rehabilitation.

In general, **Zambia** is characterized as water-secure compared to other countries in the region because it holds major rivers such as the Zambezi river and its tributaries, Luangwa and Kafue, lakes, like Lake Tanganyika and Lake Kariba and a hydro-power dam on the Zambezi River *(Government of the Republic of Zambia 2010)*. However, prolonged dry spells and erratic rainfalls have hit the country in the past and led to a food crisis in five provinces (Southern, Eastern, Western, Lusaka and Central Province) at the beginning of the 2000s. Heavy rainfall caused floods, which resulted in severe drops in maize production, the main cash crop in Zambia. In the following year the same provinces experienced extreme dry spells exacerbating the tense supply situation *(Reliefweb 2002)*. The food crisis caused population movements. Migration to towns has been adopted as a coping strategy *(Reliefweb 2002; IOM 2008)*. In line with these past observations, estimations project a climate change induced increase of rainfall intensity and longer dry spells for Zambia in the future *(Ministry of Gender for the Republic of Zambia and IUCN GGO 2016; Kozacek 2015)*.

In **Botswana and Namibia**, seasonal migration as response to rainfall variability has been applied by pastoralists in north-western and north-central Namibia as well as in the Kalahari Desert of Botswana as a coping strategy. Given arid conditions, sandy soils and Savannah ecosystems, pastoral agriculture and livestock farming constitute the major sources of income *(Reid et al. 2007; Dougill et al., 2010)*. In the arid Kunene region of north-western Namibia Ovahimba cattle farmers regularly move their livestock in search of better pasture *(Spear et al., 2015)*. In addition, pastoralists in Botswana's Kalahari use herd mobility to respond to variable rainfall *(World Bank, 2013)*. Temporary migration as a livelihood strategy marks an important feature of these pastoralists and therefore, exemplifies a major survival strategy. Despite these coping mechanisms, these regions also observe increasing permanent migration to urban areas, as the movement of livestock alone is not always a sufficient response to fluctuating and extreme climate *(Spear et al., 2015)*.

b) Flooding and mobility in Southern Africa

The most frequently occurring climate change attributed disaster in Southern Africa is flooding *(Pusch et al., 2016; UNECA, 2015)*. The sub-region is home to large transnational river systems like the Zambezi, Limpopo, Okavango and Orange River with several tributaries. Seasonal flooding occurs regularly and puts populations driving their livelihood along river basins at risk. Especially, densely populated deltas, such as the Zambezi delta, experience major floods. They usually occur in the rainy season from November to February. However, as the region experiences more infrequent and heavy rainfall, more intense flooding along river basins and flash floods affecting arid and semi-arid areas can be observed *(Pusch et al., 2016)*.

Storms and tropical cyclones exacerbate the risk of flooding in Southern Africa as they usually go hand-in-hand with heavy rainfall *(Pourazar, 2017)*. Due to the climatic characteristics of the sub-region, cyclones formed in the South West Indian Ocean pose a serious threat to the coastal countries along the Indian Ocean as well as the islands Madagascar and Mauritius. Slow-onset events such as sea level rise paired with more intense and frequent cyclones hitting coasts put populations living in low-lying areas along the coastal zones of South-East Africa and Madagascar at risk *(Pusch et al., 2016)*.

In 2015 / 2016 Southern Africa was affected by the worst drought in 35 years caused by an extremely strong El Niño climatic cycle, which brought less precipitation and higher temperatures to Southern Africa *(Bilak et al., 2016)*. El Niño is often accompanied by the opposite weather phenomenon La Niña which develops later in the course of the climatic cycle and brings heavy rainfall to the same regions strongly affected by El Niño. Extreme events like flooding are a common result *(UN Office for the Coordination of Humanitarian Affairs [OCHA], 2016)*. After the 2015 / 2016 El Niño induced drought in Southern Africa, La Niña together with tropical cyclone Dineo led to heavy flooding in 2017 in Mozambique, Namibia and Zimbabwe. People had to face repeated agricultural losses, water shortages and food insecurity *(Pourazar, 2017)*. The most recent Global Report on Internal Displacement states that cyclone Dineo displaced 170,000 people in Mozambique alone *(Internal Displacement Monitoring Centre [IDMC] 2018)*.

Its geographical location has made **Mozambique** an extremely flood- and cyclone-prone area and consequently a prominent example of environmentally induced displacement caused by flooding. The country lies downstream of nine major transnational river basins. Flooding along its plains and deltas puts farmers and infrastructure under permanent risk *(Ministry of the Co-ordination of Environmental Affairs [MICOA] 2007; GFDRR 2011)*. Furthermore, the 2,700 km long coastline is particularly vulnerable to storms and tropical cyclones emerging over the South West Indian Ocean. Over the past decades, long-term studies observed an increase in their frequency, intensity and number of landfalls *(Mavume et al., 2009; Fitchett and Grab, 2014)*. Sea level rise combined with increasingly intense storms and tropical cyclones are forecasted to flood low-lying land along rivers and coasts. Around 60 % of Mozambique's population already lives along coastal areas and is therefore exposed to these natural hazards. Moreover, migration from rural areas to coastal urban centres can be observed which puts additional people under threat *(GFDRR 2011)*.

A major displacement factor is recurrent flooding along the Zambezi River Valley in the centre and Limpopo River in the South of the country. The floods of 2000 caused the highest number of displacements in the last 20 years and were the worst to affect the country in 150 years *(Lumbroso et al., 2008; EACH-FOR, 2009; Vaz and Alvaro, 2000)*. Five weeks of heavy rain in the region let the Limpopo River swell up to 80 km wide. Extreme flooding

occurred along the river and its tributaries. The weather event was followed by cyclone Eline, which exacerbated the flood situation. Around 800 dead persons were reported *(Ministry of the Co-ordination of Environmental Affairs [MICOA], 2007)*. In total, 4.5 million people were affected and 650,000 people were displaced *(GFDRR and World Bank Group, 2014; Lumbroso et al., 2008)*. Floods along the Zambezi River have recurrently caused displacement. It is estimated that around one million people live in flood-affected areas along the Zambezi River Valley whose displacement caused by flooding takes more and more permanent characteristics *(IPCC, 2014; EACH-FOR, 2009)*. The floods in 2001, 2007, 2008, 2013 and 2017 were mainly caused by heavy rains or by cyclones following extreme rainfall *(Speranza, 2010; GFDRR and World Bank Group, 2014; Wiles et al., 2005)*. Each time between 90,000 *(2008)* and 223,000 *(2001)* were displaced *(EACH-FOR, 2009; Wiles et al., 2005)*. In 2013 another 186,000 were displaced due to flooding *(Manhique et al., 2015)*. Communities along the Zambezi River are used to flooding of low-lying river areas, however as the floods became more and more extreme in 2000, 2001 and 2007 they decided to migrate to flood-safe areas. Others were evacuated by the Mozambican government through resettlement programs. However, moving away from their homes means leaving fertile farmland on the floodplains behind. Moreover, resettled areas are characterized by water scarcity and drought which hinders an independent livelihood earning *(Lumbroso et al., 2008; Stal, 2011)*. Studies of displaced communities along the Zambezi River in Mozambique illustrate that parts of the community periodically return to the low-lying floodplains for planting and harvesting. Consequently, they follow a semi-permanent form of displacement using their own mobility patterns to secure their livelihoods *(Stal, 2011; Warner et al., 2010)*.

Similar mobility patterns can also be observed along the Zambezi River in **Zambia**. As a reaction to extreme dry spells and reduction in precipitation on the one hand as well as changes in rainfall intensity on the other hand the Lozi people in western Zambia, who live along the plains of the Zambezi River, apply specific mobility strategies. Banda et al. *(2015)* investigated their response to recurrent flooding of the Zambezi and found that they move from the Zambezi flood plain to highland areas as a survival strategy during flooding.

Additionally, tropical cyclones exemplify a significant risk to **Madagascar**. They are often associated with excessive rainfall generating flooding over large parts of the island *(World Bank and GFDRR, 2016)*. Madagascar has the highest risk of cyclones in Africa and records three to four landfalls per year *(GFDRR, 2015)*. In the cyclone season, which typically lasts from November to April, the whole island is endangered. In the recent past, an increase in cyclone intensity and frequency could be observed which is likely to be related to climate change *(Government of Madagascar, 2008)*. A Climate Change Risk Profile compiled by USAID *(2016b)* counts 35 cyclones, 8 floods and 5 periods of severe droughts in Madagascar in the last 20 years. Recurring cyclones and connected flooding have repeatedly led to human displacement. The intense cyclone season 2007 / 2008, when Madagascar was stuck by three different cyclones, left 342,923 people displaced and 191,404 homeless according to the Government of Madagascar *(2008)*. In March 2017, tropical cyclone Enawo affected nearly 500,000 people when it made landfall in the Northeast and crossed the island to the South. In total, 247,219 persons were displaced *(IOM Madagascar 2017b)*. Furthermore, rural-urban migration is an important characteristic of human mobility on the island. Many people affected by the severe drought in the South move to the capital city in search for alternative sources of income. It is estimated that between 100,000 to 150,000 people migrate to the capital Antananarivo every year. The city lies on low land and regularly experiences flooding during the rainy season. Migrants often settle in areas of high flood-risk, which makes them particularly vulnerable to weather phenomena and climatic changes.

Although aridity characterizes large parts of **Namibia**, the north-central and north-eastern area regularly experience short and intense rainfall which leads to flooding and displacement of people. Normally affected communities return to their homes after an improvement of the flood situation. However, as climate change has increased the occurrence of floods some affected communities decide to migrate permanently in search of arable and safe land for living and cultivation *(Heita, 2018)*. Namibia's north-central area is especially prone to flooding. It is influenced by the Cuvelai delta that is fed by a complex network of transitory watercourses called "Oshanas" in Southern Angola and Northern Namibia. Heavy rainfall has severe impacts on the low-lying areas, informal settlements in flood prone areas and poorly planned urban infrastructures *(Heita, 2018)*. The region recorded heavy flooding in 2008,

2011 and 2017 which forced people in the affected regions (Omusati, Oshana, Ohangwena, Oshikoto) in relocation camps established by the government *(Government of Namibia 2011; Heita 2018; International Federation of Red Cross and Red Crescent Societies [IFRC] 2017)*. Equally prone to flooding is the north-eastern Zambezi region (Kavango and Caprivi) crossed by the Zambezi and Chobe rivers. The 2010 flood had especially devastating effects. 2010 was the third consecutive year with severe flooding in which 23,782 people had to be relocated temporarily to higher grounds *(International Federation of Red Cross and Red Crescent Societies [IFRC] 2011)*. Although affected people tend to move back after the floods subside, Namibia's Migration Report of 2015 highlights that the Zambezi region has lost a significant number of its population, 5.5 % to other regions between 2010 and 2011 which is likely to be linked to the devastating flood *(Namibia Statistics Agency, 2015)*. This observation underlines the notion of increased internal migration as a response to consecutive flooding *(Heita, 2018)*.

c) Droughts and mobility in Southern Africa

The IPCC report predicts that southwestern Africa is likely to experience severe droughts during the 21st century *(IPCC, 2014)*. Such extreme weather phenomena will cause water shortages and food insecurity. Consequently, an IOM examination of the SADC region comes to the conclusion that rising uncertainty in agricultural cultivation, livestock production and subsistence farming will trigger environmental migration in search for alternative livelihood strategies *(Pourazar, 2017)*. Botswana already experiences such mobility patterns. Here, unpredictable agricultural conditions drive subsistence farmers from rural areas to abandon crop and livestock production and move to urban centres seeking to find different economic opportunities *(Lesolle, 2012)*.

Recently, Southern Africa experienced its worst drought in 35 years. The 2015 / 2016 El Niño cycle resulted in very dry weather conditions whose impacts were most strongly felt in Eastern and Southern Africa. It caused consecutive harvest failing and let the SADC Council of Ministers declare a regional drought disaster in March 2016 *(Regional Inter-Agency Standing Committee [RIASCO] 2016; UN Office for the Coordination of Humanitarian Affairs [OCHA] 2016; Bilak et al. 2016)*. Around 32 million people were considered food insecure *(UN Office for the Coordination of Humanitarian Affairs [OCHA], 2016)*. Crops, like maize, wheat, sorghum, which are produced in the region and constitute the basis for people's diet specifically suffer from high temperatures and drought conditions subsequently reducing yields *(World Bank, 2013; Kassie et al., 2013)*. The future of maize production in countries like Zimbabwe and South Africa is under threat *(Collier et al. 2008)*, e.g. the 2015 / 2016 drought has led to a drastic increase in maize prices making the big maize exporter South Africa dependent on maize imports *(UN Office for the Coordination of Humanitarian Affairs [OCHA] 2016)*.

As a result of prolonged dry spells, **South Africa** experienced a severe water crisis in 2018. Water scarcity is a prominent characteristic of the country which is likely to be intensified by climate change related rainfall variability and increasing temperatures *(Lötter, 2017)*. South Africa heavily relies on surface water for water supply which makes it extremely vulnerable to climatic changes. Additionally, increasing domestic and agricultural demands put the South African water sector under stress *(Touter and Mauck, 2017; Conrad and Carstens, 2017)*. Akin to the whole region, South Africa suffered from the 2015 / 2016 El Niño induced drought. The situation worsened in 2016 after two successive dry spells, extremely low rainfall and above-average temperatures. At that time the IOM described the situation as "the worst drought ever recorded in South Africa" (*Pourazar, 2017: 74)*. Its effects were felt in the whole country, especially in the agricultural sector. The drought led to significant decreases in harvest and consequently converted the country into a net importer of crops, while it normally exports almost one million tons of food *(Baudoin et al., 2017)*. Due to heavy summer rains in 2017 large parts of the sub-region were able to recover from the intense drought. However, the continuing absence of rain in South Africa's Western Cape Province led to severe water shortages in Cape Town and the surrounding areas *(Perine and Keuck, 2018)*. The province has experienced extremely low rainfall since 2015, which resulted in water cuts and rationing. Berg-Oliphants catchment, which serves Cape Town metro, showed a clear decline in dam levels from 2014 onwards *(Donnenfeld, 2018)*. Water restrictions were imposed in Nelson Mandela Bay, Johannesburg and Durban. The highest restrictions were imposed on Cape Town's residents which culminated in 50 litres per day water usage *(Ibid.)*. Although the city managed to reduce its annual water consumption from 2016 to 2017 by half, Cape Town water authorities

announced the 12th of April 2018 as "day zero". It implies that water supply will be cut off by then if water consumption is not reduced drastically *(Vogt and Barbosa, 2018)*. City authorities pushed back that date several times and winter rainfall in mid-2018 relaxed the situation slightly. However, appeals towards careful usage of the scarce water resources remain *(Pérez-Pena, 2018; McKenzie and Swails, 2018)*.

Drought is also a severe natural disaster affecting the South of **Madagascar**, also known as 'Grand Sud'. The arid area is home to 1.8 million people of which roughly 80 % drive their livelihood from rain-fed agriculture. The 'Grand Sud' is vulnerable to chronic drought *(UN Office of the Resident Coordinator Madagascar, 2016)*. Since 2013, the region has suffered from an extreme drought period which was reinforced by the impacts of El Niño since September 2015 and worsened into a humanitarian crisis in February 2016. More than one million people in the 'Grand Sud' are food insecure *(UN Office for the Coordination of Humanitarian Affairs [OCHA], 2016)*. Examinations have shown that affected communities use migration as a strategy to cope with drought *(UN Office for the Coordination of Humanitarian Affairs [OCHA], 2016; IOM Madagascar, 2017a)*. A study undertaken in Androy region, an area regarded worst affected by the drought and major sending region for migrants, reveals that migration is applied as survival strategy to look for alternative income opportunities. The drought and the subsequent lack of revenue from farming activities made people move and search for other types of work. The research shows that the drought, which started in 2013, is very strong. This can be concluded from high numbers of outmigration from rural areas to district capitals observed by local authorities. According to the study, in roughly half of the cases migration is permanent. This differs from previous migration patterns where migrants tend to return to their home communities if they expected an adequate rainy season *(IOM Madagascar, 2017a)*.

Mobility patterns in drought prone **Botswana** have always been marked by temporary migration from high- to low-risk areas to counter drought-induced displacement *(Heita, 2018; Pourazar, 2017; Kgosikoma, 2006)*. As Botswana's arid to semi-arid environment is characterized by erratic rainfall, water shortages, dry spells and desertification farmers largely rely on cattle and livestock production. Moreover, this form of subsistence farming is vulnerable to droughts and recurrent dry spells *(UNDP, 2012; Pourazar, 2017)*. Consequently, especially pastoralists apply mobility to cope with drought and to secure sufficient water and forage for their livestock *(Kgosikoma, 2006)*. Due to more intense periods of drought, which are projected to exacerbate in the future in Southern Africa, people leave drought-affected areas and migrate permanently. The increasing rural-urban migration to search for alternative economic opportunities puts pressure on rapidly growing urban areas such as Gabarone, Francistown, Kweneng East and Selebi-Phikwe *(Pourazar, 2017)*.

Key message for Southern Africa

Similar to West Africa, Southern Africa experiences increasing inter-annual and spatial **rainfall variability** with more variable starts and ends. This is coupled with changes in rainfall intensity. Additionally, an increase in extreme rainfall events as well as recurrent periods of long dry spells can be observed. Affected communities apply their own response and adaptation strategies to the intensification of extreme weather events. For many rural population groups (such as the Lozi people in Zambia) temporal migration is a coping mechanism to recurrent flooding. Furthermore, especially pastoralists and herd farmers apply the tradition of seasonal migration as response to specific climatic conditions that affect livestock production. However, increasing rainfall variability and extreme weather events threaten their activities and, in many cases, seasonal mobility alone does not secure their livelihoods any longer. Consequently, more permanent migration to urban centres can be observed as in the case of Botswana.

Flooding due to heavy rainfall and cyclone activities is a recurrent disaster leading to forced displacement in parts of Southern Africa. In particular, areas along large river basins and low-elevation coastal zones are hit by overflowing over and over again. Populations living along the plenty large river basins and deltas of the region and those along the south-east African coast are recurrently affected by flooding. The numbers of those displaced by flooding and cyclones are especially high in Mozambique and Madagascar. Because of special characteristics of farm land of flood-prone areas communities are often forced to return to their homeland as sufficient response and relocation strategies by governments are missing. Their mobility pattern then takes the form of circular migration. Moreover, rural-urban migration puts vulnerable populations under risk because they often settle in flood-prone areas and coastal urban centres which are likely to be affected by sea level rise and extreme weather phenomena in the future.

Taking everything into account, large parts of the arid and semi-arid areas of Southern Africa are **drought** prone and have experienced major droughts in the recent past. This has severe impacts on food security as well as water supply. Water scarcities require sufficient coping strategies, especially in the urban areas of South Africa. Additionally, it puts the production of major crops like maize and sorghum under threat. Moreover, prolonged dry spells and desertification influence cattle and livestock farming. Studies show that affected people increasingly use migration in search for alternative livelihood strategies. Whereas migration previously took seasonal and temporal forms, observations from the recent past in Botswana and Madagascar for instance reveal that movements are more frequently considered to be of permanent nature. In many cases they include rural-urban migration which puts growing pressure on urban areas. Consequently, well-managed urban planning and policies need to be in place to protect migrants from additional vulnerabilities.

4

Conclusion and recommendations

Climate change poses a fundamental risk for human security and well-being on the African continent for the next years and decades to come. When it comes to its (potential) consequences for human mobility, the findings presented in the previous chapters resemble those of large-scale research projects with a global focus, such as "Where the rain falls" *(Warner and Afifi, 2014)*, MECLEP *(Melde et al., 2017)* or "Environmental change and migration" *(Government Office for Science, 2011)*. In a way, the findings with regard to different African regions reflect the complex patterns and interrelationships which also apply on a global scale.

The effects of global warming are intertwined with social, economic, political or cultural factors, which also influence specific forms of human mobility. There is no automatism, however. For instance, a higher probability of droughts or rainfall abnormalities does not necessarily lead to more (forced) migration. In highly vulnerable contexts, the effects of environmental degradation and climatic change may even increase the danger of becoming immobile ("trapped populations") as population segments affected most by these developments are generally poor and often their livelihoods largely depend on making use of natural resources (in particular smallholders or pastoralists). Under certain circumstances, their resource base may become so eroded that they cannot afford to move at all. But if people are on the move in the context of climate change, it is often in the form of seasonal or circular labour migration within countries or between neighbouring countries. This means that individuals – instead of whole households or families – are migrating for a rather limited period of time to urban areas, centres of commercial agriculture, or mining sites. One of the goals of these migrants is to earn some money and remit it in order to mitigate hardships that their families back home are facing, and which were induced or worsened by climatic change (e.g. increasing food insecurity due to harvest failures). That way, translocal spaces of financial, communicational or other exchange between migrants and their families are being generated which lay the ground for what could be called "migration as adaptation". Even in an inner-African migration setting, however, living and working conditions of migrants are often very dire due to labour exploitation or uncertain legal conditions and / or living conditions in highly vulnerable areas at the coast or next to rivers. The patterns of migration on the African continent make a mass exodus of African "climate refugees" – a scenario feared in Europe and other parts of the global North – rather unlikely. Thus, the political response towards human mobility in the context of climate change in the African context, as well as in other geographical settings, should not be more migration control alongside trans-African migration routes towards Europe. The focus should rather be on governing human mobility in a way which makes it possible to avoid forced displacement, to maximize positive mechanisms of migration (financial or other remittances) and to minimize negative aspects like labour exploitation or human trafficking.

However, this is only the general policy principle. In order to realize sustainable forms of human mobility in the context of climate change, the following concrete policy recommendations can be formulated:

→ Capacity building and a bridging of gaps between different policy fields

The migration policy community generally refers to "migration as adaptation" and emphasizes the governance challenge when it comes to human mobility in the context of climate. By contrast, the environmental or climate policy community is still struggling with the issue of "climate migration" and rather perceives it as highly sensitive or a phenomenon which – as a whole – should be prevented with measures of mitigation and (other) measures of adaptation. Therefore, it is necessary to foster a dialogue between different (policy) fields and communities: climate change, migration, development cooperation, urban planning, humanitarian, rural development and agriculture. Scientists as well as practitioners need to facilitate such a knowledge-based dialogue. The goal has to be overcoming the still predominant "sedentary bias" of preventing migration (instead of actively setting a framework for it), generating a common understanding of the challenges related to human mobility in the context of climate change, and creating an awareness of it being a cross-cutting problem, which can only be addressed in a joint effort.

→ Multi-level governance and local empowerment

The multiple challenges of human mobility in the context of climate change are not only complex in the sense that climatic factors are closely interwoven with other factors (see above), they are also highly context-specific. That is why a horizontal exchange between different policy fields is not sufficient. "One-size-fits-all" solutions are particularly inadequate for these problem contexts. Accordingly, instead of following top-down-procedures, the "local turn", which generally can be observed in the field of (forced) displacement, needs to be fostered in ecologically vulnerable contexts in particular. That means the local administrative level but also local NGOs or different village groups (such as smallholder farmer groups) need to be empowered in order to be able to exchange ideas and concepts as they need to agree on locally reasonable, culturally acceptable and preferred solutions for climate change adaptation – no matter whether these are mobility related or not. Local population groups such as smallholders, who are of major concern with regard to human mobility and immobility in the context of climate change, are also the ones whose voices are still largely unheard when it comes to processes of adaptation planning or mobility governance. The "upper" levels (global, regional, local) therefore need to set the adequate standards and to create open policy spaces with the necessary capacity and information endowments. While the global level has created such frameworks for human mobility in the context of climate change (in particular the UNFCCC process and the Global Compact on Migration), regional as well as national levels are still struggling.

→ Collection of data and best practices

The data situation is rather poor when it comes to all kinds of human mobility in an African as well as a global setting. Human mobility in the context of climate change does not constitute an exception. National or regional census offices and others have only just started to meet this challenge and to collect more data on internal, circular or seasonal mobility forms. A solid and disaggregated data foundation is essential to address climate change related human mobility. Respective initiatives need to be strengthened at all levels. The same is true when it comes to a systematic documentation of best practices regarding the problem complex of local vulnerability and the role of human mobility in such contexts.

Appendix 1: Identification of key stakeholders

In the context of human mobility and climate change, different sectors, namely agriculture, development, climate or environment, economy and employment, as well as migration and urbanization are relevant concerning the formulation of adequate political and practical solutions. As a vast number of institutions works in the different sectors mentioned above across all countries of the three African focus regions, a complete list of these institutions would be almost endless. That is why the stakeholder list below rather tries to identify key institutions on continental / international and regional levels, which comprehensively cover at least two of the relevant sectors in their work portfolio.

Continental / international

AU African Union

Both migration and environmental change play a major role in the work of Africa's oldest and largest continental organization, which was founded in 2001 as a successor of the Organisation of African Unity (OAU).

FARA Forum for Agricultural Research in Africa

The Forum for Agricultural Research in Africa (FARA) is the apex continental organisation responsible for coordinating and advocating for agricultural research-for-development. (AR4D). FARA serves as the technical arm of the African Union Commission on matters concerning agriculture science, technology and innovation.

IFPRI International Food Policy Research Institute

The International Food Policy Research Institute (IFPRI) provides research-based policy solutions to sustainably reduce poverty and end hunger and malnutrition in developing countries. Established in 1975, IFPRI currently has more than 600 employees working in over 50 countries. It is a research center of CGIAR, a worldwide partnership engaged in agricultural research for development.

IOM International Organization for Migration – Migration, Environment and Climate Change (MECC) Division

IOM is an intergovernmental organization that provides services and advice concerning migration to governments and migrants. It also coordinates or supports regional migration related consultation processes in the three focus regions and beyond. Since 2016, IOM is a related organization of the United Nations. IOM has established an own office / division for "environmental migration", which is in charge for harmonizing its efforts in that area.

FANRPAN Food, Agriculture and Natural Resources Policy Analysis Network

The Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN) for Africa is an autonomous, non-profit, scientific organization operational in Member States of Africa with a mandate to co-ordinate policy research and dialogue and recommend strategies for promoting food, agriculture and natural resources sectors in Africa.

FAO Food and Agriculture Organization of the United Nations

The FAO is a specialized agency of the United Nations. Its central effort is to defeat hunger worldwide – and ever since, Africa has been a focal region for FAO. For some years, migration has become an important and cross-cutting topic of FAO's work.

NOMRA Network of Migration Research on Africa

NOMRA is a collaborative organization / network of African and non-African researchers and scholars interested and working on all kinds of migration issues in Africa.

UNU-INRA Institute for Natural Resources in Africa

UNU-INRA's activities centre on four core areas: research, capacity development, policy advice, and knowledge sharing and transfer.

UNU-EHS United Nations University Institute for Environment and Human Security

UNU-EHS's work includes climate change adaptation, environmentally induced migration and social vulnerability, ecosystem services and environmental deterioration processes, models and tools to analyze vulnerability and risks linked to natural hazards. Though based in Bonn, UNU-EHS has intensively worked in Sub-Sahara Africa.

UNECA United Nations Economic Commission for Africa

Based on a mandate and recommendations by the United Nations General Assembly, UNECA is trying to foster economic cooperation among African countries. Besides environmental and climate issues (in particular UNECA's African Climate Policy Centre (ACPC); see UNU-INRA), UNECA increasingly deals with human mobility, which is particularly under the mandate of UNECA's Population and youth section.

World Bank The World Bank Group

The World Bank Group comprises of five international organizations that make leveraged loans to developing countries. It is the world's largest development bank. Both environmental change and human mobility have become ever more important topics in the work portfolio of the bank during the last two decades.

Relevant regional stakeholders

ECOWAS Economic Community of West African States

Founded already in 1975, ECOWAS and its 15 member countries (among them Nigeria, Ghana, Senegal, Ivory Coast) has been a global pioneer when it comes to addressing regional migration and free movement. Meanwhile climate change also plays a prominent role in ECOWAS' work portfolio.

EAC East African Community

EAC is the regional intergovernmental organisation of the Republics of Kenya, Uganda, the United Republic of Tanzania, Republic of Rwanda and Republic of Burundi. The EAC has achieved a Customs Union, a Common Market and faster steps to a Monetary Union and subsequently to Political federation. EAC has implemented first steps towards regional free movement. Furthermore, environment, natural resources and climate change are important topics for the EAC.

IGAD Intergovernmental Authority on Development in East Africa

The Intergovernmental Authority on Development (IGAD) is an eight-country trade bloc in Africa. It includes governments from the Horn of Africa, Nile Valley and the African Great Lakes (see migration section).

SADC Southern African Development Community

SADC is a regional intergovernmental organisation comprising of 16 member states (among others Angola, Democratic Republic of Congo, Madagascar, South Africa, Tanzania). As a step towards regional integration SADC has a free trade area. A Customs Union, a Common Market and a Monetary Union are future goals. A protocol facilitating fee movement of labour and people in the region has not yet been ratified by all member states. Issues related to climate change play an increasingly important role for SADC and its sub-bodies.

IOC Indian Ocean Commission

IOC is an intergovernmental organisation of Comoros, Madagascar, Mauritius, Réunion and Seychelles formed in 1982. Its objective is political and diplomatic cooperation, economic and commercial cooperation, sustainable development in a globalisation context and strengthening of regional cultural identity.

COMESA-EAC-SADC Tripartite Programme on Climate Change Adaptation and Mitigation in Eastern and Southern Africa

This programme forms a joint initiative by COMESA, EAC and SADC to meet the multi-dimensional challenges posed by climate change in Africa. At the AU summit in 2007, Heads of State and Government agreed on the need to mainstream climate change adaptation and mitigation into their development plans. As a result, COMESA, EAC and SADC implement a joint initiative called “The African Solution” to address climate change.

West African Observatory on Migration

The West African Observatory has established itself as probably the most important migration-related Civil Society organisation in the African continent. It covers a wider range of migration related topics focusing on the ECOWAS region.

Appendix 2: References

Abbas A. M., 2017: Climate change and forced migration from Ngala and Kala-Balge LGAs, N. E. Borno State, Nigeria. In: Pirasteh S., Li J., eds., Global changes and natural disaster Management: Geo-information Technologies. Springer, Cham.

Armah, F. A., Yawson, D. O., Yengoh, G. T., Odoi, J. O. & Afrifa, E. K. A., 2010: Impact of floods on livelihood and vulnerability of natural resource dependent communities in Northern Ghana. Water, 2.

Adimassu, Z., Kessler, A., & Stroosnijder, L., 2014: Farmers' strategies to perceived trends of rainfall and crop productivity in the Central Rift Valley of Ethiopia. Environmental Development, 1–18.

Afifi, T., et al., 2012: Climate Change, Vulnerability and Human Mobility: Perspectives of Refugees from East and Horn of Africa. UNU-EHS Report No. 1. Partnership between UNU and UNHCR. Bonn: United Nations University Institute for Environment and Human Security (UNU-EHS).

Arnall, A., 2018: Resettlement as climate change adaptation: what can be learned from state-led relocation in rural Africa and Asia?, Climate and Development (online first), DOI: 10.1080/17565529.2018.1442799.

Banda, S., et al., 2015: Traditional environmental knowledge among Lozi Adults in mitigating climate change in the Barotse Plains of Western Zambia. International Journal of Humanities, Social Sciences and Education 2 (9).

Baudoin, M.-A., et al., 2017: Living with drought in South Africa: Lessons Learnt from the Recent El Niño drought period. International Journal of Disaster Risk Reduction 23.

Beirne, J., 2014: Gilgel Gibe III: Dam-induced displacement in Ethiopia and Kenya. In: IOM, ed., The State of environmental migration. https://publications.iom.int/system/files/pdf/state_environmental_migration_2014_0.pdf (22.01.2019).

Bewkett, W., 2009: Rainfall variability and crop production in Ethiopia Case Study in the Amhara Region. In: Proceedings of the 16th International Conference of Ethiopian Studies. [Ege, S., Aspen, H., Teferra, B. & Bekele, S. (Eds.)], Trondheim.

Bilak, A. et al., 2016: Global report on internal displacement 2016. https://www.internal-displacement.org/globalreport2016 (17.06.2020).

Brooks, N. (2004). Drought in the African Sahel: Long term perspectives and future prospects. Tyndell Centre Working Paper, 61.

Brown, O. & Crawford, A., 2008: Climate change: A New threat to Stability in West Africa? Evidence from Ghana and Burkina Faso. African Security Review, 17.

Butt, D. et al., 2005: The economic and food security implications of climate change in Mali. Climate Change 68.

Cabot, C., 2017: Climate change and farmer-herder conflicts in West Africa. In: Cabot, C., ed., Climate change, security risks and conflict reduction. Springer.

Carr, C. J., 2017: River basin development and human rights in Eastern Africa – A policy crossroads. Springer.

Chimdesa, G., 2016: Climate change impacts and adaptation actions in Central Rift Valley of Ethiopia. Journal of Natural Sciences Research 6 (3).

Collier, P. et al., 2008: Climate change in Africa. Oxford Review of Economic Policy 24 (2).

Conrad, J. and Carstens, M., 2017: Groundwater. In: J. Mambo and K. Faccer, eds.: Understanding the social and environmental implications of global change. Second Edition of the Risk and Vulnerability Atlas. Pretoria.

Conway, D. &Schipper, L. F., 2011: Adaptation to climate change in Africa: Challenges and opportunities identified from Ethiopia. Global Environmental Change, 21.

Dahgbeto, A. P. and Villamor, G. B., 2016: Gender-specific responses to climate variability in a semi-arid ecosystem in Northern Benin. Ambio 45 (3).

Dai, D. et al., 2004: Comment: The recent sahel drought is real. International Journal of Climatology, 24.

Dartmouth Flood Observatory (DFO), 2008: 2007 Global register of major flood events. http://www.dartmouth.edu/~floods/Archives/2007sum.htm (01.02.2019).

Davis, C. and Joubert, A., 2011: Southern Africa's climate: Current state and recent historical changes. In: C. Davis, ed.: Climate risk and vulnerability: A handbook for Southern Africa. Pretoria.

De Bruijn, M. & Van Dijk, H., 2005: Introduction: Climate and Society in Central and South Mali. In: de Bruij, M. et al., eds., Sahelian pathways: Climate and society in Central and South Mali. African Studies Centre Research Report.

Department of Disaster Management / Office of the Prime Minister (Uganda), 2012: The 2010 – 2011 integrated rainfall variability impacts, needs assessment and drought risk management strategy. office of the prime minister, Kampala, Uganda.

Dietz, T., et al., 2004: Climate and livelihood change in North East Ghana. In: Dietz, T. et al., eds., Theimpact of climate change on drylands with a focus on West Africa, Kluwer.

Dillon, A. Mueller, V., & Salau, S., 2011: Migratory responses to agricultural risk in Northern Nigeria. American Journal of Agricultural Economics 93 (4).

Donnenfeld, Z., 2018: South Africa's water crisis is bigger than the Cape. https://issafrica.org/iss-today/south-africas-water-crisis-is-bigger-than-the-cape (28.01.2019).

Dougill, A. J. et al., 2010: Anticipating vulnerability to climate change in dryland pastoral systems: Using dynamic systems models for the Kalahari. Ecology and Society 15 (2).

Egeru, A., 2015: 'Mental drought' afflicts Uganda's cattle corridor. https://www.researchgate.net/publication/305392400_'Mental_drought'_afflicts_Uganda's_cattle_corridor (06.02.2019).

Environmental Change and Forced Migration Scenarios (EACH-FOR), 2009: Environmental change and forced migration scenarios. https://keesvandergeest.files.wordpress.com/2016/07/vd_geest_2008b.pdf (24.01.2019).

Erena, S. H. & Worku, H., 2018: Flood risk analysis: causes and landscape based mitigation strategies in Dire Dawa city, Ethiopia. Geoenvironmental Disasters, 5 (16).

Eriksen, S. et al., 2008: Climate change in Eastern and Southern Africa. Impacts, vulnerability and adaptation. https://www.semanticscholar.org/paper/Climate-change-in-Eastern-and-Southern-Africa%3A-and-Eriksen-O%27brien/cfd60b4ec9e93821b6de0916e53753996fb085d2 (17.06.2020).

Ezra, M. & Kiros, G.-E., 2001: Rural Out-Migration in the Drought Prone Areas of Ethiopia: A Multilevel Analysis. International Migration Review, 35 (3).

Fagotto, M., 2016: West Africa is being Swallowed by the Sea. https://foreignpolicy.com/2016/10/21/west-africa-is-being-swallowed-by-the-sea-climate-change-ghana-benin (01.02.2019).

FEWS NET (Famine Early Waning Systems Network), 2017: Prolonged drought drives a food security Emergency in Somalia and southeastern Ethiopia. East Africa Food Security Alert (6 July 2017). http://fews.net/sites/default/files/documents/reports/EA_Alert_06_2017_final.pdf (05.02.2019).

Food and Agricultural Organization of the United Nations (FAO), 2018: Resilience analysis in Karamoja, Uganda report. http://www.fao.org/3/i8365en/I8365EN.pdf (21.01.2019).

Fitchett, J. M., and Grab, S. W., 2014: A 66-year tropical cyclone record for South-East Africa: Temporal trends in a global context. International Journal of Climatology 34.

Fong, C., 2015: The scramble for water, land and oil in the Lower Omo Valley. The consequences of industrialization on people and the environment in the Lower Omo Valley and Lake Turkana. https://www.internationalrivers.org/sites/default/files/attached-files/the_scramble_for_water_land_and_oil_in_the_lower_omo_valley.pdf (27.01.2019).

Gautier, D., Denis, D. & Loactelli, B., 2016: Impacts of Drought and Responses of Rural Populations in West Africa: A Systematic Review. Climate Change, 7.

Giannini, A., Krishnamurthy, P. K., Cousin, R., Labidi, N. & Choularton, R. J., 2017: Climate risk and Food Security in Mali: A Historical Perspective on Adaptation. Earth's Future, 5.

Giannini, A. et al., 2008: A global perspective on African climate. Climate Change, 90.

Giannini, A., et al., 2013: A unifying view of climate change in the Sahel linking intra-seasonal, interannual and longer time scales. Environmental Research Letters, 8.

Global Facility for Disaster Reduction and Recovery (GFDRR) and World Bank Group, 2014: Recovery from recurrent floods 2000 – 2013. https://www.gfdrr.org/en/publication/mozambique-recovery-recurrent-floods-2000-2013 (24.01.2019).

Global Facility for Disaster Reduction and Recovery (GFDRR), 2015: Country profile Madagascar. https://www.gfdrr.org/en/publication/country-profile-madagascar (24.01.2019).

Global Facility for Disaster Reduction and Recovery (GFDRR), 2011: Vulnerability, risk reduction, and adaptation to climate change: Mozambique. https://www.gfdrr.org/en/publication/climate-risk-and-adaptation-country-profile-mozambique (22.01.2019).

Government of Madagascar, 2008: Damage, loss, and needs assessment for disaster recovery and reconstruction after the 2008 cyclone season in Madagascar. Cyclone Fame, Ivan and Jokwe in Madagascar. https://gfdrr.org/sites/gfdrr/files/documents/GFDRR_Madagascar_DLNA_2008_EN.pdf (24.01.2019).

Government of Namibia, 2011: Report on national response to the 2011 flood disaster. http://the-eis.com/elibrary/sites/default/files/downloads/literature/Flood_2011_Final_Report.pdf (17.06.2020).

Government of the Republic of Zambia, 2010: National climate change response strategy (NCCRS). https://www.adaptation-undp.org/sites/default/files/downloads/zambia-climate_change_response_strategy.pdf (22.01.2019).

Government Office for Science (UK), 2011: Foresight – Migration and global environmental change: Future challenges and opportunities. Final project report. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/287717/11-1116-migration-and-global-environmental-change.pdf (17.06.2020).

Grace, K. L. et al., 2018: Examining rural Sahelian out-migration in the context of climate change: An analysis of the linkages between rainfall and out-migration in two Malian villages from 1981 to 2009. World Development 109.

Haile, A. T., Kusters, K. & Wagesho, N., 2013: Loss and damage from flooding in the Gambela region, Ethiopia. International Journal Global Warming, 5 (4).

Hammer, T., 2004: Desertification and Migration: A Political Ecology of Environmental Migration in West Africa. In: Environmental Change and its Implications for Population Migration [Unruh, J. D., Krol, M. S. & Kliot, N. (Eds.)]. Kluwer: Dordrecht.

Handmer, J., Penning-Rowsell, E. & Tapsell, S., 1999: Flooding in a Warmer World: The View from Europe. In: Climate Change and Risk [Downing, T. E., Olsthoorn, A. A. & Tol R. S. J. (Eds.)]. London: Routledge.

Hartill, L., 2008: Understanding West Africa's rising food prices. Catholic Relief Services (CRS), April 28. https://reliefweb.int/report/burkina-faso/understanding-west-africas-rising-food-prices (29.01.2019).

Haug, I. V., 2014: Leaving drought and hunger behind: out-migration from Karamoja, Uganda. https://publications.iom.int/system/files/pdf/state_environmental_migration_2014_0.pdf (22.01.2019).

Heita, J., 2018: Assessing the evidence: Migration, environment and climate change in Namibia. Geneva. https://environmentalmigration.iom.int/assessing-evidence-migration-environment-and-climate-change-namibia (17.06.2020).

Henry, S. et al., 2004: The Impact of rainfall on the first out-migration: A multi-level event-history analysis in Burkina Faso. Population and Environment 25 (5).

Herrero, M., Ringler, C., van de Steeg, J., Thornton, P., Zhu, T., Bryan, E., Omolo, A., Koo, J. & Notenbaert, A., 2010: Climate variability and climate change and their impacts on Kenya's agricultural sector. Nairobi, Kenya. ILRI.

Huho, J, & Mugalavai, E., 2010: The Effects of Droughts on Food Security in Kenya. The International Journal of Climate Change: Impacts and Responses, 2 (2).

Hulme, M., 2001: Climatic Perspectives on Sahelian Desiccation: 1973 – 1998. Global Environmental Change, 11, 19–29.

Hummel, D., 2016: Climate change, land degradation and migration in Mali and Senegal – Some policy implications. Migration and Development 5 (2).

Hunnes, D. E., 2012: Understanding Rural-to-Urban Migration in Ethiopia: Driving Factors, Analytical Frameworks, and Recommendations. Journal of Global Health Perspectives, 1.

Ingram, C. et al., 2002: Opportunities and constraints for farmers of West Africa to use seasonal precipitation forecasts with Burkina Faso as a case study. Agricultural Systems 74.

Intergovernmental Panel on Climate Change (IPCC), 2014: Climate change 2014: Synthesis report. Contribution of Working Groups I, II, and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Geneva.

Internal Displacement Monitoring Centre (IDMC), 2018: Global report on internal displacement 2018. http://www.internal-displacement.org/global-report/grid2018 (21.01.2019).

International Federation of Red Cross and Red Crescent Societies (IFRC), 2011: DREF operation final report. Namibia floods. https://reliefweb.int/sites/reliefweb.int/files/resources/DCE8D6D925CDFA2AC125782A00360D43-Full_Report.pdf (17.06.2020).

International Organization for Migration (IOM), 2008: Briefing Note on HIV and Labour Migration in Zambia. Available online https://www.iom.int/jahia/webdav/site/myjahiasite/shared/shared/mainsite/events/docs/Briefing_Notes_HIV_Zambia.pdf (04.02.2019).

International Organization for Migration (IOM), 2017a: Evidencing the impacts of the humanitarian crisis in Southern Madagascar on migration, and the multisectoral linkages that drought-induced migration has on other sectors of concern. https://environmentalmigration.iom.int/evidencing-impacts-humanitarian-crisis-southern-madagascar-migration-and-multisectorial-linkages (17.06.2020).

International Organization for Migration (IOM) Madagascar, 2017b: IOM Madagascar annual report 2017. https://www.iom.int/sites/default/files/country/docs/Madagascar/iom-madagascar-annual-report-2017.pdf (17.06.2020).

Jordaan, A. J., 2015: Karamoja, Uganda drought risk assessment: Is drought to blame for chronic food insecurity? http://www.academia.edu/11756290/Karamoja_Drought_Risk_Assessment_Is_drought_to_blame_for_chronic_famine_and_food_insecurity (31.01.2019).

Jury, M. R., 2013: Climate Trends in Southern Arica. South African Journal of Science 109 (1/2): 1–11.

Kassie, B. T., Hengsdijk, H., Rötter, R., Kahiluoto, H., Asseng, S. & Van Ittersum, M., 2013: Adapting to Climate Variability and Change: Experiences from Cereal-Based Farming in the Central Rift and Kobo Valleys, Ethiopia. Environmental Management, 52.

Kgosikoma, O. E., 2006: Effects of Climate variability on livestock population dynamics and community drought management in Kgalagadi, Botswana. http://www.ccardesa.org/knowledge-products/effects-climate-variability-lifestock-population-dynamics-and-and-community (17.06.2020).

Kozacek, C., 2015: Zambia electricity shortage highlights Africa's hydropower shortfalls. https://www.circleofblue.org/2015/world/zambia-electricity-shortage-highlights-africas-hydropower-shortfalls (28.10.2019).

Laube, W. et al., 2012: Smallholder adaptation to climate change: Dynamics and limits in Northern Ghana. Climatic Change 111 (3–4).

Laux, P. et al., 2008: Predicting the regional onset of the rainy season in West Africa. International Journal of Climatology 28.

Lesolle, D., 2012: SADC policy paper on climate change: Assessing the policy options for SADC member states. https://www.sadc.int/files/9113/6724/7724/SADC_Policy_Paper_Climate_Change_EN_1.pdf (21.01.2019).

Linke, A. M. et al., 2018: The consequences of relocating in response to drought: human mobility and conflict in contemporary Kenya. Environmental Research Letters 13.

Lötter, D., 2017: Risk and vulnerability in the South African Farming Sector. Implications for sustainable agriculture and food security. In: J. Mambo and K. Faccer, eds., understanding the social and environmental implications of global change. Second edition of the risk and vulnerability atlas. Pretoria.

Lumbroso, D., et al., 2008: Sustainable flood risk management strategies to reduce rural communities' vulnerability to flooding in Mozambique. Journal of Flood Risk Management 1 (1).

Manhique, A. J., et al., 2015: Extreme rainfall and floods in Southern Africa in January 2014 and associated circulation patterns. Natural Hazards, 77.

Mavume, A. F., et al., 2009: Climatology and landfall of tropical cyclones in the South-West Indian Ocean and Western Indian Ocean. Journal of Maritime Science 8 (1).

McKenzie, D., and Swails, B., 2018: Day zero deferred, but Cape Town's water crisis is far from over (09.03.2018), https://edition.cnn.com/2018/03/09/africa/cape-town-day-zero-crisis-intl/index.html (28.01.2019).

Melde, S. et al., 2017: Making mobility work for adaptation to environmental changes – Results from the MECLEP global research. https://environmentalmigration.iom.int/making-mobility-work-adaptation-environmental-changes-results-meclep-global-research (17.06.2020).

Meze-Hausken, E., 2004: Contrasting Climate Variability and Meteorological Drought with perceived Drought and Climate Change in Northern Ethiopia. Climate Research, 27.

Ministry of Gender for the Republic of Zambia, 2016: Climate change gender action plan of the Republic of Zambia. https://www.climatelinks.org/sites/default/files/asset/document/2017_IUCN_Climate-Change-Gender-Action-Plan-Zambia.pdf (17.06.2020).

Ministry of the Coordination of Environmental Affairs (MICOA) of Mozambique, 2007: National Adaptation Programme of Action (NAPA). https://unfccc.int/resource/docs/napa/moz01.pdf (22.10.2019).

Mwangi, E., Wetterhall, F., Dutra, E., Di Giuseppe, F., & Pappenberger, F., 2014: Forecasting droughts in East Africa. Hydrol. Earth Syst. Sci., 18.

Namibia Statistics Agency, 2015: Namibia 2011 census migration report. http://www.cms.my.na/assets/documents/p19dmqq344hnc6ji1ciocta1eg21.pdf (24.01.2019).

Ndaruzaniye, V. et al., 2010: Climate change and security in Africa. https://africa-eu-partnership.org/sites/default/files/documents/doc_climate_vulnerability_discussion_paper.pdf (17.06.2020).

Nguimalet, C. R., 2018: Comparison of community-based adaptation strategies for droughts and floods in Kenya and the Central African Republic, Water International 43.

Nicholson, S., 2005: On the question of the "recovery" of the rains in the West African Sahel. Journal of Arid Environments 63.

Nicholson, S. E., 2000: The nature of rainfall variability over Africa on timescales of decades to millennia. Global and Planetary Change 26.

Nielsen, J. Ø., 2016: "I'm staying!" Climate variability and circular migration in Burkina Faso. In: Tischler, J. et al., eds., Environmental change and African societies – Past, present and future, Brill.

Nielsen, J. Ø. & Reenberg, A., 2010: Cultural Barriers to Climate Change Adaptation: A case Study from Northern Burkina Faso. Global Environmental Change, 20.

Nielsen, J. Ø. & Reenberg, A., 2009: Temporality and the problem with singling out Climate as a Current Driver of Change in a small West African Village. Journal of Arid Environments, 74 (4).

Nyaoro, D., et al., 2016: Assessing the evidence: Migration, environment and climate change in Kenya, https://publications.iom.int/books/assessing-evidence-migration-environment-and-climate-change-kenya (15.01.2019).

Okeke, O. E. (2014). Conflicts between Fulani Herders and Farmers in Central and Southern Nigeria: Discourse on Proposed Establishment of Grazing Routes and Reserves. AFRREV IJAH, 3 (1), S/9, 66–84.

O'Loughlin, Witmer, F. D. W., Linke, A. M., Laing, A., Gettelman, A., & Dudhia, J., 2012: Climate Variability and Conflict Risk in East Africa, 1990 – 2009. PNAS, https://www.pnas.org/content/pnas/early/2012/10/17/1205130109.full.pdf (05.02.2019).

Ombogoh, D. B. et al., 2016: Enhancing adaptation to climate variability in the East African highlands: A case for fostering collective action among smallholder farmers in Kenya and Uganda. Climate and Development 10.

Owusu, K. and Waylen, P., 2009: Trends in spatio-temporal variability in annual rainfall in Ghana (1951 – 2000). Weather 64 (5).

Pearson, N. & Niaufre, C. (2013). Desertification and Drought Related Migrations in the Sahel: The Cases of Mali and Burkina. The State of the Environment, IDDR, pp. 79–98.

Pérez-Pena, R., 2018: Cape Town pushes back 'day zero' as residents conserve water (20.02.2018). https://www.nytimes.com/2018/02/20/world/africa/cape-town-water-day-zero.html (28.01.2019).

Perine, C., and Keuck, H., 2018: Building urban resilience to climate change. A review of South Africa. https://www.climatelinks.org/sites/default/files/asset/document/180327_USAID-ATLAS_Building%20Urban%20Resilience%20to%20CC_South%20Africa_to%20CL_rev.pdf (28.01.2019).

Pourazar, E., 2017: Spaces of vulnerability and areas prone to natural disaster and crisis in six SADC countries. https://publications.iom.int/books/spaces-vulnerability-and-areas-prone-natural-disaster-and-crisis-six-sadc-countries (17.06.2020).

Pusch, C. et al., 2016: Striving toward disaster resilient development in Sub-Saharan Africa – Strategic framework 2016 – 2020. http://documents.worldbank.org/curated/en/399341477983384347/Striving-toward-disaster-resilient-development-in-Sub-Saharan-Africa-strategic-framework-2016-2020 (17.06.2020).

Rademacher-Schulz, C. et al. 2014: Time matters: Shifting seasonal migration in Northern Ghana in response to rainfall variability and food insecurity. Climate and Development 6 (1).

Ramakrishna G. &Demeke, A., 2002: An empirical analysis of food insecurity in Ethiopia: the case of North Wello. Africa Development Bank, XXVII (1).

Regional Inter-Agency Standing Committee (RIASCO), 2016: RIASCO action plan for Southern Africa. Revised regional response plan for the El Niño-induced drought in Southern Africa. https://reliefweb.int/report/world/riasco-action-plan-southern-africa-response-plan-el-ni-o-induced-drought-southern (17.06.2020).

Reid, H., et al., 2007: The economic impact of climate change in Namibia. How climate change will affect the contribution of Namibia's natural resources to its economy. http://pubs.iied.org/pdfs/15509IIED.pdf (24.01.2019).

Reliefweb, 2002: Food Shortages in Zambia: The Facts. Available online https://reliefweb.int/report/zambia/food-shortages-zambia-facts (04.02.2019).

Roudier, P. et al., 2011: The impact of future climate change on West African crop yields: What does the recent literature say? Global Environmental Change 21.

Rowell, D. P. & Chadwick, R., 2018: Causes of the Uncertainty in Projections of Tropical Terrestrial Rainfall Change: East Africa. Journal of Climate Change, 31.

Rowell, D. P., Booth, B. B. B., Nicholson, S. E. & Good, P., 2015: Reconciling Past and Future Rainfall Trends over East Africa. Journal of Climate, 28.

Salack, S. et al., 2015: Crop-climate ensemble scenarios to improve risk assessment and resilience in the semi-arid regions of West Africa. Climate Research 65.

Salack, S. et al., 2016: Global warming induced hybrid rainy seasons in the Sahel. Environmental Research Letters 11.

Sarr, B., 2012: Present and future climate change in West Africa: A crucial input for agricultural research prioritization for the region. Atmospheric Science Letter 13.

Shongwe M. E. et al., 2011: Projected changes in mean and extreme precipitation in Africa under global warming. Part II: East Africa. Journal of Climate, 24.

Southern African Development Community (SADC) and United Nations Environment Programme (UNEP), 2010: Southern Africa sub-regional framework of climate change programmes. Adaptation and mitigation actions, supported by enabling measures of implementation. https://www.sadc.int/files/4813/5293/3518/Southern_Africa_Framework_of_Subregional_Climate_Change_Programmes.pdf (17.06.2020).

Sow, P. et al., 2014: Migration, social demands and environmental change amongst the Frafra of Northern Ghana and the Biali in Northern Benin. Sustainability 6.

Spear, D., et al., 2015: Vulnerability and adaptation to climate change in semi-arid areas in Southern Africa. http://www.assar.uct.ac.za/sites/default/files/image_tool/images/138/RDS_reports/SAFRICA/Southern%20Africa%20RDS%20full%20report.pdf (17.06.2020).

Speranza, C. I., 2010: Flood disaster risk management and humanitarian interventions in the Zambezi river basin: Implications for adaptation to climate change. Climate and Development 2 (2).

Stal, M., 2011: Flooding and relocation: The Zambezi river valley in Mozambique. International Migration 49 (S1).

Stevenson, E. and Buffavand, L., 2018: "Do our bodies know their ways?" Villagization, food insecurity, and ill-being in Ethiopia's Lower Omo Valley. African Studies Review 61 (1).

Stevenson, E., 2017: Plantation development in the Turkana Basin: The making of a new desert? Land 7.

Sultan, B. et al., 2013: Assessing climate change impacts on sorghum and millet yields in the Sudanian and Sahelian Savannas of West Africa. Environmental Research Letters 8.

Sylla, M. B. et al., 2016: Climate change in West Africa: Recent trends and future projections. In: Yaro, J and Hesselberg. J., eds., Adaptation to climate change and variability in rural West Africa. Springer.

Tache, B. & Oba, G., 2010: Is poverty driving Borana herders in southern Ethiopia to crop cultivation? Human Ecology, 38.

Touter, M., and Mauck, B., 2017: Surface water. In: J. Mambo and K. Faccer, eds., Understanding the social and environmental implications of global change. Second edition of the risk and vulnerability atlas. Pretoria.

UN Environment Report 2017: Environmental displacement. Human mobility in the Anthropocene. https://wedocs.unep.org/bitstream/handle/20.500.11822/22269/Frontiers_2017_CH6_EN.pdf?sequence=1&isAllowed=y (25.01.2019).

United Nations Development Programme (UNDP), 2012: Agriculture and food security policy brief. Reflecting on the challenges of attaining a green economy for Botswana. https://sustainabledevelopment.un.org/content/documents/1008National%20Report%20(Agriculture)%20-%20Botswana.pdf (17.06.2020).

United Nations Development Programme (UNDP), 2018: Climate change adaptation in Africa. UNDP Synthesis of experiences and recommendations 2000 – 2015. http://www.undp.org/content/dam/undp/library/Climate%20and%20Disaster%20Resilience/Climate%20Change/CCA-Africa-Final.pdf (22.01.2019).

United Nations Environment Programme (UNEP), 2004: Lake Victoria Basin outlook. https://wedocs.unep.org/bitstream/handle/20.500.11822/8613/LakeVictoria-Basin-Environment-Outlook.pdf (17.06.2020).

United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA), 2016: El Niño: Overview of impact, projected humanitarian needs and responses. https://reliefweb.int/report/world/el-ni-o-overview-impact-projected-humanitarian-needs-and-response-02-june-2016 (24.01.2019).

United Nations Office of the Resident Coordinator Madagascar, 2016: Madagascar: Drought. Office of the Resident Coordinator situation report No. 2 (as of September 2016). https://www.humanitarianresponse.info/sites/www.humanitarianresponse.info/files/documents/files/madagascar_drought_unrc_situation_report_2_sept2016.pdf (17.06.2020).

United States Agency for International Development (USAID), 2016a: Climate change risk profile. Madagascar. https://www.climatelinks.org/resources/climate-change-risk-profile-madagascar (22.01.2019).

United States Agency for International Development (USAID), 2016b: Climate change risk profile Southern Africa. https://www.climatelinks.org/resources/climate-change-risk-profile-southern-africa (21.01.2019).

van de Steeg, J. A., Herrero, M., Kinyangi, J. & Thornton, P. K., 2009: The Infuence of Climate Variability and Climate Change on the Agricultural Sector in East and Central Africa: Sensitizing the ASARECA Strategic Plan to Climate Change. Report 22. ASARECA (Association for Strengthening Agricultural Research in Eastern and Central Africa), Entebbe, Uganda, and ILRI (International Livestock Research Institute), Nairobi, Kenya.

van der Geest, K., 2011: North-South migration: What role for the environment? International Migration 49 (S1).

van der Land, V. et al, 2018: Environmental change and migration: A review of West African case studies. In: McLeman, R. and Gemmene, F., eds., Handbook of environmental displacement and migration. Routledge.

Vaz, Alvaro, C., 2000: Coping with floods – The experience of Mozambique. https://pdfs.semanticscholar.org/e241/c6001f197ee3ea1765901ac3e37dc34ce942.pdf (17.06.2020).

Vogt, J., and Barbosa, P., 2018: Drought and water crisis in Southern Africa. https://publications.jrc.ec.europa.eu/repository/bitstream/JRC111596/drought_water_crisis_in_southern_africa2018_doi_isbn.pdf (17.06.2020).

Warner, K. and Afifi, T., 2014: Where the rain falls: Evidence from 8 countries on how vulnerable households use migration to manage the risk of rainfall variability and food insecurity. Climate and Development 6 (1).

Warner, K., et al., 2010: Climate change, environmental degradation and migration. Natural Hazards 55.

Weiss, H., 2003: Migrations During Times of Drought and Famine in Early Colonial Northern Nigeria. StudiaOrientalia, 95, 1–29.

Wiederkehr, C. et al., 2018: Environmental change, adaptation strategies and the relevance of migration in Sub-Saharan drylands. Environmental Research Letters 13.

Wiles, P. et al., 2005: Learning lessons from disaster recovery: The case of Mozambique. http://documents.worldbank.org/curated/en/129821468060919859/Learning-lessons-from-disaster-recovery-the-case-of-Mozambique (17.06.2020).

World Bank and Global Facility for Disaster Reduction and recovery (GFDRR), 2016: Disaster risk profile. Madagascar. https://www.gfdrr.org/en/publication/disaster-risk-profile-madagascar (22.01.2019).

World Bank, 2013: Turn down the heat. Climate extremes, regional impacts, and the case for resilience. Washington D. C. https://www.worldbank.org/en/topic/climatechange/publication/turn-down-the-heat-climate-extremes-regional-impacts-resilience (17.06.2020).

Zinyengere, N. et al., 2013: Crop response to climate change in Southern Africa: A comprehensive review. Global and Planetary Change 111.

Published by
Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Registered offices
Bonn and Eschborn, Germany

Global Programme Human Mobility in the Context of Climate Change
Friedrich-Ebert Allee 32 + 36
53113 Bonn, Germany
Phone +49 (0) 6196 79 - 0
Fax +49 (0) 6196 79 - 1115
www.giz.de

Responsible
Dr. Dorothea Rischewski (GIZ)

Authors
Benjamin Schraven, Stephen Adaawen, Christina Rademacher-Schulz,
Nadine Segadlo

Design and layout
Eva Hofmann, Katrin Straßburger, W4 Büro für Gestaltung, Frankfurt

Photo credits
Title, p. 4 and p. 10: © GIZ / Felix Ries; p. 6: © GIZ; p. 12: © GIZ / Lennart Kehl;
p. 34: © GIZ / Dirk Betke.

On behalf of
Federal Ministry for Economic Cooperation and Development (BMZ)

GIZ is responsible for the content of this publication.
The information and recommendations of the study do not automatically reflect the opinion of BMZ or GIZ.

As at
June 2020