Joseph A. Yaro · Jan Hesselberg *Editors*

Adaptation to Climate Change and Variability in Rural West Africa

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ISBN 978-3-319-31497-6 ISBN 978-3-319-31499-0 (eBook)
DOI 10.1007/978-3-319-31499-0

Library of Congress Control Number: 2016934421

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer International Publishing AG Switzerland

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Chapter 1
Introduction to Book

Joseph Awetori Yaro and Jan Hesselberg

1.1 Introduction

This book provides conceptual and empirical discussions of adaptation to climate change/variability in rural West Africa. It brings on-board country experiences in adaptation by different socio-economic groups and efforts at building adaptive capacity. It presents a holistic understanding of adaptation and shows contextual and generic sources of adaptive capacity. Focusing on adaptation to climate change/variability is critical because the development challenges of rural West Africa have been historically intertwined with its climate. Moreover, emerging patterns of climate change are inextricably linked to developmental issues today for West Africa's agrarian communities with high numbers of the population earning a living directly and indirectly from the natural environment. Natural resource dependence and agrarian livelihoods make such communities most vulnerable to climate-driven ecological change. Therefore, it is imperative that rural people adapt to climate change, but their ability to successfully do so may be limited by competing risks and vulnerabilities. Their adaptive capacity may be impeded by sources of vulnerabilities such as agricultural policies, trade arrangements or governance issues that are rooted in the wider political economy. Providing an elucidation of these vulnerabilities and the capacities needed to enable successful adaptation and avoid maladaptation is critical for future policy formulation. Though the empirical discussions in this book are about West Africa, their applicability in terms of the processes, structures, needs, strategies, and recommendations for policy transcends

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J.A. Yaro and J. Hesselberg (eds.), *Adaptation to Climate Change and Variability in Rural West Africa*, DOI 10.1007/978-3-319-31499-0_1

West Africa and they provide useful lessons for understanding adaptation broadly in rural settings of the developing world.

West Africa is predominantly a semiarid region with a rapidly growing population and a low gross domestic product (Ayuk and Kabore 2013; Brown et al. 2009; Elbehri 2013; Jerven 2015). The rural population in the West African Savannah and Sahel constitutes one of the most vulnerable on earth, and this vulnerability is partly caused by the variability of the West African monsoon (Barbier et al. 2009). West Africa's climate is among the most variable in the world on intra-seasonal to decadal timescales (see Chaps. 2 and 3). There has been a pattern of continued aridity since the late 1960s and some recovery since the 1990s (Christiansen et al. 2007; Codjoe and Owusu 2011; Nicholson et al. 1999). The projected climate change indicates continuous and stronger warming (1.5–6.5 °C) and a wider range of precipitation uncertainty (roughly between −30 and 30 %) which is even broader in the Sahel and increasing in the farther future (Sylla et al. this volume). The mean precipitation change over West Africa shows a less evident trend and mostly oscillates between −10 and 10 %. Sylla et al. (this volume) assert that in the rest of West Africa the projected rainy season and the growing season will become shorter while the torrid, arid and semi-arid climate conditions will substantially extend. Riede et al. (this volume) assert that climate projections for West Africa show a slight increase of total precipitation and a longer rainy season with a drier phase within. These differences in projections result from the unpredictable West African monsoon system.

The changing climate and increasing variability increases the vulnerability of the region's population to climate stressors such as droughts, floods, heat waves, and changing rainfall patterns, and will increase the cost of food, health, basic infrastructural provision and humanitarian assistance. The impacts of climate change on the region are expected to be widespread, complex, and geographically and temporally variable (Marc et al. 2015; Wakhungu 2011; Yaro et al. 2010). The different climate stressors will reduce agricultural production in West Africa significantly and therefore affect the livelihoods of over half of its population living in rural areas (Hallegatte et al. 2016). The changing climate does not only affect agriculture; it impacts all facets of the lives of rural dwellers.

Rural West Africans deploy a range of ingenious strategies in dealing with climatic changes and variability, including irrigation, change in crop varieties, non-farm activities, and diversification of crops and livestock. These strategies reduce farmers' dependency on rainfall but are insufficient to reduce poverty and vulnerability for the majority (Barbier et al. 2009; Rademacher-Schulz et al. 2014; Resurreccion 2013). These adaptive strategies are dependent on adaptive capacities, which are enabled by social, economic, physical, and cultural circumstances (Derbile and Laube 2014). The IPCC (2001) defines adaptive capacity as the potential, capability, or ability of a system to adapt to climate change stimuli and their effects or impacts. A deeper understanding of adaptation is critical in answering the questions: How effective are these strategies? What determines them? Which interventions are more helpful and to whom? What policies are enabling or disabling? How can we enhance the capacity of rural Africa to adapt appropriately?

The multiplex livelihoods in dry areas mirror complex realities of life. We need to unearth the intricate processes, intentions and aspirations of rural dwellers to understand their adaptation potentials and reasons for failure and success. To be effective, these measures require different structures and institutions to galvanise necessary action and resources. Some of these measures include the following as suggested by Agrawal et al. (2008): information gathering and dissemination, resource mobilization and allocation, skills development and capacity building, providing leadership, and networking with other decision makers and institutions.

Although the main manifestations of climate change are of a physical nature, their consequences transcend ecological, social, cultural, political and economic impacts (Afifi et al. 2014; Hallegatte et al. 2016; Inderberg et al. 2015; Mendelsohn et al. 2006; O'Brien and Selboe 2015; Rademacher-Schulz and Salifu 2014) and shape prospects for food, water and health security. Adaptation can be positive or negative: positive if it is by choice, reversible, and increases security; negative if it is of necessity, irreversible, and fails to increase security. The challenge is to show how the political economy and its embedded social relations impede and facilitate effective adaptation to climate change. Building adaptive capacity requires substantial attention to crucial factors such as land rights and access to resources, legal provisions and policies, trade regimes, as well as governance issues such as elite capture of resources which generate or maintain poverty and shape access patterns defining livelihood resilience. The effects of climate change/variability should not lead to catastrophic and irreversible damage to humans since societies' adaptive capacity can be strengthened and streamlined (Heltberg et al. 2009; IPCC 2007; Leary and 2007).

1.2 Outline of the Book

Chapter 1 introduces the subject matter of the book and provides a summary of its contents. It makes a case for dealing with adaptation to climate change/variability in rural West Africa.

In Chap. 2, an analysis of the IPPCs 5th report is presented to set the background against which the discussions on adaptation can be related. The latest IPCC (2014) report concludes that Africa as a whole is one of the most vulnerable continents due to its high exposure and low adaptive capacity. Temperature projections over West Africa from global climate simulation for the end of the 21st century range between 3 and 6 °C above the late 20th century baseline depending on the emission scenario. The authors of this chapter observe that in the past a shift of the rainy season was discussed, but currently a shift cannot be observed for West Africa. Yet the length of the Sahelian rainy season reveals an increasing trend of 2–3 days per decade, with a drier phase within. However, climate projections show a slight increase of total precipitation and a longer rainy season.

Similarly, Chap. 3 continues the analysis of the physical dimension of climate change in the region. The chapter presents an assessment of recent trends and future changes of the climate in the region. It shows that the Sahel has recovered from the previous drought episodes of the 1970s and 1980s. However, the precipitation amount is not at the level of the pre-drought period. The authors argue that most countries in West Africa will have to cope with shorter rainy seasons; generalized torrid, arid and semi-arid conditions; longer dry spells; and more intense extreme precipitations.

Chapter 4 meticulously argues that the strategies for climate change adaptation designed for deliberate change have to be considered in the context of closely coupled social-ecological systems. It presents examples of prominent adaptation strategies that have been introduced in an attempt to adjust to the already evolving climatic conditions and shows that a lack of whole systems thinking is at the heart of the limited sustainability of promising strategies.

Chapter 5 examines the determinants of adaptive capacity in rural northern Ghana. It reveals that while adaptive capacity in the northern savannah zone is generally low due to high levels of poverty and poor state presence, it varies spatially due to locational, individual and community factors. The importance of both community and individual level factors and characteristics defining the capacities to adopt specific adaptation strategies to climate change threats are cogently discussed.

Chapter 6 evaluates the potential role and limitations of local knowledge in climate change adaptation from an endogenous development perspective in Ghana. It cautions that even though local knowledge enables environmental sustainability and climate change adaptation in smallholder agriculture, it is not without limits and risks.

Chapter 7 examines the concept of community-based adaptation (CBA) as a key strategy in adaptation and rural development landscapes. It shows how CBAs can be very successful at raising the profile of bottom-up expressions in the international climate change architecture with strong top-down, "scientistic" tendencies. Using social capital as an analytical capsule, this chapter investigates competing claims arising in the context of a sudden increase in the value of natural resources.

Chapter 8 focuses on trajectories of rural transformation in northern Ghana by examining changes in rural aspirations and future-oriented strategies among the rural people. It discusses the extent to which these changes contribute to better individual social mobility, rural transformation and enhanced adaptation and concludes that rural adaptation policies, often focussing on agriculture, need to take changing aspirations and larger rural social transformations into account.

Chapter 9 addresses the issue of migration as a societal response to climate change using Mali and Senegal as cases. It shows how the changing and unsteady environmental conditions lead to changing patterns of migration. It examines the interacting influence of environmental and socio-economic conditions on the decision to migrate, but stresses that unfavourable environmental conditions play a decisive role when people migrate seasonally for economic reasons.

Chapter 10 discusses the distinct overemphasis on rural agricultural spaces that undergirds much of the literature on local riskscapes in West Africa. It does this by elucidating how households that live on the fringes of rapidly transforming

peri-urban spaces are caught in a double bind of institutional and spatial marginality. The chapter argues that peri-urban households are confronted with socio-environmental risks that are similar to those experienced by their rural counterparts, while at the same time being subjected to interrelated institutional and material transformations which define such spaces as dynamic risk frontiers.

Chapter 11 discusses the turn toward ecosystem-based adaptation, which adopts a multi-sectoral approach to sustaining healthy ecosystems as a means of reducing vulnerability and enhancing the resilience of social and ecological systems to climate change impacts. It shows that although the concept of ecosystem-based adaptation appears promising, the transition from conventional climate change adaptation policies toward ecosystem-based adaptation in West Africa has been slow. The chapter also discusses the potential roles of non-governmental organizations (NGOs) in enhancing awareness, generating interest, creating opportunities, and building capacities for enhancing the transition toward ecosystem-based adaptation.

Chapter 12 employs mapping as a vital tool in using social capital for effective adaptation. It quantifies critical variables, which are displayed in interactive maps to show spatial vulnerabilities and capacities.

The concluding chapter provides general recommendations for improving the lives of the rural population via the creation of macro and micro level conditions and policies that enhance appropriate adaptation for all.

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Chapter 2
What's on the 5th IPCC Report for West Africa?

Jens O. Riede, Rafael Posada, Andreas H. Fink and Frank Kaspar

Abstract The status of knowledge on observed and projected climate change is regularly summarized in the assessment reports of the Intergovernmental Panel on Climate Change. The latest IPCC report (2013) concludes that Africa as a whole is one of the most vulnerable continents due to its high exposure and low adaptive capacity. Here, the major conclusions of the report for Western Africa are summarized. Although there are still large gaps in the available data, evidence of warming over land regions across Africa, consistent with anthropogenic climate change, has increased. Temperature projections over West Africa for the end of the 21st century from global climate simulation range between 3 and 6 °C above the late 20th century baseline depending on the emission scenario. A similar range is produced with regional climate models that are used to downscale global climate simulations. For some regions, unprecedented climates are projected to occur at around 2040. Important progress has been made in the understanding of West African weather systems during the African Monsoon Multidisciplinary Analysis (AMMA; phase 1: 2002–2010, phase 2: 2010–2020) project. For many processes in ecology, agriculture or hydrology, precipitation is one of the most important parameters. In addition to the total precipitation, the onset of the rainy season is of special interest for agriculture. In the past a shift of the rainy season was discussed, but currently a shift cannot be observed for West Africa. However, the length of the Sahelian rainy season reveals an increasing trend of 2–3 days per decade, with a drier phase within. Since the 1950s annual precipitation has tended to decrease in western and eastern parts of the Sahel region, with a very dry period in the 70s and 80s and a slight increase of precipitation afterwards, until today. However, climate projections show a slight increase of total precipitation and a longer rainy season with a drier phase within.

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J.A. Yaro and J. Hesselberg (eds.), *Adaptation to Climate Change and Variability in Rural West Africa*, DOI 10.1007/978-3-319-31499-0_2

2.1 Introduction

Climate variability and climate change have impacts on many sectors, such as agriculture, water availability and health. Depending on the adaptive capacity of a society, these impacts might result in strong vulnerability. One of the main features responsible for climatic conditions over West Africa is the West African monsoon system (WAM). The underlying atmospheric processes and interactions with the land surface and ocean are complex and not yet fully understood. Several recent research activities have addressed the knowledge gap the and did advance our understanding of the WAM system. Among these are the African Multidisciplinary Monsoon Analysis (AMMA, phase 1: 2002–2010, phase 2: 2010–2020) or the GLOWA-Impetus and GLOWA-Volta project. Results of these activities have been published in several special issues (Lafore et al. 2010; Plocher et al. 2011; Speth et al. 2010).

The status of knowledge on global and regional climate change and related impacts has been summarized in the 5th Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC). Widespread impacts of climate change have been identified on all continents and detailed regional summaries are available.

The following sections provide a summary of these findings. Section 2.2 gives a short introduction to the climate of West Africa. Sections 2.3 and 2.4 provide a summary of the major IPCC conclusions about observed and projected climate change in West Africa. Readers not familiar with the work of IPCC can find some background information in Box 1.

Box 1. The Intergovernmental Panel on Climate Change

The IPCC is a scientific body under the auspices of the United Nations (UN) which reviews and assesses the most recent scientific, technical and socio-economic information produced worldwide relevant to the understanding of climate change. This international body publishes Assessment Reports (AR) periodically to provide a clear and up to date view of the current state of scientific knowledge about climate change. The IPCC is currently organized in 3 Working Groups and a Task Force. Working Group I deals with "The Physical Science Basis of Climate Change", Working Group II with "Climate Change Impacts, Adaptation and Vulnerability" and Working Group III with "Mitigation of Climate Change". The Task Force on National Greenhouse Gas Inventories is to develop and refine a methodology for the calculation and reporting of national greenhouse gas emissions and removals. The preparation of the last report (Fifth Assessment Report, AR5) involved more than 830 authors and review editors from over 80 countries. They in turn drew on the work of over 1000 contributing authors and about 2000 expert reviewers who provided over 140,000 review comments.

The assessments have become much more complete over time, evolving from making very simple, general statements about sectorial impacts, through greater concern with regions regarding observed and projected impacts and associated vulnerabilities, to an enhanced emphasis on sustainability and equity, with a deeper examination of adaptation options (Hewitson et al. 2014). The AR5 provides an assessment of regional aspects of climate change in different parts of the world. The evidence linking observed impacts on biological, physical, and (increasingly) human systems to recent and ongoing regional climate changes has become more compelling since the AR4. One reason for this is the improved reporting of published studies from hitherto under-represented regions of the world, especially in the tropics (Rosenzweig and Neofotis 2013).

That said, there is still a large disparity between the copious evidence being presented from Europe and North America, as well as good quality data emerging from Australasia, polar regions, many ocean areas, and some parts of Asia and South America, on the one hand, and the much sparser coverage of studies from Africa, large parts of Asia, Central and South America, and many small islands, on the other. However, as the time series of well-calibrated satellite observations become longer in duration, and hence statistically more robust, these are increasingly providing a near global coverage of changes in surface characteristics such as vegetation, hydrology, and snow and ice conditions that can usefully complement or substitute for surface observations (Stocker et al. 2013).

The IPCC AR5 includes an extensive chapter dedicated to Africa in which the observed climate trends and projections are described (Niang et al. 2014). In this section we summarize observed and projected climate trends described in the IPCC Report, with a special focus on the Western part of the continent.

2.2 Climate Zones in West Africa

The climate in Africa has huge variation between the most northern parts in Tunisia and the most southern parts in South Africa. Therefore a variety of climate zones exist in Africa: from tropical rainforest climates in East, Central and West Africa to alpine climate on the East African Mountains. The term "West Africa" is commonly used to refer to the western part of Africa, although the geographical boundaries of this area are not clear and differ from one source to another. For instance, Lélé and Lamb (2010) considers "West Africa" as being bounded by the Atlantic Ocean to the west and south, by the north of the Sahel-zone at around 20° N latitude to the north, and by 10° E to the east. Another definition of Western Africa is the economic area "Economic Community of West African States" (ECOWAS) including 15 countries in Western Africa (Benin, Burkina Faso, Cape Verde, Gambia, Ghana,

Guinea, Guinea-Bissau, Ivory Coast, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, Togo). This is the definition that has also been used in the latest IPCC report. On average the region is around 300 m above sea level, with only a few mountainous regions.

Wet and dry tropical climate zones occur in the region. Figure 2.1 shows the distribution of annual precipitation in the region. Precipitation has a strong south-north-gradient: the annual amount decreases significantly from the Atlantic coast in the south towards the Sahara in the north. The aridity increases accordingly with the distance from the ocean. Based on these great differences in precipitation, three climatic zones exist in Western Africa (e.g., according to Njeri et al. 2006, Fink et al. 2016): (a) The Sahelian zone, with irregular annual rainfall that does not exceed 500 mm, and a maximum rainfall occurring in August. This zone is located roughly at 12.5° N latitude and its climate is semi-arid. (b) The Sudanian zone with a precipitation amount between less than 200 mm in the north of Nigeria and 1000 mm in the north of Mali. The climate is sub-humid and located approximately between 9° N and 12.5° N. (c) The tropical humid Guinea Cost zone located along the Gulf of Guinea, characterized by annual mean rainfall higher than 1500 mm.

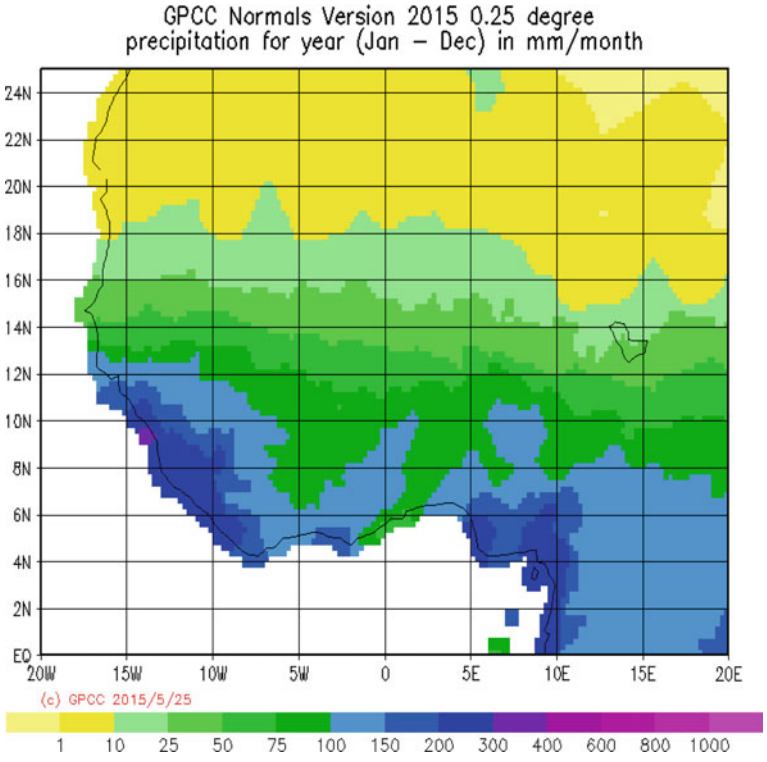


Fig. 2.1 Annual precipitation based on the gridded dataset of the global precipitation climatology center—version 2015 (Becker et al. 2013; Meyer-Christoffer et al. 2015)

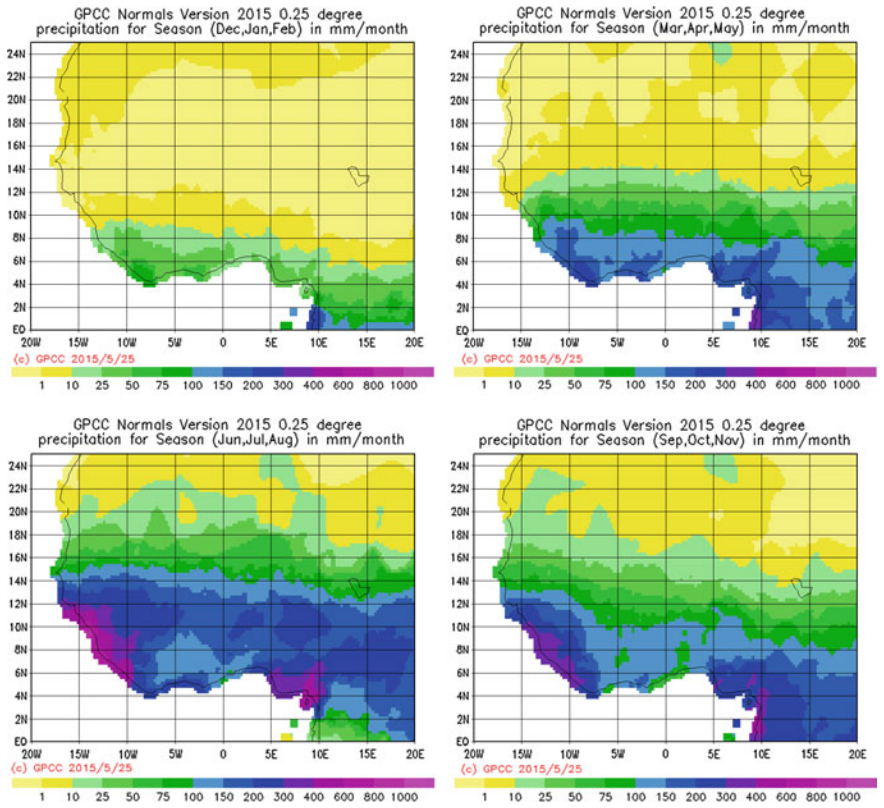


Fig. 2.2 Average annual precipitation over West Africa based on the gridded dataset of the global precipitation climatology center (version 2015; Meyer-Christoffer et al. 2015). There is a strong pattern in seasonality (*upper left*) dry season, DJF, end of dry season, beginning of rainy season from the south to the north MAM (*upper right panel*), rainy season JJA (*lower left panel*), end of rainy season SON (*lower right panel*)

Rainfall in this zone varies according to the orientation of the coastline and inland mountains with coastlines perpendicular to the SW monsoon. These coast show very high precipitation amounts, contrary to, for example the Ghana-Togo dry zone (Fink et al. 2016). The Guinea Cost and the Sudanian zone both have a bi-modal rainfall distribution (Fig. 2.2) (UNEP 2006).

Rainfall in the tropics is mostly convective and therefore rather unevenly distributed over time and space. Convective events can occur at any time in the year, but are more likely in the rainy season. A characteristic feature in Western Africa is that the isolated convective showers organize into large thunderstorm complexes. For details on West African rainfall types see Fink et al. (2010b). The seasonal patterns of rainfall and temperature in Western Africa are influenced by two air masses: the dry and usually hot Harmattan north-easterly winds originating from the Sahara, and the low-level monsoonal south westerly winds originating from the

Atlantic Ocean. The movement of the air masses is associated with northwards and southwards pulsations of a narrow confluence zone of discontinuity ("Intertropical Discontinuity" (Fink et al. 2016)) between the dry Harmattan and the tropical maritime monsoon to the south.

Annual temperatures in these zones are in the range of 26–30 °C, but distinct differences exist in the overnight temperatures and near-surface humidity in winter: night-time temperatures regularly fall below 10 °C in the Sahel. On the Guinea coast, minimum temperatures typically do not fall below 18 °C. Relative humidity stays below 50 % throughout the day in the Sahel, whereas values are high throughout the year on the Guinea coast (Fink et al. 2016).

Box 2. Climate Scenarios (Representative Concentration Pathway Scenarios (RCP))

Climate projections for the period until 2100 are performed with global climate models. Applying the models for that time frame requires assumptions about the atmospheric composition, i.e., the concentration of atmospheric greenhouse gases. The development of future atmospheric composition depends on the emissions of these gases from anthropogenic and natural sources. Anthropogenic emissions are driven by economic and technological development as well as political decisions, especially related to usage of fossil fuels and land use. In order to make climate model runs of different groups comparable, they have to be based on the same assumptions on future emissions or concentration. Assumptions about future development are typically aggregated in 'scenarios'. The assumptions can vary greatly, but should be internally consistent within one scenario. For the climate model runs in the 5th Assessment Report, the scenarios are called 'Representative Concentration Pathways' (RCPs). These scenarios prescribe the temporal development of emissions and concentrations of the full suite of greenhouse gases, aerosols and chemically active gases, as well as land use/land cover. Four main scenarios have been defined with different targets of radiative forcing in the year 2100: RCP 8.5, RCP 6.0, RCP 4.5, RCP 2.6. The numbers refer to the radiative forcing in W/m^2 in 2100. Differences in the radiative forcing between these scenarios are relatively small up to 2030, but become very large by the end of the 21st century and dominated by CO_2 forcing. RCP 8.5 is a high pathway which reaches >8.5 W/m^2 by 2100 and continues to rise for some time after 2100; RCP 6.0 and RCP 4.5 are so-called "stabilization pathways" in which the forcing is stabilized at approximately 6 and 4.5 W/m^2 shortly after 2100. In RCP 2.6 the radiative forcing peaks at approximately 3 W/m^2 before 2100 and then declines to approx. 2.6 W/m^2 in 2100. In order to reach such a forcing, greenhouse gas emissions have to be reduced substantially over time.

The scenarios are used to run global climate models for the 21st century. Such models are developed and operated by several modeling centers. Taken together, the ensemble of results for each RCP scenario allows for assessing

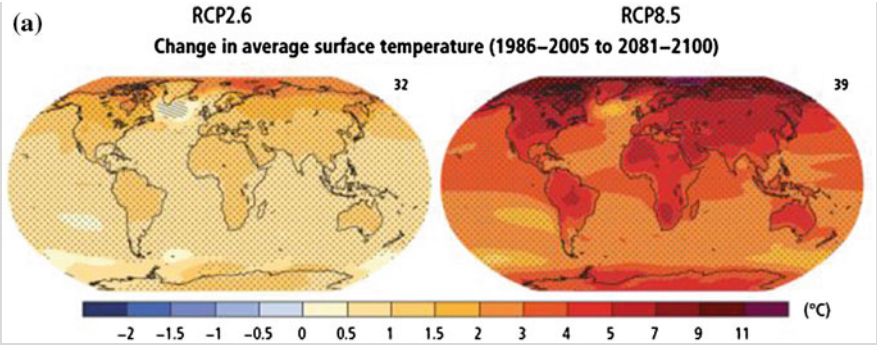


Fig. 2.3 Change in average surface temperature based on a multi-model mean projections for 2081–2100 relative to 1986–2005 under the RCP2.6 (*left*) and RCP8.5 (*right*) scenarios. *Thin lines* denote one ensemble member per model, *thick lines* the CMIP5 multi-model mean. On the *right-hand side* the 5th, 25th, 50th (median), 75th and 95th percentiles of the distribution of 20-year mean changes are given for 2081–2100 in the four RCP scenarios

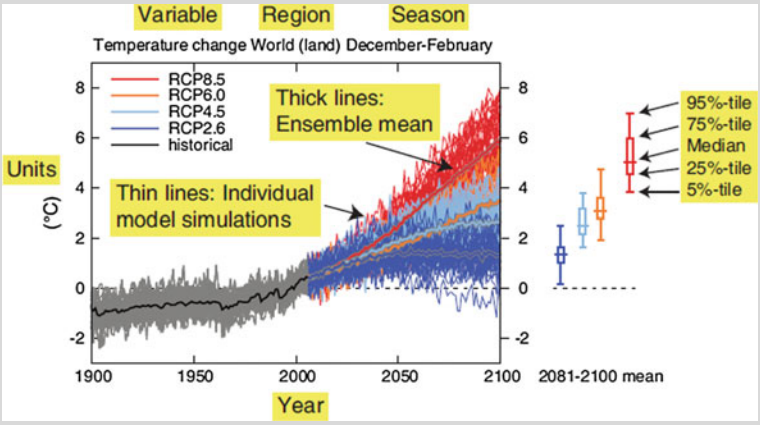


Fig. 2.4 Explanation of the features of a typical time series figure presented in the IPCC AR5. (IPCC AR5 Figure AL.1)

the uncertainty that arises from the use of different models. To provide a framework for systematic comparison the centers agree on so-called "Model Intercomparison Projects (MIPs)". Many results of the AR5 are based on the 5th Coupled Model Intercomparison Project (CMIP5[1]). The typical resolution of the atmospheric component of global climate models in the AR5 is in the order of 1°–2°. Regional Climate Models (RCMs) are used to simulate regional climate at higher spatial resolution. Lateral boundary conditions are taken from global climate simulations. Again, several centers contribute with

[1]The **Coupled Model Intercomparison Project (CMIP)** provides infrastructure in support of climate model diagnostics validation, intercomparison documentation and data access.

their models within the "COordinated Regional climate Downscaling Experiment (CORDEX)".

Global climate projections based on the scenarios result in strongly different changes in global surface temperature.

Geopolitical agreements to control emissions may affect further anthropogenic emissions of greenhouse gases (GHG), aerosol particles and other factors like land use change. To assume the climate of the future, different scenarios have been developed, and based on these scenarios potential climate changes are simulated to provide these results for decision makers. Integrated Assessment Models (IAMs) have been used for the RCPs including economic, demographic, energy, and simple climate components; therefore simple models have been used to produce time series of GHGs concentrations that are used as forcing in Atmosphere-Ocean General Circulation Models.

2.3 Observed Climate Trends

The IPCC AR5 pointed out that on a global scale temperatures have increased since 1950 and the global temperature will continue to rise until the end of the century. During the last 50–100 years the temperature has increased by 0.5 °C or more over most parts of Africa. In particular, the minimum temperature increases faster than the maximum temperature (Stern et al. 2011; Funk et al. 2012; Nicholson 2013) and focusing on climate scenarios, it is very likely that land temperatures over Africa will rise faster than the global average, especially over the arid regions like the Sahel (Fig. 2.5) (Stocker et al. 2013). One problem with the verification of these trends is a lack of observational data over several regions in Africa.

> *"...there is low to medium confidence in historical trends in daily temperature extremes in Africa and South America as there is either insufficient data or trends vary across these regions."*
>
> (IPCC AR5I, Stocker et al. 2013)

The interpretation of precipitation observations is more complex than those for temperature. In general, trends in precipitation come with higher uncertainties than those in temperature (Rowell 2012) and exhibit higher spatial and seasonal dependence (Orlowsky and Seneviratne 2012). Therefore, observed trends in precipitation vary more than those for temperature. Over Africa it is very likely that precipitation has increased over the eastern and southern parts. However, it is very likely that there is a decrease in precipitation over the western and eastern Sahel region in northern Africa between 1951 and 2010 (Fig. 2.5). Note that the IPCC report pointed out that the lack of sufficient observational data does not allow for conclusions to be drawn about trends in annual precipitation over the past century,

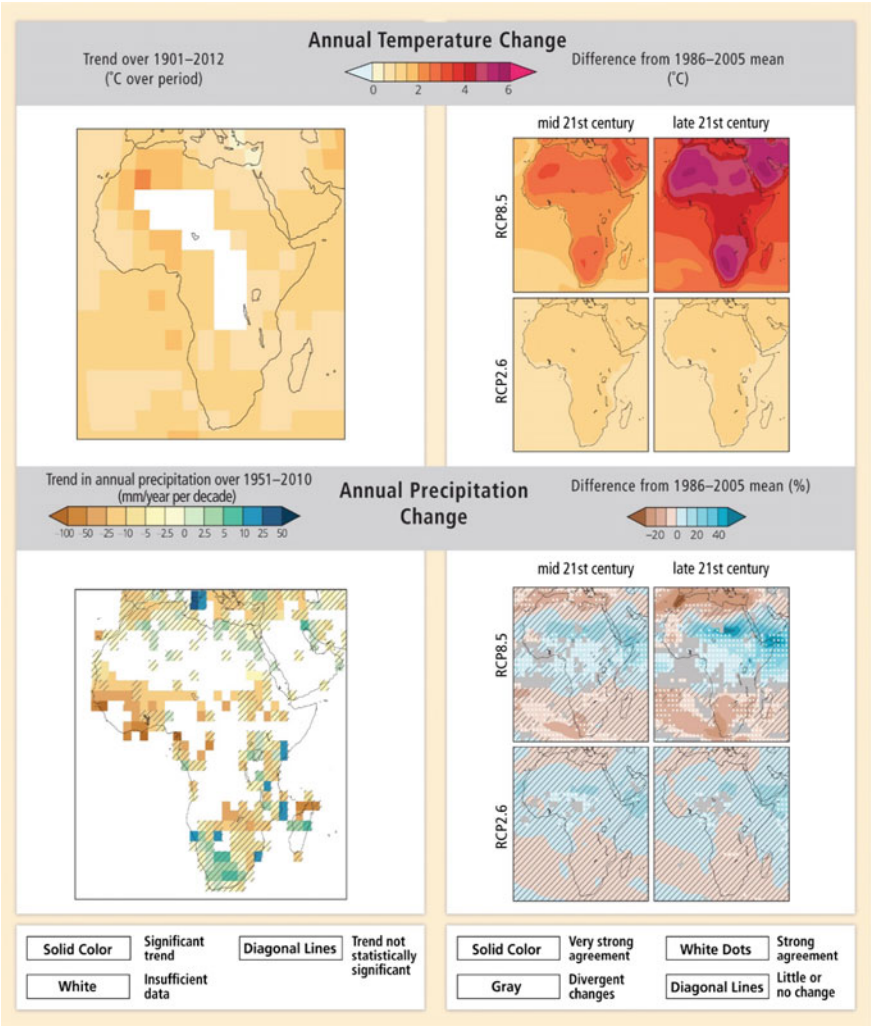
and that there are discrepancies between existing observed precipitation datasets (Sylla 2013; Nikulin et al. 2012; Kim 2013). Areas with insufficient observation data are shown in Fig. 2.5 as white shapes.

2.4 Climate Trends in West Africa

For the IPCC assessment report all available data have been used to get a picture of global and regional historical and ongoing development of climate. On the regional scale for West Africa and the Sahel, observations show an increase in annual mean temperature over the last 50 years. As mentioned by the AR5 of the IPCC, "Collins (2011) shows statistically significant warming of between 0.5 and 0.8 °C between 1970 and 2010 over the region using remotely sensed data with a greater magnitude of change in the latter 20 years of the period compared to the former" (Collins 2011). Moreover, there is strong evidence of an anthropogenic signal in continent-wide temperature increases in the 20th century (Min and Hense 2007; Stott et al. 2010; IPCC 2014). Also, climate extremes have increased, as there is a decrease in number of cold days and nights and an increase in number of warm days and warm nights between 1961 and 2000 (New et al. 2006; Niang et al. 2014).

Over the Sahel the precipitation has decreased over the course of the 20th century, whereas over the last 20 years a recovery of the precipitation has been observed (WGI AR5 Section 14.3.7.1; (Nicholson et al. 2000; Lebel and Ali 2009; Ben Mohamed 2011; Ackerley et al. 2011; Biasutti 2013)). The lack of long time series and the gaps in the understanding of the weather system lead to a differential view and interpretation of this signal. Several studies focused on the precipitation recovery in West Africa lead to different causes: (1) natural variability (Mohino et al. 2011) or (2) a forced response to increased greenhouse gases (Haarsma et al. 2005; Biasutti 2013; Dong and Sutton 2015) or (3) reduced aerosols (Ackerley et al. 2011). A recently published study reported that the annual rainfall trend is statistically positive for the Sahel between the West Coast and 15°E (Sanogo et al. 2015) between 1980 and 2010. At the same time, the onset of the rainy season has not significantly shifted, although the length of the Sahelian rainy season reveals an increasing trend of 2–3 days per decade (Sanogo et al. 2015). During the 1970s and 1980s western Africa and especially the Sahel was challenged by several droughts.

> *"Confidence is low for a global-scale observed trend in drought or dryness (lack of rainfall) since the middle of the 20th century, owing to lack of direct observations, methodological uncertainties and geographical inconsistencies in the trends."*
>
> (AR5 WGI chapter 2 (Hewitson et al. 2014))


Annual Temperature Change
Trend over 1901–2012
(°C over period)
0 2 4 6
Difference from 1986–2005 mean
(°C)
mid 21st century
late 21st century
RCP8.5
RCP2.6
Trend in annual precipitation over 1951–2010
(mm/year per decade)
-100 -50 -25 -10 -5 -2.5 0 2.5 5 10 25 50
Annual Precipitation Change
Difference from 1986–2005 mean (%)
-20 0 20 40
mid 21st century
late 21st century
RCP8.5
RCP2.6
Solid Color
Significant trend
Diagonal Lines
Trend not statistically significant
White
Insufficient data
Solid Color
Very strong agreement
White Dots
Strong agreement
Gray
Divergent changes
Diagonal Lines
Little or no change

◀ **Fig. 2.5** Modified graphic from the IPCC chapter AR5 WG2 Chapter 22, show observed and projected changes in annual average temperature and precipitation. (Top panel, left) Map of observed annual average temperature change from 1901–2012, derived from a linear trend. [WGI AR5 Figures SPM.1 and 2.21] (Bottom panel, *left*) Map of observed annual precipitation change from 1951–2010, derived from a linear trend. [WGI AR5 Figures SPM.2 and 2.29] For observed temperature and precipitation, trends have been calculated where sufficient data permit a robust estimate (i.e., only for grid boxes with greater than 70 % complete records and more than 20 % data availability in the first and last 10% of the time period). Other areas are white. Solid colors indicate areas where trends are significant at the 10 % level. Diagonal lines indicate areas where trends are not significant. (Top and bottom panel, right) CMIP5 multi-model mean projections of annual average temperature changes and average percent changes in annual mean precipitation for 2046–2065 and 2081– 2100 under RCP2.6 and 8.5, relative to 1986–2005. Solid colors indicate areas with very strong agreement, where the multi-model mean change is greater than twice the baseline variability (natural internal variability in 20 yr means) and ≥90 % of models agree on sign of change. Colors with white dots indicate areas with strong agreement, where ≥66 % of models show change greater than the baseline variability and ≥66 % of models agree on sign of change. Gray indicates areas with divergent changes, where ≥66 % of models show change greater than the baseline variability, but <66 % agree on sign of change. Colors with diagonal lines indicate areas with little or no change, where <66 % of models show change greater than the baseline variability, although there may be significant change at shorter timescales such as seasons, months, or days. Analysis uses model data and methods building from WGI AR5 Figure SPM.8. See also Annex I of WGI AR5. [Boxes 21-2 and CC-RC]. (*Source* Fig. 22-1 IPCC WG2 Chapter22, Niang et al. 2014)

2.4.1 Droughts in West Africa

In the 4th Assessment Report (AR4) it has been concluded that droughts had become more common, especially in the tropics and the sub-tropics since the 1970s (IPCC 2007). The IPCC Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX") described in the Assessment Report 4 (IPCC 2007) states that there are not sufficient direct observations of dryness to suggest high confidence in observed trends on a global scale. However, there was enough information on dryness to show a significant increase in more intense and longer droughts worldwide with a medium confidence. Due to the fact that there are only a few direct measurements of drought related variables such as soil moisture (Robock et al. 2000), often drought proxies like the Palmer Drought Index (PDSI), Standardized Precipitations Index (SPI) and the Standardized Precipitation Evapotranspiration Index (SPEI) or hydrological drought proxies (Vidal et al. 2010; Dai 2011) are used to assess drought. The use of different drought proxies for the ranking of drought events is problematic because the chosen proxies (e.g., precipitation, evapotranspiration), together with the time scale, strongly affect the ranking (Vidal et al. 2010; Sheffield et al. 2012).

Another problem comes with the complexity of drought as calculated parameter. Drought can be at best incompletely represented by commonly used drought indices. Therefore the interpretation of the results can produce discrepancies between different studies depending on the proxy. For example, Sheffield et al. (2009) found decreasing trends in the duration, intensity and severity of drought globally, while Dai (2011) found a general global increase in drought, with several

regional variations. In the latest IPCC (IPCC chapter 2) (Hartmann et al. 2013) it is stated that there is still a problem with drawing conclusions about drought because of global differences in data availability, quality and length of records. However, there is an indication with a high confidence that dryness increases in the Mediterranean and West Africa.

2.5 Future Climate of West Africa

Exposition and the huge land mass may increase the possibility of a faster temperature increase in Africa than in other regions. Therefore, temperatures in Africa are projected to rise faster than the global average increase during the 21st Century (Christensen et al. 2007; Sanderson et al. 2010; Joshi et al. 2011; James and Washington 2013). Global mean temperature is expected to rise by more than 2 °C on average in the ensemble-mean of global projections above the late-20th-century baseline over most land areas of the continent in the mid-21st-century for RCP8.5, and to exceed 4 °C over most land areas in the late-21st-century for RCP8.5.

Following the RCP8.5 mean annual temperature, changes in mean annual temperature will affect Africa with an uneven magnitude. Larger changes are expected over northern and southern Africa and smaller changes over central Africa. The ensemble-mean changes are less than 2 °C above the late-20th-century baseline in both the mid- and late-21st-century for RCP2.6. Under different scenarios the global average near-surface air temperature moves beyond 20th Century simulated variability by 2069 (±18 years) under RCP4.5 and by 2047 (±14 years) under RCP8.5 (Mora et al. 2013). Comparing this global pattern with the African pattern, these unprecedented climates are projected to occur one to two decades earlier than the global average because the relatively small natural climate variability in this region generates narrow climate bounds that can be easily surpassed by relatively small climate changes. Figure 2.5 shows projected temperature increases based on the CMIP5 ensemble, based on Fig. 2.4 (Niang et al. 2014).

West Africa is expected to be strongly impacted by temperature increase. The latest IPCC report shows a warming range of 3 and 6 °C above the late 20th Century baseline (Meehl et al. 2007; Fontaine et al. 2011; Diallo et al. 2012; Monerie et al. 2012; Niang et al. 2014) (Fig. 2.3). Diffenbaugh and Giorgi (2012) identify the Sahel and tropical West Africa as a hotspot of climate change for both RCP4.5 and RCP8.5 pathways and unprecedented climates are projected to occur earliest (late 2030s to early 2040s) in these regions (Diffenbaugh and Giorgi 2012). Observed and simulated variations in past and projected future annual average temperature over the Economic Community of West African States (ECOWAS) are captured in Figs. 2.5 and 2.6; the graphics indicate that the projected temperature rise is very likely to exceed the 1986–2005 baseline by between 3 and 6 °C across the region by the end of the 21st century under RCP8.5.

As mentioned before, precipitation is more uncertain than temperature, which results in higher uncertainties for the climate projections (Rowell 2012; Orlowsky

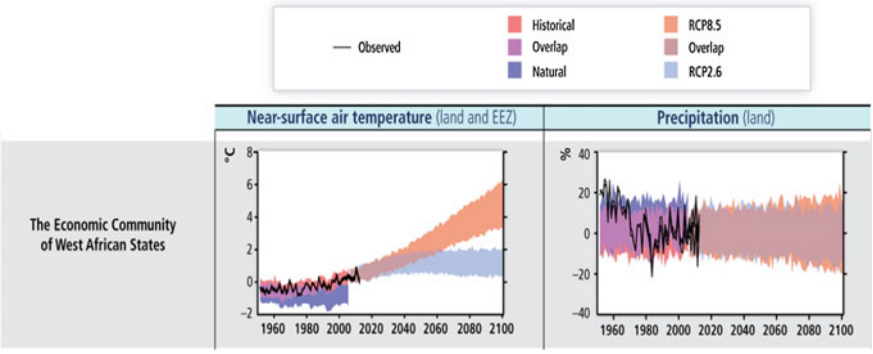


Fig. 2.6 Observed and simulated variations in past and projected future annual average temperature over ECOWAS. Black lines show various estimates from observational measurements. Shading denotes the 5–95 percentile range of climate model simulations driven with "historical" changes in anthropogenic and natural drivers (63 simulations), historical changes in "natural" drivers only (34), the "RCP2.6" emissions scenario (63), and the "RCP8.5" (63). Data are anomalies from the 1986–2005 average of the individual observational data (for the observational time series) or of the corresponding historical all-forcing simulations. Note this figure is a slightly modified picture taken form IPCC WGII Fig. 22-2 (Niang et al. 2014)

and Seneviratne 2012). The fluctuation in annual precipitation is illustrated in Fig. 2.6. In general, the difference between the model bias of the scenarios RCP8.5, in orange, and RCP2.6, in light blue, is obvious for temperature but not for precipitation. Using the mean of historical observed precipitation, it is seen that there was a huge variation in annual precipitation in the past. The model does not predict a drastic change in the amount of precipitation until 2100.

Recent studies have shown an inter-model variation precipitation projection especially in the amplitude and direction of change that is partially attributed to the inability of GCMs to resolve convective rainfall (Christensen et al. 2007; Fontaine et al. 2011, Roehrig et al. 2013; Klutse et al. 2015). Furthermore, the rainfall season is predicted to be wetter and delayed by the end of the 21st Century (Christensen et al. 2007). However, using RCMs, the CORDEX initiative analyzed recently the result of ten RCMs along with the ensemble of their statistics in simulating daily precipitation characteristics during the WAM period (Klutse et al. 2015). In the regional projections, huge discrepancies occur between the RCMs and the observations, and among the RCMs themselves. Main differences between the models are the impact of convective events during the WAM period. Convective effects determine mean precipitation and daily statistics such as intensity of rainy days, frequency, extremes and duration of rainfall events. A more detailed analysis of regional climate model can be found in the chapter "Climate Change over West Africa: Recent Trends and Future Projections" (Sylla et al. 2016 (this book)).

Overall, there is a low confidence of the delay in the onset of the West African rainy season with intensification of late-season rains in the latest projections of the CMIP5.

2.6 Summary

Based on the latest IPCC Assessment Report 5, this chapter discussed the current climate conditions in Africa with a special focus on West Africa based on observations and gives an outlook into the future based on climate scenarios and projections. Since 1950 temperature over West Africa has increased and it will increase further in the future. As observed, the number of cold days and nights has decreased whereas the number of warm days and nights has increased. Precipitation is relevant for many processes in ecology, agriculture or hydrology. Since the 1970s West Africa has been affected by several droughts; during this time precipitation was below the average. Following the IPCC report, the amount in precipitation has increased since 1986. Projections indicate an increase in precipitation until 2100 depending on the scenario. Also, the onset of the rainy season has not significantly shifted since 1980. However, the length of the Sahelian rainy season reveals an increasing trend of 2–3 days per decade, with a drier phase within.

Overall, the possibility of detailed scientific analysis of long-term changes is still restricted due to the limited availability of sufficient observational data. Therefore, an improvement of the observations network, data rescue activities of historic climate data and an improvement of the climate data management in the region is urgently needed.

Acknowledgements JOR and RP are funded by the BMBF within the SASSCAL initiative (grant 01LG1201 J: Climate data management).

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Chapter 3
Climate Change over West Africa: Recent Trends and Future Projections

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Abstract The West African climate has evolved in recent decades to respond to elevated anthropogenic greenhouse gas (GHG) forcing. An assessment of its recent trends and future changes is presented here based on various data sources (observations and models), along with an extensive review of recent literature including the latest Intergovernmental Panel on Climate Change report. A gradual warming spatially variable reaching 0.5 °C per decade in recent years is observed. In addition, the Sahel has recovered from the previous drought episodes (i.e., 1970s and 1980s); however, the precipitation amount is not at the level of the pre-drought period. Although these features are common across the different data sources, their magnitudes differ from one source to the other due to a lack of reliable observation systems. Projected climate change indicates continuous and stronger warming (1.5–6.5 °C) and a wider range of precipitation uncertainty (roughly between −30 and 30 %) larger in the Sahel and increasing in the farther future. However, the spatial distribution unveils significant precipitation decrease confined to the westernmost Sahel and becoming greater and more extensive in the high level GHG forcing scenario by the end of the 21st century. This coexists with a substantial increase in both dry spell length and extreme precipitation intensity. West Sahel is thus the most sensitive region to anthropogenic climate change. The rest of West Africa also experiences more intense extremes in future climate but to a lesser extent. It is also reported from other previous studies that the projected rainy season and the growing season will

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J.A. Yaro and J. Hesselberg (eds.), *Adaptation to Climate Change and Variability in Rural West Africa*, DOI 10.1007/978-3-319-31499-0_3

become shorter while the torrid, arid and semi-arid climate conditions will substantially extend. It is thus evident that in a "business as usual" World, most countries in West Africa will have to cope with shorter rainy seasons, generalized torrid, arid and semi-arid conditions, longer dry spells and more intense extreme precipitations. Such conditions can produce significant stresses on agricultural activities, water resources management, ecosystem services and urban areas planning. However, some GHG mitigation (i.e., a mid-level forcing) could help to reduce the stress.

Keywords Anthropogenic climate change · Recent trends · Sahel precipitation recovery · Projections · Uncertainties · Extreme events

3.1 Introduction

In the timeline of the Intergovernmental Panel on Climate Change (IPCC) Assessment Report 5 (AR5), global warming resulting from enhanced anthropogenic greenhouse gases (GHGs) forcing on global climate is scientifically well established (IPCC 2013). In fact, global near-surface air temperatures have increased at a rate unequal to any other periods on record including paleo periods (Hartmann et al. 2013; Karl et al. 2015). Such increases have substantial consequences on precipitation and its variability, especially drought and flood episodes in both the tropics and the subtropics (Zwiers et al. 2013; Giorgi et al. 2014a).

It is thus common that the developing countries' low-income populations are likely to be affected by factors related to global warming, making West Africa one of the regions in the world that are most vulnerable to climate change. This is particularly true for rural areas where agriculture is the most prominent instrument for securing income and overcoming poverty (Boko et al. 2007). This region experiencing exponential population growth is already facing the consequences of climate change through gradual land degradation and loss of croplands and ecosystem services (Lambin et al. 2003; Leh et al. 2013; Carney et al. 2014) and high water stress and scarcity (Schewe et al. 2014), along with recurrent and localized droughts and flash floods (Douglas et al. 2008; Dai 2013). These conditions, expected to be exacerbated in the future, constitute significant threats to water resources, agricultural activities and ecosystem services (Lobell et al. 2011; Anyamba et al. 2014).

While local populations have difficulties adapting to such present-day conditions, the absence of governmental politics that would help to alleviate the consequences of future climate change adds another degree of vulnerability for rural inhabitants. Therefore, reliable adaptation methods are urgently needed in order to address the negative impacts of climate change and this requires the understanding of recent trends and the elaboration of robust climate change scenarios for the West African domain.

In this chapter, recent trends and future projections for the West African climate system are investigated by reviewing findings from the latest IPCC report and using

various observation products and a multi-model ensemble based on the newly generated COordinated Regional climate Downscaling EXperiments (CORDEX; Giorgi et al. 2009) simulations.

3.2 Recent Trends in Climate Change over West Africa

This section examines recent trends in seasonal (May-September) mean temperature and precipitation over West Africa for the period ranging from 1983 through 2010. To this end, various observation products including data from the University of Delaware (UDEL 0.5° × 0.5° resolution; Legates and Willmott 1990), from the Climatic Research Unit of the University of east Anglia (CRU 0.5° × 0.5° resolution; Harris et al. 2014) and from the African Rainfall Climatology (ARC 0.1° × 0.1° resolution; Novella and Thiaw 2013) are used to account for uncertainties in different observed products (Nikulin et al. 2012; Sylla et al. 2013a). The latest IPCC report findings and highlights are also reviewed and compared with key studies that explore similar topics.

In recent decades, a clear warming in both CRU and UDEL is trending over most West Africa (i.e., Fig. 3.1). These trends are statistically significant at the 90 % level. The Gulf of Guinea and west Sahel, for instance countries such as

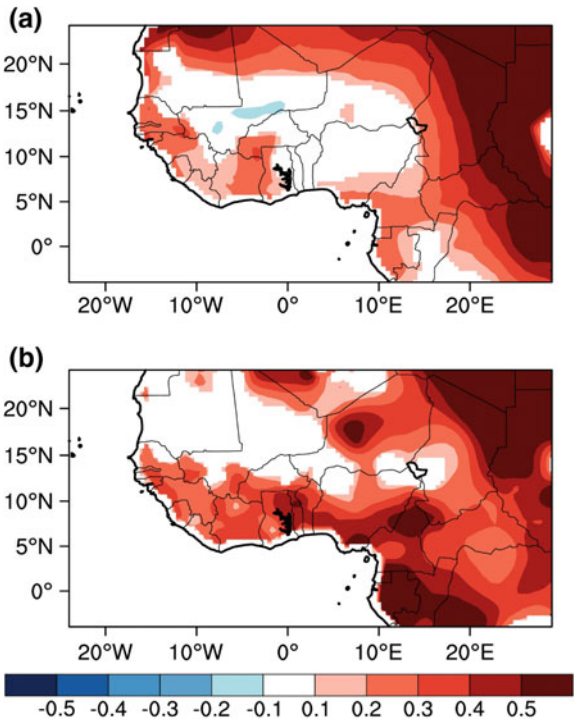

Fig. 3.1 Linear trends in mean seasonal (May–September) temperature over West Africa for the period 1983–2010. Only areas where the trend is statistically significant at the 90 % level are shaded. *Temp* stands for Temperature, *CRU* for Climate Research Unit and *UDEL* for University of Delaware. **a** CRU Temp trend: 1983–2010. **b** UDEL Temp trend: 1983–2010

Ghana, la Cote d'Ivoire, Guinea and Senegal experience the most significant and warmest signals ranging from 0.2 °C to more than 0.5 °C per decade. This is consistent with the last IPCC report (IPCC 2013) and a recent study from Padgham et al. (2015) stating that the whole of West Africa has recorded in recent decades a warming of between 0.3 and 1 °C. In contrast, southern Sahara and northern Sahel (e.g., southern Mauritania, Mali and Niger and northern Burkina Faso) show no significant changes. While these patterns are common to both observation products (CRU and UDEL), it is worth highlighting the point that the two data also have substantial differences. For example, in southern Mali and a larger part of Nigeria and Niger, UDEL unveils a more significant positive trend while CRU exhibits no significant trend, making it difficult to unambiguously assess the recent changes in temperature patterns in these regions during the last decades.

For the precipitation (Fig. 3.2), a tendency towards a significant increasing trend of about 0.2–1.0 mm/day per decade occurs along the Sahel band. This positive

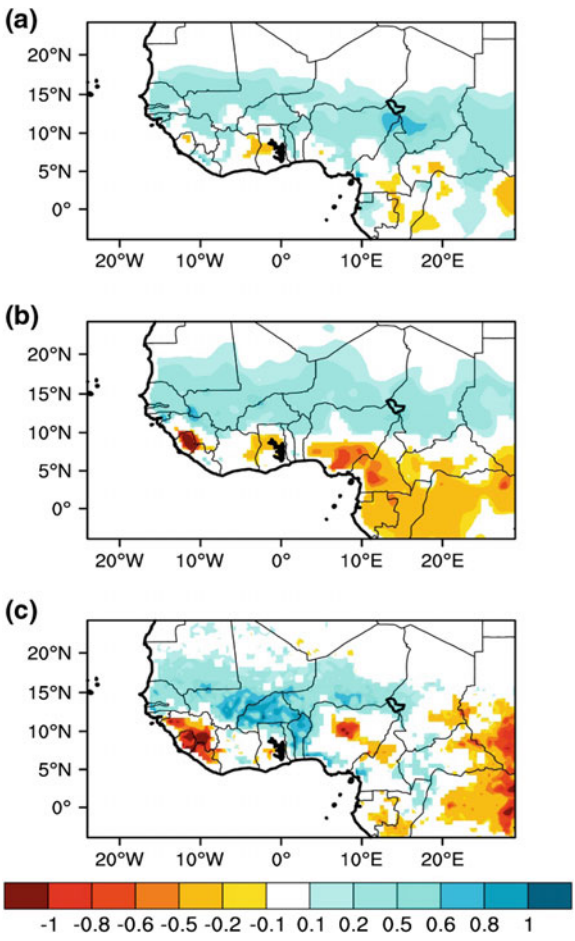

Fig. 3.2 Linear trends in mean seasonal (May–September) precipitation over West Africa for the period 1983–2010. Only areas where the trend is statistically significant at the 90 % level are shaded. *Precip* stands for Precipitation, *CRU* for Climate Research Unit, *UDEL* for University of Delaware and ARC for African Rainfall Climatology. **a** CRU Precip trend: 1983–2010. **b** UDEL Precip trend: 1983–2010. **c** ARC Precip trend: 1983–2010

precipitation trend, statistically significant at the 90 % level, covers countries such as Senegal and Burkina Faso but also the southern half of Mauritania, Mali, Niger and Chad. The precipitation increase is more spatially extended in UDEL and larger in magnitudes in ARC. However, the general pattern is similar in all the three observation products, making it a robust signal. Another common feature is the significant negative trend around a few areas in the orographic regions and a portion of the Gulf of Guinea. Overall, this indicates that the Sahel has experienced wetter conditions while the orographic regions and a small part of the Gulf of Guinea have recorded drier conditions in recent years.

Such a result is consistent, to some extent, with recent studies (Nicholson 2005; Hagos and Cook 2008; Mahe and Paturel 2009; Riede et al. (2016) (this issue)). For example, Lebel and Ali (2009) noted that precipitation over central Sahel has increased by about 10 % during the period that ranges from 1990 through 2007 compared to 1970–1989, while in the west Sahel, the deficit remains unchanged. In another study, Druyan (2011) found that since the last few decades (1990s and 2000s).

Seasonal precipitation accumulations over the Sahel have recovered but do not reach the levels of the period preceding the drought episodes of the seventies and eighties. As a matter of fact, IPCC (2013) reports a drying trend over West Africa in a longer time series ranging from 1951 to 2012. Recently, a more extensive study by Ibrahim et al. (2014) reveals that in the last two decades, not only have the annual precipitation totals increased, but also the rainy days have been more frequent, leading to the partial recovery of precipitation amount. This recent precipitation recovery in the Sahel is due, to a great extent, to the direct influence of higher levels of anthropogenic greenhouse gases in the atmosphere, along with changes in anthropogenic aerosol precursor emissions (Haarsma et al. 2005; Ackerley et al. 2011; Biasutti 2013; Dong and Sutton 2015), although natural variability might have played an important role (Mohino et al. 2011). In addition to the wetter precipitation trend, the prevalence of a higher interannual variability, a delayed onset and an early retreat of the monsoon season in recent years over West Africa have been reported (Biasutti and Sobel 2009; Sylla et al. 2010a; Diallo et al. 2013; Seth et al. 2013; Hartmann et al. 2013).

3.3 Projected Climate Change over West Africa

According to the latest IPCC (2013) report, the present-day warming and the increased variability of precipitation are likely to be exacerbated in future climate with large regional variations and different degrees of confidence. However, mean precipitation shows substantial uncertainties as the Coupled Models Intercomparison Project Phase 5 (CMIP5; Taylor et al. 2012) Global Climate Models (GCMs) disagree in both direction and magnitude of change. In this regard, IPCC (2013) states that there is low to medium confidence in the robustness of projected regional precipitation change over Africa in general until a larger body of regional results become available through, for example CORDEX. We thus use the set of Regional

Climate Models (RCMs) participating in the CORDEX program and available for the West African domain (see Sylla et al. 2016) to assess future climate change over the region. Although there is inherent value in each group of models (GCMs and RCMs), using RCMs is probably more appropriate because of the presence of complex terrains, high variations of landcover and the mesoscale nature of precipitation over West Africa (Teichmann et al. 2013; Dosio et al. 2015; Sylla et al. 2015). The higher resolution in CORDEX (50 km compared to 100s km in CMIP5) would favor the gain of more detailed climate change information at the regional/local level. The CORDEX experiments have been described in detail by Jones et al. (2011). In addition, the outputs have been thoroughly validated over West Africa (Gbobaniyi et al. 2014; Klutse et al. 2015). For this assessment, a multimodel ensemble approach is carried out for the sake of robustness in the projections (Diallo et al. 2012; Sylla et al. 2013b; Haensler et al. 2013; Dosio and Panitz 2015).

In Fig. 3.3, the CORDEX multimodel long-term time series of seasonal (May-September) mean temperature and precipitation anomalies are shown along with the range of possible values for the Sahel, the Gulf of Guinea and whole West Africa during the historical (1970–2005) and the future (2006–2100) periods and for both RCP8.5 and RCP4.5. These RCP forcing scenarios are described in detail by Moss et al. (2010) and Riede et al. (2016). The anomalies are calculated with respect to the seasonal mean of the reference period 1976–2005. The CORDEX time series confirm IPCC findings, indicating that the regions have undergone significant warming in recent decades and that this is going to be amplified in the future regardless of the greenhouse gas (GHG) forcing scenario. This is the result of previous GHG emissions and also inertia in the climate system (IPCC 2013). Considering a "business as usual" (high level GHG) forcing scenario (RCP8.5) and a mid-level one (RCP4.5), the warming gradually increases and reaches its maximum on 2100. However, the temperature changes from the two forcing scenarios start to diverge only around 2050 and this divergence is maximal on 2100. The mid-level GHG forcing scenario yields to lesser warming while the high level forcing produces a greater warming. Thus, at the end of the century, possible warming over West Africa ranges from 1.5 to 6.5, with the Sahel experiencing the largest changes.

The mean precipitation change over West Africa and the two subregions (Fig. 3.3) shows a less evident trend and mostly oscillates between −10 and 10 %. In addition, climate change causes more precipitation variability with greater amplitudes (i.e., Fig. 3.3b, d, f). The range of possible precipitation changes spans both negative and positive values (mostly between −30 and 30 %), indicating that projected precipitation is highly uncertain over the region, consistent with IPCC (2013). It is interesting to note that the range of uncertainty gradually increases as the RCP forcing increases (i.e., as the time frame increases), suggesting that the different RCMs generate substantial different responses to a larger forcing. The largest uncertainty is found in the Sahel as in IPCC (2013), probably because of differences in the models' representations of the West Africa Monsoon and its interactions with deep convection (Fontaine et al. 2011; Sylla et al. 2011; Roehrig et al. 2013). However, considering the spatial pattern of change (i.e., Fig. 3.4), it is clear that

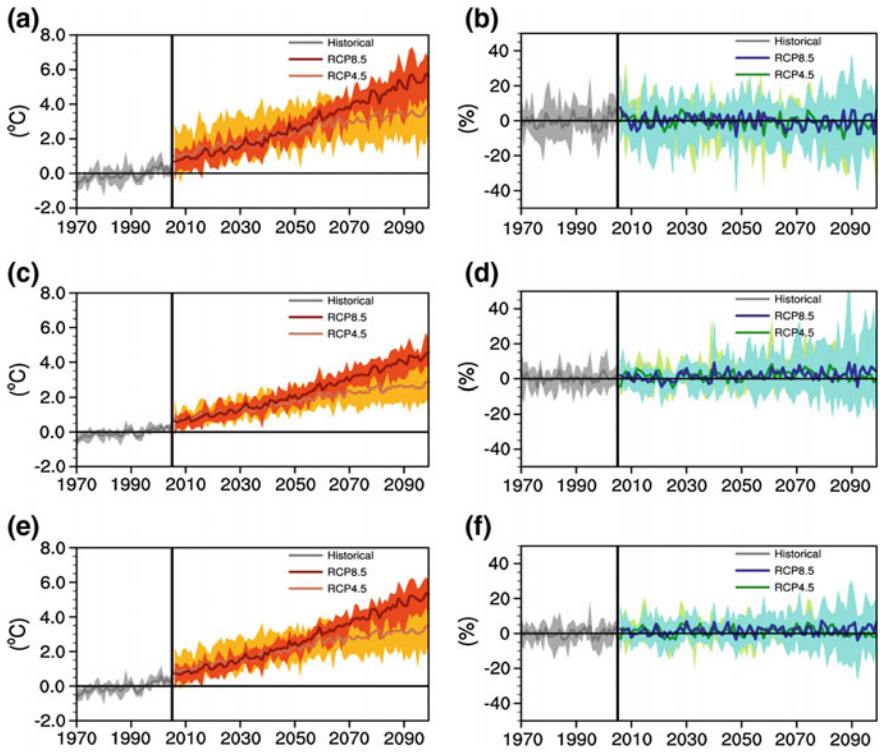

Fig. 3.3 Long-term time series (1970–2100) of seasonal (May–September) mean temperature (*left panels*) and precipitation (*right panels*) anomalies for the Sahel (*upper panels*), the Gulf of Guinea (*middle panels*) and the West Africa (*lower panels*) and for both RCP4.5 and RCP8.5 based on multimodel CORDEX simulations. The anomalies are calculated with respect to the seasonal mean of the period 1976–2005. The *shaded areas* denote ensemble maxima and minima. **a** Sahel temperature change. **b** Sahel precipitation change. **c** Guinea temperature change. **d** Guinea precipitation change. **e** West Africa temperature change. **f** West Africa precipitation change

although most of West Africa experiences no changes, a significant precipitation decrease of about 5–40 % prevails in the West Sahel. This precipitation reduction strengthens and further extends spatially to the East as the forcing increases from RCP4.5 to RCP8.5 and the time period shifts from 2036–2065 to 2071–2100. During the late 21st Century, it covers the whole of Senegal, southern Mauritania and Mali and northern Guinea. It is worth mentioning that a few precipitation increases (5–10 %) are also projected but to a lesser extent in some small areas in the Gulf of Guinea, covering Sierra Leone, Liberia and Cote d'Ivoire and over East Sahel in countries such as Niger and Chad. Similar results have been reported in different studies using either single or multiple RCM experiments and have been linked to changes in the West African Monsoon features such as the monsoon flow, African Easterly Jet and African Easterly Waves, but also Integrated Moisture Flux

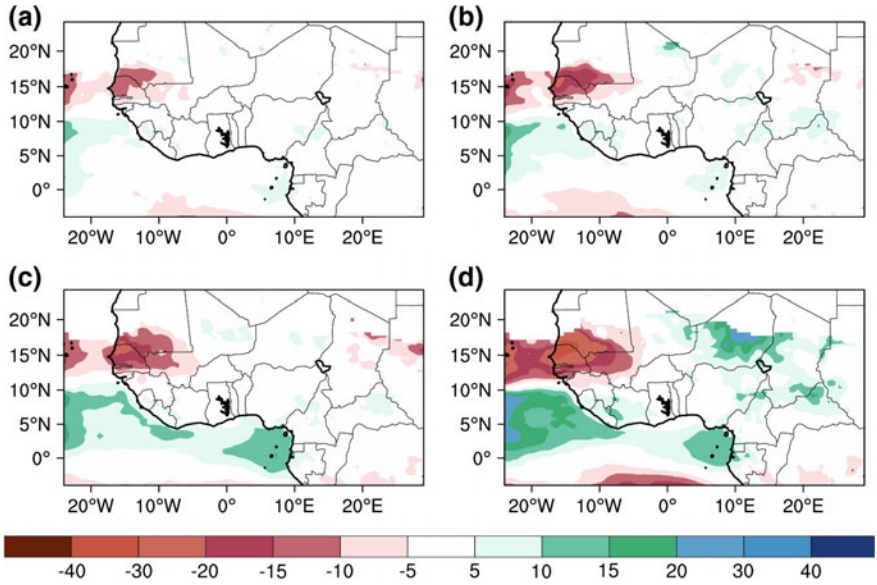

Fig. 3.4 Seasonal (May–September) mean Precipitation changes (RCP4.5/RCP8.5 minus Historical) from the multimodel ensemble mean of CORDEX simulations for the early (2036–2065) and the late (2071–2100) 21st Century. Changes *shaded* are statistically significant at the 90 % level. **a** Precip: RCP4.5 (2036/2065)—Historical. **b** Precip: RCP8.5 (2036/2065)—Historical. **c** Precip: RCP4.5 (2071/2100)—Historical. **d** Precip: RCP8.5 (2071/2100)—Historical

Divergence and Moist Static Energy (Diallo et al. 2012; Laprise et al. 2013; Abiodun et al. 2013; Teichmann et al. 2013; Mariotti et al. 2014; Sylla et al. 2015).

Although it is important to derive and understand changes in mean precipitation, extreme precipitation events have a much greater impact on natural systems and human activities (Parry et al. 2007). To characterize extreme events, two indices are considered here: the dry spell length and the total precipitation intensity of very wet days.

The dry spell length is calculated as the maximum number of consecutive dry days (i.e., days with precipitation lower than 1 mm). The total precipitation intensity of very wet days is the fraction of precipitation accounted for by the very wet days (wet days above the 95th percentile). While the dry spell length index measures drought occurrence (WMO 1986), total precipitation intensity of very wet days provides an indication of high intensity precipitation that can cause widespread flooding events (WMO 1989).

Changes in dry spell (i.e., Fig. 3.5) indicate a significant lengthening of maximum dry period primarily confined over West Sahel and, as with the mean precipitation, extends westwards as the radiative forcing (from RCP4.5 to RCP8.5) and the time frame (from 2036–2065 to 2071–2100) increase. Therefore, the largest and more extended changes covering almost all West Africa are found by the end of the 21st Century and for the high GHG forcing scenario, RCP8.5. In this case, increases

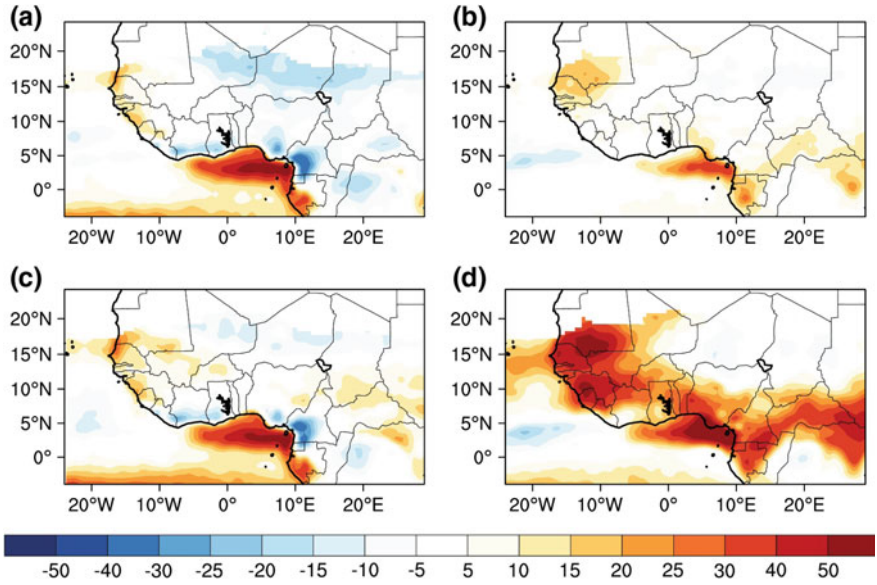

Fig. 3.5 Changes (RCP4.5/RCP8.5 minus Historical) in seasonal (May–September) mean maximum Dry Spell Length (DSL) based on multimodel ensemble of CORDEX simulations for the early (2036–2065) and the late (2071–2100) 21st Century. Changes *shaded* are statistically significant at the 90 % level. **a** DSL: RCP4.5 (2036/2065)—Historical. **b** DSL: RCP8.5 (2036/2065)—Historical. **c** DSL: RCP4.5 (2071/2100)—Historical. **d** DSL: RCP8.5 (2071/2100)—Historical

in the length of dry spell of around 30–50 % with respect to the reference period (1976–2005) are projected in many parts of West Africa in countries such as Senegal, Guinea and Sierra Leone, but also in southern Mauritania, Mali, Burkina Faso and Nigeria, and northern Cote d'Ivoire. Despite these dominant positive changes, few decreases in dry spell length occur in the mid-level forcing scenario (RCP4.5) along the Gulf of Guinea (southern Cote d'Ivoire, Ghana, Nigeria and Cameroon) and east Sahel (central Mali, Niger and Chad).

Projected very wet days intensity leads to different patterns following the fact that a mid-level or a high level GHG forcing scenario is considered (i.e., Fig. 3.6). In fact, in the former (RCP4.5) and for both future time periods (2036–2065 and 2071–2100), amid few regions with no significant changes, small decreases of 5–10 % prevail in most of West Africa. In particular, in areas along the Gulf of Guinea and east Sahel where a decrease in dry spell length occurred, a reduction in extreme precipitation intensity is also projected. This indicates that GHG mitigation can help minimize the effects of climate change over West Africa as it can significantly decrease the occurrence of extreme events. In the high level GHG forcing, a small tendency towards more extreme intensity (5–10 % of increase) is predominant during the early 21st Century; however, by the end of the century, substantial increases are widespread all over West Africa. Countries such as Senegal, Cote

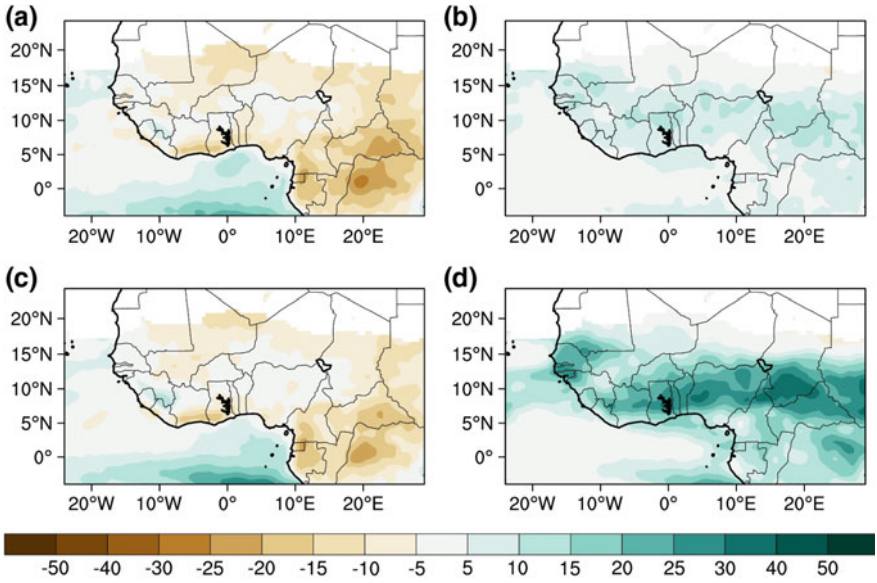

Fig. 3.6 Changes (RCP4.5/RCP8.5 minus Historical) in seasonal (May–September) mean intensity of precipitation events above the 95th Percentile (95Ptot) based on multimodel ensemble of CORDEX simulations for the early (2036–2065) and the late (2071–2100) 21st Century. Changes *shaded* are statistically significant at the 90 % level. **a** 95Ptot: RCP4.5 (2036/2065)—Historical. **b** 95Ptot: RCP8.5 (2036/2065)—Historical. **c** 95Ptot: RCP4.5 (2071/2100)—Historical. **d** 95Ptot: RCP8.5 (2071/2100)—Historical

d'Ivoire, Ghana, Benin, Togo, Nigeria and Chad will experience more intense future increase (more than 40 % of increased intensity compared to the reference period) while other countries such as Mali, Burkina Faso and Niger will undergo a moderate intensity increase of about 20 %. It is thus evident that for the high GHG forcing scenario, longer dry spells and more intense precipitation extremes will become more common over West Africa, with Senegal, Mali, Mauritania, Nigeria and Cote d'Ivoire being more prone to such changes.

The latest IPCC (2013) and Riede et al. (2016; this issue), along with previous studies using either GCMs or RCMs, have reported similar results on the amplification of annual and seasonal extreme events over West Africa as a response to future anthropogenic climate change (Sylla et al. 2010b; Lintner et al. 2012; Vizy and Cook 2012; Scoccimarro et al. 2013; Abiodun et al. 2013; Giorgi et al. 2014b). It was found that such increases of extremes are mostly driven by an intensification of the local hydrological cycle (Giorgi et al. 2011; Sylla et al. 2012) and that their changes may be largest before the mature monsoon season, i.e., around the onset of the rainy season over the Sahel, thus triggering greater impacts (Sylla et al. 2015).

In addition to the increase in dry spell length and intensification of wet extremes discussed above, the shortening of the Sahel rainy season is projected to be more pronounced (i.e., Sarr 2012; Ibrahim et al. 2014), the growing season length further

reduced (i.e., Cook and Vizy 2012), the torrid, arid and semi-arid climate regimes generalized over West Africa, and the moist and wet climate zones much less extensive (Elguindi et al. 2014; Sylla et al. 2016). It is thus clear that West Africa is substantially vulnerable as these changes will not only threaten agricultural activities, water resources management and ecosystem services, but will also considerably disturb urban areas planning.

3.4 Conclusion and Outlook

West Africa is already facing the consequences of climate change. In this chapter, the recent trends and future scenarios are investigated by doing an extensive review of recent literature, including the latest IPCC report, and undertaking a thorough analysis of various observation products and the newly generated CORDEX multi-GCMs/multi-RCMs projections.

The results first confirm that the region has undergone warming in recent decades as a response to increased anthropogenic GHG forcing. This elevated GHG amount in the atmosphere, in addition to changes in aerosols concentration, has favored the Sahel to partially recover from its previous drought episodes. Although this is consistent across the various data sources and the available literature, one key problem is the magnitudes of such recent changes that vary considerably between the different data sources.

This is a direct consequence of lack of sufficient observed datasets, which has prompted the research centers collecting them to just interpolate from few stations. In fact, as stated by the latest IPCC report, there is not enough historical data to show observed trends over large areas of Africa. This situation is mostly due to a general decline of meteorological stations and the absence of reliable data transmission and storage. This not only prevents a thorough understanding of current trends but also induces considerable uncertainty about future climate conditions. Therefore, it is not surprising that in the last few years, some programs have emerged, among them the West African Science Service Center on Climate Change and Adapted Landuse (WASCAL). The main objective of such programs is to strengthen climate services through climate monitoring over West Africa in collaboration with national meteorological agencies. Investment in such programs must be a top priority for regional governments and international partners.

Projected climate change from multimodel CORDEX experiments confirms that temperature over West Africa will continue to rise by about 1.5–6.5 °C in the future. In addition, it shows that future precipitation changes can range between −30 and 30 % with respect to the reference period, indicating the existence of substantial uncertainties in projected precipitation over the region. The uncertainty range is larger in the Sahel and around the end of the 21st century, suggesting that the various GCM/RCM combinations respond to increasing GHG forcing very differently. Despite these uncertainties, some interesting patterns have emerged during the last three decades of the century (2071–2100) and consist of a significant

decrease in mean precipitation, a lengthening of the dry spell and an increased intensity in extreme precipitation over west Sahel covering countries such as Senegal, Mauritania and Mali. These west Sahel countries, along with Cote d'Ivoire and Nigeria, are most prone to the combined increase of droughts and potential floods more pronounced in the high level GHG forcing. The other West African countries will also experience, to a lesser extent, the intensification of such extreme events. On top of these projected climate conditions, the recent literature has emphasized other important aspects of climate change over West Africa such as the reduction of the length of the rainy season and the growing season, increases in the intensity of extremes before the mature monsoon season, and an extension of torrid, arid and semi-arid conditions. It is worth mentioning that the use of a mid-level GHG forcing scenario has led to a small decrease in dry spell length and extreme precipitation intensity amid large areas with no significant changes. This suggests that mitigating anthropogenic GHG emissions could help minimize the effects of climate change over West Africa.

Although this analysis reaches promising results, a wide range of uncertainty still exists in available observation products and CORDEX projections, preventing a thorough assessment of climate change over the region. It is thus critical, on the one hand, to invest in extensive climate monitoring and data collection, and on the other hand, to undertake much more coordinated higher resolution (i.e. 10–25 km) climate change experiments within CORDEX, Phase 2 for a better assessment of recent trends and future climate conditions over West Africa.

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Chapter 4
Seasonal Variability: Impacts, Adaptations and the Sustainability Challenge

Joanna Pardoe, Julia Kloos and Noël Perceval Assogba

Abstract The reality of having to live with some degree of anthropogenic global warming provides a strong impetus for the development and implementation of climate change adaptation strategies. Humans are credited with the ability to foresee and thus to selectively introduce adaptation strategies in anticipation of and response to the challenges of global warming (Gallopín in Glob Environ Change 16 (3):293–303, 2006; Gunderson in Ecol Soc 15(2):1–11, 2010). However, these strategies of deliberate change have to be considered in the context of closely coupled social-ecological systems (SES). Adaptations introduced must therefore be compatible with the social-ecological system in its entirety (Berkes et al. in Navigating social-ecological systems. Building resilience for complexity and change. Cambridge University Press, Cambridge, 2003) and that requires a holistic, systems approach. Using two case studies from West Africa, this chapter presents examples of prominent adaptation strategies that have been introduced in an attempt to adjust to the already evolving climatic conditions. However, through these examples, this chapter demonstrates that a lack of whole systems thinking is at the heart of the limited sustainability of promising strategies. The chapter will examine where the obstacles to sustained implementation arise, concluding with recommendations to address the limitations.

To examine limitations to adaptation in the case study communities, this chapter will aim to answer the following three key questions:

1. What are the impacts of climatic variability, changing rainfall patterns and natural hazards such as floods, dry spells and droughts on rural livelihoods?

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J.A. Yaro and J. Hesselberg (eds.), *Adaptation to Climate Change and Variability in Rural West Africa*, DOI 10.1007/978-3-319-31499-0_4

2. Which adaptation strategies have been introduced to or evolved within the case study areas in order to respond to climate changes?
3. What limitations and barriers restrict sustained adaptation in promising strategies?

4.1 Climate Change in West Africa

West Africa is often labelled as a climate change hotspot (Mertz et al. 2009; Tschakert 2007). This label is based on an understanding that West African communities are often comprised of small, rural communities that especially rely on natural resources via agriculture for their subsistence. The close connection with the environment and climatic regime is combined with climate change projections that suggest changes to the rainfall totals for West Africa. Although, projections remain unclear as to the direction of change in total rainfall, with some predicting an increase and others a decrease, it is generally agreed that rainfall patterns will become less consistent, resulting in greater seasonal variability (Mertz et al. 2012; Juana et al. 2013; Niang et al. 2014).

Seasonal variability is already apparent and manifest in rural communities in the West Sudanian Savannah climate zone, which is the target agro-ecological zone of this chapter. As shown in Fig. 4.1, the traditional bi-modal seasonal pattern comprises a rainy season from May to October/early November and a dry season for the remaining months. The single rainy season provides the sole opportunity for rural communities to produce the crops that they depend upon for their subsistence. Yet, growing evidence from scientific and local observations suggests that the rainy season no longer covers the same period as it did traditionally (Ibrahim et al. 2014; Biasutti and Sobel 2009; Sarr 2012). Farmers reported shifts in the onset of the rainy season, which used to start in April, towards May (Sanfo et al. 2014). This delays the farmers' sowing activities by 10–20 days compared to their parents' (van de Giesen et al. 2010). Furthermore, the rainfall during the wet season is disrupted

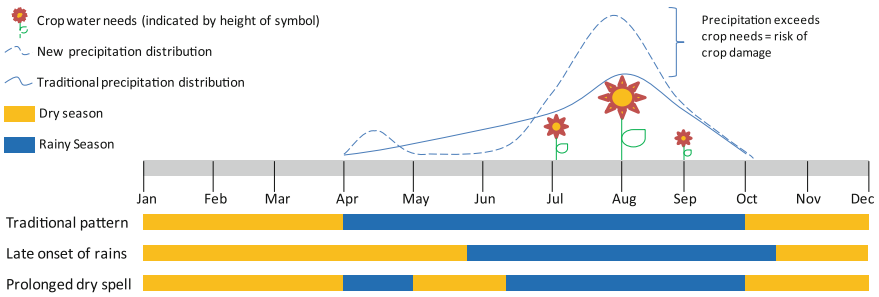

Fig. 4.1 Seasonal variation (based on Ibrahim et al. 2014; Biasutti and Sobel 2009; own interviews)

with prolonged dry spells and heavy bouts of rainfall that exceed the tolerance of traditional cultivation (Mertz et al. 2012; van der Geest 2004).

Climate change is expected to exacerbate the patterns of seasonal variability that are already emerging (Niang et al. 2014). In order to manage these current and future projected changes, adaptation strategies are critical. Given that seasonal variability is already manifest in the West Sudanian Savannah, the impetus to develop and implement adaptation strategies has already resulted in the implementation of new strategies and adjustments. The following sections examine the extent to which these strategies are supporting farmers in adjusting to the new seasonal patterns, highlighting limitations and opportunities to improve the long term sustainability of the strategies.

4.2 Case Study Context

To examine the challenges of adaptation to seasonal variation, we take an area including Dassari in the Commune Materi in north-west Benin as our main, in depth case study and draw on additional insights from Dano in the Ioba province in south-west Burkina Faso to broaden the scope of our findings (Fig. 4.2). Both case studies comprise small villages clustered around the slightly larger 'main' villages of Dassari (Benin) and Dano (Burkina Faso).

Case studies are useful for a detailed examination of factors at the local level and suited to questions requiring an in-depth understanding of complex social-ecological systems. The two case study communities lie in the same climatic zone of the West Sudanian Savannah and comprise communities that are largely dependent on rain-fed subsistence agriculture. This provides the strong connection between the social and ecological spheres of the system. Differences between the case studies can be seen in slight variations in the crops grown and different influences from government and NGO activities and projects. It is anticipated that

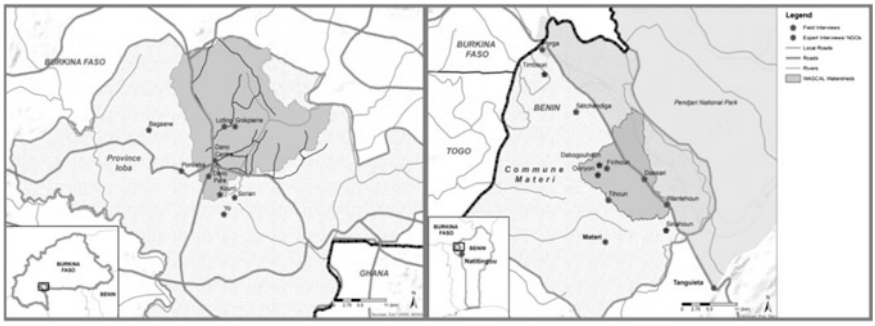

Fig. 4.2 Case study location with surveyed villages (*left* Dano in Burkina Faso, *right* Dassari in Benin. *Cartography* S. Haas)

by using two case studies, this chapter will provide a clear illustration that lessons from the case study examples can be applied to other places with similar climate and social-ecological characteristics.

4.3 Methods

In order to reveal the adaptation strategies that have been developed to address some of the impacts of seasonal variability in the West Sudanian Savannah and to gain a detailed picture of their implementation, in-depth interviews provided the main source of data. The data was collected over the course of more than two years, from November 2012 to February 2015, during which time the authors repeatedly undertook periods of field research in the case study communities. Interviews were conducted with a range of local stakeholders from individual residents and householders to those employed in agencies, governmental organisations and non-governmental organisations relating to agriculture and disaster risk management. The interviews were structured to examine themes of experiences and interpretations of climate change/seasonal variability, adaptation strategies implemented and the degree to which those strategies have addressed the challenges and been sustained over time. Sampling was based on a snowball approach for 'expert' interviewees and random selection for local residents. Translators were vital to the interview process, but with the inclusion of two different case studies with different translators for each case study and for some of the visits, any biases that may have developed from this approach have been minimised as much as possible.

As Table 4.1 demonstrates, similar numbers of interviews took place with local residents in the Benin and Burkina Faso case studies, with slightly more in the major case study of Benin. For expert interviews the weighting towards the Benin case study was much stronger. Due to the presence of a powerful foundation for agricultural research and development support (Dreyer-foundation) in Dano, Dassari was chosen as a main research site. The villages around Dassari can be considered as an area with a more typical influence of numerous small-scale interventions from governmental (GOs) and non-governmental organisations (NGOs). This led to a higher number of NGO and GO interviews for Dassari.

The reason for conducting more interviews with farmers than organisations overall was the focus on adaptation measures on the ground. The point at which the adaptation measures are implemented and the groups benefitting directly from any adaptation successes are the farmers/residents themselves. This group is therefore the most important for identifying the strategies implemented and the limitations

Table 4.1 Interviews per category

	Organisations	Farmers
Benin	24	114
Burkina Faso	8	76

that might prevent sustained implementation. The interviews with organisation and agency representatives provided further information to support the farmer interviews, in particular regarding the role of organisations and agencies in this process and efforts to sustain the strategies.

4.4 Impacts

The interviews revealed that as subsistence agriculture is the dominant source of livelihood in the case study areas, the main impacts of concern relating to seasonal variability are the impacts on crops. The traditional seasonal pattern was well suited to the most important crops (Fig. 4.1). Light rainfall in April/early May would soften the ground to enable weeding and tilling in preparation for sowing. Crops would then mature with rainfall requirements being highest during the peak rainfall months of August/early September before tapering off to allow harvesting of mature crops (Fig. 4.3). However, seasonal variability means that rainfall peaks and lows are now occurring out of sync with the crop demands, effectively resulting in agricultural floods and dry spells, and sometimes droughts. This can be worsened by a reduction in the total length of the usable growing season.

The shorter growing season is disputed by scientific observation (van der Geest 2004; Rademacher-Schultz and Mahama 2012). Observations suggest that the length of time from the first, initial rainfall until the end of the rains and the onset of the dry season is still approximately 6 months. However, what scientific observation fails to demonstrate is that although the very first rainfall occurs in April or early May, increasingly there is a gap between these initial rains and the onset of consistent rains. Where the break extends beyond two weeks, any crops that may have been planted are effectively ruined. Furthermore, the land may dry out, requiring a repeat of effort when the rains do restart.

Another problem occurs where the rainfall volumes fluctuate within the main part of the rainy season. When rainfall is too high, this can flood and damage crops that are not yet mature enough to withstand heavy rains. Occurring later in the

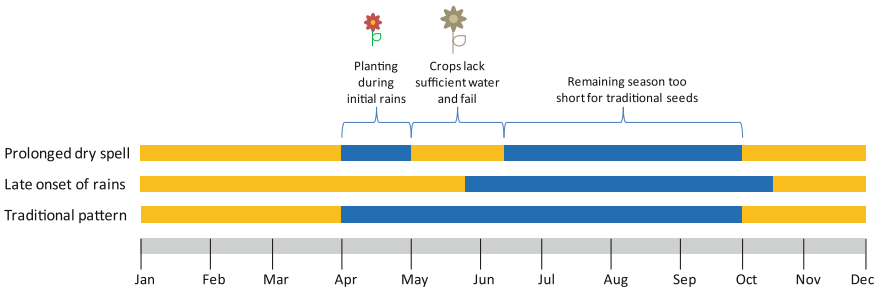

Fig. 4.3 Risks of planting early

season, these fluctuations are highly problematic because this leaves too little remaining time in the season for replanted/re-sowed crops to mature.

When crops are damaged, the reduced yield places the subsistence/food security of a household in jeopardy. If damaged crops are replaced, this will require additional labour for which reimbursement might be necessary if labourers have to be hired. Furthermore, replanting crops requires additional seeds. These seeds may be taken from the household stores of the previous harvest, potentially reducing the amount of grain available for consumption and increasing the severity of the 'hunger period' for that household.

As such, seasonal variability jeopardises the yield of crops and consequently places a household under greater pressure, encouraging the consumption and sale of assets such as livestock. This strain increases over time as seasonal variability repeatedly challenges household capacities to secure an adequate yield. As a result, farmers seek strategies to adapt to seasonal variability and improve their outcomes. The following section presents the most commonly adopted approaches for responding to seasonal variability based on the results of interviews. In the discussion section, these approaches are reflected upon. In particular, consideration is given to the extent to which they help or hinder adaptation and risk reduction towards rainfall variability and the floods and dry spells associated with this. The discussion raises the implication of these outcomes for the food security of subsistence farmers dependent on rain-fed agriculture.

4.5 Responses

In analysing the interviews there was a distinct lack of a consensus not only *between* different actors (i.e., governmental agency staff compared to local residents), but also *among* the different actors (i.e., heterogeneity in local residents group). This made it particularly challenging to unpick a single 'reality' from the different accounts. In the analysis process, it became clear that the actors at all levels represented a diverse group and a variety of different entry points for adaptation. As such there was a need to embrace the heterogeneity in order to reveal the more subtle and enlightening mechanisms at work that explain why some people adapt and others do not and also why there is an overall lack of sustained adaptation over time.

The interviews revealed a host of different approaches to seasonal variability. Some of these approaches originate from the community level, others from government and non-governmental organisations. We do not intend to provide an exhaustive account of all of the adaptation strategies available to the case study communities; instead, this chapter focuses on key approaches that reflect some of the existing diversity in adaptation strategies and illustrate a range of challenges for sustained adaptation.

4.5.1 Adjusting Planting Time

One of the main strategies for adapting to the different seasonal precipitation patterns has been to adjust the point at which crops are planted. This is an approach undertaken by individual households based on their own judgement, often taking into account recommendations by agricultural agencies such as the Centre d'Action Régionale de Développment Rural (CARDER) in Benin. Uncertainty surrounding the seasonal patterns and subjective decision making processes have resulted in a divergence in approaches to the timing of planting, with some choosing to plant early, in line with the traditional rainy season, and others choosing to plant later, once they feel confident that the rains have properly 'set in'. In addition, there are some households that vary their approach from year to year and others that make no changes in the hope that the next year will be better.

4.5.1.1 Planting Early

The interviewees that had decided to plant their crops earlier stated that they would plant their crops at a particular time, regardless of the rainfall (BFCen9; BFGni; BFLof1). Others stated that they would plant early, but rather than select a particular day or set a deadline, they would plant after the second or third rainfall (BFTam2012; BFSte2012).

Planting early was advocated as a strategy by those who felt that it was better to install seeds early in the rainy season in order to capitalize on any initial rainfall. These respondents understood that they risked having to replant their seeds in the event of a long break in the rains at the start of the season, and indeed several interviewees commented that they were accustomed to re-sowing their crops after such events. However, they still advocated early planting, as this would ensure that the crops were mature enough to withstand heavy rainfall later in the season and prolonged breaks (BNTim4; BFLof8; BFSor7; BFTam2012). Figure 4.3 illustrates the opportunities and risks of planting seeds early in the rainy season.

Planting early enables farmers to capitalize on initial rains to grow a full complement of crops. However, if the rains break for more than two weeks, damaging these crops, the farmers have to rely on their stores of grain to re-sow. This also requires additional labour which may be associated with further costs. Where grain stores are limited, replanting is problematic, as it may require the depletion of other assets to purchase seeds, or it may require a household to reduce their calorie intake until the next harvest. This makes the effort of replanting even more challenging as the household members have less energy. Further pressures that add challenges to the early planting process are climatic factors such as high temperatures which persist throughout April and cultural obligations associated with ceremonies that take place at this time, reducing labour and financial capacity.

The challenge for early planting of cotton, rice and maize is that these crops still require some initial rains in order to soften the ground. Without these initial rains,

farmers are unable to plant unless they can obtain ploughing equipment. Those with access to cattle/oxen for ploughing are able to plough their fields early. Those without own oxen have to negotiate with oxen owners. Many farmers reported that they try to maintain good relations with oxen owners to ensure that they are served early. Early payments for the service can also increase the likelihood of being served early.

4.5.1.2 Planting Later

In contrast to planting early in the rainy season, others advocated waiting for or 'following' the rains (BFLof2; BFDre1; BFTam2012) and thus usually planted later in the rainy season as they waited for several 'good' rainfall events to assure them that the rainy season had really begun. Those who planted later often did so based on an impression that the rains 'played tricks' (BFSor1) and that "the rainy season is no longer following the rules" (BNFir2), beginning early as in the case of the traditional rainy season but then breaking for a period of more than two weeks and up to one month. Having lost crops often and having re-sown 2–3 times per season has induced a shift towards late planting for some farmers (BNDas2015b).

In addition to those who choose to plant late, some households are forced to plant late either because they do not have access to ploughing equipment to prepare the land before the rains have softened the ground or because they are positioned near the end of a waiting list and thus have to wait for others to finish ploughing their land before gaining access to the equipment. It can be particularly challenging for female farmers to pay for ploughing in cash. Additionally, they have to work first at their husband's fields on staple crops and thus have to wait until after their husbands have ploughed their fields (Interview AVIGREF).

In Dassari in 2013, limited access to ploughing equipment exacerbated the problems experienced in the late onset of the rainy season. Those who had waited for the rains to be properly installed found themselves unable to plough at the end of July and into the beginning of August. Desperate, the farmers had no choice but to seek ploughing equipment in order to prepare their land as the season was running out. However, once on the list, farmers had to wait for the equipment to become available, pushing their planting date later and later and creating the risk that the season would end before the crops had fully matured. Fortunately, in 2013, the rains continued into late October, but had they ended earlier as in the year 2014, it would have been a particularly challenging year for a large proportion of farmers. Thus, although this approach of planting later, after the rains have been properly installed, reduces the risk of having to replant crops damaged by dry spells, it also increases the risk of plants being unable to mature sufficiently by the end of the season.

Those planting late not only risk the season being too short for the crops to mature, but they also struggle to plant their full complement of crops or full crop coverage across all of their fields due to time pressure. When farmers rush to plant their crops in a short space of time, the planting is labour intensive and more

stressful, leading to confusion as crops are mixed up and the sowing not as carefully planned (BNDab1).

4.5.1.3 Mixed Planting Strategies

In addition to planting early or late, some farmers divide their sowing activities into two parts. In particular, for cotton, some farmers explained that they would plant part of their cotton crop very early, after the first rains on oxen-ploughed fields, and a second part after the rains have installed themselves properly and tractors become available (BNTan2014a). Similarly, some farmers plant crops, such as maize, close to their homestead at an earlier date than they plant on their fields or in the bush. As rains might be particularly strong in August and September, this strategy can also help them to reduce the risk of damage from excessive rainfall, as the early sown crops will be more mature and thus better able to withstand the heavier rains. By spreading the risks across the season, farmers avoid the need to replant the entire cropped area. This strategy ensures at least some harvest and helps to avoid peaks in labour demand. However, it is also sub-optimal in terms of production, as conditions will favour one part of the crop and not the other.

Essentially, any change in planting time is a gamble. If the rains are early, late or on time and the farmers have planted accordingly, they will benefit. If not, they will suffer. Even mixed strategies have drawbacks in that resources are spread thin and chances of at least some losses are increased. As BNPor10 explains, “they are trying lots of different strategies but none are guaranteed”.

Recognising the need to provide support for adaptation to climate variability through greater intervention than simply adjusting planting dates, a range of additional adaptation strategies have been introduced by the government, NGOs or development cooperation to the case study areas. Most of these strategies have some connection and support from beyond the local level and as the following sections demonstrate, the lack of a complete, holistic systems perspective in these devised approaches hinders the effectiveness of potentially promising strategies and often limits their long-term sustainability.

4.5.2 Tractors

When rains arrive late or are weak, ploughing by hand or with oxen can be particularly difficult. After a long dry season, oxen are weak as fodder for them is restricted during this time. This, combined with the hard soils, increases the risk of mortality among oxen if they are used to plough such hard land. Tractor-driven ploughs offer a potential solution as they can work on hard soils more easily and enable farmers to plant their crops more rapidly and capitalise on any early rains. However, if rainfall has not been sufficient, this will still reduce the speed of

ploughing and increase the risk of malfunctions or technical breakdowns. Additionally, tractors are more expensive to purchase than oxen.

Of the 18 tractors available in Materi, only 13 are presently functional. A lack of mechanical skills and spare parts in the local area means that these tractors are slow to repair, if repairs are possible at all. Without maintenance support services, these tractors have a limited lifespan which limits the sustainability of this adaptation strategy. In order to sustain the availability of tractors, further investment in training and mechanisms to access spare parts is clearly needed. Given the benefits that tractors provide, particularly to those who wait to plant and thus reduce their risk of having to re-sow, it would certainly be beneficial to resolve these problems, but without a holistic approach to adaptation strategies, the broken tractors remain unused, gathering dust.

In addition to the problems in maintaining the tractors, access to tractors is further compounded by complex and informal bartering systems that have developed from pressure to manage high demand on the limited number of tractors. Indeed, the 18 tractors in Materi are split between private, public and cooperative ownership, each prioritising service to different groups and subject to different negotiation systems. For instance, the women's rice cooperatives own two tractors. This makes membership of a rice cooperative particularly attractive; however, these two tractors are not sufficient to promptly satisfy all needs. Thus waiting lists have to be drawn up. Women who are not involved in cooperatives become particularly disadvantaged because their smaller fields are less attractive as they yield lower profits for tractor owners. This is compounded by their dependence on their husband's negotiating power and skills.

With the three private tractors that exist in the local area, negotiations are made by the farmers and the tractor owners directly. Different payment methods are available, including the possibility of credit (Interview CARDER Materi 2014a). However, here cotton producers are at a slight advantage as tractor owners can be sure that they can pay back after the season (Interview AVIGREF; BNTan2014a). In general, if farmers are able to pay for tractor services early, and particularly if they are located in villages that include a larger number of early payers, this can also boost their position on the waiting list (Interview CARDER Materi 2014a; BNTan2014_1). As such, availability of cash at the onset of the rainy season is considered as an important criterion for prompt access to tractors (Interview CARDER Tanguieta 2014).

As farmers are placed in an informal queue for tractor ploughing services, they remain uncertain of when exactly the tractor will arrive, which depends not only on their position in the queue but also on the rainfall. If the rains stop, the tractor will be unable to plough, causing a delay. Farmers are often not given notice when the tractor is due to arrive and thus may not have the field prepared in time. Other factors that come into play are the location of the village. Villages closer to main roads are often reported as being served earlier, for example, interviews in Tanougou reflected that they were always served earlier than Batia (BNTan2014a).

Thus, whilst tractors provide support and an adaptation option, particularly for those who wait for the rains to be properly installed before planting, there are some

major limitations to the effectiveness of tractors. Payment and waiting lists based on informal principles and negotiation, together with disadvantages for those not involved in cotton or rice cooperatives or located in close proximity to roads, all combine to provide challenges to timely access. This is all compounded by problems in servicing and maintaining the tractors over time.

As a result of these challenges and limitations, tractors are increasingly being overlooked for more traditional approaches such as using oxen. Where farmers cannot wait any longer and are too uncertain as to the likelihood of the tractor arriving in time, they will revert to using oxen and risk damaging these assets. It has to be recognised that 'new' crops such as maize, rice and cotton have made farmers dependent on ploughing services. The often less desirable 'Traditional' crops do not require ploughing, which raises an important question about whether such introductions for diversification are truly helpful to farmers in adapting to climate variability or whether they contribute new challenges and pressure instead.

4.5.3 Short Cycle Seeds

In line with crop diversification, another adaptation strategy introduced has been increasing the range of seed varieties available. Short cycle seeds provide considerable promise for late planting. These shorter cycle seeds are available for maize and rice. For maize, the improved variety reduces the cropping duration to 75 days instead of 90 days. This allows replanting in the event of delayed rains. For rice, different varieties are available for different locations such as river valleys versus upland areas. At a superficial level, shorter cycle seeds appear to provide an excellent solution to the problem of reduced growing time; however, a deeper look also reveals problems with this strategy.

One of the main problems with the shorter cycle seeds is the distribution of or access to these seeds. Traditionally, farmers would use and plant seeds directly from the yields of their previous crop or would be able to access the seeds at local markets. This provides the farmers with an easily accessed supply. The new varieties, however, have to be replenished on a bi-annual basis and are not available directly at the farmer's fields or at local markets; instead, they have to be obtained from agricultural extension services directly or through cooperatives. For some farmers, travel to the extension services is not possible due to distance and transportation challenges and sometimes seeds may simply be unavailable from the local CARDER (Interview CARDER Materi 2014). Furthermore, as improved varieties require fertilizer, farmers have to trade the increased costs of inputs (improved seeds + fertilizer) against the expected production. Availability of financial means at the onset of the rainy season to be able to pay for fertilizer and seeds is a considerable problem that hampers many farmers from using improved varieties. Organizing themselves into cooperatives is one common way to overcome some of the financial hurdles.

In addition to access challenges, interviewees highlighted quality issues with the short cycle variety of maize. One interviewee (BNTet1) highlighted the point that the short cycle maize produces a smaller cob and that the quality of the grain deteriorates more rapidly in storage. According to BNDab2 and BNSet2, the short cycle varieties of maize yield a grain that declines in quality and taste more rapidly than the traditional grains, staying fresh for only two months after harvest and becoming completely inedible after 5–6 months. This shorter storage time creates a dependence on other varieties or crops for food security during the hunger period.

4.5.4 Cultivation and Use of Trees

Cultivation and use of trees in agroforestry parkland systems is very common in the case studies (Djossa et al. 2007). Baobab (*Adansonia digitata)*, Shea (*Vitellaria paradoxa)* and Néré trees (*Parkia biglobosa*) are left on fields (Interview AVIGREF 2014) and farmers benefit from their leaves, seeds, fruits and wood for nutrition, medicine, fuel wood and bio-insecticide production (Djossa et al. 2007; Interview AVIGREF 2013a). Several tree species receive increasing attention in the case study areas as an additional source of income and as a less weather-dependent agricultural activity (although strong winds were considered as the main hazard).

Cashew trees (*Anacardium occidentale*) are grown in some parts of the major case study area in Benin. Cashew harvesting is mainly promoted and facilitated through projects as, for instance, in Firihoun where farmers have developed cashew plantations (BNFir2015a). During the early years of the cashew plantations, other crops such as maize can be grown in the plantation site, amongst the trees, but as the trees grow, this becomes infeasible. Cashew plantations therefore reduce the available land for other crops over time. While farmers agree on the benefits of the cashew production in terms of income generation, marketing of the cashew nuts is not easy for them due to a weak organisation of the value chain in the case study region (Interview GIZ 2015).

Mango trees are another example of a potential strategy to diversify income earning opportunities, but they suffer from similar problems of selling the quickly perishable produce for which no processing activities take place in the case study (BNOri2015a, BNOri2015b). Additionally, farmers have highlighted problems of bushfires which burn trees and reduce the harvest and freely grazing animals which destroy tree seedlings or reduce the productivity of young trees (BNFir2015a; BNFir2015b; BNOri2015b; BNNod2015a).

Currently, the value chain development is perceived as insufficient by farmers (BNFir2015a). Many farmers are aware of the potential that these trees offer in terms of income security, but cannot take advantage of it due to shortcomings along the whole value chain. More recently NGOs and development cooperation aim to reinforce the capacities of the farmers with regard to utilizing such trees and these agencies facilitate the organization of producers into cooperatives. They try to develop mechanisms along the whole value chain including processing into high

value products such as cashew nuts (e.g., GIZ ProAgri-project; Interview GIZ 2015). But it is yet to be seen whether those mechanisms can truly support farmers in adapting.

4.5.5 Compost

Compost making is a strategy that is widely promoted by NGOs and international development organisations in cooperation with the local agricultural offices (CARDER). The appeal of using compost as organic fertilizer for the fields is the use of locally available material at very little or no cost. Compost can contribute to maintaining soil fertility and increase water holding capacity, which makes crops more drought resistant (e.g., Niggli et al. 2009; Wani et al. 2013; Kloos and Renaud 2014; BNDas2015f; Interview AVIGREF 2014). Using organic material for fertilization reduces farmers' dependency on chemical fertilizer for maize, rice and cotton production, as these are the crops that require fertilizers to be productive. Many farmers are aware of the technique and most villages in Materi (Benin) and Dano (Burkina Faso) received training on the production of compost provided by NGOs, development organisations or CARDER (Interview CARDER 2015). In order to allow the compost to mature over time, residual organic matter is collected after the harvest and combined with animal dung in a specially constructed concrete/cement pit.

Despite the acknowledgement by many farmers that compost improves their farm productivity and increases drought resistance, all at a low or negligible cost, compost production has not been widely adopted outside of organic cotton cultivation, where it is an essential element of production. The relatively low levels of adoption are the result of several key challenges that farmers face in compost production.

One of the main challenges facing composting uptake relates to the need to regularly add water for the composting process. Access to water in the dry season is particularly difficult as well supplies diminish (BNPou2015a). In order to limit the amount of time spent searching for water, the compost pits are constructed relatively close to the homestead (BNFir2015a, BNDas2014b). However, this creates further challenges when the compost is ready to be applied to the fields. The main fields are often located at a distance from the homestead. Thus transportation equipment such as a mules or ox-driven carts is required and this is not always available to the farmer. Where compost is able to reach the field, its application is labour intensive, restricting its use on a large scale (Field surface area < 1 ha) (BNDas2014b; BNDas2015f; Interview CARDER Materi_a).

Availability of animal dung can also be a limiting factor. Where farmers have cattle, these are usually maintained by local, sedentary Fulani herders who provide the cattle owners with access to the cattle dung on the pastures. Those without many animals or cattle thus have an interest to maintain good relations with the Fulani so that they can also access this source. In some villages with a high demand for

animal excrement, Fulani herders have started to sell dung, making additional profit.

Some expect compost to play a larger role in the future as an adaptation strategy (BNFir2015a; BNMer2015a). However, for wider uptake, the underlying issues of water availability, transportation and access to sufficient organic matter need to be addressed.

4.6 Non-adapters

This chapter has so far reviewed a range of adaptation strategies being adopted in the case study areas, demonstrating the potential for these strategies to overcome the challenges presented by seasonal variability and climate change, along with barriers to more successful and wider adoption. Although the practical barriers to these adaptation strategies have been discussed, other barriers to wider adoption exist in the perceptions of farmers.

Indeed, many of the farmers interviewed responded that despite suffering losses from seasonal variability, they would continue to follow the same approach as they always have. This decision not to adapt was based on a belief that the challenges that they have faced with seasonal variability are anomalous and they remain optimistic that the next year will be better (e.g. BNDAS2014a). Any difficulties they face are deemed simply 'God's will' and accordingly farmers respond with simple short term measures to manage the impacts at the time, rather than adopting anticipatory adaptation strategies (BNDas15; BNTet1; BFKou5). This fatalist perspective is a major barrier to adaptation that becomes increasingly pressing given the climate change projections.

In addition to optimists and fatalists, previous experiences of poorly integrated adaptation strategies are another source of non-adaption. As BNDab4 commented, where adaptation strategies and interventions are introduced but subsequently fail to provide sustained benefits, the reputation of the agents promoting the strategy as well as the process of adaptation in general can become critically tarnished, with farmers remaining sceptical about any future strategies. This heightens the imperative to ensure that any new adaptation measures are well thought out and take an integrated, holistic approach. Experiences of failed measures will undermine any future efforts to introduce new adaptation strategies.

The perception of agencies and their reputations are not only relevant to farmers' faith in adaptation measures, but can also have a bearing on whether farmers seek support in the first place or not. The interviews revealed that some farmers believed that national support agencies such as CARDER simply could not help them (BNSet2015a; BNMer2015a). This was based on a perception that CARDER focuses on cotton production and thus non-cotton producing farmers are isolated from the reach of the agency's activities.

4.7 Discussion

With regards to the uncertain conditions associated with seasonal variability, the example of adjusting planting times particularly illustrates the challenges of adapting to climatic changes that are inherently variable. Whether planting early, late or using mixed strategies, the decision on planting time remains a gamble. As such, other strategies are required. This chapter has provided a range of examples of adaptation strategies implemented in the case study areas through local, national and international support. However, as demonstrated, a lack of holistic, systems thinking has constrained the long-term success of these strategies.

The examples of short cycle seeds and composting have both illustrated barriers to widespread and sustained adoption due to problems in accessing input materials. Both examples highlight problems of transportation but also availability of the key 'ingredients' such as the seeds themselves in the case of short cycle seeds, or manure and water in the case of compost production. In contrast, the example of tree products illustrated problems with managing the outputs of these activities. Whilst tree products provide an additional source of income which can be combined with traditional farming techniques, a lack of markets for the produce remains a critical barrier to the effective adoption of this strategy. Finally, the example of tractors demonstrated problems with introducing new crops such as maize, rice and cotton that require soil ploughing. This has led to a new dependency of farmers on tractors. However, while growing demand and missing rain hinder ploughing, so does a lack of tractor maintenance. The tractors require spare parts and servicing which, like markets for tree products, are not available in the case study locations. The result of this is that strategies that appear initially promising often falter at a later stage in the process.

Despite the evidence of barriers and limitations to widespread and sustained adaptation, solutions do exist. In other parts of Benin, for example, markets for tree produce have been established. Furthermore, maintenance and servicing facilities are also available for tractors elsewhere. Efforts need to be made to extend such facilities to the case study areas. However, this is likely to require a concerted effort across agencies and organisations. Different agencies facing the same barriers have to seek solutions in a coordinated way. The same requirement is also needed to address some of the limitations at the input level, such as short cycle seeds and composting. Again, support from local agencies can address these challenges, but the support should be in the form of extending and enhancing direct engagement with farmers. Direct and enhanced engagement should aim to build trust by developing partnerships and ensuring that problems with new techniques can be addressed. For many adaptation strategies where solutions have to be found beyond the very local level, better coordination across actors and agencies from the local to the national level, from governmental to non-governmental organisations is of particular importance. By working in partnership with local communities, these strategies can then be developed in a manner that takes into account local perspectives and beliefs to enhance their adoption.

4.8 Conclusion

Adapting to seasonal variability, floods and droughts is a considerable challenge for agriculture dependent communities. Simple, low tech strategies such as adjustments to planting times have limited potential to overcome the challenges and often retain an element of uncertainty, essentially constituting a gamble. As such, other strategies are required. This chapter has outlined several key adaptation strategies implemented in the case studies of Burkina Faso and Benin. The strategies are promising and certainly carry potential to improve farmer productivity and help adapt to the changing climate. However, as a result of a lack of holistic and coordinated approaches which are sensitive to the perspective and beliefs of farmers, the long-term sustainability and effectiveness of the strategies is particularly limited. Problems with accessing inputs, selling outputs and maintaining equipment all provide risks to adaptation in the case study areas. The solutions exist but require coordinated action across actors at different levels and better engagement with farmers, particularly to address non-adapters. Progress has begun, but if current adaptation strategies do not receive the complete coordinated support that they require, this will also have implications for how any future strategies might be received.

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Chapter 5
An Assessment of Determinants of Adaptive Capacity to Climate Change/Variability in the Rural Savannah of Ghana

Joseph A. Yaro, Joseph K. Teye and Simon Bawakyillenuo

Abstract The varied stressors posed by climate change and variability to the livelihoods of agrarian societies in many developing countries call for an examination of the determinants of adaptive capacity. Data collected through a questionnaire survey, in-depth interviews and focus group discussions, is used to explain the determinants of adoption of five major adaptation strategies. The analysis reveals that while adaptive capacity in the northern savannah zone is generally low due to high levels of poverty and poor state presence, it varies spatially resulting from locational, individual and community socio-economic and institutional factors. Adaptive capacities are rooted in the nature of household and community assets as well as societal rules and policies. Both community level factors and characteristics of individual farmers condition the idiosyncratic variables defining the capacities to adopt specific adaptation strategies to climate change threats. Important farmer characteristics that determine critical adaptation strategies in the northern savannah include age, sex, assets, family size, size and type of land, skills/education, and perception of climatic changes. This paper recommends that local resilience building mechanisms be scaled up while modern mechanisms should be introduced for dealing with the impacts of climate change.

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J.A. Yaro and J. Hesselberg (eds.), *Adaptation to Climate Change and Variability in Rural West Africa*, DOI 10.1007/978-3-319-31499-0_5

5.1 Introduction

The impacts of global climate change-related hazards on regional and local economies and people are indisputable (Mertz et al. 2009; Rademacher-Schulz and Salifu 2014). As one of the most critical phenomena of the globe at present, climate change is expected to exacerbate immediate development stresses through temperature increases, water scarcity, increased weather variability and more frequent extreme events (Sissoko et al. 2011). These human-induced natural hazards amplify existing socio-economic and ecological sources of vulnerability in sensitive ecological systems such as those in savannah and Sahelian Africa (Dietz et al. 2004b). The effects of climate change are very serious in dry regions of Africa because the livelihoods of the majority of people in rural Africa are dependent on natural resources and major sources of savings (such as livestock), social capital, and the availability and quality of natural conditions for agriculture. Responding to climate hazards depends on individual, household and community adaptive capacity, which refers to the potential, capability, or ability of any of these units to adapt to climate change stimuli or to their effects or impacts (IPCC 2001). Adaptive capacities are rooted in the nature of household and community assets and activities, and also in societal rules and policies (Gbetibouo 2009).

The north of Ghana is highly vulnerable to climate hazards including droughts, floods, strong winds, and high temperatures, with serious ramifications on physical and human systems (Antwi-Agyei et al. 2012; Bawakyillenuo et al. 2014; Codjoe and Owusu 2011; Derbile 2013; Dietz et al. 2004a; Eguavoen 2012). The local people in this region have responded in various ways to prevent livelihood and environmental loses using a range of strategies including irrigation via dry season gardening (Eguavoen 2012; Yaro 2002), seasonal migration (Rademacher-Schulz and Salifu 2014; Van der Geest 2011), modern agronomic practices (McSweeney et al. 2008; Opare 2012), intensification of agriculture with increasing fertiliser use (Bawakyillenuo et al. 2014), and diversification of livelihoods to include non-farm activities (Yaro 2006). There is, however, little understanding of the effects of individual and community level factors on the adoption and effectiveness of various climate adaptation strategies.

This chapter examines the major determinants for the adoption of five major adaptation strategies in dealing with climate stress in northern Ghana. Specifically, it examines the factors that define the individual and the community's adoption of irrigation, fertiliser use, modern agronomy, non-farm activities, and seasonal migration strategies. Generally, communities with strong state and traditional institutions, good markets, and good biophysical conditions have better levels of adaptive capacity (Agrawal 2008; Yaro et al. 2014; Yohe and Tol 2002). The influence of institutions, markets and biophysical conditions are reflected in infrastructure, knowledge and skills, technological/innovation, diversity and lucrativeness of livelihood activities.

As social differentiation and inequalities create asymmetrical patterns of adaptive capacities (Adger 1999) with consequences for livelihoods at the local level, studies on adaptive capacities of different actors are very important for policy formulation. Yet, few researchers have sought to explain the variations in adaptive capacities of different households and communities (Gbetibouo 2009; Maddison 2006; Nhemachena and Hassan 2007). Adaptation to climate change is a developmental challenge involving all facets of life that influence wellbeing (Cannon and Muller-Mahn 2010). The factors that define the vulnerability of any human system are defined by the physical properties of its environment, but other factors are framed by social-economic context and social preferences (Nielsen and Reenberg 2009; Yohe and Tol 2002). The challenge in responding to climate change is building the adaptive capacity of the most vulnerable in society to enable them abate its impacts and take advantage of new conditions.

We use the case of communities in northern Ghana for this study. Poverty in Northern Ghana remains significantly higher, more widespread and more persistent than in the rural southern areas since the colonial era (Bening 1975; Dickson 1968; Goody 1980; GSS 2014; Konings 1984). Northern Ghana has savannah vegetation with moderate rainfall and high temperatures. The region's climatic condition, especially its unreliable historical rainfall patterns have always constituted a problem for its development since time immemorial (Oguntunde et al. 2006). Ghana has experienced about a 1 °C rise in temperatures over the past three decades, while within the same period rainfall has decreased by 20 % and run off by 30 % (EPA 2000; McSweeney et al. 2008). Based on future scenarios, it is projected that total annual rainfall will decrease by 9–27 % by the year 2100, with the range representing spatial variations (Minia 2004). The pattern of rainfall for the West African arid environments in the period 1960–1990 shows dramatic declines in average precipitation (Dietz et al. 2004b; Put et al. 2004). In the Sahel, there were substantial variations in rainfall in the second half of the twentieth century and a decline for all dryland areas (Held et al. 2005). However, rainfall has recovered significantly over the past two decades (Jung and Kunstmann 2007). The alternation of good and bad weather for agriculture has become a reality (See Chaps. 2 and 3) as models show that the number of extremely dry and wet years will increase during the present century (Huntingford et al. 2005). The major climate change hazards include unpredictable rainfall patterns that impose drought and flooding conditions with consequences on crop yields and food security (Dietz et al. 2004a; van de Giesen 2010).

The paper is organized as follows. Section 5.2 establishes the relationship between climate change, adaptation strategies and adaptive capacity. Section 5.3 describes the research methods. Section 5.4 presents the findings, while Sect. 5.5 constitutes the major conclusions.

5.2 Climate Change, Adaptation Strategies and Adaptive Capacity

Heltberg et al. (2009) argue that serious damage to natural systems from climate change need not result in catastrophic and irreversible damage to humans because it all depends on the effectiveness of societies' adaptive capacity. According to the IPCC (2001, p. 982) adaptive capacity is "the ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences." Because adaptation does not occur instantaneously, the relationship between adaptive capacity and vulnerability depends crucially on the timescales and hazards with which we are concerned (Brooks et al. 2005). How individuals and communities deal with climate hazards is dependent on their adaptive capacities, which define the kinds and intensities/effectiveness of strategies adopted.

The capacity to adapt to climate-change impacts hinges on proactive measures adopted by different socio-economic groups living in differentiated geographical and socio-economic circumstances (Christiansen et al. 2007). Formal and informal institutions shape the livelihood impacts of climate hazards through a range of indispensable functions they perform in rural contexts such as information gathering and dissemination, resource mobilization and allocation, skills development and capacity building, providing leadership, and networking with other decision makers and institutions (Agrawal 2008).

Adaptive capacity is important in understanding whether farmers adapt their behaviour in response to short-term climate variability or long-term climate change (Burton 1997; Thomas et al. 2007). Farmers base their decision to adapt their farming practices not only on changes in average conditions, but also on a number of other climate factors observed through personal experience such as extreme events; rainfall frequency, timing, and intensity; and early or late frosts (Thomas et al. 2007; Vogel and O'Brien 2006). Burton (1997) argues that willingness to adapt to climate change and variability depends on experience, time horizon, and the risk tolerance of individual decision-makers.

Determinants of adaptation and forms of adaptation vary across space and time. The asset status of households, mediated by social factors and exogenous trends or shocks, results in the adoption and adaptation over time of dynamic livelihood strategies which respond to changing pressures and opportunities (Ellis 2000, 40). The resilience of peasants to either weather fluctuation or economic stress depends to a large extent on their capital base, be it human, financial, physical or social, and the complex strategies that they adopt within and among livelihood systems (Yaro 2004). In Ethiopia and South Africa, wealth, measured by the households' ownership of key assets, is shown to be an important determinant of adaptation (Bryan et al. 2009). Also, rural services increase the likelihood of adaptation across income terciles. Gbetibouo (2009) finds in the case of South Africa that household size, farming experience, wealth, access to credit, water and extension, tenure rights, and off-farm activities are the main factors that enhance adaptive capacity. Nhemachena and Hassan (2007)

argue that female-headed households are more likely to take up climate change adaptation methods. Maddison (2006), reviewing the literature, lists farm size, education, topographical features, access to extension services, market access and credit availability, tenure status, agro-climatic conditions, and the availability of water as important drivers for farmer adoption of strategies. These examples of factors influencing adaptation are in line with some of the determinants of adaptive capacity outlined by the IPCC (2001): economic resources, technology, information and skills, infrastructure, institutions and equity.

When faced with climate adversity, farmers deploy a range of response strategies ingeniously crafted over the years to deal with the situation. However, due to limitations emanating from internal and external factors, farmers make strategic choices and investments according to their abilities. The levels and quality of these investments in smart strategies determine the sustainable livelihood outcomes. Understanding why different actors have varying strategies and success rates is important in order to understand the drivers of the strategies. Interventions can be crafted based on these varying strengths and weaknesses of different socio-economic groups in different geographical spaces.

5.3 Study Areas and Methods of Research

This chapter is developed from research data from the project "Assessing Adaptive capacity to climate change and climate variability in the rural northern savannah of Ghana",[1] which was carried out by the authors in 2012. The study was conducted in six villages: Nyangua and Pungu-Bavugnia (Kassena Nankana East district); Wungu and Gbeduri (West Mamprusi district); and Nyoglo and Kanshegu (Savelugu Nanton district), (see Fig. 5.1). Located in the Upper East region of Ghana and bordered by Burkina Faso to the north, the Kassena Nankana East district has an estimated population of 109,000, with Navrongo being the capital town. The landscape of the district is broadly undulating with a few isolated hills of about 300 m in height, and also characterised by savannah ochrosols soils. The district records an average rainfall of 950 mm per annum and has a very high water table, suitable for the sinking of shallow wells for dry season gardening. The West Mamprusi and Savelugu Nanton districts are located in the Northern Region. While the total land area of the former is about 5013 km^2 with a population of about 168,011 in 2010, the latter occupies an area of 1790.70 km^2, with a total population of 139,283 in 2010. The West Mamprusi district is characterised by savannah glycol soils with a low water table, which inhibits access to underground water. The landscape of Savelugu Nanton district is mostly flat and gently sloping, with interior savannah woodland vegetation.

[1]Funded by the Office of Research, Innovation and Development (ORID), University of Ghana [Project grant number URF/4/008/2011–2012].

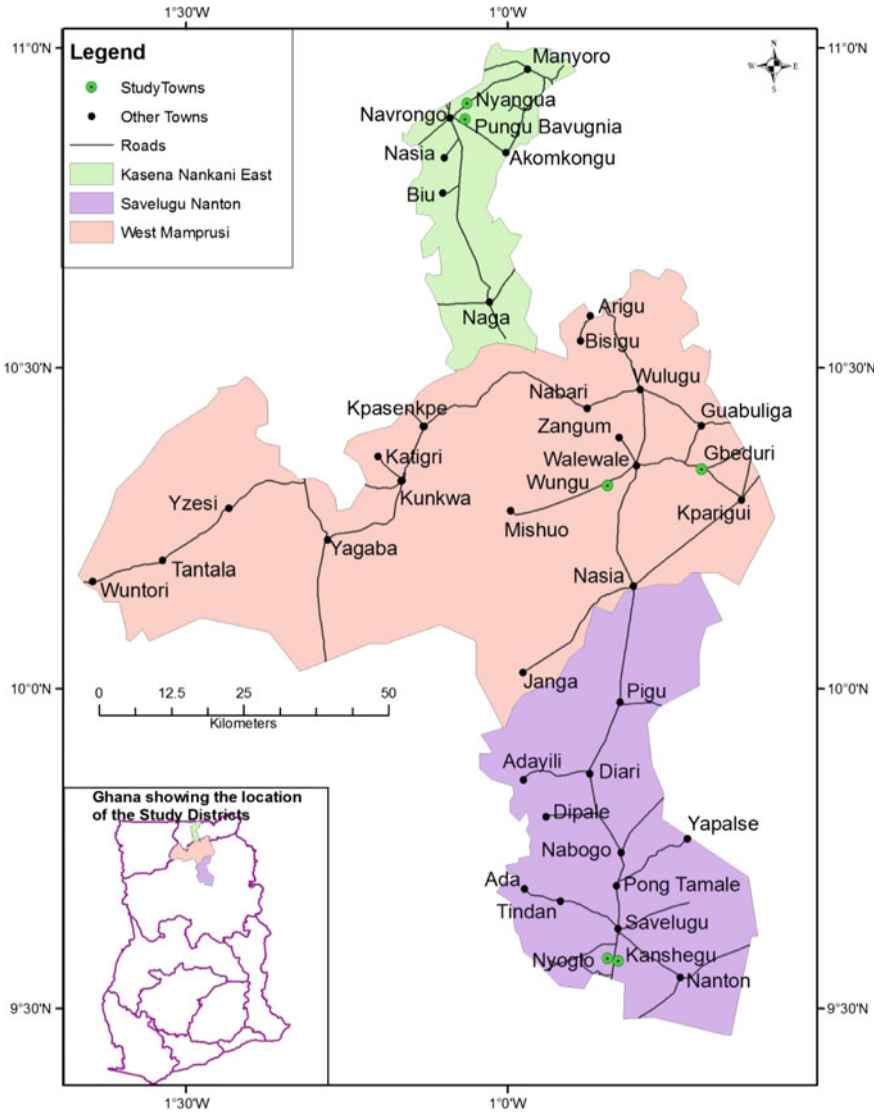

Fig. 5.1 Map showing location of study communities in northern Ghana

An eclectic mix of participatory qualitative assessments and quantitative research methods were employed in the study (group discussions; individual in-depth interviews and a quantitative survey). The participatory approaches adopted play a crucial role in enhancing understanding and use of climate information shrouded in uncertainty (Roncoli et al. 2009).

Two group discussions were held in each village. These were the men's focus group, consisting of the traditional chief and ordinary men of all ages, numbering

between 12 and 18 people. The second group discussion was made up of women of all ages, also numbering between 12 and 18 people. Themes of the groups' discussions included the historical perspectives of farming, perceptions of the climate, governance of local institutions, natural resource endowments, access to resources, adaptation strategies to climate change over time and factors of adaptive capacities. Men and women provide different perspectives in a patriarchal gendered society, hence the need for separate discussions.

In-depth interviews were conducted with men and women in each village and with state officials in the district capitals. In each village, 5 men and 5 women were purposively selected for these interviews based on the wealth group and occupational mix. Based on the participants' own wealth ranking conducted at the focus group discussions, respondents in each gender category were made up of 2 very poor, 2 moderately poor and 1 rich person.

These mixed backgrounds of respondents were very essential to gaining the diverse perspectives and realities on the adaptive capacities of different socio-economic groups. The officials interviewed included the planning officers at the districts, Non-governmental Organisations (NGOs), and extension officers, and the purpose was to understand how their roles enhance or constrain the adaptive capacities of the study villages.

A total of 530 individual questionnaires were administered in the six villages based on the proportion of their total populations using a simple random strategy. Of the respondents, approximately 55 % (291) were males while 45 % (239) were females. The major themes covered by the survey were: perceptions of climate change and variability; adaptation strategies; determinants of adoption of strategies; and the institutional support systems.

5.3.1 Logistic Regression Model

We employed binary logistic regression models to analyse the household survey from the 530 farmers. Binary logistic regression analysis was deemed appropriate because the outcome variable (adoption of an adaptation strategy) has two independent response categories. Each of these farmers chooses whether or not to adopt a strategy to deal with climate change. Let the variable A_i^* represent the farmer's choice to adopt a strategy (e.g., irrigation) and βE_i be a vector of explanatory variables that determine the farmer's decision, such as village, area of land under cultivation, household size, perception of changes in rainfall, and educational level of the farmer. The general model for adopting a strategy is as follows:

$$A_i^* = \beta E_i + \varepsilon_i \tag{5.1}$$

where the farmer's decision is $A_i = 1$ if he adopts a strategy and 0 if he does not. The respondents were categorised into different categories. For instance, five age categories of the respondents were used to analyse irrigation. These are

20–29 years, 30–39 years, 40–49 years, 50–59 years and 60 years and older. Given that the study communities were rural areas where many people have a low educational status, the educational level of the farmer was categorised into two; lower than Junior High School/Middle School on the one hand, and Junior High School/Middle School or higher on the other. The household size was divided into three groups: 5 members or less, 6 to 10 members and more than 10 members. Three categories of wealth were created for the farmers, and these are poor, moderate and rich. The size of land the individual farmer cultivated was categorised into two; 5 acres or less, and more than 5 acres. A reference category was chosen for each of the variables and this was indicated in the tables presented on the analyses.

5.4 The Findings

We followed the above model to examine the determinants of adaptive capacity of various autonomous climate change adaptive strategies.

5.4.1 Determinants of Adoption of Irrigation

Although irrigation is one of the most effective strategies for dealing with climate variability (Bawakyillenuo et al. 2014; Westerhoff and Smith 2009), only 37 (7 %) of the 530 farmers interviewed adopted this strategy. The results of the binary logistic regression show that the main determinants of the adoption of irrigation strategies were village of residence, age of the farmer, and perception of changes in rainfall (see Table 5.1). When other factors are controlled, farmers from Nyoglo are about 7 times more likely to adopt irrigation strategy compared to those from Kanshegu (the reference category). The relatively high proportion of farmers adopting irrigation at Nyoglo can be explained by the fact that there is a small dug-out with canals which enable cultivation of vegetables. Also farmers from Bavuginia were about 45 times more likely to adopt the irrigation strategy compared with those from Kanshegu. In Bavugnia the water table is very high, making it possible to sink shallow wells, which are sunk and renovated each dry season for cultivating vegetables, including tomatoes. On the other hand, farmers in Wungu were about 7 times *less likely* to adopt the irrigation strategy compared with their counterparts from Kanshegu. The low level of adoption of this strategy in Wungu may be explained by physical and economic factors. Observation shows that the water table in this region is quite high and there is no state funded irrigation scheme in this community. Consequently, irrigation in this community is by means of diesel pumps supplying water from the White Volta tributaries and this involves more investments in equipment and valley land. However, many farmers are too poor to use these types of irrigation systems. Respondents in Wungu and Gbeduri are

Table 5.1 Determinants of irrigation adoption strategy

Irrigation strategy	Odds ratio	Std. Err	P-ratio
Village			
Kanshegu (*reference category*)	1.0000		
Wungu	0.142488	0.166148	0.095*
Nyoglo	6.979668	4.925743	0.006***
Nyangua	3.404079	2.941079	0.156
Gbeduri	0.712129	0.607086	0.69
Pungu-Bavuginia	44.73095	32.79679	0.000***
Age of respondent			
20–29 (*reference category*)	1.0000		
30–39	0.204898	0.155122	0.036**
40–49	0.26758	0.210148	0.093*
50–59	0.586003	0.455128	0.491
60 and above	0.375413	0.290601	0.206
Gender			
Female (*reference category*)	1.000		
Male	1.170045	0.471619	0.697
Education			
Lower than JHS/Middle School (*reference category*)	1.0000		
JHS/Middle School or higher	0.867878	0.369989	0.74
Household size			
1–5 members (*reference category*)	1.0000		
6–10 members	0.752065	0.36786	0.56
More than 10 members	0.455228	0.256529	0.163
Wealth			
Poor (*reference category*)	1.0000		
Moderate	0.819477	0.396124	0.68
Rich	1.497077	0.855244	0.48
Land size			
Up to 5 acres (*reference category*)	1.0000		
More than 5 acres	1.574797	0.604874	0.237
Perception of change in temperature			
Decreased (*reference category*)	1.0000		
Increased	0.626187	0.446415	0.511
Perception of changes in rainfall			
Decreased (*reference category*)	1.000		
Increased	10.00209	4.85298	0.000***
Ownership of radio			
No radio (*reference category*)	1.000		
Owns radio	1.9524	0.845517	0.122
Pr = 0.0000 Pseudo R^2 = 0.4146	N = 430		

Note * indicates the level of significance, * represents a weaker level of significance, that is 10 %, and a p-ratio of 0.05 or greater, but less than 0.1. ** denotes a 5 % level of significance (that is, a p-ratio of less than 0.05 but greater than or equal to 0.01.*** denotes a 1 % level of significance; that is, a p-ratio of less than 0.01; The Pseudo R^2 shows the extent to which the independent variables explain the dependent variable. Thus, a model that gives a higher Pseudo R^2 is usually preferred to one that gives a lower Pseudo R^2

yearning for small dams, which are less expensive to operate. Thus, the lop-sidedness in the level of adoption of irrigation farming within the different villages, with farmers in Nyoglo exhibiting the highest propensity to adopt, is underpinned by their relative environmental conditions and the provision of community wide infrastructure. A village such as Nyoglo, which is endowed with a river and fertile soil, is favourable for irrigation compared to villages such as Kanshegu, Wungu and Gbeduri that lack these kinds of environmental features.

Surprisingly farmers who have the perception that rainfall has increased were 10 times likely to adopt irrigation strategies in farming than those who think rainfall has declined. Also, younger farmers were more likely to adopt irrigation strategies than older farmers. The results revealed that farmers aged 30–39 years were about 5 times less likely to adopt this strategy compared to those aged 20–29 years. Similarly, those aged 40–49 years were about 4 times less likely to adopt the strategy than those aged 20–29 years. The relatively higher level of adoption among younger farmers may be explained by the fact that irrigation is part of innovation, which may be diffused more through young and relatively more educated farmers than older uneducated farmers. The types of irrigation systems used involve the use of muscle power to draw water, especially from wells, and are therefore adopted by determined strong young men. Also, the types of crops cultivated and machines operated in irrigation systems may be new and require some learning. Younger farmers are more willing to learn new techniques for new crops than older farmers.

Our analysis thus suggests that both community level factors and the characteristics of the individual farmers determine the capacity to adopt irrigation. The individual factors may explain why even within the same geographical area, different social groups have different adaptive capacities (Bawakyillenuo et al. 2014; Teye and Owusu 2015).

5.4.2 Determinants of Agronomic Practices

Changes in agronomic practices have been employed by farmers in many parts of the world to deal with climate variability. These strategies that broadly fall under agronomic practices include changes in planting times (early or late), changes in crop varieties, intensive practice of mixed cropping and the use of tractors to till the land instead of human labour (Bawakyillenuo et al. 2014; Westerhoff and Smith 2009). A majority of farmers (96 %) reported that they have changed their agronomic practices as a result of climate change and variability. The modern agronomic practices are disseminated by the extension services, irrigation authorities, migrant experiences and farmer experimentations (listed from focus groups). The determinants of the adaptive capacity for these strategies are knowledge, skills, experience, funds, and drudgery of practice. The late rains have necessitated changes in the planting calendar for almost all farmers. Those unable to change or follow the changing rainfall patterns were poor farmers who were unable to procure new seeds after already losing own seeds to early planting. With regards to changes

in crop variety, some farmers noted that they have now shifted from the cultivation of varieties that mature within a short time:

> We have also shifted from the four-month variety of maize to the three-month variety. This makes it possible for the crops to mature before the rains stop. (A 36-year-old farmer in Gbeduri in 2012)

Some farmers also reported that they have shifted from the cultivation of millet to maize because of unreliable rains:

> We used to cultivate largely millet, but now, it is all about maize. We are now shifting to the variety of crops from the Ministry of Agriculture…almost everybody has shifted away from millet, sorghum, yam (traditional crops) etc., to maize, groundnut, rice and beans (Chief and elders of Wungu in 2012).

The use of tractors to prepare the land has also become necessary because of changes in rainfall regime:

> As a result of the changing rainfall pattern we now rely on maize and rice as our main crops. Apart from that we can no longer prepare our land by hand because if you want to do so you may miss the opportunity to plant within the short planting period made possible by the high irregular rains.
>
> It appears the rainy season has reduced in length. Consequently, we now have roughly 2–3 weeks of planting period, so that if you don't engage the services of a tractor you might miss the period and it can affect your chances of getting a good harvest (Chief of Nyoglo 2012).We use tractors in tilling the land because of the unreliable nature of the rains. If you want to make ridges, you might not get moisture to do that. The rain comes at very irregular intervals. So it makes sense for you to employ a tractor to do it so that you can plough and plant using moisture provided by a single rain. You can see that it is the rain that is forcing us to abandon ridging as a form of land preparation (A 30-year-old male farmer, Nyoglo).

Despite the high proportion of farmers adopting this strategy, there were variations in the rate of adoption across different localities. As shown in Table 5.2, the determinants of capacity to change agronomic practices were perception of change in rainfall, educational level, and farmer's village of residence. Farmers from Wungu were over 7 times more likely to adopt agronomic practices compared to those from Kanshegu. Also, farmers who have schooled to at least Junior High/Middle School level were about 5 times more likely to use agronomic practices in their farm than those who did not. On the contrary, farmers who perceived that rainfall has increased were about 7 times less likely to adopt agronomic practices in their farms compared to those who think rainfall has decreased.

5.4.3 Determinants of Fertilizer Application Strategy

The data generated shows that as a result of declining soil fertility caused by over-cultivation and climate variability, application of fertilizers has generally increased in the study community. A chief expressed the importance of fertilizers in the following sentences:

Table 5.2 Determinants of adoption of agronomic practices

	Odds ratio	Std. Err	P-ratio
Village			
Kanshegu (*reference category*)	1.0000		
Wungu	7.151259	7.043762	0.046**
Nyoglo	1.771199	1.670452	0.544
Nyangua	8.089292	11.18479	0.131
Gbeduri	4.041999	4.329604	0.192
Bavuginia	4.171834	5.362157	0.266
Age of respondent			
20–29 (*reference category*)	1.0000		
30–39	2.613184	3.610449	0.487
40–49	1.183614	1.602343	0.901
50–59	0.585373	0.802507	0.696
60 and above	4.816141	8.06515	0.348
Gender			
Female (*reference category*)	1.0000		
Male	0.91499	0.614597	0.895
Education			
Lower than JHS/Middle School (*reference category*)	1.0000		
JHS/Middle School or higher	4.862595	4.200196	0.067*
Household size			
1–5 members (*reference category*)	1.0000		
6–10 members	0.292541	0.322188	0.264
More than 10 members	3.152411	4.364041	0.407
Wealth			
Poor (*reference category*)	1.0000		
Moderate	1.928854	1.883772	0.501
Rich	0.724952	0.717227	0.745
Individual land size			
Up to 5 acres (*reference category*)	1.0000		
More than 5 acres	1.366368	0.946893	0.652
Perception of change in temperature			
Decreased (*reference category*)	1.0000		
Increase in temperature	2.564087	1.9574	0.217
Perception of change in rainfall			
Decreased (*reference category*)	1.0000		
Increased	0.142798	0.123106	0.024**
Ownership of radio			
No radio (*reference category*)	1.0000		
Owns radio	0.809692	0.530769	0.747
Pr = 0.0089 Pseudo R^2 = 0.2680	N = 428		

Note ***, ** and * indicate significance at the 1, 5 and 10 % levels, respectively

> Fertilizer has become a necessity in our farming practices. If you don't use it, you may not get anything meaningful. This is due to the fact that our soils have become impoverished. Fertilizer, however, is not accessible both physically and financially to everybody, because of poverty (Chief of Nyoglo in 2012).

As shown in Table 5.3, the main determinants of the use of fertilizer amongst Ghanaian farmers were the village the person finds himself/herself in, the sex of the farmer and the economic status of the farmer's household. About 21 % of the changes in the dependent variable, that is fertilizer application, can be explained by variables such as the village, age, gender and educational level of the farmer. Other explanatory variables are household size, wealth of farmer's household, ownership of radio, and perception of changes in rainfall and temperature.

The survey revealed that male farmers were about 6 times more likely to use fertilizer than female farmers. Also, farmers who were moderately rich were about 3 times likely to use fertilizer than poor farmers. Furthermore, farmers who resided in Nyoglo were nearly 13 times likely to adopt a fertilizer application strategy in their farm compared to those from Kanshegu. Farmers from Wungu, on the other hand, were about 3 times less likely to adopt this strategy. Contextual factors such as availability of bush lands, which enables fallowing and shifts to virgin lands, explain the low fertiliser use in Wungu. The other communities except Gbeduri are characterised by 'land hunger', which results in continuous cropping, necessitating artificial fertilisers.

5.4.4 Shift to Non-farm Activities

Shifting from agricultural activities to non-farm enterprises is increasingly adopted in many societies as a form of diversification of the rural economy (Boamah 2014; Yaro 2006). About 27.8 % of respondents reported that they are engaged in off farm activities due to climate change and variability. The main non-farm jobs included processing of agricultural produce, farm labour, trading, jobs in the civil or public service, and the provision of services of all kinds. The views of respondents on this strategy are summarised in Box 1.

Box 1: Shift to off-farm activities

> The major activities are farming and trading. However, many others are also into skilled jobs such as carpentry, masonry, driving, electrical works, television and radio repairs, etc., (Men focus group, Gbeduri in 2012).
>
> Farming is no longer good, so it makes sense to diversify our livelihoods (Men focus group, Kanshegu in 2012).
>
> Shea butter and rice processing are the main livelihood activities of women in this community. Apart from the two, some women also engage in groundnuts processing. [However]… every woman now wants to engage in more than one activity as a way of achieving livelihood security (Women focus groups, Kanshegu and Nyoglo in 2012).

Table 5.3 Determinants of fertilizer application

	Odds ratio	Std. Err	P-ratio
Village			
Kanshegu (*reference category*)	1.0000		
Wungu	0.37855	0.174448	0.035**
Nyoglo	12.52757	13.65952	0.02**
Nyangua	1.328359	0.790004	0.633
Gbeduri	0.552473	0.310138	0.291
Bavuginia	1.909145	1.196522	0.302
Age of farmer			
20–29 (*reference category*)	1.0000		
30–39	1.572871	0.916976	0.437
40–49	1.071975	0.629391	0.906
50–59	0.956765	0.590892	0.943
60 and above	1.003774	0.664141	0.995
Gender			
Female (*reference category*)	1.0000		
Male	5.812668	2.017085	0.000***
Education			
Lower than JHS/Middle School (*reference category*)	1.0000		
JHS/Middle School or higher	1.081494	0.399271	0.832
Household size			
1–5 members (*reference category*)	1.0000		
6–10 members	0.832355	0.344876	0.658
More than 10 members	1.320078	0.628198	0.560
Wealth			
Poor (*reference category*)	1.0000		
Moderate	2.668791	1.121763	0.020**
Rich	1.797105	0.897617	0.241
Perception of change in temperature			
Decreased (*reference category*)	1.0000		
Increase in temperature	1.135517	0.559743	0.797
Perception of change in rainfall			
Decreased (*reference category*)	1.0000		
Increased	1.278486	0.383062	0.412
Ownership of radio			
No radio (*reference category*)	1.0000		
Owns radio	0.696095	0.224688	0.262
Pr = 0.0000 Pseudo R^2 = 0.2103	N = 503		

Note ***, ** and * indicate significance at the 1, 5 and 10 % levels respectively

> As you can see I'm in a uniform, I work with Zoom Lion Ghana. But, I don't consider it a job like farming, even though I work there regularly (A 30-year-old male farmer, Nyoglo).
>
> We also cut firewood to sell and engage in charcoal burning in order to buy food (Women's focus group, Wungu in 2012).

In order to engage in some of these activities one needs skills, education, strength as in youthful physical capacity, and financial capital. The binary logistic analysis (Table 5.4) shows that the propensity to shift from farming to non-farm activities is determined by a number of factors, such as the village, age, gender, educational level and size of household of the farmer. Farmers from Gbeduri are about 7 times likely to shift to non-farm activities as a result of climate change compared to farmers from Kanshegu. The proximity of Gbeduri to the district capital Walewale and the availability of natural capital such as wood lots, valleys, and higher farm produce for processing explains the high opportunities for non-farm work. Also farmers aged from 30 to 39 years were about 3 more times likely to shift to non-farm activities than those aged 20–29 years. Again, farmers with Junior High School/Middle School qualification were about 2 times more likely to shift from farming to non-farming activities than those with lesser educational qualification. This may be explained by the fact that farmers with a relatively higher level of education have more skills and can deal with language barriers that prevent people from migrating, trading and performing complex calculations and negotiations with the modern capitalist world. On the other hand, male farmers were about 2 times less likely than female farmers to shift to non-farm production as a result of climate change. As shown in the statement below, women are mostly into trading:

> Women in this village are mostly engaged in petty trading: selling of foodstuff, processing and selling of shea butter, selling of cooked food and general provisions, etc. (Women focus group, Gbeduri in 2012).

Family size also has influence on diversification. Households with 6–10 members were twice less likely to adopt this strategy compared to households with 1–5 members.

5.4.5 Seasonal Migration Strategy

The role of migration in dealing with climate change and variability has been widely acknowledged (Afifi et al. 2014; Van der Geest 2011). Seasonal migration is mainly climate induced, but made more attractive by urban informal job opportunities. The pattern of seasonal migration is changing from rural destinations to urban ones (focus groups in all communities). The majority of men still migrate to rural locations as farm hands while the majority of women migrate to urban areas as

Table 5.4 Determinants of shift to non-farm activities

	Odds ratio	Std. Err	P-ratio
Village			
Kanshegu (*reference category*)	1.0000		
Wungu	1.937642	1.050422	0.222
Nyoglo	0.717586	0.460138	0.605
Nyangua	2.256024	1.420787	0.196
Gbeduri	6.632547	3.897586	0.001***
Bavuginia	0.814059	0.49224	0.734
Age of respondent			
20–29 (*reference category*)	1.0000		
30–39	2.859566	1.64427	0.068*
40–49	1.743649	1.046341	0.354
50–59	1.315241	0.840272	0.668
60 and above	1.511906	0.996597	0.531
Gender			
Female (*reference category*)	1.0000		
Male	0.476433	0.146278	0.016**
Education			
Lower than JHS/Middle School (*reference category*)	1.0000		
JHS/Middle School or higher	1.950152	0.623823	0.037**
Household size			
1–5 members (*reference category*)	1.0000		
6–10 members	0.519957	0.172719	0.049**
More than 10 members	0.544628	0.216334	0.126
Wealth			
Poor (*reference category*)	1.0000		
Moderate	1.516803	0.564474	0.263
Rich	0.892371	0.449793	0.821
Perception of change in temperature			
Decreased (*reference category*)	1.0000		
Increase in temperature	0.93071	0.427519	0.876
Perception of change in rainfall			
Decreased (*reference category*)	1.0000		
Increased	0.800912	0.233032	0.445
Ownership of radio			
No radio (*reference category*)	1.0000		
Owns radio	1.375054	0.436654	0.316
Pr = 0.0000 Pseudo R^2 = 0.1577	N = 429		

Note ***, ** and * indicate significance at the 1, 5 and 10 % levels respectively

head porters, shop assistants and house helps (women's focus group discussions). The age of the respondents and the community to which they belonged were the main determinants of migration strategy. As shown in Table 5.5, the binary logistic model for migration being adopted as a means to respond to climate change was highly significant at a 1 % level of significance. None of the respondents from Kanshegu adopted this strategy, hence it could not be used as the reference category. Wungu was used as reference category.

Table 5.5 Determinants of migration strategy

	Odds ratio	Std. Err	P-ratio
Village			
Wungu (*reference category*)	1.00000		
Nyoglo	0.0300498	0.0207081	0.000***
Kanshegu	(omitted)		
Nyangua	0.1526143	0.0902062	0.001***
Gbeduri	0.9238995	0.4569854	0.873
Bavuginia	0.2459255	0.1175907	0.003***
Age of respondent			
20–29 (*reference category*)	1.00000		
30–39	0.5131379	0.2943041	0.245
40–49	0.527736	0.3115631	0.279
50–59	0.2864456	0.1783769	0.045**
60 and above	0.3209749	0.2008828	0.069*
Gender			
Female (*reference category*)	1.00000		
Male	1.130709	0.3361452	0.679
Education			
Lower than JHS/Middle School (*reference category*)	1.00000		
JHS/Middle School or higher	0.8619634	0.2681385	0.633
Household size			
1–5 members (*reference category*)	1.00000		
6–10 members	1.72203	0.5840839	0.109
More than 10 members	1.288348	0.5045684	0.518
Wealth			
Poor (*reference category*)	1.00000		
Moderate	0.9769176	0.3447383	0.947
Rich	0.950338	0.474396	0.919
Individual land size			
Up to 5 acres (*reference category*)	1.00000		
More than 5 acres	1.235535	0.3324711	0.432

(continued)

Table 5.5 (continued)

	Odds ratio	Std. Err	P-ratio
Perception of change in temperature			
Decreased (*reference category*)	1.00000		
Increase in temperature	1.610564	0.7341893	0.296
Perception of change in rainfall			
Decreased (*reference category*)	1.00000		
Increased	0.9042359	0.2555224	0.722
Ownership of radio			
No radio (*reference category*)	1.00000		
Owns radio	1.21576	0.3640002	0.514
Pr = 0.0000 Pseudo R^2 = 0.2902	N = 369		

Note ***, ** and * indicate significance at the 1, 5 and 10 % levels respectively

Compared to Wungu, respondents from Nyoglo were about 33 times *less likely* to adopt migration as a way of coping with climate change. This may be explained by the fact that a higher number of farmers in Nyoglo have adopted irrigation which is a more effective in situ adaptation strategy (Teye and Owusu 2015). Also, farmers from Nyangua were about 7 times, and those from Bavuginia about 4 times less likely to adopt this strategy than those from Wungu. The results suggest that the proportion that adopts seasonal migration was lower among households that adopt irrigation than those without irrigation. While only 22 % of farmers who adopted irrigation migrate seasonally, 32.5 % of their counterparts who do not irrigate their fields migrate seasonally. These variations were statistically significant (X^2 = 4.1976; *P*-value = 0.040 < 0.05). Consistent with the migration literature (Awumbila et al. 2014), age also determines propensity to migrate seasonally. Respondents aged 50–59 years, and 60 years and above were respectively about 3.5 times and 3 times less likely than younger respondents to adopt migration as a means of dealing with the challenges that come from climate change. This may be explained by the fact that older farmers do not want to leave their families to go and struggle in new communities. Contrary to suggestions in the literature that wealth determines propensity to migrate in response to climate change (Awumbila et al. 2014; Black 2011) the relationship between wealth status and adoption of seasonal migration was not significant (X^2 = 0.8337; *P*-value = 0.659 > 0.05).

5.5 Conclusions

The savannah ecological zone of Ghana has an unfavourable political economy of state neglect, high poverty and a sensitive physical environment (Chambers 1980; Eguavoen 2012; Yaro. 2013). Our findings indicate that both community level factors and characteristics of individual farmers determine capacities to adopt various

adaptation strategies to climate change threats. Community of residence determines capacities to adopt *all* the strategies under investigation (irrigation, water harvesting, fertiliser application, shift to non-farm jobs and ability to migrate). The importance of community of residence in shaping adaptive capacity is linked to the nature and quality of the natural environment, which plays a critical role in defining the possibility of each strategy and the adoption of innovation. For instance, valleys and shallow water tables due to the rock formation are important attributes that determine the adoption of irrigation. Similarly, the level of fertility of farmlands, which also depends on the availability of fallow lands and soil attributes, is an important determinant of fertiliser use. Community of residence also determines the role of institutions and the availability of certain infrastructure, which can shape adaptive capacities. For instance, the level of sophistication of the technology adopted in irrigation is contingent on state infrastructural support and the financial capability of households.

Some individual level characteristics also strongly determine the adoption of certain strategies. Gender determines ability to adopt, fertiliser application and shifting to non-farm occupations. As a result of control over factors of production, males have a higher capacity to adopt fertiliser application than females. However, females have a higher capacity to move to non-farm jobs than men. The age of the farmer determines ability to adopt irrigation, shifting to non-farm work and migration. Younger farmers were more likely to adopt these strategies than older farmers. Wealth is also an important determinant of the capacity to adopt application of fertilisers.

The capacities to adopt various strategies do not only result from material conditions, but also from non-material factors such as personal experience, skills, knowledge, and information, as corroborated by previous studies (Thomas et al. 2007; Vogel and O'Brien 2006). Our findings suggest that knowledge and perception of climate change particularly determine farmers' capacity to adopt irrigation and agronomic practices. This confirms the assertion that the strategy people adopt to deal with climate change is highly dependent on what they think and believe is happening (Teye et al. 2015). Burton's (1997) assertion that willingness to adapt to climate change and variability depends on experience, time horizon, and the risk tolerance of individual decision-makers, is critical in any understanding of livelihood adaptation and adaptive capacities. There is therefore the need to provide adequate climate information to help shape the perceptions.

Beyond the decision to adopt a strategy is the ability to do so, which often depends on the asset base of the household including human capital as measured by educational levels and household sizes; financial capital as measured in savings and stores; loans; and access to resources such as land. Household size is still an important determinant of some strategies because technology uptake for labour saving jobs is low. Even for the strategy of migration, larger households tend to be more flexible in releasing willing individuals who want to migrate. Education and other skills learnt on the job create the possibility for households to adopt strategies involving modern and foreign innovations as they are easier to comprehend, while conservative values erode with education. The poverty levels are still high, with

many recording low levels of material assets. Just as in the study by Bryan et al. (2009) in Ethiopia and South Africa, wealth or resource endowment is shown to be an important determinant of one's adaptive capacity and eventual adaptation, aided by rural services. The high levels of poverty resulting in low levels of investments and other constraints explain poor implementation of adaptive strategies.

Assets are important in defining the ability of individuals and households to adapt to climate change, but these are not effective without the right policy and developmental coordination from the state level. Where the capacity of the state is weak, then NGOs become important in facilitating the build-up of community assets. A misunderstanding by the state and donors of the vulnerability conditions and life aspirations of rural people can lead to faulty development projects that limit internal adaptive capacities. Heltberg et al. (2009) are right in this regard in arguing that serious damage to natural systems from climate change need not result in catastrophic and irreversible damage to humans because it all depends on the effectiveness of societies' adaptive capacity, which is shaped by policies and institutions. Both traditional and local state institutions are important since they both manage different segments of community life (Yaro et al. 2014) and perform indispensable functions such as information gathering and dissemination, resource mobilization and allocation, skills development and capacity building, providing leadership, and networking with other decision makers and institutions (Agrawal 2008).

The wider political economy of incentives and constraints are overarching determinants of vulnerability in the area. The inability to procure the needed inputs due to high prices mandated by international neoliberal policies and the myriads of social changes taking place in rural societies have wider ramifications for adaptive capacities and the livelihoods of the poor. This makes the space of vulnerability as put forward by Watts and Bohle (1993) an important conceptual tool for exploring the intertwining factors such as physical environment, social-economic, and political preferences (Yohe and Tol 2002) in determining adaptive capacities and vulnerabilities. The findings support the view of Nielsen and Reenberg (2009) that livelihood changes in human–environmental systems may be best understood by looking at the co-evolution of different driving forces over time.

By distorting the viability of agriculture and other natural resource-based activities on which many in the study communities depend, climate change has called for a radical transformation of the agricultural sector. This transformation requires building capacities and competencies at several levels that are invariably low in developing countries. This study recommends the scaling up of local resilience building mechanisms while introducing modern mechanisms for dealing with the impacts of climate change hazards. Development is the best solution to dealing with climate hazards as people move out of poverty, which mainly prevents them from adapting appropriately. Local measures should include an effective extension service and NGO agents with modern appropriate knowledge and technologies, irrigation infrastructure, microfinance support, and insurance schemes. State policies need to balance the neoliberal conundrum of forces with neo-Fabian practices in order to build the capacities of people to compete in the global world. Finally, there must be

conscious efforts at institutional changes at both the traditional informal and formal levels in addition to national and global policy changes which have implications for the abilities of the rural poor. Our focus on adaptation should be holistic to respond to multiple vulnerabilities at different levels and timescales so as to ensure effectiveness.

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Chapter 6
Climate Change, Local Knowledge and Climate Change Adaptation in Ghana

Emmanuel K. Derbile, Francis X. Jarawura and Mohammed Y. Dombo

Abstract Although the potential role of local knowledge in community development is receiving increasing recognition as a strategic resource, little attention is paid to a critical evaluation of both its potential and limitations in climate change adaptation (CCA) in Sub-Saharan Africa. The purpose of this chapter is to critically evaluate the potential role and limitations of local knowledge for CCA in small holder agriculture from an endogenous development (ED) perspective in Ghana. The chapter draws on a review and content analysis of selected empirical studies on local knowledge in CCA in northern Ghana. The findings reveal a potential contradiction. On the one hand, evidence abounds on the potential role of local knowledge for enabling environmental sustainability and climate change adaptation in smallholder agriculture in accordance with the basic tenets of ED. On the other hand, there is caution that local knowledge is not without limits and risks; thus, sustainability and adaptation goals can be undermined if choices of local strategies do not take into account the local context and the need to maintain a balance in development. We therefore, argue that although local knowledge is the primary knowledge for CCA in smallholder agriculture, this potential is being overstretched and limited by increasing extreme climatic variability, low adaptive capacities and global change processes. We put forward an ED approach as a sustainable method for promoting the role of local knowledge in smallholder agriculture and Community-Based Natural Resource Management (CBNRM) for CCA under local governance in Ghana.

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J.A. Yaro and J. Hesselberg (eds.), *Adaptation to Climate Change and Variability in Rural West Africa*, DOI 10.1007/978-3-319-31499-0_6

Keywords Climate variability · Local knowledge · Climate change adaptation · Endogenous development · Ghana

6.1 Introduction

It is now well known that climate change is one of humankind's greatest contemporary challenges which deserve prime attention (IPCC 2007, 2013). Climate change undermines livelihood security, particularly in Developing Countries, due to dependence on climate sensitive resources and low adaptive capacities (Dietz 2001, 2004; Dalby 2009; IPCC 2013). For instance, a large proportion of the population in Sub-Saharan Africa depend on rain-fed agriculture as a primary source of livelihood, but production is compromised by climate variability and the vulnerabilities that people experience are exacerbated by poverty and limited government support for Climate Change Adaptation(CCA) in the sub-region.

In Sub-Saharan Africa (SSA), smallholder farmers have largely depended on a wide range of local knowledge for minimizing their vulnerability to climate change. A dual and dynamic perspective of local knowledge is adapted in this chapter. First, local knowledge here refers to indigenous knowledge, the unique and traditional knowledge of a people indigenous to a particular geographic area, community and a given culture (Nuffic and UNESCO 1999:10). Such knowledge changes over time through local adaptations, experimentation and innovations, and is passed on from one generation to another through oral and/or experimental means (Niarmir 1995). Secondly, local knowledge is used here to refer to adapting new and external knowledge to local contexts and applications, which often leads to the production of new local knowledge (Cohen and Levinthal 1990; Evers and Gerke 2013). Local knowledge is gained through long-term experience and consists primarily of cognitive capabilities that shape action (Antweiler 2012). Although it is referred to as a 'knowledge system' among anthropologists, as also used in some instances in this chapter, it does not often present itself as a comprehensive system (Antweiler 2012). Nonetheless, it exhibits many attributes of a system in both its tacit and explicit forms and is therefore, central to development. In this respect, many authors have stressed that the importance of knowledge in development lies in understanding knowledge processes(Arce and Long 2000; Pottier et al. 2003; Hornidge 2007; Sillitoe 2009 in Antweiler 2012: 5657).

The role of local knowledge in climate change adaptation is receiving increasing attention in climate change research. In general, farmers possess valuable knowledge on the weather and how to deal with the challenges it poses (Nyong et al. 2007). For instance, local people in various parts of Africa have been successful in devising various means of dealing with climate variability and change drawing on their local knowledge (see Davies 1996; Derbile 2012, 2013; Jarawura 2013; Asaah et al. 2013; Golo and Yaro 2013; Derbile and Laube 2014).

Although the importance of local knowledge for climate change adaptation is receiving increasing recognition particularly in SSA, little attention is paid to a

critical evaluation of both its strengths and limits and the policy implications for Climate Change Adaptation Planning (CCAP). Hence, does the application of local knowledge for adapting smallholder agriculture to climate change present both strengths and limitations, and what are the policy implications for CCAP? Central to this chapter, therefore, is a critical evaluation of the strengths and weaknesses of local knowledge for climate change adaptation in smallholder agriculture in Ghana.

6.2 Climate Change and the Northern Savannah of Ghana

According to Nicholson et al. (1999), in the semi-arid and sub humid zones of West Africa, the amount of rainfall experienced between 1968 and 1997 is lower than that experienced between 1931–1960, revealing a declining pattern. The challenges of climate change are expected to become severer and more significant in the near future (Dietz 2001; IPCC 2013). Climate modelling by Minia (2004) shows that mean daily temperatures will increase between 2.5 and 3.2 °C and that rainfall will decrease by 9–27 % by the year 2100. For West Africa, extreme wet seasons and climate events (floods and drought) could increase by 20 % over the next two decades (Christiansen et al. 2007). These projections are consistent with the decline in rainfall observed throughout West Africa over the last 50 years. Although the region has seen a relative recovery in rainfall since the late 1990s, the increase in variability and changes in patterns have negated the potential positive effects on crop productivity (IPCC 2007).

This chapter focuses on the northern Savannah agro-ecological zone of Ghana which comprises the Guinea Savannah and the Sudan Savannah (Fig. 6.1). This entire savannah zone is part of the larger Volta Basin of West Africa affected by climate change and climate variability. It is characterized by high unpredictable rainfall patterns and extreme climatic events, droughts, heavy precipitation events and floods. The Guinea Savannah receives relatively higher rainfall compared to the Sudan Savannah.

In general, rainfall in Ghana has reduced by about 20 % since the 1960s (EPA 2000). Over the last three decades, there has also been a general rise in rainfall variability and climate extremes, particularly, droughts and floods (EPA 2000). Droughts and floods have been more prevalent and profound in the northern Savannah zone. The Savannah zone is more susceptible to the effects of climate change as this area has only one rainy season compared to two rainy seasons in the forest zones.

Agriculture is the primary livelihood in this zone and is largely rain-fed, resulting in high vulnerability to climate change and variability. Farmers cultivate food crops including maize, groundnuts, millet, cassava and yam. Farming is mainly targeted at satisfying consumption. However, farmers sell some of their produce for cash in order to meet monetized needs (Yaro 2013). In Ghana, the northern Savannah is the most vulnerable area to climate variability; the effects of climate variability on food production in the area are greater than anywhere else in

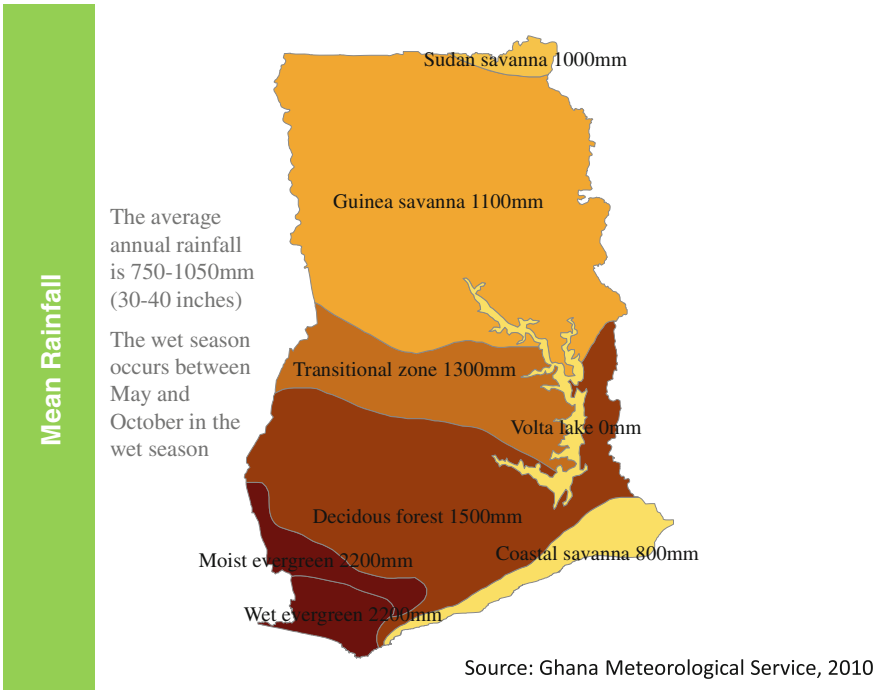

Fig. 6.1 A map showing ecological zones and average annual rainfall in Ghana

the country (UNDP 1997; Van de Giesen et al. 2010; EPA 2012). One of the reasons for this high vulnerability is that the area has a uni-modal rainfall regime compared to two seasons in the transitional agro-ecological and forest zones and this concentrates climate risks in a single season (Dietz et al. 2004). Another reason for the high vulnerability is the low mechanization in agriculture, particularly limited access to irrigation.

6.3 The Underpinnings of Endogenous Development: Local Knowledge, Environmental Sustainability and Climate Change Adaptation

This chapter draws on the theoretical underpinnings of endogenous development (ED) for interrogating the relationship between local knowledge, environmental sustainability and climate change adaptation. Endogenous development is essentially a bottom–up and participatory approach to development, particularly community development. According to Haverkort (2006: 43–44), endogenous development refers to development that primarily emanates from within communities themselves. The process of development draws primarily, though not exclusively on locally

available resources. These resources include local knowledge, skills, competencies, culture, leadership and the way communities organize themselves. The others include land, water and the natural vegetation. The process of development can benefit from external knowledge and resources as complementary to local resources. However, the process of development allows for experimenting, local learning and building local economies that ensure the retention of benefits in the local area. Many other researchers have supported the notion of ED as a community-based and participatory approach to development that draws mainly on local resources and to a lesser extent on external resources (Millar and Bonye 2005; Lammerink 2010).

Nonetheless, the process of endogenous development allows for selective borrowing and/or adaptation of external knowledge and resources to the local context for addressing local needs. Thus, endogenous development is not restricted to only local processes and resources; it is open to utilizing opportunities provided by globalization (Haverkort 2006: 43–44).

Drawing on the experiences of COMPAS (Comparing and Supporting Endogenous Development), an international network that supports endogenous development, Haverkort characterizes the areas for ED support in multiple ways (Table 6.1).

These identifiable areas for ED support describe the essential features of endogenous development as local, community and people centred (Table 6.1).

An endogenous development framework (Fig. 6.2) is appropriate for analyzing the relationship between local knowledge, environmental sustainability and climate change adaptation. This is because ED builds on the worldview of the local people and a cosmovision that prescribes unity or integration of the natural, social and

Table 6.1 Areas of endogenous development support

• Development that builds on locally available resources
• Objective based on locally felt needs and values, acknowledging the interests of different social categories
• In situ reconstruction and development of local knowledge systems: understanding, testing and improving local practices and enhancing the dynamics of local knowledge processes
• Maximizing local control of development
• Identifying development niches based on the characteristics of each local situation
• Selective use of external resources
• Retention of the benefits in the local area
• Exchange experiences between different localities and cultures
• Training and capacity building for rural people, development staff and researchers
• Networking and strategic partnership and policy influencing
• Further understanding of systems of knowing, learning and experimenting

Source Haverkort (2006: 46)

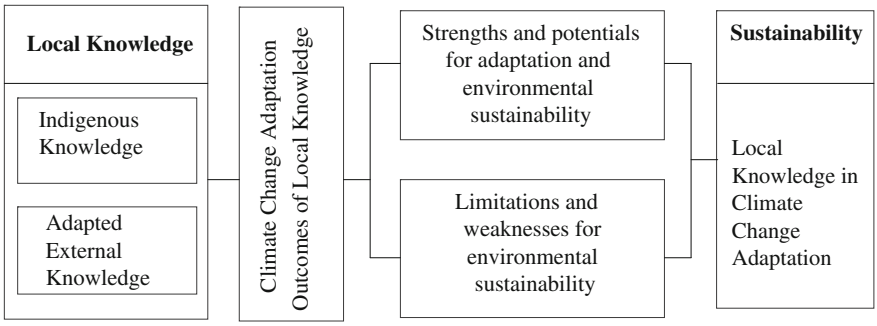

Fig. 6.2 Conceptual framework: local knowledge and climate change adaptation in smallholder agriculture under endogenous development

spiritual worlds (see Haverkort 2006). This orientation towards a holistic worldview is akin to local knowledge systems in Africa. For instance, Lammerink (2010) argues that methodologies for supporting endogenous development take into account people's worldviews and livelihood strategies as the starting point for development and thus, maintain a local focus.

The framework (Fig. 6.2) assumes local knowledge as an entry point because sustainable adaptation to climate change in the Developing World will require an assessment of the role of such knowledge, which has long been the bedrock of community development strategies. The value of local knowledge as an invaluable resource and a driver of innovations for sustainable development is widely recognized (Chambers 1979; Antweiler 1998; Pottier 2003; Aluma 2004). Local knowledge describes the knowledge that people hold and apply for their daily sustenance and which is transmitted and modified through time. Local populations in the Developing World have always depended largely on local knowledge for dealing with environmental challenges, including climate change.

Local knowledge underlies the strategies involved in preparedness and adaptive phases to environmental change, shocks and stresses (Derbile 2010), and this also provides a window for experimentation and learning about adaptation experiences and outcomes. The goal of every smallholder farmer is to secure livelihood through successful adaptation which is strongly tied to environmental sustainability. However, experimentation and or application of local knowledge for environmental sustainability and climate change adaptation could yield either successful or failed outcomes. Successful outcomes reflect the strengths and potential of particular local strategies as explicit local knowledge. In the same vein, local strategies that do not work quite well will reflect the weaknesses and limitations of such local knowledge. However, both streams of outcomes are relevant for informing continuous experimentation, evolution of new knowledge and innovations for enhancing the sustainability of the environment and of climate change adaptation.

A closer examination of the concept of environmental sustainability as applied here is important for establishing the connection between local knowledge and

climate change adaptation. Environmental sustainability is the ability to protect the use of future resources by properly maintaining and protecting the resources that are being exploited. The maintenance of the quality of the environment on a long term basis is not alien to people in the Developing World as they focus on securing their livelihoods (Goodland 1995). However, more central to the subject of climate change adaptation is the notion that environmental sustainability is about strategies that ensure continuous renewal of ecosystem resources for the benefit of present and future generations (Chambers 1999; Ellis 2000).

During the last century, when environmental sustainability emerged as an important theme, most of the international agreements and programmes designed to sanction human-environment interaction to ensure the sustainability of the environment were based on what was termed scientific knowledge (Chambers 1999). These initiatives largely achieved very little due partly to lack of political commitment from various countries. Another crucial reason for the failure, particularly in the Developing World, is the failure to include local perspectives or knowledge on environmental management (Chambers et al. 1999; Byg and Salick 2009). Local people, particularly those in the Sahel and Savannah zones of West Africa, were largely seen as people vulnerable to climate extremes and economic decline who unwillingly overexploited scarce natural resources, thereby undermining their own existence and the sustainability of the environment by enhancing the advance of the desert. However, it soon emerged at the end of the century that such 'desertification' and/or failure of local knowledge narratives were not entirely true; indeed, they had little veracity (De Bruijn and van Dijk 2005).

This framework is appropriate for addressing the question of how and to what extent local knowledge can and does enable environmental sustainability and climate change adaptation from an endogenous development perspective.

6.4 The Methodology

This chapter draws on a critical review of secondary data on local knowledge for adapting food crop farming to climate variability in the northern Savannah agro-ecological zone. The chapter draws on specific examples of various local knowledge systems of adaptation to climate variability across the Northern, Upper East and Upper West regions. Content analysis was employed for extracting and analyzing key content on local knowledge on adaptation. The analytical tool, Strengths, Weakness, Opportunities and Threats (Threats (SWOT) was employed for a critical analysis and synthesis of the strengths and opportunities as well as the weaknesses and threats to the sustainability of local knowledge.

6.5 Local Knowledge in Climate Change Adaptation: Prospects and Limitations for Environmental Sustainability and Climate Change Adaptation

This section reviews some local knowledge practices for climate change adaptation and discusses their strengths and limitations for environmental sustainability in the Guinea savannah of northern Ghana. The analysis is centered around the following local strategies for climate change adaptation: the cultivation of multiple farms, staggering seeding between farms, cultivating drought resilient indigenous crops and planting in valleys and river banks crops hitherto planted on higher ground.

6.5.1 Multiple Farms and Staggering Seeding

The creation and cultivation of multiple farms is a common characteristic of smallholder farming in northern Ghana. It is an essential part of their local knowledge in agriculture that has been practiced from generation to generation and has become useful for coping and/or adapting to climate variability in rain fed farming. This system results from various factors including land tenure, population growth, differential soil fertility and the growing need to stagger seeding as a means of dealing with climate variability and 'uncertain rainfall'. Families usually do not own large parcels of land at one place. Rather, they cultivate between two and three different farms. In the *Atankwidi* basin of northeastern Ghana for instance, farmers generally cultivate two or three different forms of farms. These may include the compound farm (*Sammani*), bush farm (*Moom*) and valley farms (*Boo*) (Derbile 2012). Also, population growth ensures that people in northern Ghana are increasingly extending cultivation into bush lands several kilometers away, creating new and more fragments (Yaro 2004). Furthermore, soil infertility and differential soil requirements of different crops result in some farmers creating farms at suitable locations for different crops (Jarawura 2013). The creation of multiple farms is also a response to increasing climate variability and changes in the rainfall calendar. Multiple farms by themselves act to reduce vulnerability to climate change as different farms may experience different micro climate circumstances. Also, multiple farms allow for the staggering of planting, which is considered an important means of dealing with climate variability. The strategy involves slightly varying the timing of planting seeds between different farms to reduce vulnerability to rainfall variability (Derbile 2010, 2012). Indeed, it is a traditional strategy enabled by the availability of land and a flat and undulating terrain that enables human mobility.

However, the creation of multiple farms, particularly bush farms, often requires effective transport rather than walking. Different forms of intermediate transport such as the bicycle and animal drawn transport are often necessary for sustaining such a farming system. Thus, transportation becomes a major challenge, particularly for poor farmers, as exemplified by the view of farmers in the *Savelugu* area:

> Those with tractors can go far into the bush to make farms. The poorer ones join them. If you help them to clear their fields, they will also help you tilt your land and eventually help you to harvest and to bring your food home…but if you have no tractor and you don't want to be a labourer to a rich man then you just stay home and continue to cultivate the impoverished lands (Jarawura 2013: 166).

Fifty years after independence, rural transportation in Ghana is still underdeveloped, so that accessibility to most rural communities and bush farms is limited. Poor rural transportation is partly the cause of post-harvest losses. Farmers lose some of their harvest during transportation or are unable to transport their produce to the market in time. The multiple farm strategy therefore appears to be unsustainable for the poor who cannot afford better modes of transport.

In respect of environmental sustainability, the rising trend in the creation of multiple farms in the hinterland poses serious challenges, as it often leads to deforestation. In the *Savelugu* area, this results in wanton destruction of secondary livelihood sources provided by nature or the commons (Jarawura 2013). The cutting of the *shea* tree is the farmer's major concern. There are also complaints about the loss and near extinction of medicinal plants. Meanwhile the loss of vegetation is known to have adverse consequences on rainfall and the potency of soils to offer nutrients to crops (IPCC 2013). Furthermore, the multiple farm strategy is only possible in places with low population densities and relatively fertile soils, as in the Northern Region and eastern part of the Upper West Region, the Sissala area. In the Upper East Region, particularly in areas with the highest population densities, there are virtually no bush lands with great potential for cultivation. First, urbanization and expansion of rural settlements as a result of population growth has led to the conversion of many arable lands into settlements. Secondly, much of the remaining bush lands have been degraded to the point that investment returns on farming are minimal and a disincentive. Although valleys and river banks have relatively fertile soils, the majority of farmers lack access to these productive lands because they are limited in geographic spread.

6.5.2 *Cultivation of Drought and Flood Resilient Crops*

The cultivation of crop varieties that are resilient to drought is one of the strategies widely applied for climate change adaptation in northern Ghana. Yaro (2004) notes that such crops include both traditionally known varieties and exotic ones introduced by the government and development agencies. Traditional crops include millet and sorghum. Millet is resistant to both drought and flood and has enabled farmers reduce their vulnerability to extreme climatic events in northern Ghana (Van der Geest 2004). In some cases there is mixed cropping of two or more drought resistant crops to build resilience to drought and floods. The cultivation of indigenous crop varieties, namely early millet (*Naara)* and late millet (*Zea)* together or with other crops in northeastern Ghana enables adaptation to dry spells and drought (Derbile 2010).

Despite the potential of these indigenous crops for climate change adaptation, increasing rainfall variability is overstretching their resilience or capacity to adapt. Farmers' knowledge on timing of planting is increasingly being challenged by changes in the rainfall patterns. Farmers have complained of many instances in which planted seeds have failed to germinate due to the lack of rain. Meanwhile replanting is not often an option for all farmers. Some farmers are unable to afford the cost of replacing seeds (Jarawura 2013) or do not have surplus seed stock to draw on. In many other instances, it is too late to replant.

Furthermore, farmers in the northern Savannah agree that their traditional methods of weather prediction are not without problems (Jarawura 2014). In fact, it is claimed that farmers in Africa are increasingly aware of the inaccuracies of the signs of nature used in their prediction of rainfall and are reducing their dependence on them (Slegers 2008). Some farmers have moved a month further in planting their seeds given that the onset of the rainfall season has shifted forward. However, this is not without problems. Shortening rainfall duration has become a main challenge in the cultivation of late millet (*Zea*) because it is a long duration maturing crop variety. Although farmers continue to plant these crops, yields have dropped significantly due to the effect of drought so that it is gradually being replaced by maize as a staple crop in many parts of northern Ghana. For instance, a shrinking rainfall season has adversely affected the production of long maturing millet and sorghum varieties in the *Atankwidi* basin of the Upper East Region because the maturation of seeds is truncated by the lack of moisture (Derbile 2010). Thus, farmers are dropping the cultivation of millet and sorghum for quick maturing varieties of crops which are not necessarily drought resilient in northern Ghana (Yaro 2013).

6.5.3 Cultivation of Valleys, Marshy Lands and River Banks

Another local response to rainfall variability is the cultivation of crops in valleys, marshy lands and river banks for adapting crops to droughts. These areas are better at withholding moisture and provide moisture for plant growth during drought. In Savelugu, a farmer underscores the relevance of valleys and marshy lands for adapting farming to climate variability (Jarawura 2013: 162):

> Every wise household head is now looking for marshy lands in the bush […]. The low land areas are very scarce but those areas save us a lot […] because these places can hold water for so long…and when there is inadequate rainfall […] you may not even feel it […] even if you don't smile but you will not cry at harvest.

Traditionally, valleys, marshy areas and river banks have been used for the cultivation of rice. Thus, farmers have adapted this knowledge of rice planting in wet areas to planting staple crops hitherto planted on higher ground for adapting to drought (Jarawura 2013). The evidence shows that the cultivation of food crops along riverbanks in the White Volta basin enabled adaptation to drought and

comparatively, provides higher yields than farming in other locations such as compound and bush farms (Asaah et al. 2013).

However, access to valleys and marshy arable lands is limited and the competition for these has resulted in over exploitation and environmental problems. Thus, while providing a means to deal with climate variability and change, over exploitation can potentially lead to degradation of these land resources, which could potentially affect the sustainability of agriculture. The Egyptians and Sudanese have depended on the cultivation of river banks for a long time, but this has also led to siltation and annual flooding of the Nile.

In addition, most valleys and river banks are prime grazing lands, so that conversions into crop lands deprives livestock of the best natural feed, adversely affecting production.

6.5.4 Adoption of Early Maturing Crops

Farmers are also adapting food crop farming to rainfall variability through the adoption of early maturing crop varieties in the Savannah zone. This involves the adoption of both traditional and new crop varieties (Yaro 2013; Derbile 2010). The latter include new varieties of potatoes, sorghum, soya beans, beans, and groundnuts. The cultivation of such early maturing crop varieties reduces risk to rainfall variability, particularly the shortening of the rainfall season. For example, farmers in north-eastern Ghana have adopted an early maturing potato variety, known in local parlance as *Gerigo* for adapting cropping to the shortening rainfall season. *Gerigo,* literally meaning 'fool', was imported from Burkina Faso through social exchanges and named after the capability of the new potato variety to strive under poor soil and rainfall conditions (Derbile and Laube 2014). Farmers successfully adapted the new potato variety and new varieties of rice and maize to local production through the application of indigenous knowledge (Derbile 2010).

The adoption of early maturing crop varieties comes with its own limitations. For instance, farmers pointed out that the new potato variety cannot be stored for as long as the traditional or indigenous varieties they cultivated in the past. In addition, they observed that the new potato variety was not as tasteful as the traditional variety and that it was unsuitable for preparing local dishes (Derbile 2010). In addition, most early maturing crop varieties, particularly maize and rice, require the application of fertilizer to optimize yields, but fertilizer is out of economic reach to most farmers. Thus, adoption of early maturing crop varieties is not a one-size—fits all solution as its not suited to least input agriculture systems of smallholder farmers in northern Ghana. Clearly, while early maturing crop varieties present an opportunity for adaptation to climate variability, they also come with some technological challenges, and social and economic cost.

6.5.5 An Era of Genetically Modified Crops (GMCs)

Following the successful passing of a Bill in Parliament in support of the introduction of Genetically Modified Crops (GMCs), another stream of new crops farmers have to deal with are GMCs. Genetically modified maize and soy bean varieties are being experimented on and promoted in northern Ghana by some development agencies and capital interest, but information about these activities is limited partly because of resistance from some civil society organizations such as the Peasant Farmers Association of Ghana (PFAC) and some non-governmental organizations. In Ghana, as in many other parts of the World, people are divided as to whether GMCs are good for development or not. GMCs are proposed as one of the possible means of dealing with climate change as well as meeting growing global demand for food. It is claimed that some crops have been successfully genetically modified to be drought and pest resistant. These crops are also regarded as high yielding (Thomson 2007). Some GMCs are also engineered to develop their own toxins to kill targeted pests. Thus, they could help solve the problem of climate change induced pest infestation. Pesticides, on the other hand, tend to kill a number of pests without isolating those that are harmful to the crop. It is claimed that farmers in the United States who grow GMCs have reduced the use of pesticides on their farms. This has tended to result in the use of less fuel in farm operations since farmers use machinery in spraying their farms (Bazuin et al. 2011).

Notwithstanding these benefits, GMCs come with multiple risks, challenges and uncertainties. For example, it is argued that it is harder to kill insects that develop resistance to the toxins produced by GMCs. In the USA, some insects have already developed resistance to GMCs. There is also the emergence of super bugs. This has resulted in farmers in the USA reverting to or increasing the use of pesticides. An increase in the use of pesticides does not only expose humans and the environment to potential harm but also eliminates a major benefit of using GMCs (Phipps and Park 2002). GMCs also pose a great threat to biodiversity as winds and pollinators can contaminate the native vegetation with GMCs. Also, the fact that seeds from GMCs cannot be replanted poses a financial threat to farmers who are used to harvesting their own seeds for planting (Dean and Armstrong 2009).

There are also fears that plants may acquire ecological advantages that could enable them multiply and become weeds (Dalton 2008). If this happens, it could increase vulnerability to climate change of small holder farmers in Ghana, particularly those in the fragile Savannah agro-ecological zone which has just one rainy-season. The zone is also inhabited by very poor farmers who already have serious difficulties in dealing with crop pests (CIDA 1999; Codjoe and Owusu 2011). These factors imply that adoption of GMCs will not necessarily reduce farmers' vulnerability to climate change in northern Ghana. More so, there are safety concerns in terms of human consumption. It is still too early to determine the

actual risk involved in the consumption of GMCs and there is every reason to suspend commercial production for more research (Dean and Armstrong 2009).

6.6 Sustainability: Local Knowledge, Environmental Sustainability and Climate Change Adaptation

In this section, we analyze the link between local knowledge, environmental sustainability and climate change adaptation. First, SWOT[1] analysis is applied to determine the prospects and limitations of local knowledge for climate change adaptation (CCA) and environmental sustainability. The implications for environmental sustainability are then discussed within the theoretical framework of endogenous development.

The SWOT analysis enabled a holistic examination of the role/potential role and limitations of local knowledge in climate change adaptation (Table 6.2). In the introductory and theoretical review, local knowledge has a dual application: first, as indigenous knowledge unique to a local population and environment that is subject to change in response to climate change; and second, as adaptation of new and external knowledge to the local context for climate change adaptation.

The analysis presents two opposing sides on the potential role of local knowledge for environmental sustainability and climate change adaptation from an endogenous development perspective (Table 6.2). As a corollary, the potential roles (strengths and opportunities) and limitations (weaknesses and threats) of local knowledge are both real and seem to present a contradiction in respect of the role of local knowledge for promoting endogenous development. These contradictions are worth summarizing around a couple of strategies:

- The cultivation of multiple farms and the staggering of seeding between them is a local strategy for spreading risk and adapting food crop farming to rainfall variability. However, it often leads to deforestation and land degradation, and is impractical in areas with high population densities because of scarcity of land. Efficient transportation modes are also required but these are very often out of reach for poor farmers.
- Cultivation of drought and/or flood resilient indigenous or local new crops is another strategy for adapting cropping to rainfall variability. However, extreme rainfall variability is posing a challenge to the capacities of these crops to adapt. At the same time, traditional methods of forecasting rainfall for farming have also become problematic and lack precision.
- The cultivation of valleys, marshy lands and river banks is yet another local strategy for adapting food crop farming to climate variability. However, access

[1]SWOT is an analytical tool and an acronym referring to strengths, weaknesses, opportunities and threats.

Table 6.2 Strengths and weaknesses of local knowledge for CCA

Strengths	Weaknesses
• Availability of indigenous knowledge as the basic knowledge infrastructure • Applicability of indigenous knowledge to adapting new and external knowledge to local conditions • Primary focus on utilization of local resources such as land, river banks, valleys and marshy areas, soil, water and plant and animal residues • Openness to experimentation, shared learning, discoveries, validation and comparative analysis • Enabling of modest coping and adaptation outcomes, particularly, ensuring modest yields and some amount of food access • Suitability and compatibility with local dishes and culture • Adaptability to low input agriculture under poverty	• Unsuitability of some aspects (indigenous crop varieties) for adapting cropping to shortening rainfall durations • Limited geographic spread and access to vital resources, such as valleys and marshy areas and river banks for CCA • Lack of systematic documentation with high risk of loss given that it is largely passed on and shared through oral traditions • Non adaptability of new and early maturing crop varieties to least input agriculture systems that are practiced • Inability to store some adapted new crop varieties (e.g., potatoes) for long • Coping and adaptation outcomes being non transformational, yet ensuring modest yields and some amount of food access
Opportunities	**Threats**
• Availability of external sources and inflows of new and early maturing crop varieties and other agro inputs that support adaptation • Suitability of early maturing crop varieties for adapting cropping to shortening rainfall duration	• Climate variability and extreme climatic changes which continue to pose a threat to the abilities of indigenous and new crop varieties, e.g., shortening duration of rainfall, floods, droughts and high temperatures • The possibility that the introduction of GMCs may erode indigenous knowledge in agriculture and lead to establishment of new production systems • The concern that the introduction of GMCs will create seed market dependency, erode knowledge in seed preservation and render seeds inaccessible to poor farmers

to valleys and river banks for cultivation is limited, while the few that are accessible have been over exploited, leading to land and soil degradation.

- The adoption of early and new maturing crops enables adaptation but requires application of fertilizer for optimal yields, and this presents an additional economic burden unsuited to low input agriculture systems.
- GMCs could potentially enable climate change adaptation, especially, engineered drought and pest resilient high yielding varieties. Nonetheless, their introduction could potentially lead to the extinction of indigenous crop varieties and the loss of some important indigenous knowledge. GMCs do not seem to be compatible with indigenous knowledge systems of production in much the same way as the previous generations of new crop varieties.

The analysis reveals that although local knowledge presents some prospects and potential for environmental sustainability and climate change adaptation, it also presents some potential limitations that can undermine sustainability. Nonetheless, there is sufficient evidence on the strategic role of local knowledge for sustaining smallholder agriculture under climate change.

From the analysis (Table 6.2), indigenous knowledge in smallholder agriculture is the basic knowledge infrastructure communities largely depend on for production, and by extension, for adaptation to climate variability. This comprises their knowledge of indigenous crop varieties, land resources and soils, and their capabilities for resilience and moisture retention. It also includes their ability to draw on indigenous knowledge for experimentation and adaptation of new knowledge for enhancing climate change adaptation capacities under low input agriculture. Thus, although new and external knowledge is important for climate change adaptation, its application largely draws on indigenous knowledge as the platform for experimentation and adaptation to production at local levels. This underpins the strategic importance of local knowledge for understanding climate risks and enabling climate change adaptation (see Nyong et al. 2007; Davies 1996; Derbile 2013; Jarawura 2013; Golo and Yaro 2013). Pottier (2003: 3–4) clearly underpins the significance of local knowledge in development in stating that: "The problems of rural development are no longer seen to reside in traditional cultures…….of under-developed people, but rather in the partial and biased understandings that have emanated from the unreflexive application of a western scientific rationality…Indeed traditional cultures are now seen as containing the bases for any effective development…".

Nonetheless, there are limits to the extent to which local knowledge can provide solutions to the climate change challenge. This is because weaknesses of and threats to local knowledge potentially undermine the sustainability of its role for enhancing environmental sustainability and climate change adaptation. These limitations are multiple, specific to particular local strategies and dependent on availability of particular local resources at community levels. Haverkort (2006) cautions that indigenous knowledge and practices may not provide solutions to all present day challenges because of its own limitations. Similarly, Millar and Bonye (2005) underscore that processes of globalization sometimes fail to support peculiar needs of specific regions or populations because of a tendency to promote western modern knowledge and technologies as global standards. They cite an example in agriculture that corroborates one of the findings discussed in this chapter. Thus, although the use of external inputs has increased and led to improvements in productivity, there is growing awareness of the problems associated with this approach (Millar and Bonye 2005).

For the most part, the application of local knowledge and the strengths and opportunities that it presents are consistent with the basic tenets of ED. Indigenous knowledge and adapted external knowledge complement each other in building capacities for environmental sustainability and climate change adaptation. The role of indigenous knowledge is even more critical given limited access to agricultural extension services among smallholder farmers in Ghana. For instance, livelihood systems and livelihood diversification in northern Ghana are primarily shaped by

local knowledge, local resources and an African World View. Livelihood diversification proceeds with subsistence agriculture as a primary livelihood for many households, but also as an important cultural heritage and way of life that provides the basis for diversification into non-farm livelihoods and social organization of life (Derbile 2014). Thus, the primary dependence on local resources (Haverkort 2006; Lammerink 2010) and local knowledge (Derbile 2010; this chapter) in efforts towards enhancing environmental sustainability and climate change adaptation gives true meaning to ED.

Although the role of local knowledge in climate change adaptation seems to present some contradictions, the potential and prospects are overwhelming as evidenced in explicit knowledge for climate change adaptation in smallholder agriculture. The potential limitations and risks of local knowledge are real and their effects can potentially constitute a departure from the basic tenets of ED. However, such risks could be minimized if choices of local strategies are informed by the need to maintain a balance in development and an appropriate understanding of the local context. This conforms to an essential feature of ED as a harmonious approach to development that has a potential for addressing contradictions and meeting local needs. For instance, ED provides a complementary window for integration of global processes of technological and economic changes and supports co-evolution of knowledge within the context of a diversity of cultures (Haverkort 2006).

According to Haverkort (2006), a common feature of local knowledge is that life is conceived in terms of three interrelated and inseparable domains, namely the natural world, the social world and the spiritual world, despite a diversity in the ways that local knowledge is expressed. This integrative worldview finds common expression in traditional worldviews and knowledge systems in Africa. For instance, this integrative worldview finds expression in the cosmovision and worldview of the people of northern Ghana (Millar 1999) and the Shona people of Zimbabwe (1999). As a corollary, the notion of unity exists between the natural, social and spiritual worlds in the traditional way of knowing in agriculture and other fields of life (Haverkort 2006:44). Thus, in the application of local knowledge for climate change adaptation, targeting harmony between the three interrelated domains will ensure a balance in development and give true meaning to an ED approach to climate change adaptation.

6.7 Conclusion and Policy Implications for Planning

This chapter set out to analyze the potential role and limitations of local knowledge for climate change adaptation in northern Ghana. The analysis reveals a contradiction. On the one hand, we conclude that there is evidence of the potential role of local knowledge for enabling environmental sustainability and climate change adaptation in smallholder agriculture in accordance with the basic tenets of endogenous development. On the other hand, we caution that such local knowledge

is not without limits and risks, because sustainability and climate change adaptation goals can be undermined if choices of local strategies do not take into account both the strengths and weaknesses of particular local knowledge's in the local context.

Thus, local knowledge for CCA were analyzed for their potentials, but also for their limitations. First, cultivation of multiple farms and staggering of seeding between them is limited by the need for efficient transportation, risks of deforestation and land degradation, as well as infeasibility in areas with high population densities and scarcity of land. Second, the resilience of local drought and flood resilient crops is increasingly overstretched by increasing extreme climatic variability and this situation poses risks of adaptation failures. Further, low lands such as valleys and river banks are useful for adaptation, but access to them is limited and the few farmers with access have over exploited them with significant risk of degradation. Although the adoption of new and early maturing crops is useful for adaptation, they require application of fertilizer for optimal yields, which poor farmers cannot afford. Finally, the potential spread of GMCs is a reality and a threat to the sustainability of local knowledge in smallholder agriculture, particularly least input agricultural systems in Ghana and Africa.

Consequently, we conclude that although local knowledge systems are the primary knowledge systems for adapting smallholder agriculture to climate variability among smallholder farmers, this potential is being overstretched by global change processes and its sustainability threatened by increasing extreme climatic variability, low adaptive capacities and the risks associated with GMCs.

As a matter of policy, this chapter underscores the importance of an endogenous development approach to promoting the role of local knowledge in smallholder agriculture and Community-Based Natural Resource Management (CBNRM) for building capacities for CCA through local governance and development planning at the district level in Ghana. In more specific terms, attention should be paid to improving indigenous knowledge in agriculture within the context of an improvement approach to agriculture transformation, specifically natural resource management with a focus on soil and water conservation, and adaptation of compatible external knowledge to local production systems for promoting innovation and sustainability in smallholder agriculture. Finally, GMCs should not be promoted at the expense of local crops in smallholder agriculture. If GMCs must be promoted, this should be done among medium and large scale producers for commercial purposes in order to protect the poor who survive on smallholder agriculture.

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Chapter 7
Building Bonds and Breaking Bridges: Community Based Adaptation (CBA) as a Source of Conflict in a Northern Ghanaian Landscape

Sebastiaan Soeters

Abstract Community-based adaptation (CBA) is considered a key strategy in today's adaptation and rural development landscapes. There is, as Terry Cannon notes, a 'rush by climate change practitioners to be involved in CBA'. The chapter finds that CBAs implemented in rural communities generate new and/or intensified conflict as land and water resources come to be used differently, more intensively and/or redistributed in the context of competing claims to natural resources (communities, social groups, livelihoods etc.). Despite this, conflict receives very little attention in the apolitical framings of the policy and practice of planned adaptations, including CBA. The chapter takes as its case study a CBA (with a strong dry-season farming component) implemented in Ghana's Upper East Region (UER). It employs social capital—especially the distinction between bridging and bonding social capital—as a construct to explain the impact that adaptation interventions have on relations within a community (bonding social capital) in terms of collective action in the management of natural resources, and how this might affect relations between communities, including migrant pastoralist communities (bridging social capital).

7.1 Introduction

Community-based adaptation (CBA) is considered a key strategy in today's adaptation and rural development landscapes. In a relatively short period of time, CBA approaches to strengthening adaptive capacity have developed a strong

For more information on this case, please visit the project website http://www.adaptationlandscapes.org/ghana/ and see our film, 'Watermelon Men'.

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J.A. Yaro and J. Hesselberg (eds.), *Adaptation to Climate Change and Variability in Rural West Africa*, DOI 10.1007/978-3-319-31499-0_7

ideological support-base amongst adaptation practitioners, and has been adopted by powerful development actors such as the United Nations Environmental Program (UNEP), the Food and Agricultural Organisation (FAO), the Department for International Development of the United Kingdom (DFID), the United States Agency for International Development (USAID), as well as a number of large Non-Governmental Organisations (NGOs). As an indication of the rising popularity of CBA, whilst the first major international conference on CBA in Bangladesh (CBA1) in 2005 hosted 40 attendees, the ninth conference on CBA (CBA9) in the same series held in Nairobi in 2014 hosted over 400 delegates from 90 different nationalities. There is, as Terry Cannon notes, a 'rush by climate change practitioners to be involved in CBA' (Cannon 2014). This popularity has caused CBAs to be very successful at raising the profile of bottom-up expressions in an international climate change architecture with strong top-down, "scientistic" tendencies. Fundamental to CBA is that strategies to combat climatic changes and variability should be developed within existing local institutional and knowledge frameworks (Reid et al. 2015). Equally fundamental is the notion that in order to strengthen local adaptive capacity, collective action is required for managing natural resources. CBAs implemented in rural communities therefore seek to alter, redistribute, optimise and/or make more effective the use of natural resources either directly or by strengthening existing institutions governing the management of local natural resources. Despite the undoubted usefulness and success of CBA in raising the profile of local voices, obvious questions arise at the local level about whose natural resources or, put differently, who is included in the 'collective' which is to manage local natural resources, and who is not. This in turn raises questions about CBAs' propensity to marginalise (even make invisible) natural resource user groups who are either not members of the CBA target community or minority groups who use natural resources in ways not intended by the CBA. In other words, CBAs may draw physical and vocational lines around natural resources and ascribe legitimacy to some groups (by arming them with various forms of capital, depending on the CBA) at the expense of others, and in doing so, CBA's may create new winners and losers or reinforce existing contours between winners and losers, thereby creating new risks for conflict. Large variations in both types of CBAs as well as local contexts makes it difficult to draw meaningful conclusions about CBAs as a source of conflict more generally. Assessing inter- and intra-community interests within one framework further complicates the matter. One way of doing this (perhaps the only way) is by re-exploring concepts relating to social capital, defined generically as the capacity of people and/or groups to act collectively. As a construct, social capital has been subjected to criticism on several fronts (see Forsyth 2013 for an overview), and one may ask weather more work on social capital is necessary or indeed, desirable. However, in the domain of development practice, despite persistent criticism, social capital has proven remarkably robust as a focal construct underpinning interventions. The recent popularity of CBA reaffirms this robustness and suggests that new research into community impacts of permutations of social capital continues to be relevant, especially in the context of climatic change and variability and the impact thereof on the scarcity of local natural resources. As a

point of departure, as social networks are regarded as the primary enabling factor determining communities' capacity to act collectively (including in the management of natural resources), strengthening social capital is an underlying objective of all CBA interventions. Furthermore, social capital, especially its more recent division into bridging social capital—'economic and other ties that are external to the group'—and bonding social capital—'ties within a defined socioeconomic group'—provides an excellent analytical capsule for making sense of how CBAs may serve as a source of conflict between and across scales. As a construct, social capital is therefore able to link inter- and intra-community networks and relate the state of such networks to conflict. Thus, using social capital as an analytical capsule, this chapter investigates competing claims arising in the context of a sudden increase in the value of natural resources (through intervention). The chapter is based on empirical work in Farfar, a Bimoba community in Ghana's Upper East Region (UER) in which the Adaptation Learning Program (ALP), a CBA, was implemented by the Cooperative for Assistance and Relief Everywhere (CARE) Ghana International in 2010. On a relatively small piece of land 7 kilometres from the Farfar settlement itself, wedged between a tributary of the White Volta and the slopes of the Gambaga escarpment, a tract of 'bush' has been cleared by farmers from Farfar and, with the support of ALP, watermelon farming has emerged as a very lucrative sector for those with access to land, finance and various other forms of necessary capital. By analysing the impact of dry-season farming in Farfar on different forms of social capital (bonding and bridging), the chapter argues that CBA may serve as a source of conflict and, by implication, that CBAs should be designed as expressly conflict-sensitive. The paper concludes with, again borrowing from social capital, some preliminary ideas about how this may be achieved. This, the chapter suggests, does not mean re-assessing where the bottom is (in terms of bottom up approaches to strengthening adaptive capacity), but rather, recognising that in any landscape there may be more than one bottom. The chapter starts by introducing an explanatory framework for relating inter- and intra-community dynamics to conflict, through the use of social capital as an analytical construct. Section 7.3 describes the study area and provides a brief methodological note. Section 7.4 introduces the Adaptation Learning Program (ALP) and assesses the implications for conflict. The final section offers a conclusion, including some preliminary ideas about how CBAs may be, by design, more conflict sensitive.

7.2 Contextualizing CBA, Social Capital and Conflict

CBA has emerged as a widely employed strategy for adaptation interventions in developmental contexts (Cannon 2014). It is premised on the assumption that environmental knowledge, vulnerability and resilience to climate impacts are embedded in societies and cultures, and suggests therefore that the focus of adaptation interventions needs to be on empowering and supporting communities to take action based on their own decision-making processes (Reid et al. 2015). CBA emerged from voices within

development architectures that sought to challenge mainstream, top-down approaches to climate change adaptation. It is, as Fenton et al. note, 'different from top-down approaches as it is a community-led process, allowing climate vulnerability to be addressed at the local level in its specific context of impacts and adaptive capacity' (Fenton et al. 2014: 389). Whilst CBA covers a wide range of activities (with different levels of community involvement), collective action in the management of natural resources (broadly defined) is the cornerstone of CBA interventions (Ensor and Berger 2009). As 'social capital' refers to the norms and networks that enable people to act collectively (Woolcock and Narayan 2000; Coleman 1988; Fukuyama 2002), strengthening social capital is a core characteristic of CBAs (Ensor and Berger 2009). The attractiveness of social capital within development and climate change architectures rests largely upon the positive potential which collective action possesses for social and economic development, including communities' capacity to cope with external stressors. Social capital is however not good per se; a number of studies have illustrated the negative potentials of social capital (for example, young men joining gangs in Latin American contexts, and Indian girls being taken out of school as a result of conservative pressures from within communities). It seems clear that conflicts (broadly defined) between groups (including institutionalisations such as joining gangs) also requires high levels of social capital. In this way, social capital, and the collective action it enables, may also have negative impacts for local social and economic development.

Conceptual explanations for the linkages between types of social capital, the functionality of governance structures and conflict are relatively clear. In this regard—conflict as an outcome of the combination of levels of social capital and the functionality of governance structures—the distinction between 'bonding social capital' and 'bridging social capital' is useful. Bonding social capital refers to 'ties within a defined socioeconomic group' such as, for instance, an ethnically bound community. Bridging social capital, on the other hand, refers to 'economic and other ties that are external to the group' (Adger 2003: 392). Both bonding and bridging social capital rely on levels of trust; however, bonding social capital resides in stronger ties such as family, kinship and/or ethnicity, whilst bridging social capital often relies on formalised associational structures to generate necessary trust, and is ordinarily weaker than bonding social capital. Importantly, different levels of bonding and bridging social capital, under different conditions (relating to the functioning of governance frameworks), create different outcomes, some of which are desirable for development, and others not. For instance, Woolcock and Narayan observe that where levels of bridging capital are low and governance structures are well-functioning, groups (at any scale) are likely to be excluded, resulting in latent conflict (Woolcock and Narayan 2000). Alternatively, where states are dysfunctional, high levels of bridging social capital help groups to cope (see Fig. 7.1). In such instances, bridging social capital substitutes for governance.

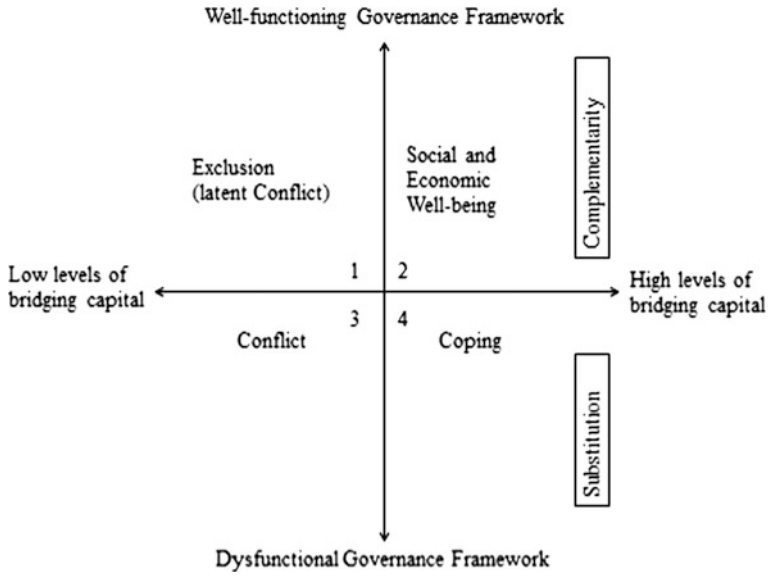

Fig. 7.1 Relationship between Bridging Social Capital and Governance. *Source* Narayan (1999)

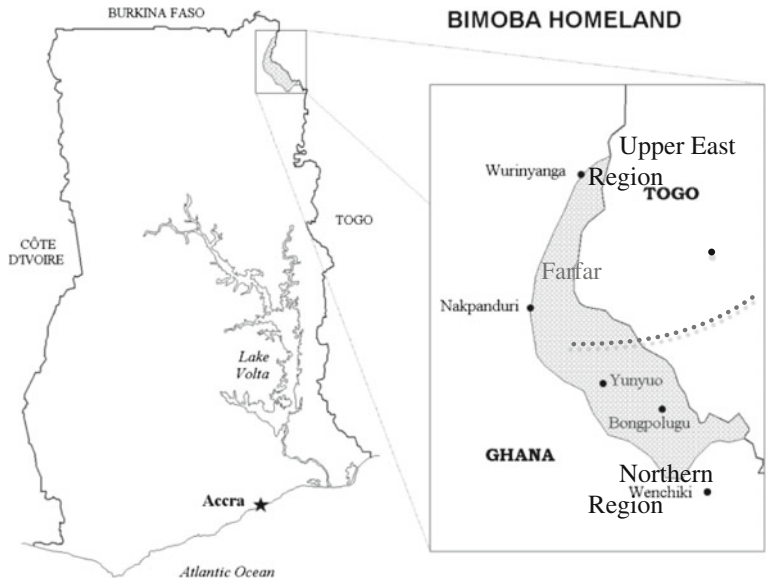

Fig. 7.2 Ghana, showing the Bimoba Homeland [with the *dotted line* indicating the border between the Upper East Region (UER) and the Northern Region (NR)]

Whilst the permutations of different levels of bridging and bonding social capital, on the one hand, and levels at which governance structures function, on the other, have been well-researched (see Adger 2003; Woolcock 1998; Narayan 1999; Woolcock and Narayan 2000), the relationship between levels of bonding and bridging social capital have received rather little attention. A conceptual basis which may explain the conditions under which a strengthening of bonding capital undermines or consolidates bridging social capital, or indeed vice versa, is therefore absent. Narayan does note that 'when power between groups is asymmetrically distributed, it is cross-cutting ties, the linkages between social groups [bridging social capital], that become critical to both economic opportunity and social cohesion' (Narayan 1999; 13). Intuitively, a sudden increase in the value of natural resources (as a result, for instance, of the take-off of dry-season farming due to an intervention), coupled with measures that strengthen bonding social capital (within the community), may result in a weakening of bridging social capital as groups seek to strengthen control over natural resources and regard other groups as threats. This is especially the case in contexts of dysfunctional or absent governance frameworks so that communities who enjoy access to necessary land and water (continuing with the case of dry-season farming example) seek to consolidate their exclusive access to suddenly valuable natural assets through other means, including, where necessary, conflict with communities they see to be threatening their control over now valuable natural resources. This may be understood through a number of languages including a discourse that suggests that the relative cost of conflict decreases as the local value attached to the ownership and/or control of land and water increases. The strengthening of bonding social capital strengthens the basis of community identity, with other communities, including nomadic pastoralist communities, being seen increasingly as potential threats to land ownership and/or control. Importantly, as previous studies show, social capital bears no clear relation to institutional performance (Widner and Mundt 1998). It is therefore not the case that strengthened bonding capital within communities necessarily improves the functioning of local government structures, as one may assume; bonding social capital may therefore strengthen with no discernible change in the functionality of local governance frameworks. With reference to Fig. 7.1, a scenario in which interventions induce conditions for strengthening bonding capital (by, for instance, introducing new intra-community financing schemes and/or providing communities with valuable weather forecasting data), whilst simultaneously increasing the value attached to natural resources (by improving the profits associated with dry season farming), may well strain relationships between communities (a weakening of bridging social capital), which, in the presence of dysfunctional governance structures, shifts the relationships between communities from 'coping' (quadrant 4), where bridging social capital substitutes for dysfunctional governance, to 'conflict' (quadrant 3), where low levels of bridging social capital coupled with a dysfunctional governance structure result in conflict or the risk thereof.

7.3 Background Characteristics of Study Area and Methodology

The UER is amongst the poorest of Ghana's 10 regions, with a poverty rate above 35 % (USAID Ghana 2015) compared to a national average of 28 % (UNICEF 2015). The UER is also the second least urbanised of the 10 regions, with a rural population comprising 79 % of the total population (2010 Housing and Population Survey, Summary Report of Final Results 2012: 21). It is characterised by high population density: 104 persons per km^2 compared to a national average of 75 persons per km^2 (including urban areas). Land shortages have contributed to high north-south migration rates, a situation which is reflected in the regional population growth rates; the population of the UER grew by only 1.2 % between 2000 and 2010, the lowest in the country by some distance, with the Upper West Region (UWR), the second lowest, recording a population increase of 1.9 % over the same period (2010 Housing and Population Survey, Summary Report of Final Results 2012; 2).

The Bimoba are one of several ethnic groups in the UER. The Bimoba number over 100,000, of which approximately half reside in the UER (Hippolyt 2015: 41). Farfar is, in turn, a Bimoba community, located 15 kilometres south of Garu, the district capital of the Garu-Tempane district, one of 10 districts in the UER. It is a seemingly unspectacular rural, northern Ghanaian community. It is one of 5 villages in the Farfar-Bantifarigu Electoral Area (EA), which consists of around 400 households (CARE 2014). The average household size is close to 10 members, with a high dependency ratio (CARE 2014). Like many rural communities in the UER, rainy season subsistence farming (millet, sorghum, cassava, maize, yams) in Farfar serves as the primary source of livelihood. Some, young men in particular, have established off-farm livelihoods such as transportation services, carpentry, mason work, or small shops on the fringes of the market square. A few women also own small shops and have other sources of income such as Shea butter production, pottery, crafts and pito brewing and selling, petty trading and charcoal burning (CARE 2014).

Generally speaking, traditional authorities in Ghana possess significant authority and the institution of chieftaincy is endorsed by the Government of Ghana (GoG). The 1992 Constitution of Ghana under Article 270 (1) states that the institution of chieftaincy, together with its traditional councils as established by law and usage, is guaranteed. Each region has a house of chiefs, representatives of which hold office in the National House of Chiefs based in Kumasi. Not all chieftaincies are however treated with the same regard. In customary terms, the Bimoba are, to use the language employed by scholars of Ghana's traditional political systems, an "acephalous group", meaning they have no clearly definable centralised power structure, in contrast to several other prominent northern "chiefly groups", such as the Mamprussi, Dagomba and Gonja (Fortes and Evans Pritchard 1940: 5). Whilst residents of Farfar identify as Bimoba, the ethnic group comprises of a series of clans or clan groups (Meij 2008). The clan or clan group is the primary customary

focus of the Bimoba (Meij et al. 2008: 29). Each of the 5 communities in the Farfar-Bantifarigu EA has a chief, sometimes referred to locally as headmen; however, whilst the position of these chiefs appears important externally, in dealing with chiefs of other communities, internally, the chief's power is limited. From interviews with Farfar community members including the local assemblyman, it appears that the chief and his elders have no authority to allocate or redistribute land, although he may mediate in the event of a dispute and is consulted on local governance issues regarding land (Farfar's Assemblyman, 2014). In the absence of a strong customary governance framework, land in Farfar is claimed on a first-come-first-served basis. Whilst high rural population densities (2010 Housing and Population Survey, Summary Report of Final Results 2012; 22) contribute to a general scarcity of agricultural land, individuals who clear remaining bush lay claim to the land and the benefits deriving there from (Interviews with Local Farmers 2014). Land may be rented or leased to or from third parties who may or may not be residents of Farfar and/or belong to the Bimoba ethnic group. Traditionally, the eldest son of the first wife inherits land, making it difficult for some groups, notably women, to own land, as they are not ordinarily involved in clearing bush in order to claim land and have no customary right to inheritance (Interviews with Local Farmers 2014).

Formal local government structures exist alongside customary structures. Each community in the Farfar-Bantafurigu EA selects members of Unit Committees (UCs), the lowest level of government representation. The Unit Committees support the EA's Assemblyman, who is elected every 4 years and represents the EA at the District Assembly (in the case of Farfar, the Garu-Tempane District). Whilst Ghana's decentralisation is, by African standards, well-established, local governments remain weak and largely ineffective at the local level. For instance, none of the farmers interviewed for this study have at any time received technical extension services from the local government with regard to either dry- or rainy-season farming. Furthermore, in 2013 only 1.64 % of Garu-Tempane district's revenue came from internal sources such as taxation (Garu-Tempane District Assembly 2007), the remaining 98.36 % having accrued from external sources (development projects and from the central governments Common Fund). The traction of local government to control land and/or access to resources, or indeed to settle disputes over natural resources, is therefore limited. Despite the apparent absence of local government (in terms of services and/or other investments), the Assemblyman enjoys broad-based legitimacy, and elections are highly contested. Whilst customary and civic governance frameworks exist mostly separate from one another, there are some attempts to strengthen linkages. For instance, the website of the Garu-Tempane District Assembly notes that chiefs help the District Assembly in 'revenue mobilization, mobilization of communal labour for the execution of projects, awareness creation in environmental protection and in security and justice' (Garu-Tempane District Assembly Website). In practice, it appears, this is rarely the case. In all, governance frameworks in Farfar are weak. Ambiguity and institutional overlap further serves to weaken the legitimacy of both customary and civic governance actors. In the absence of governance institutions, including legal safeguards

regarding the acquisition and ownership of land, sudden increases in the value of land (broadly defined), result in ad hoc settlement protocol and a high incidence of contestations over the ownership of land, especially with members of other communities.

What sets Farfar apart from other rural settlements in the UER is the recent development of a watermelon sub-sector on a low lying, isolated, 250 acre flood plain wedged between a tributary of the White Volta and the slopes of the Gambaga escarpment, 7 km south of Farfar's central market. This patch of land is not only fairly unique in terms of the geography of northern Ghana, but also the focus of the Adaptation Learning Program, the case study of this chapter.

7.4 Methodology

The study is based on two short fieldwork periods in 2014. The study set out to determine, first, the main focus of ALP in Farfar. This, as with ALP itself, was determined by community members. A number of focussed group discussions were conducted. Participants were asked what they felt was the main contribution of ALP to improving adaptive capacity (and/or improving livelihoods). Most groups concluded (resolutely) that ALP had succeeded in making watermelon farming more effective. This included participants of groups, including women, who did not have access to land to farm watermelon. Several groups noted that the establishment of VSLAs was another major success of ALP. When asked what loans from VSLAs were spent on, many participants mentioned seeds and 'spray' for watermelon farming. A number of VSLA members noted that they regularly borrowed money on behalf of relatives (usually husbands) from the VSLA of which they were members. Thus, even those who did not have land to farm watermelon borrowed money from the VSLA for watermelon farming. Focus groups were also asked to reflect on the intensity of intra-community relations in the context of watermelon farming. Some bemoaned the fact that they did not have land for farming watermelon, but suggested that the community as a whole benefitted from watermelon farming through a series of economic spill-overs within the community. Those without land were also lobbying the local government to build a dam close to the community so that they and others like them could also farm watermelon. The assemblyman stated that he regarded this as one of his top priorities (Farfar's Assemblyman, 2014). He also suggested that his proposal to have a dam built was strengthened by the fact that some of the community members were already farming watermelon (Farfar's Assemblyman, 2014).

The second goal was to assess if there were contestations around dry-season land, and where such contestations came from. Thirty-nine farmers were interviewed for this purpose. Altogether, they farmed almost 85 acres of the total 250 acres of farmland. Farmers were interviewed on farms. This had a dual function: first, there appeared to be a disparity between what respondents said in the village (surrounded by others, including non-farmers) and what respondents said on

the farm, especially in terms of farm sizes which, when necessary, were verified with GPS; second, it afforded us an opportunity to develop a map of farmers. This is used in a separate body of work on geographies of exclusion. Farmers were asked, amongst other things, whether their land had been contested, the source of contestation and how it was resolved. This provided a good indication, not only about whether there were conflicts, but also of attitudes towards competing claims. Such competing claims were usually regarded with some hostility and as wholly illegitimate. The illegitimacy was argued on customary grounds ("I claimed the land first"). Farmers were asked on what basis the claims from other communities were made. They noted that the land was not in the UER (but that this does not matter, as they are all Bimoba). They were also asked what they regarded as the biggest threat to farming watermelon. Many pointed to natural factors, such as the drying of the soil and diseases. A number also pointed to threats emanating from other communities, including Fulani migrant pastoralists. This was confirmed in a series of interviews with officials from the District Assembly. Finally ALP documentation and personal correspondence with implementing staff were used in order to determine the ALP process, the ideology behind the process and how it was intended to work in Farfar.

7.5 The Impact of the Adaptation Learning Program (ALP) on Social Capital: Implications for Conflict

The Adaptation Learning Program (ALP) was implemented in selected rural communities in Mozambique, Niger, Ghana and Kenya. It is a five-year project, scheduled to end in 2015, and funded ($13 million across the 4 countries) by the UK's Department for International Development (DFID), the Danish International Development Agency (DANIDA) and the Ministry of Foreign Affairs of Finland. For Farfar, the introduction of ALP facilitated a flourishing dry-season watermelon sector. In Ghana, ALP has four target communities in the East Mamprussi District (Northern Region) and four more in the Garu-Tempane District (Upper East Region). ALP target communities coincide with Electoral Areas (EAs) such that the EA is treated as a community. The Farfar ALP target community, the focus of this paper, therefore officially corresponds with the Farfar-Bantifarugu EA. The Farfar-Bantifarugu EA consists of 5 separate communities (locally defined, with each possessing a degree of customary autonomy), of which Farfar and Bantifarugu are only two. For the remainder of this chapter, 'Farfar' refers to the Farfar ALP community as it has been defined by ALP.

According to farmers interviewed for this study, the watermelon farming started as recently as 2007 (3 years prior to the start of ALP) when, it is rumoured, a seasonal migrant returned from 'Kumasi' with watermelon seed, 'cleared bush' on the seemingly 'unused' or under-used flood plain, and planted watermelon with some success ("Interviews with Farmers." Personal interviews, 6 Dec. 2014). The

land is accessible along a footpath either on foot, by bicycle or on a motorbike. Most of the land is farmed by residents of the Farfar-Bantifarugu EA. Whilst rainy-season farming continues to be considered the main farming season, it is generally associated with domestic consumption whilst dry-season farming (almost all of which is watermelon) is the major cash economy in Farfar, serving also as the major impetus for social and economic change and stratification in this area. It is regarded by farmers and non-farmers alike as a valuable and, if successful, very lucrative enterprise. Whilst most of the farmers of watermelon come from the Farfar EA, some farmers residing in Nakpanduri (a Bimoba community in the Bunkpurugu-Yanyoo district), located at the southern periphery of the flood plain (see Fig. 7.3) access it from the southern side (located in the Northern Region, which is to the south of the Upper East Region).

ALP is not a prescriptive intervention. In line with the central tenets of CBA, it seeks to empower communities to increase adaptive capacity through their own decision-making rather than introduce entirely new agricultural or other technologies. ALP has a number of express goals such as 'developing and applying innovative approaches to Community-Based Adaption (CBA) to generate best practice models; empowering local communities and civil society organisations to have a voice in decision-making on adaption; promoting best practice models for CBA among adaptation practitioners and aiming to influence national, regional and international adaptation policies and plans' (CareClimateChange). Through ALP, a

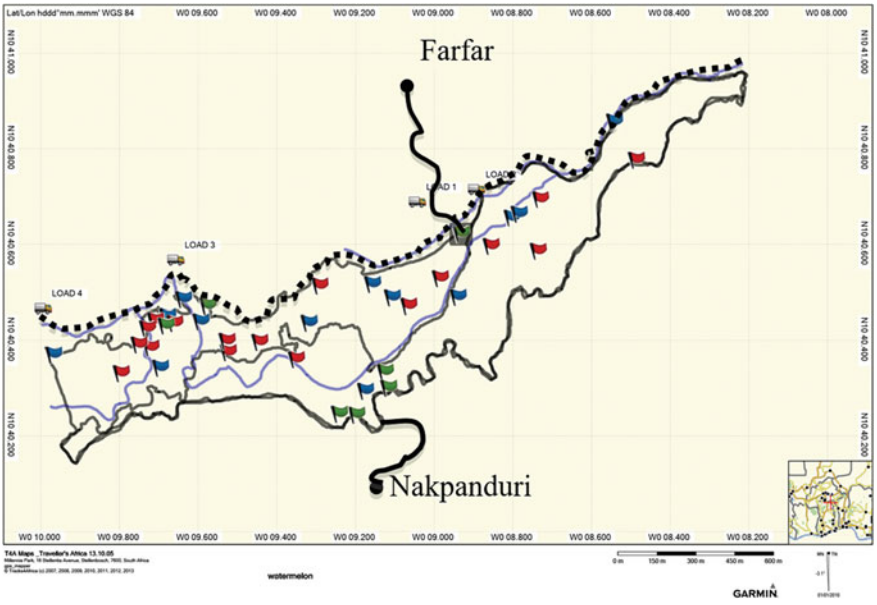

Fig. 7.3 Watermelon farms of interviewees (with *dotted line* indicating the border between the Upper East Region and the Northern Region). *Flags* relating to farmers interviewed (*red* indicates adult men, *blue* youth and *green* women)

new community health clinic has been established in Farfar, financed by the District Assembly, and seasonal weather information is made available to community members through pre-appointed community monitors who bridge the gap between the community and the implementing partners. ALP is far broader than a just a dry-season farming programme. ALP also did not introduce dry-season watermelon farming, which was started prior to the implementation of ALP in 2010. However, an overwhelming number of farmers (including women), when asked what they felt the major contribution of ALP was to Farfar's local adaptive capacity, noted its role in making dry-season farming more effective (Focus Group Discussions with Farmers. Personal Communication 27th November 2014). Furthermore, many of the farmers interviewed had been farming watermelon for less than five years, and therefore started within the period in which ALP has been active in Farfar. In the Community Adaptation Action Plan (CAAP), developed during the initial stages of ALP, making dry-season watermelon farming more effective emerged as the second highest priority (the first being building a new health clinic). Thus, in Farfar, ALP has come to be largely focussed on dry-season watermelon farming (including VSLA components).

ALP may be interpreted as a series of actions that seek to address a number of access problems relating to dry-season watermelon farming. Thus, in order to address the first failure—female access to land—male farmers were sensitised on the importance of giving some of their dry-season land to their wives to start their own farms. Cultural norms and practices (including household duties) discriminate against female land ownership and farming. In order to address the second failure—access to finance, especially amongst women—ALP facilitated the establishment of 'an innovative credit system', the Village and Savings Loans Associations (VSLA), with a predominantly female composition. Association members make regular (fixed) contributions to the VSLA, and members are able to take loans from the VSLA in order to, amongst other things, buy inputs, pay school fees and provide start-up capital for micro-enterprises. Although not all of Farfar's residents are members of VSLAs, the consensus amongst both members and non-members (male and female) is that the VSLAs have been extremely effective in providing important access to finance in order to buy inputs for farming, especially dry-season farming. Of the 39 farmers interviewed, 24 belonged to a VSLA and employed the VSLA to finance inputs. All 15 of those interviewed who were not members of a VSLA expressed a desire to join a VSLA when if a position in a VSLA became available. Several noted that despite not being members, they were able to take loans through the membership of their wives. The Demand for VSLA membership seems to outstrip its supply, with many non-members indicating that they hope to join a group when a position in a VSLA becomes available. VSLAs provide an important source of cash for buying costly inputs for dry-season watermelon farming, at a time in the production cycle when finances are ordinarily scarce. Finally, to address the third failure—that of infrastructure deficiencies (market access)—ALP provides advocacy training. This is intended to enable local groups lobby the local government to provide the necessary infrastructure. In this regard ALP has been the least successful as a result of a lack of resources and institutional weakness at the

District Assembly level. ALP has also provided generators and water pumps used exclusively in dry-season watermelon farming. In short, how ALP unfolds is context specific (as it is intended to be) and in Farfar, dry-season watermelon farming has subsumed other activities contained within the ALP package.

7.5.1 Analysis of ALP Through a Social Capital Lens

The main ALP activities require some existing level of social capital in order to function. For instance, VSLAs, the interpretation and distribution of weather information and the sensitisation of men to the importance of increase female participation in dry season farming are all premised on a level of intra-community trust, cooperation, solidarity and reciprocity, which form the basis of social networks. As an illustration of the importance of such ties, a number of farmers interviewed who were not members of a VSLA noted that they found it difficult to join a VSLA because when a position became available (usually as a result of death), the vacant position was almost always allocated to a family member of one or more of the members. As noted, ALP has also provided Farfar with two generators and water pumps to pump water up from the river over the riverbank and onto watermelon farms. The pumps are leased out to farmers for a daily fee, with proceeds being used for maintenance and repair, and as a contribution to VSLAs. The high rate of collective action required for pump use is possible due to bonds that exist within the community. The market mechanics of dry-season watermelon farming in Farfar also require collective action; the difficultly in accessing farms and transporting watermelons off farms, as well as accessing traders, requires a level of intra-community dependence which is addressed through social networks. Labour is sourced within Farfar. School holidays make more labour available as children return home and are put to work in the business of farming. Whilst many in Farfar do not have land to engage in dry-season watermelon farming directly, it is by all accounts a community activity, with different groups within the community being relied on to fulfil different functions, and benefits deriving from watermelon farming, whilst not equally distributed, are felt throughout the community as successful watermelon farmers employ labour for farming, for building new houses, and as drivers and mates for small transportation businesses which a number of farmers have engaged in as a way of both increasing income and diversifying its sources. Farfar, according to many of its residents, is now a place which people come to in order ‘to enjoy themselves’. Much of this is due to cash injections deriving from watermelon farming.

ALP activities, however, are not only based upon existing social capital; they also work to strengthen and consolidate social capital. This is an implicit objective of ALP, an end, so to speak, for the purpose of increasing the community’s capacity to collectively manage natural resources. In other words, the successful functioning of a number of ALP activities also works to increase levels of trust within the community, and therefore, the strength of social networks. For instance, communal labour employed to transport watermelons off-farms to loading bays binds labourers

to farmers, and borrowing money from VSLAs to finance inputs binds VSLA members (non-farmers) to watermelon farms. Middlemen (who are usually also farmers) who link (other) farmers to traders and negotiate prices with those traders, come to be bound to other farmers. Furthermore, whereas in the past Farfar (as is the case in the UER more generally) was characterised by high levels of seasonal out-migration, interviewed farmers noted that they were now, as a result of watermelon farming, able to remain in Farfar year round (Farmer. Personal interview, 27 November 2014). The impact of decreased out-migration strengthens familiarity and trust within the community, thereby reinforcing social capital. Importantly, the type of social capital that is both critical to the activities of ALP (as a means), and an outcome of the success of those activities (as an end), is bonding social capital. Indeed, the descriptions above relate exclusively to social capital that strengthens the networks within the community rather than with external groups.

ALP appears to have no meaningful explicit or implicit focus on social capital that links Farfar to local government or to other communities, including nomadic pastoralist communities that enter the region during the dry season when conditions in the Sahelian regions offer little in the way of pasture and water. To be fair, advocacy training is provided in order to increase the ability of the community to engage the District Assembly (DA) so as to provide services. However, as noted earlier, this component of ALP appears the least successful. ALP treats communities like socio-economic islands. This treatment is especially problematic given the density of the population of the UER, the fragility of natural resource bases, and the co-dependence on natural resources of multiple user groups, including groups outside of the ALP-communities. Whilst it is difficult methodologically to capture changes in the relationships between communities, based on interviews and relevant secondary data it is possible to offer some plausible insights into the current state of inter-community relations.

7.5.2 Empirical Evidence of Local Conflicts Through a Social Capital Lens

As watermelon farming is both highly lucrative and the land upon which the crop can be farmed extremely scarce, ownership and/or use of land is both complex and contested. Of the 39 farmers interviewed, 13 had had their lands contested on one or more occasion in the last 5 years. Of those 13, nine had land contested by Bimobas of the Northern Region (NR), that is, those residing in nearby Nakpanduri (see Table 7.1).

The competing claim from Bimobas of the NR for lucrative watermelon land is strengthened by institutional ambiguities created by the co-existence of civic and customary governance regimes. More specifically, whilst Farfar itself (the village) is located within the UER, the land used for farming watermelons is, in administrative terms, located in the Northern Region (the dotted line in Fig. 7.3 represents the boundary between the NR and UER) Nakpanduri is also closer to the land than

Table 7.1 Number of dry-season farmers indicating that their land ownership has been contested

	Total respondents	No. land contested	Contested by farmers from Nakpanduri
Adult Male	14	4	3
Youth	18	7	6
Women	7	2	0
Total	39	13	9

Farfar (see Fig. 7.3). However, both Farfar and Nakpanduri, as well as the lucrative land that divides them, are located within the Bimoba homeland (see Fig. 7.2). Exploiting this jurisdictional ambiguity, Bimoba of the NR claim that the land belongs, not to the Bimoba of the UER, but to the Bimoba of the NR (Interviews with Farmers 2014). In contrast, the Bimoba of Farfar suggest that this (regional and district) boundary is irrelevant as the watermelon land, including the settlements of Farfar and Nakpanduri, are part of the Bimoba homeland, and thus, farmers from Farfar and Nakpanduri have an equally legitimate claim to the land (Farmer. Personal interview, 4 Dec 2014). As farmers from Farfar claimed it first, they claim the land is rightfully theirs, as is customary. It is of course contextually important that, as noted earlier, the Bimoba are an acephalous group; the customary governance structure relating to their ethnicity as a whole is weak, with the focus instead being on the clan or clan group (sub-ethnic structures).

Resolutions between competing parties (Bimoba of Farfar and Bimoba of the NR) are usually reached in an ad hoc manner, with different mediators borrowing from different sources of status (wealth, size of land, Assemblymen, opinion leader etc.) (Farmers. Personal interviews. Various dates between 25 November 2014 and 23 December 2014). One particularly illustrative case arose in December 2011, one year after the start of ALP. Farmers from Farfar claimed that following an altercation with Bimoba of the NR over the ownership of land during the day, pesticides were used to destroy 15 acres of watermelon during the night. Some farmers indicated that ordinarily, such a dispute might have been settled internally (Farmers. Personal interviews, Dec. 2015), either through customary governance structures, or through the respective Assemblymen, who not only share a profession and meet regularly at the District Assembly, but also share an ethnic identity. In this instance the case was reported to the district branch of the National Disaster Management Organisation (NADMO), an organisation that is broadly regarded as inefficient. In their report NADMO state that having investigated the site, they found that the 15 acres had been destroyed not by an outside party, as farmers from Farfar claimed, but through the misuse of pesticide by the farmers themselves. The evidence, according to NADMO, was the presence of 'empty cans of pesticide in and around the affected area' (NADMO 2011).[1] When asking Farfar's assemblyman what he

[1]This finding was reconfirmed by NADMO officials in subsequent discussions.

thought of the findings, he noted that 'the evidence mentioned does not mean that they [Bimoba of the NR] did not destroy the crops, because there are always empty cans of pesticides on the farms (Farfar's Assemblyman. Personal interview, 2nd December 2014). The assemblyman noted further that '15 acres of land covers several farmers' land [farms sizes range between 0.5 and 5 acres], so many farmers would need to have misapplied pesticides on the same day. This is not likely' (Farfar's Assemblyman, Personal interview, 2nd December 2014).

Noteworthy is the fact that two communities belonging to the same ethnic group seek out a (weak) government institution, widely regarded as ineffective, to mediate in a conflict. It points to a breakdown of relations and the presence of mistrust between two communities in close proximity to one another. In a similar vein, Farfar's Assemblyman noted, 'one of the first things I did when I became assemblyman is to summon migrant Fulani herders in the area and told them that if their cattle was found on dry-season watermelon land [during the dry-season farming period], the cattle would be shot' (Farfar's Assemblyman, 2014). More recently, when cattle belonging to migrant Fulani herders were said to have destroyed crops, the Assemblyman was seen searching for the cattle on his motorbike, armed with a rifle (Interview with Researcher, 2015).

Whilst it is difficult to say anything conclusive about changes which have occurred regarding bridging social capital linking Farfar with other communities (including pastoralist communities), it is clear that mistrust between Farfar and other communities is rife, that the level of bridging capital is low, and so too therefore is the capacity to take collective action (as a landscape), including searching for non-conflictual resolutions regarding the use and management of shared natural resources.

7.6 Conclusions and Recommendations

By promoting the idea that the solutions to climate change in rural localities in the global south must be embedded in existing knowledge and institutional frameworks, CBAs have been successful in making local voices more visible in international climate change architectures. The promotion of bottom-up approaches to combatting climate change through CBA is a welcome relief within an international climate change architecture with strong top-down, "scientistic" tendencies. However, in focussing on communities as the locus of climate change action, CBAs are prone to marginalising other natural resource user groups. This applies to groups either beyond the target community boundaries (neighbouring communities who also lay claim to natural resources) or those who use the natural resource in a manner which the CBA either does not intend, or does not cater for (such as pastoralist communities in search of grazing pasture). Target communities, armed with new forms of capital as a result of the intervention, see the legitimacy of their claims to exclusive use of local natural resources strengthened at the expense of others. In other words, CBAs are prone to recognising only one bottom when often,

especially in densely populated, rural areas characterised by two or more land tenure frameworks, from the perspective of natural resources, there may be several bottoms. Thus, whilst CBAs may strengthen a community's capacity to act collectively (bonding social capital), thereby increasing local adaptive capacity, they may do so at the expense of the capacity to act collectively with groups beyond the target community (bridging social capital). In line with existing conceptual models relating to social capital, a scenario with low levels of bridging capital results in either latent or manifest conflict, depending on the quality of governance structures. Indeed, the ALP, a CBA implemented in Farfar in Ghana's UER which has successfully made watermelon farming amongst farmers from Farfar more effective and lucrative, has led to an erosion of relations between Farfar and the nearby community of Nakpanduri through a series of contestations over increasingly valuable dry-season farming land. Similarly, whilst Fulani pastoralists' use of the same land as pasture land (thereby destroying watermelon harvests) is not locally regarded as a claim to land by farmers, a number of watermelon farmers deemed pastoralists a major threat to farming watermelon. The assemblyman of Farfar, upon taking office, summoned pastoralists and warned them that 'if their cattle was seen on the watermelon land they would be shot'. In order to avoid such contestations, interventions which seek to strengthen adaptive capacity should reduce the community focus of such projects. Using natural resources rather than communities as a point of departure for designing and implementing adaptation interventions should work to de-territorialise such interventions, so that the existence of multiple user groups will be recognised and different ways arrived at for the best collective management of natural resources (see Yembilah and Grant for an analysis of territorial and non-territorial livelihoods in northern Ghana). Interventions designed in this way would be better positioned to increase bonding and bridging social capital, thereby reducing the risk of conflict between competing claims.

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Chapter 8
Climate Change Adaptation, Education, and Rural Transformation in Northern Ghana. Moving Beyond an Agricultural Focus

Wolfram Laube

Abstract Incremental climate change adaptation policies in rural Africa often focus on agriculture, agro-technology, and the management of natural resources, while larger trajectories of rural transformation seem to be ignored. To address this gap, I conducted multi-local qualitative and quantitative research in Northern Ghana to explore—beyond the visions provided by planned adaptation and development programs—changes in rural aspirations and future-oriented strategies which rural people, particularly the youth, pursue. Furthermore, the extent to which these changes indeed contribute to better individual social mobility, rural transformation and enhanced adaptation has been studied. Research results show that most young people have future aspirations that go beyond the agricultural sector. Families invest considerable time and finances in formal education, hoping that the next generation will be able to move ahead into 'modern' careers. But the rural educational system fails to deliver quality, successful students often lack the funds to continue their education, and rural and national job markets do not provide the necessary employment for large numbers of graduates. Unable to achieve their aspirations, large numbers of frustrated and vulnerable semi-educated young people engage in piecemeal livelihood strategies, moving between rural and urban and agricultural and modern sectors. It seems high time that climate change adaptation policies and investments for rural Africa moved beyond incremental agricultural climate change adaptation to address the need for larger transformation by seriously investing in rural education and alternative youth employment strategies—climate proofing not only farms but also people.

Keywords Climate change adaptation · Rural transformation · Individual aspirations · Education · Youth employment · West Africa · Ghana

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J.A. Yaro and J. Hesselberg (eds.), *Adaptation to Climate Change and Variability in Rural West Africa*, DOI 10.1007/978-3-319-31499-0_8

8.1 Introduction

Discourses about climate change are increasingly important when rural development and rural transformation are discussed. This seems obvious as changes in temperature, evapotranspiration, rainfall patterns, as well as in the frequency of extreme events have the potential to alter and heavily impact agricultural patterns of production and yields. This is particularly threatening many African countries, in which agriculture still provides an important part of the national gross domestic product (GDP) and is the major source of employment as well as income for large parts of the population. Here agriculture is often performed by a large number of smallholders at low-input and low-technology levels. Therefore, farmers are heavily dependent on climatic conditions which are potentially changing for the worse. The potential threat of climatic change for African agriculture and for Northern Ghana in particular has been acknowledged for some time (Boko et al. 2007, p. 236; Collier et al. 2008; Dietz et al. 2004) and is currently reemphasized (Niang et al. 2014). However, there is still a considerable degree of uncertainty with respect to the output of global and regional climate change models, because some bio-physical processes as well as their feedback loops are not fully understood, and because it is unclear which emission scenarios will materialize (Monier et al.2015; Webster et al. 2012). This uncertainty is also reflected in the different climate change projections that different studies imply for (northern) Ghana (Laux et al. 2008; Tschakert et al. 2009; Yaro et al. 2014). While temperature increase and shifts in the annual growing season seem certain and would negatively affect crop yields for large parts of the African Savannah belt, changes in the amount of rainfall seem to be unclear (Niang et al. 2014). Despite this uncertainty the potential threats—especially for northern Ghana—are projected to be enormous and include "water stress, reduced food security, increased impacts from extreme weather events, displacement of people (due to floods) and an increase in the transmission of vector borne diseases" (Yaro et al. 2014).

The threats of climate change have not been missed by official Ghanaian institutions such as the Environmental Protection Agency (EPA), which have assessed the potential impact of climate change on the country. Their projections rely on rather pessimistic scenarios that estimate reduction in rainfall of up to 27 % by 2100 (Minia 2004). Official institutions such as the Ministry for Science and Technology (MEST), which hosts the National Climate Change Commission and the National Development Planning Commission (NDPC), are liaising to address the potential impact of climate change on Ghana through a National Climate Change Policy Framework (NCCPF). In the meantime a discussion document, "Ghana Goes Green Growth", which outlines the governmental climate change adaptation strategy, has been published (MEST 2010). Scientist have criticized official climate change policy making to be slow, driven by the interest of international climate change institutions and donors, and to be focused on mitigation rather than adaptation. Critics have suggested that such policy should be refocused on adaptation strategies, especially for the agricultural sector (Cameron 2011; Sarpong and Anyidoho 2012). However, the potential threat for agricultural and economic development is stated in policy

documents such as the "Ghana Shared Growth Development Agenda" (GSGDA) developed by the National Development Planning Commission (NDPC) (NDPC 2010) and the "Ghana Goes Green Growth" (MEST 2010) document. The strategy document of the Savannah Accelerated Development Agency (SADA)—arguably the most important development initiative for Northern Ghana, if implemented well—also expresses the need to climate proof agriculture, which is seen the major regional growth engine:

> Our pro-poor growth model is based on modernizing agriculture sequentially […]. The strategy further takes into consideration the fragility of the soils, the short rainy seasons, and the vagaries of the weather associated with climate change. (Savannah Accelerated Development Authority [SADA] 2010, p. 5)

The focus of development and climate change adaptation strategies for northern Ghana up to 2030 is on sustainable natural resource management, the commercialization of agriculture, increasing integration into global markets, and the development of the requisite infrastructure (road networks, irrigation facilities, transport and marketing) (Savannah Accelerated Development Authority [SADA] 2010). This is very much in line with the general agricultural development strategy developed by the Ministry of Food and Agriculture and broader agricultural development initiatives promoted in Africa (Ministry of Food and Agriculture [MOFA] 2007; World Bank 2009).

The commercialization of smallholder agriculture and global market integration can be questioned as local farmers run the risk of being crowded out in the face of the competition from highly subsidized global food industries and may find it difficult to adapt to fluctuating prices, changing quality requirements and consumer preferences (Holmén and Hydén 2011; Raikes and Gibbon 2000). Ghanaian examples of these tendencies can be seen in the tomato (Laube et al. 2012) and pineapple industries (Fold and Gough 2008). Such double exposure (Eakin 2005; Leichenko and O'Brien 2008) to the effects of global environmental change and disadvantageous patterns of global trade seems to partially question the focus on export-oriented agricultural commercialization in climate change adaptation strategies for northern Ghana. Furthermore, it has been amply shown that apart from climate change there are numerous factors such as other environmental changes, agricultural policies, market access and price regimes, political developments and natural disasters that negatively affect smallholder agriculture and rural livelihoods (Laube et al. 2012; Nielsen and Reenberg 2009; Reid et al. 2000). Effective strategies for planned climate change adaptation can only be understood in this wider context. There is an increasing awareness of the fact that climate change adaptation cannot only consist of an incremental adaptation towards changing environmental conditions—like the climate proofing of smallholder agriculture—but may necessitate transformational processes that also address other underlying root causes such as economic or political marginalization and may result in major societal restructuration (Cannon and Müller-Mahn 2010; Marshall et al. 2012; Pelling and Manuel-Navarrete 2011).

But structural conditions only partially determine the way in which people can adapt and how rural societies are transformed. Adaptation and transformation also depend largely on cultural factors such as local knowledge, institutions [here understood as shared values, norms, rules or regulations (North 1990)], risk perceptions as well as the preferences and aspirations that rural populations have for their own future. While culture can create barriers to adaptation as people, for instance, fail to perceive risks or refuse to adopt adaptive strategies (Adger 2009; Nielsen and Reenberg 2010), culture in the form of aspirations—ideas and perceptions of individual futures that are shared at least among parts of particular societies (Appadurai 2004)—is an important driver of adaptation and rural transformation. I would argue that aspirations are important factors that determine the adaptive or even transformational capacity of societies as they form the cultural basis for the psychological flexibility, anticipation of the need, and willingness to undertake major changes. These are factors that have been identified to be crucial as barriers as well as drivers of adaptive processes (Marshall et al. 2012).

But debates about climate change adaptation often seem to be focusing on technological solutions to material problems to the neglect of non-material aspects (Adger et al. 2011). Furthermore, despite the long-term impact of climate change—projections often being made up to 2100—planned adaptation is often oriented towards short-term climate-proofing of the status quo—so-called 'incremental adaptation' (Kates et al. 2012). At the same time, climate change adaptation discourses are often framed in ways that serve the particular interests of interest groups that are able to frame adaptation discourses in ways that match their particular professional context and allows such groups to draw on international resources and to continue or expand their usual business (Sarpong and Anyidoho 2012 for Ghana; Schulz and Siriwardane 2015) rather than developing future-oriented strategies that take note of the aspirations and interest of those—for instance many young people in northern Ghana—who are likely to encounter the full impact of climate change and are therefore supposed to undergo planned adaptation processes. The need to pay greater attention to autonomous adaptation strategies and to adapt planned adaptation to locality-specific conditions has been stressed—also with respect to northern Ghana (Bawakyillenuo et al. 2014), but the focus of research has been largely on smallholder adaptation in a short-term perspective, paying more attention to farming, migration, and alternative rural livelihoods, but less to the need for more far-reaching transformations that most rural youth dream about.

Having worked on natural resource management, changes in agriculture and patterns of rural transformation in northern Ghana since the early 2000s (Laube 2007a, b; van Edig et al. 2002), I had the impression that a mismatch exists between the climate change adaptation discourses of scientists, the Ghanaian government and international donors, on the one hand, and the aspirations of large parts of the increasingly young population in Northern Ghana, on the other. Officially, the region is portrayed as an area in which smallholder-based growth through climate-proof and commercial agriculture is leading to successful climate change adaptation and economic growth. But for large parts of the rural population, the vast majority being below 25 years old (see Table 8.1), formal education and modern

Table 8.1 Demographic information of the Kassena Nankana East Municipality

	KNEM
Population	76.975
Population growth (2000–2010)	20.8 %
Population below 25 years	60.1 %
Rural population	72.7 %
Agricultural households	82.7 %
Literacy	47.5 %
Poverty incidence*	70.4 %

*Poverty incidence for the Upper East Region as reported by Coulombe and Wodon (2007), GSS (2014)

careers are becoming increasingly important—a demand largely neglected in the major donor and government initiatives for the region (Northern Rural Growth Programme [NRGP] 2007; Savannah Accelerated Development Authority [SADA] 2010). This neglect seems irritating in a situation in which the local population is investing considerable time and money in education and professional careers in order to adapt to multiple challenges of their particular environment, and more and more people seem to be moving out of agriculture. The degree of deagrarianization —"a long-term process of "economic activity reorientation", of "occupational adjustment", and "a realignment of human settlement (residence) away from agrarian patterns" (Bryceson 1996, p. 99)—is sometimes questioned as people, despite other aspirations, may be forced to return to smallholder agriculture (Yaro 2006). Yet the growing importance of education in northern Ghana is well documented in the form of enrolment figures (Ministry of Education 2011) and suggests a surge in educational zeal that is usually accompanied by changing aspirations and occupational readjustment (Foster 1968). The rising educational engagement, however, is not met by matching educational facilities—the quality of rural public education in northern Ghana is often poor and outcomes—such as performance in basic education certificate exams (BECE)—are often disastrous (Danquah Institute 2011; Essel 2011; GNA 2012).

In the light of the discrepancies between official climate change adaptation strategies and local aspirations, the research underlying this paper set out to document and explain changing rural aspirations, patterns of rural education, and the negative consequences of their neglect. In doing so the study took a historical approach in an effort to understand local patterns of change and changing aspirations, not only in terms of environmental changes, but more importantly, in the light of socio-economic, political, ideational changes. Research results show how rural aspirations—influenced by altering climatic, environmental, socio-economic, political and ideological contexts—have changed over time into a situation in which the youth,[1] supported by their families and peers, want to develop their future based

[1]Youth', especially in the African context, is not a straightforward concept and it is difficult to define clear age brackets (Abbink and Van Kessel 2005, p. 6). Local definitions may vary between different contexts, e.g., the social and political domain, and in relation to different groups of

on ‘modern’ ideas of school education and professional careers, rather than engaging in (commercial) smallholder agriculture often perceived to be tedious, risky and leading into poverty. The research interrogated how far new aspirations actually enable upward social mobility, or rather lead to further marginalization. Last but not least, the paper discusses the need to widen approaches to rural development and planned climate change adaptation in ways that take account of local aspirations.

8.2 Aspirations and Aspiration Failure

The literature on aspirations (Appadurai 2004) inspired the conceptual framework on which I draw when I try to discuss the expectations and plans for the future that the rural people in northern Ghana develop and that are shared beyond the individual level. Aspirations are individual ideas about the future and about good life which are culturally defined (Appadurai 2004, p. 67). This focus on shared perceptions does not imply an essentialist and static view of culture, and internal dissent and weak cultural boundaries in a globalized world are acknowledged (Appadurai 2004, p. 62). Closely related to culturally shared visions of the future is the ‘capacity to aspire’. This contains the actual know-how, developed by own experiences and those of other actors’ immediate social environment, that is necessary to achieve one’s aspirations. Appadurai (2004, p. 69) argues that this capacity is not evenly distributed in society. Affluent members of society can more easily navigate pathways into the future and more frequently exchange knowledge that forms the basis for the capacity to aspire. For poor people, like the large majority of people in the study area, it has been long argued that it is the lack of experience of different avenues to the future and to a good life which limits their capacity to aspire (Foster 1980). Following this thought, many of the economic and educational studies that have worked with this approach have focused on the limits of the capacity to aspire—‘aspiration failure’ as Ray (2006, p. 409) terms it—and how it can explain sub-optimal economic behavior of the rural poor (e.g. Bernard et al. 2011) or educational underachievement of disadvantaged students (Bok 2010). However, focusing aspiration failure seems to be limiting. I would follow Appadurai (2004, p. 84) when he states that there is the need “to build the capacity to aspire in those who have the most to lose from its underdevelopment—the poor themselves”. But given the way aspirations have changed in the poor rural

(Footnote 1 continued)

people, e.g., along gender lines. In northern Ghana, for instance, members of youth associations, mainly active in the political domain, can be adult men well into their forties, who have not reached the status of decision making elders, while married women mothering multiple children in their thirties would certainly not pass as youth. However, within the context of this research, which is interested in the role of education and patterns of occupational choice and social mobility, the focus was on female and male people in the age bracket of 12–35 years.

environment of northern Ghana over time, I actually believe that many young people here have the capacity to aspire. They recognise the need to undergo formal education, possible career pathways to pursue and the necessary steps to attain educational success. What is inhibiting educational success and greater degrees of social mobility is a lack of quality education facilities and funds to promote education beyond the basic level. But as has been argued above, major development and climate change adaptation strategies for the area do not really aim to improve transformational processes that allow people to move out of the agricultural sector through the creation of alternative livelihoods and options to develop modern careers—which is, as will be shown below, what many young people strive for.

8.3 Research Area and Methodology

In order to assemble the empirical basis for my analysis I undertook four field trips (which constitute a total of six months) to northern Ghana from February 2012 to April 2014. The main focus of my study was the Kassena Nankana East Municipality (KNEM) in the Upper East Region (UER) of Northern Ghana, specifically Biu, a small farming village of approximately 3000 inhabitants about 20 km south of Navrongo, the district capital. Biu was selected because I had undertaken prior research on smallholder farming and changing natural resource regimes in the area (Laube 2007a), and therefore had good rapport with the local community. Furthermore, with the assistance of the local headmaster a follow up study on local JHS leavers seemed possible. Initially, qualitative interviews with a host of male and female actors such as students, parents, school drop outs, teachers, officers of the Ghana Education Services (GES) and the local district assembly, as well as local (neo-) traditional authorities were conducted to gain a better understanding of the changing aspirations and typical life paths of the rural youth in historical perspective. Interviews were held in English where possible or with the help of a translator. In most cases the interviews were recorded and transcribed for further analysis. To better document the aspirations of the youth, a survey of 120 school-leaving male and female students in five district schools was conducted. The questionnaire asked for demographic background and contained open questions in which students were asked to write short paragraphs about their aspirations, but also about the problems they see in continuing their education and developing modern careers. To find out to what extent aspirations are realistic, a follow-up study on all students that completed their education at Biu Junior High School (JHS) from 1987–2012 was conducted. Furthermore, a census of 194 households in Biu was conducted to get a broader picture of local educational achievements over time. Research also involved two trips to Abuakwa, a suburb of Kumasi and major destination for young migrants from Biu, to conduct individual and group interviews on the living conditions, perspectives and strategies of young educated migrants.

8.4 Research Area in Historical Perspective

In the 18th and 19th century the research area was politically relatively independent from the larger kingdoms of the Mamprusi, Dagomba towards the South and the Mossi towards the North. But the peasant population was frequently attacked by slave raiders and warlords (Goody 1967). Under British colonial rule—in the research area since 1905—local life started to slowly change. On the one hand, the *Pax Britannica* brought slave raids and warfare to an end; on the other hand, it led to the introduction of forced labor and taxes payable in kind, brokered by 'traditional' authorities under indirect rule. Forced labor migration became increasingly important since the 1910s as the demand for labor in southern Ghana greatly increased (Lentz 1998: 214). But soon many people went to the south voluntarily and labor migration reached huge dimensions from the 1920s when people started going south to earn money, gain experience, escape from problems at home, or satisfy their curiosity (Nabila 1987).

While migration became an important feature of local society (Ungruhe, 2010, p. 262), formal education did not play any major role for the majority until the end of colonial rule in 1957. The British consciously suppressed efforts to promote formal education—made, for instance, by missionaries—because they wanted to curb eloquent resistance against their rule and to protect the reserve of cheap labor that northern Ghana provided for the colonial economy (Bening 1971; Plange 1979, p. 13). In a village like Biu, the son of the local catechist was the first to join the mission school in Navrongo in 1947, and only a handful of boys attended the newly opened native authority school in neighboring Kologo from 1948 (interview with R.A. male educationist, 75, Navrongo, 27.04.2012) .

The picture slowly started changing after Ghana's independence in 1957, when Ghana's first president, Kwame Nkrumah, promised to address the underdevelopment of northern Ghana. Many schools were built, teachers trained, and free basic education as well as special stipend programs for northern students offered. This led to the emergence of an educated elite of foremost men, and also—albeit with some difficulties—women (Behrends 2002), who were able to attain modern careers, e.g., in the educational sector, public administration, security services, or academia (Bening 1990). However, up to the 1990s more than 80 % of the population of northern Ghana was illiterate (Kelly and Bening 2007), and as recent as 2010 this figure was 52.5 % (GSS 2010).

The population of the KNEM continues to be relatively young, quickly growing, predominantly illiterate, largely rural, and agricultural (see Table 8.1). It is earmarked by high rates of poverty.

A decline of local smallholder agriculture has seen increases in seasonal and permanent out-migration as well as investments in education to escape the smallholder poverty trap.

8.5 'Book Gives Power': Historically Changing Local Aspirations

During pre-colonial times, local societies were hardly diversified. Apart from artisanal specialists such as blacksmiths and potters, the large majority of the population consisted of peasants that took care of most of their own needs. Spiritual and political leadership was largely based on kinship and organized around principles of seniority (Dittmer 1958). There was little room for individual advancement and education was highly gendered and meant to prepare children for their future roles in the local society. Practical education was based on experiential learning and children assumed increasing responsibilities as they learned from seniors before they married and founded their own semi-independent households. Similar to the transfer of practical knowledge, skills and technology, assumption of political and spiritual office included long periods of 'on-the-job' training by assisting in rituals, meetings and negotiations (as described by Fortes (1938) of the neighboring Talensi).

But local aspirations slowly changed over the course of the 20th century. In response to forced and voluntary labor migration, a 'culture of migration' developed (Hahn 2004). Young men, and later young women, were expected to go South, not only for economic reasons, but as part of becoming adults. They gained experience, knew new places and languages, acquired skills, and bought goods, which symbolized the new 'status'. Therefore, migrating southwards became part of local aspirations. Labor migration was complemented by (forceful) recruitment into the British Gold Coast Regiment. In the First and Second World Wars a large number of Ghanaian soldiers fought for the British (Killingray 1978, 1983). Many of those were recruited from northern Ghana, and their war time experiences in Europe and Asia certainly opened their eyes and changed their world view. However Killingray (1978, p. 529) argues that: "[t]he majority of soldiers saw their futures back in the Northern Territories, where their war-time savings and gratuities would enable them to buy brides, cattle, and perhaps enhanced status. In many ways they were possibly little different from northern migrant laborers who returned home from work on the cocoa farms and in the mines of Ashanti and the south." But while that may have been true for often illiterate 'farmers-turned-soldiers-turned farmers', Schleh (1968, p. 209) argues that for some the military experience opened the way into traditional offices by achievement rather than ascription, but that few became important agents of change and modernization in their home communities (ibid.: 2019).

Christianization, the expansion of the colonial administration, and the promotion of 'modern' education opened up new life paths, career opportunities and ways to get ahead in Navrongo, the local center of colonial and missionary activities. The Kassena in particular, living close to the mission and benefitting from the fact that the first French missionaries had learned Kasem across the border in Haute Volta, took advantage of these opportunities (Howell 1994). But life in the villages further away from Navrongo was only partially affected. Up to the 1950s, for instance, only a few boys from Biu were going to school and Christianity had only just begun to

spread. Like in other areas of Ghana (Foster 1968), not many strived for careers in the colonial administration, in church, or even schooling, and those who pursued such careers were referred to as "having gone astray in the bush". It was only later, in the 1970s and 1980s when the first people from Biu became teachers or nurses, or assumed positions in the Catholic church, that people slowly realized the value of education and the benefits of 'modern' careers. But interest in education stalled when in the 1970s a large irrigation scheme was constructed close to Biu. Forceful land acquisition and the construction activities initially proved traumatic and many established farmers were alienated, but many younger men saw irrigation as beneficial and therefore continued to focus on agriculture (Laube 2007a). Increased labor demand—also on children—that resulted from the expansion of farming activities kept rates of school attendance low. But since the 1980s and 1990s irrigable land has become scarce, and depreciated prices for agricultural products, as well as the abolishment of farming subsidies and technical support under structural adjustment programs, have made farming less attractive. Farming—once the basis of local aspirations and success—has lost its appeal. As Chief Afaa, one of the chiefs of Biu pointed out:

> And […] even if you're talking of farming, if you look at all those who are at the farms working, they are very lean. They are farming the whole year round and they are not healthy because they're spending all their energy onto the farms and they are getting no good returns. So we say we are farming and are not getting profit on the farm. You farm, there is no fertilizer. There is no weedicide for you to remove grass. The birds will come and take away all the rice. Then you come out with less than what you've put inside. So what profit is it? So it's like putting a rope around your neck. (Chief Afaa, male, 60, Biu, 08.11.2012)

Like smallholder agriculture, labor migration proves to be less beneficial these days. In interviews with migrants from Biu in Kumasi, they stated that migration to southern Ghana is increasingly problematic. The cost of living in urban centers has greatly risen, while jobs are difficult to come by. Widespread youth unemployment in southern Ghana forces young Southerners to take up jobs they were formerly leaving to migrants from the north, and manual labor in the plantation economy is increasingly being replaced by the use of machinery and agro-chemicals.

Farming and labor migration have thus lost their attractiveness. Furthermore, successful local role models epitomize the benefits of education and professional careers and have influenced local aspirations. When they compared the returns from farming or migration with the benefits that people who acquired education and got employment are enjoying, the aspirations of most local people changed. Apart from economic reasons, it was also the feeling of disempowerment and deficiency that goes along with illiteracy that local respondents stressed when saying:

> I am sitting in darkness. And this is a worry. Since I am already in darkness, I would not want my children to be in darkness. I don't want to send my letter to anyone to decode for me. That is why I want all my children to go to school. (Amina Abaaba, male farmer, 70, Biu, 04.11.2012)

The inability to deal with the challenges of modern life in Ghana, and especially to effectively present and defend one's interests in interactions with politicians, officials and NGOs is another reason rife in local discourse. The link between 'modern' education, locally referred to as 'book', and empowerment was often stressed. As a popular local song recorded goes:

> If you teach a child, and he does not want,
> Leave him, let him go to Tamale to throw yams [becoming a labor migrant].
> Today, no Filiga [white man] will come to your house and you shit,
> No Kambunga [Ashanti] will come to your house and you shit.
> The olden days are over.
> Even if you have acres of land or cooked food in abundance,
> If you do not have schooling what knowledge do you have?
> If you have cattle and keep driving them into the kraal, without book you have nothing.
> Book gives power. Book gives power. (Dozindema Singers, Biu, 09.04.2012)

This song was performed by local musicians who usually play at weddings and funerals in Biu and neighboring villages. Their songs, usually accompanied by drums and flutes, are locally very popular as they often comment on social and political developments. Apart from condemning school drop outs, who will have to become labor migrants and perform tedious and despised jobs away from home, the song reflects historical experiences in the 1980s, when the people of Biu where deprived of large tracts of land for the construction of the nearby Tono irrigation scheme constructed under the supervision of expatriate engineers in collaboration with Ghanaian security forces, often from southern Ghana (Laube 2007a, p. 92 ff). Despite their perceived wealth—the people mostly affected belong to the local earth priest lineage of Dozindema—the villagers, lacking education and self-confidence, were not able to resist unlawful and forceful expropriation. Only late in the 1990s, with the help of educated locals, was Biu able to regain considerable control of land within the irrigation perimeter (Laube 2007a, p. 313 ff).

Results from the census of 194 households in Biu reflect the increasing importance of school enrolment in Biu (see Table 8.2). While 68.9 % of those older than 31 years had no formal education, 99.1 % of the household members between

Table 8.2 Educational attainment among the members of Biu households according to age groups (N = 1221)

Age groups according to educational levels	Educational attainment (%)						Total
	None	K.G.	Primary	JHS	SHS	Tertiary	
0–3	70.2	17.0	12.8				100.0
4–5	11.1	37.0	51.9				100.0
6–12	4.9	6.6	87.4	0.5	0.5		100.0
13–16	0.9		69.8	28.3	0.9		100.0
17–20	12.8		31.1	37.8	16.9	1.4	100.0
21–25	19.3		16.3	28.9	31.9	3.7	100.0
26–30	31.1		22.2	24.4	17.0	5.2	100.0
≥31	68.9		16.6	7.5	4.3	2.7	100.0

13 and 16 years had at least entered primary school and/or were pursuing further education. The numbers clearly indicate how schooling has gained importance and how high enrolment rates are at present.

The shift in aspirations towards school education and professional careers also reflected in the survey conducted with 120 male and female final-year students from five JHSs in the KNEM. Asked about their preferred occupations, three quarters of the final-year students stated that they were dreaming of careers in the public sector, particularly in the health, education and security fields, while the rest were aiming for jobs in the private sector (see Table 8.3). None of the 119 students who answered this question, 71 % of which come from farmer households, expressed the wish to become a full-time farmer.

When explicitly asked whether they could imagine doing some farming in the future, less than half (43.1 %) answered in the affirmative (see Table 8.4). While more boys than girls contemplated engaging in some farming in the future, this interest was rather expressed by the urban youth. Asked for an explanation, many respondents stated that they wanted to do some part-time farming to complement the salaried employment they were looking for. This reflects a typical pattern in the research area, where many state employees and local business men engage in commercial farming activities (Laube 2007a; Tonah 1993).

The number of students who could imagine engaging in labor migration in the future was particularly low. Only slightly more than one third of the students were willing to do so.

The findings presented above show that local aspirations have greatly changed. Framing and labor migration, typical features of local livelihood strategies in the

Table 8.3 Occupational choice of final-year students (in percent)

Age groups according to educational levels	Educational attainment (%)						Total
	None	K.G.	Primary	JHS	SHS	Tertiary	
0–3	70.2	17.0	12.8				100.0
4–5	11.1	37.0	51.9				100.0
6–12	4.9	6.6	87.4	0.5	0.5		100.0
13–16	0.9		69.8	28.3	0.9		100.0
17–20	12.8		31.1	37.8	16.9	1.4	100.0
21–25	19.3		16.3	28.9	31.9	3.7	100.0
26–30	31.1		22.2	24.4	17.0	5.2	100.0
≥31	68.9		16.6	7.5	4.3	2.7	100.0

Table 8.4 Percentage of students who imagine a future as farmers (in percent)

Future in farming (N = 116)	All respondents	Girls	Boys	Rural youth	Urban youth
Yes	43.1	39.0	47.4	28.2	66.7
No	51.7	54.2	49.1	67.6	26.7
undecided	5.2	6.8	3.5	4.2	6.7

past, have lost their attractiveness and are perceived to be sub-standard activities. As has been shown a wide array of social, economic, political as well as ideational factors account for changing aspirations. When not explicitly asked, local respondents did not refer to climate change as a particular driver of changing aspirations, but referred to the non-profitability and the tedium of farm work, the lack of machinery and inputs, and the shame associated with entering farming after having attended school. However, climate variability was mentioned by some of the students when asked why they would not become farmers:

> The reason why I don't want to become a farmer is that farmers are always suffering with their crops. If it didn't rain, their crops will not be able to do well and they can't get any food, if their crops are well grown. (16-year-old female student from Naaga Junior JHS, 05.03.2013)

The local youth, many of them first generation literates, have the capacity to aspire, and at least theoretically, know how to pursue educational and occupational objectives which go far beyond their status quo. However, the point that high aspirations, especially those of the marginalized rural youth, are likely to be thwarted by the absence of conducive educational environments in many illiterate homes, poor educational facilities, and a lack of funding for education beyond JHS, has been long made (Foster 1968, 1980), but needs to be empirically supported.

8.6 Educational Outcomes, Professional Careers, and Social Mobility

In order to find out to what extent aspirations actually translate into educational outcomes, occupational success, and social mobility, I conducted a follow up study on 600 students who were taught in Biu JHS between 1987 and 2008. Despite the assistance from the headmaster of Biu JHS, Jacob Afeliga, we were not able to recover all past and present information. School records are patchy and not all students, especially those coming from neighboring communities, could be followed up on. In a number of cases even relatives were not able to report about the current status of former students. These missing cases introduce a positive bias in the study, since it is usually those students who discontinued their education and joined the rural and urban precariat of southern Ghana, who severed their links to their home community.

Looking at the results for the remaining cases, the poor educational attainment of students of Biu JHS becomes apparent (see Table 8.5). About 10 % of the students drop out and do not finish JHS. More than 40 % of the students do not pursue further education after JHS, and only 31.4 and 10.4 % respectively were able to join SHS and proceed to tertiary institutions.

Despite high aspirations, less than half of all JHS leavers were able to continue their education. This highlights the problematic nature of educational progress and professional careers in the research area.

Table 8.5 Educational status of students leaving Biu JHS from 1990–2008 (in percent)

Educational status of students (N = 567)	Sex		Total
	Female	Male	
Primary school	9.7	9.7	9.7
JHS	45.9	39.1	42.3
Vocational training	10.1	2.7	6.2
SHS	28.0	34.4	31.4
Tertiary education	6.3	14.0	10.4
Total	100.0	100.0	100.0

The difficulty of getting ahead becomes even more obvious when looking at the employment that the JHS leavers obtain after the 'end' of their education. Of 530 former students, 165 (31.1 %) were continuing their education at various stages. But only a few of those students, who had completed their education, were able to enter 'modern professions' (see Table 8.6).

Only 10.5 % of the former students had actually attained positions mostly as qualified teachers, nurses or security personnel in government services or as independent business people. 17.8 % had attained some moderate degree of social mobility and worked as craftspeople (seamstresses, carpenters, masons or hair-dressers) or private employees—jobs that do not pay very well, but provide a steady income. But for the large majority social mobility was an unattainable dream. 31.2 % had become farmers and 40.2 % were either unemployed, tried to make a living as casual laborers or petty traders, or had entered governmental youth employment programs poorly paying, rather short-lived, and highly controversial (Daily Graphic 2013; Odoi-Larbi 2013).

These results contrast starkly with the aspirations of the rural youth (see Table 8.4), who mainly dream of government employment and modern professions. It is obvious that only a minute fraction are able to achieve their aspirations and to attain good education, 'modern' careers and meaningful upward social mobility.

For many of those who did not make it this is a traumatic experience and they feel ashamed to remain in Biu as farmers or even craftspeople. Engaging in manual

Table 8.6 Employment of former Biu JHS students in 2012 (in percent)

Current employment of JHS-leavers (N = 365)	
Farmer	31.2
Unemployed	12.3
Employment program	9.0
Casual worker	12.3
Petty trader	6.6
Craftsperson	10.7
Private employee	7.1
Business person	1.1
Government employee	9.6
Total	100

labor equals failure, once you have completed JHS. The situation is even getting worse, as it is increasingly difficult to become a farmer. Land and inputs are difficult to obtain and in a group discussion with former Biu JHS students who live as casual workers in Kumasi the lack of alternative employment opportunities, land, and capital to engage in farming were mentioned as the most important reasons for migration (see Table 8.7), although witchcraft was also held to be important.

Table 8.7 Ranked reasons for migration

Reason	Remarks	Rank
Lack of salaried work	There are almost no options to engage in salaried work in Biu or in the KNMD	1
Lack of capital/credit facilities for farming or business	Parents are poor and cannot provide capital for farming or to start businesses. Since there are no opportunities for wage labor the youth are unable to raise their own capital. Without their own seed capital, jobs and land, they also find it difficult to get access to credit	2
Lack of land	Most of the land, especially within the Tono project, has been allocated. Therefore, it would be difficult for the youth to start the profitable irrigation farming even if they had capital	2
Fear of witchcraft	Witchcraft/witchcraft allegations are very common in Biu. Youth confronted with particular problems (barrenness/sickness) that are said to be related to witchcraft flee the village to escape the evil forces	2
Nagging parents	Many parents overly criticize and control their children, especially if they are not able to become independent and do not fully contribute to the households' livelihood. Children flee such houses	3
Reduce number of mouths to feed	In poor households, where there is enough labor but no land to extend farming, young people find it difficult to stay at home because they cannot significantly add to the household income but put additional demand on the households' food supplies and other resources. Otherwise they may feel humiliated by nagging parents	4
Remittances	A number of people migrate in order to support their families/family members at home or in educational institutions	4
Frustration	Young people that successfully passed JHS but lack the funds to further their education feel frustrated (shame/'*chive*') and leave for Kumasi in order not to be seen/not to have to see others prospering	4
Success of others	Young people see others coming back from the South being able to put up buildings, engage in farming and buy animals. Encouraged by these examples they also leave for the South	4

Migrants were asked to name the most common reasons for migration and to rank them in a debate in which they also provided the explanation for the choice of reasons

Table 8.8 Typical forms of employment and average remuneration for migrants in Kumasi

Job	Usual duration	Remuneration (in GHS)
Cleaning	Monthly	40 monthly
Security person	Permanent	150–200 monthly
Truck pushing	Daily	5–10 per day
Sawmill worker	Monthly	100–250 per month
House boy	Monthly	40 per month
Molding blocks	Daily	30 Pesewa per block/appox. 50 per day
Pounding Fufu	Daily	– 7–15 per day – Depending on size of pot used for boiling Yam/Kassava
Farm work	Daily/yearly arrangements exist	10 per day (early morning till early afternoon, food will be provided)
Logging (loading logs/poles in teak plantations)	Daily	Per pole/approx. 30 per day
Driving (trained)	Differs	Differs
Construction work	Daily	15–20 per day, depending on work
Driver mate (Trotro)	Monthly	100 per month

However, nagging parents, overly criticizing 'unproductive' children, and the shame associated with not being able to continue one's education were also mentioned as important reasons why people migrate. Some of the migrants interviewed in Kumasi were already above 30 years and continued living on menial and frequently changing jobs that afforded them between 50 and 150 USD a month in 2012 (see Table 8.8).

Looking at the aspirations of the local youth and the realities of educational attainment and upward social mobility, it is clear that only a few are able to fully live up to their own expectations, especially in the economic domain. In order to understand some of the reasons for this disappointing performance it is necessary to understand some of the underlying conditions.

8.7 Factors Influencing Poor Educational Performance and Low Occupational Success

When trying to understand what influences local people's ability to progress, attention is easily drawn to the poor quality of rural education in northern Ghana. Large classes (especially in primary schools) with up to 60 students, a lack of trained teachers and teaching materials, as well as the difficulties of students from educationally deprived households, all contribute to a situation where educational success is difficult to achieve. This is acerbated by the fact that in the in the

Ghanaian public education system student progression before the end of JHS is automatic. Although teachers may ask students to repeat classes when they perform badly, this is not obligatory and many students continue their education despite serious deficits. The first exclusionary exam is the BECE. Up to 2013, students who attained aggregates higher than 30 points were not allowed to continue their education in Senior High School (SHS), but needed to repeat (parts of) JHS or to rewrite the BECE to better their aggregate. Students with better aggregates stand higher chances of being admitted into popular SHSs with a good reputation, if they can afford the often exorbitant school fees.

How poor the overall performance of northern students was can be seen from the fact that less than half of the students were able to continue beyond JHS (see Table 8.5). While records were patchy for Biu JHS, out of the 395 students for whom BECE results were recorded until 2008, only 151 (38.2 %) obtained results that qualified them for further education. Out of the 244 students who got aggregates above 30, only 27 students rewrote the BECE at Biu and only seven were eventually able to get good enough results to progress to SHS. In the KNEM, the number of passing students dropped below 30 % (Vibe Ghana 2012) and in the UER, in 2012, less than 50 % of students passed their BECE (GNA 2012). As the BECE does not qualify a person for any higher form of professional training, especially within the government sector, students who want to progress need to attend SHS. This importance has not changed since Foster (1980, p. 210) wrote:

> Secondary schools are extremely significant since not only are they terminal institutions for the bulk of the relatively small number of students who enter them in the first place, but they also control access to the colleges and universities. They are, therefore, key points of articulation between the primary and tertiary levels, and generally represent the most selective point in the educational structures of the majority of African nations.

The SHS admission policy in Ghana has changed, so that in 2013 students with an aggregate of 40 were allowed to enter SHS while in 2014 almost all students were eligible to proceed to SHS (Dery 2014). But given the deficiencies of many JHS students it is questionable whether this is sustainable, or whether it just helps to prolong waithood and keep the youth in costly educational institutions without offering a way forward for most students.

This is especially problematic since education, which is free during primary school and JHS, has to be paid for at SHS level. Fees stood at 328 GHS per term for first year SHS students in 2011/2012 but have risen to 668.50 GHS per term for the year 2014/2015 (Dery 2014; GNA 2011). Yet the cost of SHS education is significantly higher since Parent-Teacher-Associations (PATs), which undertake important infrastructural projects, fix additional fees independent of the school fees. Given the poverty levels in rural northern Ghana, many families find it difficult to raise these amounts. As this problem prevails nation-wide, SHS fees are a recurring topic in Ghanaian politics. The opposition National Patriotic Party flagged free SHS as one of their central election promises during the presidential election campaign in 2012 and in the 2014 budget the ruling National Democratic Congress promised that "Government will progressively absorb GES-approved examination, library,

entertainment, SRC, science development, sports, culture, and internet fees charged to secondary level students in the effort to make SHS free" (as cited in IMANI, 2015). However, despite rising numbers of students at all levels, the educational budget has stalled at about 24 % of the national budget over the last decade, and government expenditure per-student has dwindled like donor support for the educational sector. Long-discussed programs for 'brilliant-but-needy-students' are still non-existent.

For female students in particular, it is very difficult to continue education if results are bad and funding is scarce. Less female than male students attended SHS and tertiary institutions. Parents often invest in boys rather than girls, as it is believed that boys will support the parents in future, whereas girls traditionally move to their husbands' homes after marriage, thus leaving the needy parents behind. Lacking support, many girls marry after finishing JHS and discontinue schooling. However, girls are more likely than boys to engage in vocational training activities such as apprenticeship, often after bearing children.

The difficult situation of the Ghanaian youth, with mostly poor educational outcomes and high rates of youth unemployment, is obvious, not only in the deprived North, but also elsewhere in the country, and is acknowledged in the national youth policy (Ministry of Youth and Sports 2010). The government has tried to address it through policy initiatives such as the National Youth Employment Program (NYEP), which was launched under the reign of President J.A. Kuffour in 2006. It was meant to ensure that the youth, including graduates of JHS, SHS and Technical/Vocational School as well as school drop outs and illiterates had access to productive employment. The NYEP covered nine modules including Youth-in-Agri-Business; Youth-in-Trades and Vocations; Youth-in-ICT (Information, Communication and Technology); Community Protection System; Waste and Sanitation Management Corps; Rural Education Teachers Assistants; Paid Internships and Industrial Attachments; Vacation Jobs; and Volunteer Services (Ministry of Manpower Youth and Employment 2006, p. 6). However, despite being a move in the right direction, the programme suffered from a lack of participatory planning, a strong focus on internships that did not lead to large employment impacts, political capture, and inefficient implementation that finally led to a restructuring of the implementing agency, the Ghana Youth Employment and Entrepreneurial Development Agency (GYEEDA) (Daily Graphic 2013; Dapatem 2013; Gyampo 2012; Sumberg et al. 2014). Apart from these pitfalls, some components of the NYEP seemed to be counterproductive. Youth employed as rural educational teaching assistants had no educational background and were poorly trained, but were often used as full-fledged teachers, with the danger of further lowering the standard in educational institutions. Furthermore, the Youth-in-Agribusiness component, quite in line with the 'youth in modern agriculture'-rhetoric of the National Youth Policy (Ministry of Youth and Sports 2010) and the focus on agricultural commercialization per se, promoted the re-entry of the rural youth into the agricultural sector. But it is doubtful that this initiative, if continued, will affect the youth positively. As Sumberg et al. (2014, p. 14) state "[…] there is little evidence to suggest that modernization of the production side of African agriculture is likely to result in large numbers of promotive or transformative employment

opportunities for young people in rural areas." Questions can also be raised about the extent to which the agricultural sector could absorb the large young population. This is especially true for northern Ghana, where promises of agricultural modernization are threatened by the potential impact of climatic changes. However, climate change is not taken into consideration in the NYEP and not even mentioned in documents such as the National Youth Policy (Ministry of Manpower Youth and Employment 2006).

Given the difficulties of effectively promoting (rural) quality education and youth employment, and considering the current political emphasis on agriculture-driven growth for northern Ghana which should be enabled by climate-proofing, modernizing and commercializing the sector, it can be doubted that educational quality and occupational outcomes will improve soon. It seems the aspirations and aspirational capacity of the rural youth as they have been outlined above will not be met anytime soon. This seems problematic as it is the aspirations, plans, and hopes for the future that should be considered when future development, but also climate change adaptation, is being planned.

8.8 Conclusion

This chapter shows that Ghana, and particularly Northern Ghana, is projected to be increasingly affected by the impacts of global warming and concomitant climatic change. While the results of climate change modelling are still fraught with uncertainties, particularly—but not only—with regard to future emission scenarios, successive Ghanaian governments have begun to address the impact and possibilities of adaptation to climate change. While policy responses have been criticized as slow and too focused on climate change mitigation, this chapter raised a different question. The need to give attention and priority to local conditions, life courses, needs, and aspirations in development policies per se, and to avoid focusing on climatic changes in planned climate change adaptation in particular, has been emphasized. Therefore, the chapter discusses to what extent climate change adaptation policies, or sectoral policies regarding agriculture meant to help northern Ghana to adapt to climate change, such as SADA, are driven by the expectations and aspirations of those who are likely to face the harshest consequences of climate change in northern Ghana—the rural youth. To do this, results from qualitative and quantitative research were introduced to show how local aspirations changed over time and how they are currently constituted. Moving away from a 'peasant culture'—in which the youth would be successively introduced to the gendered knowledge, institutions, beliefs, technologies, division of labor, and distribution of assets—most rural people, whether young or old, expressed the need for the youth to groom aspirations beyond agriculture. This change in attitude is not the result of climatic or environmental changes alone. It has developed in an economic and political context in which small-scale farmers have been continuously marginalized under the colonial regime, after independence, and particularly after structural adjustment, and in a situation in which the agricultural sector—at least from the

local perspective—does not provide the chance for the vast majority of young rural people to make a decent living, let alone an avenue to transform their lives. But change in aspirations does not only come as a reaction to the difficulties encountered in small-scale agriculture, but also as a result of impressions about new opportunities that people want to take and new role models that they wish to follow. These dynamics could also be seen at work in the rise as well as the demise of labor migration as a central element of individual personal as well as economic development. Current aspirations, of both male and female youth, focus on educational achievement and upward social mobility based on modern careers, preferably in government institutions that provide sufficient security as well as room for complementary economic activities. Young people want to be financially independent, have good jobs or their own business, and have a nice block house, good clothing, and their own means of transport. They aspire to have small families and to afford their children good education. These aspirations are largely in line with the models of modernity that are promoted in Ghanaian school books, churches, and mass media. But it could be shown that under the given conditions of the absence of a conducive academic environment at home, poor educational facilities, and a lack of means to continue education past JHS, the large majority of rural school leavers are not able to attain good educational outcomes. Most end at the JHS level and find it very difficult to follow modern careers. Most return to farming, an activity that is perceived to be unrewarding, or engage in labor migration, which has also lost its appeal as most migrants join the urban or rural precariat in southern Ghana. The new aspirations do not make farming obsolete. Farming remains—like labor migration—an exit option for the many who fail to perform well in education or are unable to pursue their educational or occupational goals beyond JHS. Even if successful, many young people would like to engage in commercial agriculture once they have achieved their professional goals.

But while local aspirations have changed, regional development and climate change adaptation policies—in line with a neo-liberal development agenda that focuses on national economic growth—rely on the modernization, commercialization and climate-proofing of (small-scale) agriculture. This focus may make sense, although it is also frequently doubted by those who are (forced to) remain in agriculture. But this policy focus greatly ignores the aspirations of large parts the rural population, whereas educational and employment sector policies that could help people to achieve their aspirations are either absent or poorly implemented.

Individually, families try to escape this deadlock by putting their children in private schools—even in Biu a private primary and JHS are available—hoping that in such institutions education will be better and that their children will be able to make progress. Nevertheless, for the majority of past and current school leavers new aspirations are not achieved. While educational and professional failure is perceived as shame, the poor opinion about manual labor—not only on the farms, but also by artisans or casual laborers—makes reliance on such livelihood activities dissatisfactory.

Given local aspirations and the greatly limited educational achievement and upward social mobility in northern Ghana, it is paradoxical that currently the Ghanaian government and international donors seem to neglect the educational sector but to focus mainly on the commercialization of smallholder agriculture to adapt to climate change. It has been argued that true adaptation processes need to be transformational and to go beyond the incremental adaptation of the current agro-ecological, socio-economic, and political status quo to changing climatic conditions. But while the need to transform larger patterns of distributional and regional inequalities is often stated—at least officially SADA and the Ghana Shared Growth Agenda make such statements—actual policies and their implementation fall behind this objective. This may be caused by the overlapping interest of quite a wide array of actors from a range of international, national, and regional organizations and agencies who define climate change adaptation in ways that allow them to—more or less—continue or even expand their usual business, such as the provision of (irrigation) infrastructure, the governance of natural resources, or the promotion of commercial agriculture. While this can be understood given the underlying incentive structure, it means ignoring important chances which lie in the transformational potential of existing aspirations and in the general readiness for change, especially among the youth in rural northern Ghana.

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Chapter 9
Migration as Societal Response to Climate Change and Land Degradation in Mali and Senegal

Stefan Liehr, Lukas Drees and Diana Hummel

Abstract The majority of the rural population in the West African Sahel depends on subsistence and small-scale farming. Thus, climate change, with its increasing temperatures and rainfall variability, impacts the environment and poses considerable risks to livelihoods. Given these circumstances, migration can be an important strategy for coping with the changing environmental conditions. Focusing on two regions in the West African Sahel, Bandiagara in Mali and Linguère in Senegal, the paper addresses the issue of migration as a societal response to climate change. It draws on results from the interdisciplinary project *micle*. Within the project qualitative and quantitative socio-empirical surveys have been conducted and a number of geo-scientific data from remote sensing and field measurements have been collected in the two study regions. The empirical data have been integrated and analysed using the methods of Bayesian belief networks (BBN). A policy analysis of relevant environmental, development and migration policies, supplemented by scenario analysis, identified options for political action. The results of the interdisciplinary analysis show that changing and unsteady environmental conditions lead to changing patterns of migration regarding its duration and destination. Depending on the migration motives and social-ecological conditions, the migration patterns can be very specific. Although environmental conditions have a certain impact on these patterns, all in all socio-economic conditions show a greater impact on the people's migration decision. While socio-economic factors like higher education are important for long-term migrations to the capital, unfavourable environmental conditions play a decisive role when

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J.A. Yaro and J. Hesselberg (eds.), *Adaptation to Climate Change and Variability in Rural West Africa*, DOI 10.1007/978-3-319-31499-0_9

people migrate seasonally for economic reasons. One important leverage point for political action is therefore the promotion and facilitation of formal education.

Keywords Bayesian belief networks · Climate change · Interdisciplinary research · Migration · Policy analysis · Sahel · Scenario development

9.1 Introduction

For the last two decades, there has been an increasing interest in the relationship between climate change, environmental degradation and mobility of the population in the public and scientific debate (Wilkinson 2002; UNDP 2009; IPCC 2014a). The West African Sahel is expected to be the most affected by the effects of climate change and climate variability such as hotter and drier climates, oscillations in rainfall patterns, droughts, land degradation and desertification. For West Africa, predictions suggest an increase of between 3 and 4 °C, while rainfall predictions vary highly in time and space. An increased tendency for extreme events such as droughts and floods is estimated (IPCC 2014b). Against this background, negative impacts on food production, including crops as well as livestock farming, are expected for the region (IFPRI et al. 2014; Worldbank 2012). More than thirty years ago, during the 1970s and 1980s, the West African Sahel experienced a number of severe droughts and a considerable decrease in rainfall in the following years. Together with political conflicts, these droughts contributed to severe famines and the displacement of large parts of the population (Findley 1994; Morrissey 2014). Notwithstanding a recovery of rainfall over the last three decades that has been registered, many studies suggest that a growing population and climatic trends will result in increasing land degradation, combined with negative effects on natural resources, agricultural productivity, food security, and thus increasing outmigration of the affected population (Warner et al. 2010; UNEP 2011; Véron 2012). Yet, the West African Sahel region is well-known for its high population mobility as part of the history and culture, combined with a multitude of migration patterns and trajectories. Since pre-colonial times, mobility has been common in the region and has included both cyclical migrations linked to agricultural production styles, as well as movements resulting from the search for better economic opportunities and changes of the natural environment (Cordell et al. 1996; Castles 2009).

Today there is a broad consensus in the discourse on environmentally induced migration, at least in the academic debate, that migration is a complex phenomenon and is thus not determined by one single factor (Piguet et al. 2011; Black et al. 2011; Hummel 2015). Climate change as such usually does not directly cause people to move, but it produces specific environmental effects such as temperature increases, fluctuations in precipitation, and extreme events such as hurricanes or floods, which can impair the livelihoods and increase the vulnerability of parts of the population. Hence, it is a context-specific interplay of environmental, social, cultural, demographic, economic and political factors that must be considered (Black et al. 2011;

Piguet et al. 2011). This means that migration cannot be explained in a deterministic and linear way, since its causes, features and patterns are highly complex, dynamic and context-dependent. The challenge for empirical research is therefore to relate the multiple factors influencing migration in order to understand the specific weight of each and their interactions. Given this overall agreement in the scientific debate, most studies have moved from simple push-pull frameworks to more comprehensive research that considers the interplay of ecological and social factors, or a deeper view on scale-related interrelations of individuals or households with societal settings, for example, issues of social inequality or the role of social networks for migration decision-making (Hummel et al. 2012: 15f.).

Another shift in the debate can be observed: until a few years ago, the prevailing perspective is that environmentally-induced "migration is the worst scenario and the option to avoid, and policies should strive to enable people to stay" (Piguet et al. 2011: 15). In contrast, recent studies focus on the role of migration as an adaptation strategy of households and individuals to reduce vulnerabilities to environmental, social and economic risks, and to diversify their income (Tacoli 2009, 2011). Other authors emphasize the role of migration as one of alternative "livelihood strategies" of individuals or households (McDowell and de Haan 1997), or just as a "way of life" (Black 2006: 2). Given these recent discussions, we critically discuss the issue of migration as adaptation or coping strategy using the example of migration patterns in two selected regions in Mali and Senegal. We will argue that migration can be regarded as a societal response to climate change and land degradation.

Whether it constitutes an adaption strategy, a livelihood strategy or a way of life depends on the specific social-ecological conditions which influence the different actions and strategies taken by individuals, groups and societies to cope with changes of their natural environments. These actions and decisions are influenced by social, cultural, political and economic settings, and environmental changes in turn influence these settings. Causes and motives for migration overlap and thus cannot be strictly separated into single factors. Based on the results of the inter- and transdisciplinary research project *micle* "Climate Change, Changes to the Environment and Migration in Sahel", in this paper we will focus on the social-empirical analysis, modelling, and policy analysis.

9.2 Project Region

In order to assess the effects of climate change and land degradation on migration it is reasonable to consider a region that is subject to changing environmental conditions and has a mobile population which depends on these conditions in every day life.

Being located in the Sahel region, both study areas—Linguère in Senegal and Bandiagara in Mali (Fig. 9.1)—show the characteristics of semi-arid grass and shrubland (Herrmann et al. 2005). The unstable climatic and environmental conditions of the West African Sahel are reflected in the ongoing controversial debate about desertification and re-greening (Dardel et al. 2014). Even more crucial, they

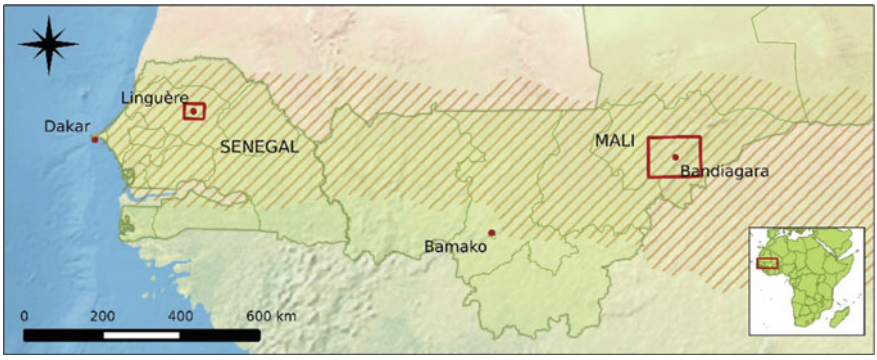

Fig. 9.1 Location of study areas at Linguère and Bandiagara (*rectangles*). The *shaded area* indicates the Sahel's extent, delimited by the 250 mm/a isohyet in the north and 900 mm/a in the south (based on the definition of the MEA 2005). (*Data sources:* DIVA-GIS, Natural Earth Data. *Cartography*: Lukas Drees)

affect the life of the inhabitants, especially because the project region is predominantly a rural area where agriculture and livestock farming play a dominant rule regarding people's economic activities.

For both crop farmers and livestock farmers, the rainy season (between June and October) and the amounts and the distribution of rainfall in this period are decisive for their livelihood. This is especially true for farmers who usually do rainfed subsistence farming and hardly have the opportunity for irrigation. Still, people adapted to a certain degree to the unreliable conditions that can cause poor harvests in any year. This situation is aggravated by a rise in temperature since the 1960s and the ever-present risk of longer dry spells, as they occurred in the 1970s and 80s (Brandt et al. 2014a). At the same time, the area used for agriculture increased during the last decades, especially at the cost of open shrubland and grassland (Hummel et al. 2012). When all these factors are taken together, the increasing pressure on natural resources and soil become obvious.

According to national statistical data for the Mopti region in Mali that Bandiagara belongs to, the total enrolment rate in 2004 was only 50 % (IPE-Mali 2009), while it was slightly higher in Linguère with 55 % in 2006 (ANSD 2007). This is only one of the indicators which cause that both countries are ranked among the 25 least developed countries in the Human Development Index (Malik 2014).

Within the Malian project region the predominant ethnic group are the Dogon, followed by the Peulh (or Fulani/Fulbe). The latter, being also one of the two main ethnic groups around Linguère in Senegal, are traditionally half-nomadic livestock farmers, but are becoming more sedentary. In contrast, Dogon as well as Wolof, who account for the second of the larger ethnic groups in the Senegalese study area, usually cultivate fields. On these fields crops such as millet, sorghum and peanuts prevail, while the livestock is mainly made up of goats, sheep and cattle.

Further occupations of the population include trade, craft and forestry. Keeping in mind that firewood is the main source of energy, its importance and thus the

importance of maintaining these resources becomes apparent. In this context, climatic and anthropogenic influences are very decisive and a sustainable forestry management is likely to become crucial over the coming decades (Ndiaye 2007).

The West African Sahel has been and still is a region where migratory movements are part of everyday life. This applies especially to herders who seasonally move with their cattle to adapt to the environmental conditions. But also, many other social groups chose to migrate for various other reasons. In spite of many medial narratives of an 'invasion' of Europe and of human trafficking, research has shown that most migrants move within the country and West Africa and migrations to Europe play a minor role (Spaan and van Moppes 2006; de Haas 2007, 2008).

These characteristics of the study areas, namely the high dynamics in climatic and environmental conditions as well as in demography (with a negative net migration rate) and the population's high dependency on activities that are strongly affected by land degradation, in particular livestock farming and small-scale agriculture, are the main reasons for selecting these areas (Hummel et al. 2012).

9.3 Research Approach

Forming the basis for the following analyses was a social empirical survey which consisted of two phases. An explorative phase between February and April 2011 with qualitative interviews preceded and prepared for the main phase which lasted from November 2011 until April 2012. Within the latter, 905 standardised interviews were conducted in the study areas Bandiagara and Linguère and with migrants originating from these regions in the capitals Bamako and Dakar. Both qualitative and quantitative data are used to answer questions concerning the perception of environmental changes, their influence on every day life and migration decisions, as well as further motives for migrating and the temporal and spatial patterns of migration.

Nonetheless, in order to gain an integrated view of migration in the project region, it is crucial to consider socio-economic and cultural factors together with environmental factors. While the social and natural sciences have proven methods to analyse the respective factors of their disciplines, the integration of this knowledge poses challenges that require case specific solutions. A productive conceptual framework to guide the identification of relevant factors as well as the development of a customised method is the concept of social-ecological systems (SES) (Hummel et al. 2011; Hummel 2015; Liehr et al. in preparation). By looking at human-nature interactions with special regards to ecosystem services and the security of supply of the population, a central link between both spheres that is very important for migration decisions is covered. Applying this concept allows us to look at migration as a practice adopted to respond to climate change and land degradation. This practice is framed by institutional settings like the respective traditions and cultural norms but also by knowledge on, e.g., migration destinations and social networks (Drees and Liehr 2015). In addition, the SES is able to depict further relevant influences on the environment/migration nexus (Hummel 2015).

Besides the cooperative process of conceptualisation, several methods are used to integrate the social- and natural-scientific work and results of the project. First, we carried out collaborative field work and joint work on developing the questionnaire, then we built the hypotheses and developed scenarios in the interdisciplinary research team, while taking into account stakeholders' opinions. Finally, we incorporated the survey data and (remote-sensing) data on environmental conditions into an integrated model.

Considering the empirically diverse results, there is the need for a model that can handle data flexibly with regard to its origin, type and unit. Furthermore, we have to consider that no matter how well-founded the data appears, a considerable degree of uncertainty will always persist. With Bayesian belief networks (BBN) we chose a modelling method which meets these requirements, since it can incorporate any kind of data from expert assessments to quantitative data, while—due to its probability-based approach—it explicitly addresses uncertainty (Aguilera et al. 2011; Landuyt et al. 2012). Moreover, the graphical expression of the linkages between the crucial factors as a network can be used to communicate with stakeholders and decision makers.

Based on the policy analysis and supported by the modelled results of the scenarios, we made policy recommendations with regard to the major causes of land degradation, possible adaptation strategies—including migration—and the relevant and viable formal and informal institutions.

9.4 Social Empirical Findings

9.4.1 Perceptions of Climatic and Environmental Change

For many interviewees the droughts in the 1970s and 1980s are important events that shape their view on climatic and environmental changes. Since the occurrence of these extreme events, and in particular the drought in 1973, most interviewees (55 % of Senegalese and 71 % of Malian) are of the opinion that the rainfall amounts decreased within the last 20–30 years. While approximately one out of four respondents perceived an alternation of rainfall amounts, hardly anyone saw an increase or constancy.

Although the mean annual rainfall amounts are still lower compared to the pre-1970 conditions, recent analyses show that they have been increasing since the 1990s (Brandt et al. 2014a). Since farmers also report decreasing crop yields, these may explain the perceived lower rainfall amounts and thus affect the perception of climatic changes. Still rainfall distribution, degradation or a lack of appropriate fertilisers and seeds may also cause smaller harvests. In particular, irregularities of precipitation within the seasons are often referred to in the qualitative interviews. A further explanation for this contradiction between measurements and perception may be local narratives about decreasing rainfall, as assumed in other studies in the Sahel (Tschakert 2007; Mertz et al. 2009).

More in line are measurements and perception of vegetation trends and diversity. While trends of re-greening as well as of degradation partially occur due mainly to human activities and practices, the diversity of (tree) species has dramatically declined. Both of these developments are documented by interviewees and natural scientific data (Brandt et al. 2014b).

The environmental conditions are of particular importance, since 89 % of the respondents' families rely on agriculture as their main source of income and food supply. Also the main individual economic activity is agriculture—including farming and livestock breeding—and accounts for 67 % of those interviewed in rural areas. Based on the interviews conducted in the capitals, farming is still the most important activity, with 54 % in Mali and 33 % in Senegal. Of the latter, a further 17 % are engaged in livestock breeding.

With regard to the preceding year, the survey asked for negative factors that influenced the crop yields. Of major concern were the lack of rain (69 % in Senegal, 85 % in Mali) and the misdistribution of rain (66 and 36 %). For Senegalese farmers crop pests (50 %) and the lack of seeds (42 %) were also important, and the lack of fertilisers was mentioned by one out of four interviewees in both countries. Additionally, within the qualitative survey a decreasing soil fertility, overexploitation of the soil and, in Linguère, also the general growing scarcity of land due to population growth were named.

9.4.2 Migration Patterns and Dynamics

Since the scientific literature does not provide a consistent definition of migration, the project *micle* decided to define migration as 'being absent from the place of origin for more than three months'. This definition complies with the definitions used in the Human Development Report (UNDP 2009) and the Foresight project (Foresight 2011). Based on this definition the majority (87 %) of those interviewed in the study areas have migrated, which substantiates the assumption that migration is an inherent part of everyday life in the study area. Because factors like educational level and economic activity do not show a significant influence on the migration experience, it can be stated that migration is a phenomenon across all social strata. However, within the Malian study area the gender of a resident plays an important role regarding the migration experience. While 80 % of the Senegalese men and 78 % of the Senegalese women left their home villages for more than 3 months, only 70 % of the women but 94 % of the men from Bandiagara migrated. As many interviewees confirm, the main reason for this unequal distribution is the traditional way of life and associated restrictions that deny women the opportunity to migrate. This applies especially to the middle and the last decades of the last century, but gradually these restrictions are lifted.

The duration migrants stay at their destination before returning to their place of origin or moving to another destination is in many cases less than a year. People often (40 %) leave after the harvests as seasonal migrants and return before the next

harvest (3–9 months). Temporary migrations from 10 months up to 5 years occur more often in Mali (46 %) than in Senegal (28 %) where, on the other hand, permanent migrations (more than 5 years) are more common (33 vs. 14 %). Notable differences by gender can only be observed for Mali, where 49 % of men migrate seasonally (compared to 22 % of women) while only 9 % do so permanently (24 % of women). Strikingly, seasonal migration also accounts for nearly 50 % of the migrations during the droughts in the 1970s and 1980s.

If we consider the destinations of migration it is apparent that international migrations account for a rather small number of migrations from Senegal, while many (25 %) Malian migrants cross the national border to the Ivory Coast. Figures 9.2 and 9.3 show the percentages of migrants in the national regions and in foreign countries

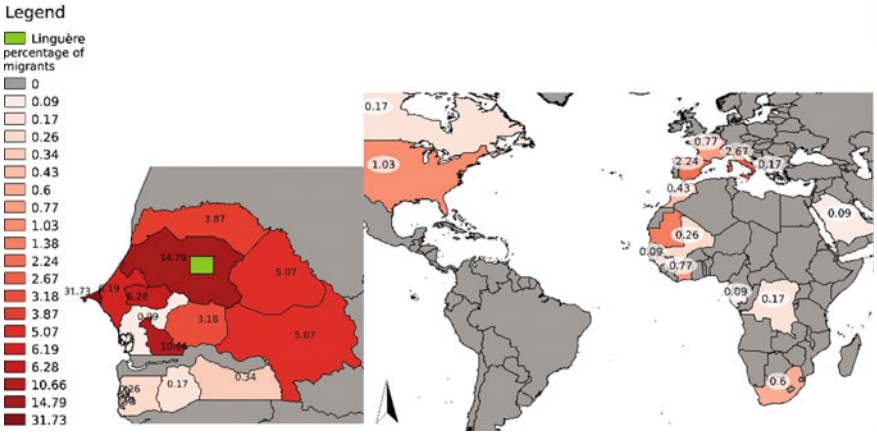

Fig. 9.2 Frequency of migrations from Linguère to Senegalese regions (*left*) and other countries (*right*)

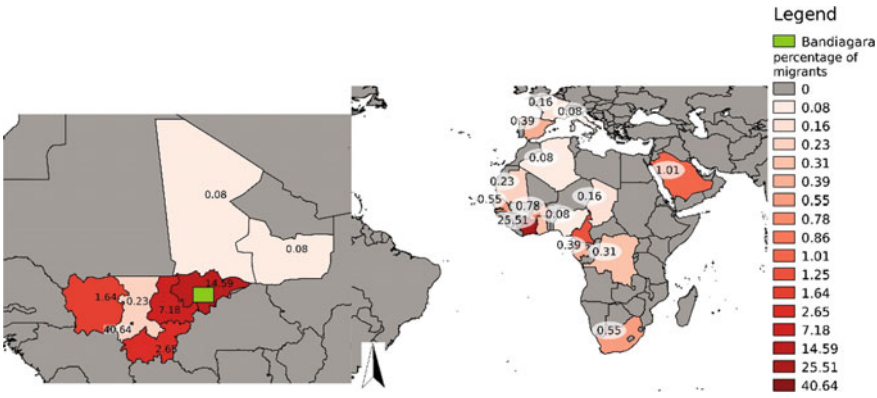

Fig. 9.3 Frequency of migrations from Bandiagara to Malian regions (*left*) and other countries (*right*)

(numbers represent migrations of the interviewees and their relatives). Both figures reveal that besides the region of origin, the capitals Dakar and Bamako in particular attract most of the migrants (categories up to 31.73 and 40.64 %). Furthermore, it is obvious that migrations to Europe are (especially for Malians) of minor importance. In contrast, when we summarise the data for the ten biggest cities of both countries, they account for nearly 60 % of the interviewees' destinations.

9.4.3 Migration Motives

Although migratory movements can hardly be explained by single causes, the vast majority of migrants (65 %) name the search for money and jobs as one of the main motives for migration. Only the few interviewees that have completed secondary school (about 10 % of all interviewees) name education as the most important motive for migration. Further differences exist between men and women. Although economic motives are dominant for both of them, they are noticeably less frequent for women who more often migrate for familial reasons or to visit someone. On the other hand, 15 % of the men, compared to 4 % of the women, name education as a migration motive. Moreover, the qualitative interviews revealed the importance of relatives and friends that live at the destination. These social networks help to reduce costs and risks of migration and thus foster chain migration.

This view of the motives for migration shows the importance migrations have for a household's livelihood. Besides other strategies like selling animals or mutual help between neighbours, migration is an important measure to diversify the household's income in years with poor harvests. In this sense migration serves as a coping strategy or an immediate reaction to bad conditions and as an adaptation strategy for income diversification in the long run.

9.5 Modelling and Scenarios

9.5.1 Modelling Procedure

In order to get a better understanding of the complex interactions between socio-economic and environmental conditions, we adopted an integrative modelling approach using Bayesian belief networks (BBN), which complements and combines the natural and social scientific results. The conceptual framework on which the modelling process is based is shown in Fig. 9.4. The environmental and socio-economic variables interact and affect the motives for migration, which influence the decision to migrate and the spatial and temporal patterns of migration. While the environmental variables mainly encompass data on land cover and precipitation, the socio-economic variables are, on the one hand, biographical facts like age and

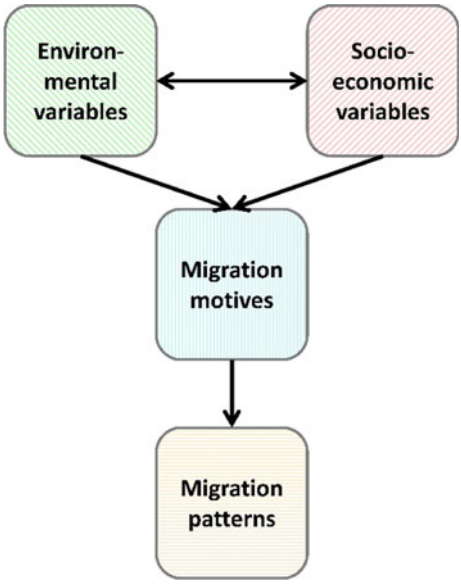

Fig. 9.4 Conceptual framework of the BBN

gender, and on the other hand, socio-economic aspects like occupation and education. The main migration motives, which were identified due to their correlation with characteristic patterns of migration, are *education*, *family*, *sustenance/employment* and *visit/curiosity*. Finally, the migration patterns are classified as follows: in accordance with the social empirical survey the duration of migration is classified into *seasonal*, *temporal* and *permanent*. The destinations comprise the categories *capital*, *within region of origin* and *distant destinations*.

The first and vital step for the following modelling procedure is the integration of social empirical and environmental data. The basis for this lies in the social empirical survey that provides the data for the socio-economic variables, the migration motives and patterns. It must be stated that the data refers only to the first migration experiences, since the points of departure for following migrations are not necessarily within the study area. In order not to distort the migration rates, the interviews conducted within the capitals (with people originating from the study areas) were excluded, since these interviewees had necessarily already migrated. Subsequently, the environmental conditions at the interviewees' place of origin are defined by calculating the average value of the mapped data on land cover and precipitation within a radius of 3 km around the respective village (spatial intersection). Variables that can be assigned to a specific year are furthermore aligned with the year of migration (temporal intersection).

Based on the identified motives for migration, four submodels are constructed. For the migration motives *education*, *family* and *visit/curiosity*, only socio-economic variables were chosen as potential influencing variables or parent nodes, as the term used for BBN. On the other hand, the motive/child node *sustenance/employment* is also influenced by environmental variables. By using an iterative process of

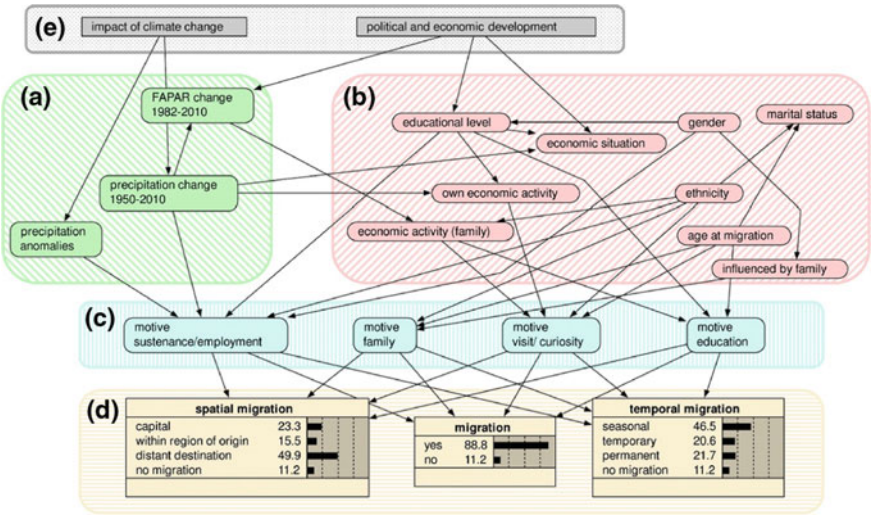

Fig. 9.5 Trained BBN for Linguère with interacting environmental (*rectangle* **a**) and socio-economic factors (**b**) affecting the migration motives (**c**) that influence the migration patterns (**d**). For the latter probability distributions are included, which exist—except for the scenario nodes—also for the other nodes. The nodes in *rectangle e* represent the scenario axes and they, as well as their linkages, are not part of the basic model (*source:* Drees and Liehr 2015)

sensitivity analyses and train-and-test method, the parent nodes were gradually reduced from all potential variables to those variables that are most sensitive to changes of the migration motive and possess the highest predictive accuracy. Finally, all submodels are combined in one main model on the basis of the interrelations between the influencing variables that are also linked to result in the final network structure. These steps were conducted for each study area in order to construct individual models for both areas (for a detailed description of the modelling procedure see Drees and Liehr 2015).

The final structures of the BBNs for Linguère and Bandiagara, shown in Figs. 9.5 and 9.6, are trained with the complete dataset. By applying the EM (expectation maximisation) algorithm, which is incorporated into the software Netica™, Version 5.12 (Norsys 2014) which was used, we take account of gaps in the dataset.

9.5.2 *Analytic and Diagnostic Reasoning/Findings*

Once the networks are trained, they can be used to perform manifold analyses (estimating the probable consequences of certain conditions) and diagnoses (estimating the probable conditions for certain consequences).

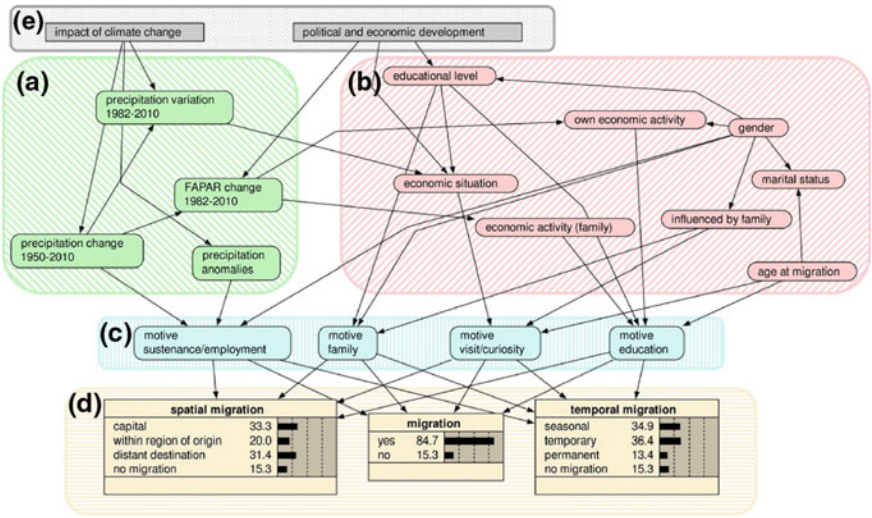

Fig. 9.6 Trained BBN for Bandiagara with interacting environmental (*rectangle* **a**) and socio-economic factors (**b**) affecting the migration motives (**c**) that influence the migration patterns (**d**). For the latter probability distributions are included, which exist—except for the scenario nodes—also for the other nodes. The nodes in *rectangle e* represent the scenario axes and they, as well as their linkages, are not part of the basic model (*source:* Drees and Liehr 2015)

With regard to the structure of BBNs, it can be stated that the most important influencing nodes in both models for Linguère and Bandiagara are similar. The major difference is caused by the absence of the node *ethnicity* within the network for Bandiagara, due to the fact that 98 % of the interviewees belonged to one ethnic group (Dogon). The presence/absence of *ethnicity* in the networks can be further seen as a major cause for differing linkages among the social-ecological variables, as well as between them and the migration motives (see Table 9.1; Figs. 9.5 and 9.6). Moreover, important differences arise for the probabilities of the *motive family* and *distant destinations*, both being more likely within Linguère, and the duration of migration. For the latter, temporal migrations in Bandiagara are more likely compared to Linguère at the expense of the probabilities for seasonal and permanent migration patterns (Table 9.1).

Examples of analyses performed with the BBNs are estimations of the consequences of varying environmental and economic conditions that can be modelled by selecting certain states of the corresponding variables. For unfavourable conditions these could be poor economic situation, negative precipitation anomalies and decreasing long-term changes of land cover and precipitation. More favourable conditions, accordingly, are modelled by selecting contrasting states. These analyses show that no change in the intensity of migration can be observed for deteriorating conditions, although an increase in migration rates is often assumed within assessments on a broader spatial and temporal scale (WBGU 2007; UNEP 2011) or are a

Table 9.1 Major differences between the models for Linguère and Bandiagara

	Linguère	Bandiagara
Unique nodes	Ethnicity	Precipitation variation 1982–2010
Major differences in the important linkages (*parent node/s* → *child node/s*)	Gender → educational level/familial influence	Gender → educational level/familial influence/own economic activity/marital status
	FAPAR change/ethnicity → economic activity (of the family)	FAPAR change → economic activity (of the family)
	Ethnicity/age at migration → motive family	Gender/educational level → motive family
	Gender/ethnicity/educational level → motive sustenance/employment	Gender → motive sustenance/employment
Major differences in the migration motives (*prior probabilities*) (%)	Motive family: 53 %	Motive family: 22 %
Major differences in the migration patterns (*prior probabilities*) (%)	Distant destinations: 48 %	Distant destinations: 32 %
	Seasonal migration: 45 %	Seasonal migration: 35 %
	Temporal migration: 23 %	Temporal migration: 36 %
	Permanent migration: 20 %	Permanent migration: 13 %

main hypothesis in local or national studies (in the Sahel), albeit rarely confirmed (Findley 1994; Henry et al. 2004). Nonetheless, our analyses reveal that the migration motives and patterns change in cases of less favourable environmental conditions. While the motive sustenance/employment, non-permanent migrations and distant destinations become more likely in this case, on the other hand, improved conditions increase the probabilities for the motive education, permanent migrations and migrations within the region. These changes in migration patterns are also stated in various other studies (Black et al. 2011). Interestingly, Afifi (2011) finds an opposing effect to our results—as well as to other studies (e.g., Findley 1994)—with an increase in long-term and permanent migration in Niger in case of deteriorating environmental conditions. However, in the latter case the deterioration of environmental conditions seems to be of a higher magnitude than in our study.

Similarly, diagnoses can be performed by selecting certain patterns of migration which result in changing probabilities within the influencing variables. Thus, an inverted approach of selecting *seasonal migrations* to *distant destinations* yields corresponding results for the conditions and moreover shows that men are more likely to have these migration patterns than women.

9.5.3 Scenario Analysis

In a further step we developed scenarios with a time horizon of about 50 years to use the knowledge gained in the models about dependencies and characteristics of migration, in order to assess the effect of alternating future conditions on migration. We identified two axes with two states each that frame the different scenarios. The first axis represents the *regional impact of climate change* and the second axis the *political and economic development* (grey nodes in Figs. 9.5 and 9.6). The four combinations of the states of the scenario axes form the four scenarios that were described in consistent storylines in view of the probable changes in fields like agriculture, politics, economy, demography and environment (for a detailed description of the scenarios see Drees and Liehr 2015).

Beginning with economic growth and institutional stability, the two scenarios *Limitation* and *Prosperity* are characterised. While in the *Limitation* scenario the good progress in most sectors is limited by the severe impacts of climate change, the relatively stable climatic conditions in the *Prosperity* scenario foster unconstrained favourable developments. If economic stagnation and institutional instability and severe regional impacts of climate change coincide in the scenario *Crisis*, a stagnating development and threats due to climate change lead to a partial worsening of the people's situation. The final scenario *Stagnation* is characterised by a stagnating political and economic development that prevents gains from relatively favourable climatic conditions (low regional impacts of climate change).

To implement the scenarios in the existing models, both scenario axes are included as decision nodes in the networks. By manually choosing between the two states of each decision node the four scenarios can be implemented. The interfaces to the influencing variables in the BBN were identified as follows: *political and economic development* is linked to *economic situation*, *educational level* and *FAPAR change* (representing land cover); *impact of climate change* is linked to nodes that relate to rainfall. While *Stagnation* serves as a baseline scenario that represents the status quo in the BBN, the other scenarios are expressed by adjustments of the conditional probabilities of the linked variables. These adjustments are implemented according to the briefly outlined storylines.

The modelled results for the scenarios demonstrate that changes in the economic and political situation are likely to have a greater impact on migratory movements in both study areas. Again, no considerable changes in the overall migration rates can be observed for any scenario. If, compared to the baseline scenario, only the pressure due to climatic conditions intensifies (*Crisis*), merely minor changes can be observed for the BBN for Bandiagara, while there are small increases in the probabilities for the motive *sustenance/employment* and *distant destinations* in Linguère. In contrast, the scenarios *Limitation* and *Prosperity* yield noticeably increasing probabilities for permanent migrations to destinations *within the region of origin* and for the migration motive *education*. In the case of Bandiagara the motives *family* and *visit/curiosity* also become more likely, whereas in the case of Linguère, notably the probability of the motive *sustenance/employment* decreases.

Differences between these two scenarios are small and thus substantiate the comparably low impacts of climatic changes.

In conclusion, the complex social-ecological interdependencies affecting migration in the study area become apparent in the modelling. Even though socio-economic conditions are most relevant, climatic changes are likely to affect people's livelihood and thereby their migration decisions and resulting migration patterns, not least because of the great importance of agriculture. Above all, this becomes apparent in the effect the social-ecological conditions have on the migration motives and the possibilities for households to react to bad conditions (i.e., short-term migrations) or to develop lasting adaptive measures (i.e., through education). This crucial distinction between "*ex ante* risk-management" and "*ex post* coping strategy" (Rademacher-Schulz et al. 2014: 51) is further discussed below.

9.6 Role of Policies

People's mobility in Mali and Senegal in the context of climate and environmental change depends on different international, regional and national policies in the fields of migration, development and environment. Thus, in order to identify possible starting points for political strategies and regulation, a perspective that considers the different political scales and sectors is needed.

Different sub-regional initiatives, treaties and regulations are significant for the regulation of migration in the West African Region, such as the ECOWAS (Economic Community of West African States) Common Approach on Migration. Formally, ECOWAS citizens have the entitlement to enter freely, reside and settle in member states. Notwithstanding that the implementation of this policy remains difficult (Awumbila et al. 2014), migrants from the Malian *micle* study area of Bandiagara, for example, can legally move to Ivory Coast for labour purposes.

Senegal and Mali seek to embed migration management in development strategies and have multiplied their efforts to cooperate internationally, mainly with the European Union and several other European countries (Sieveking and Fauser 2009; Trauner and Deimel 2013). 'Mobility partnerships', for example, offer temporary access to the EU labour market in exchange for cooperation on irregular migration (Some 2009). Overall, the EU migration policy is ambivalent: on the one hand, and above all, it is restrictive and control-oriented, and on the other hand, it is preventive and seeks to combat the root causes of migration such as poverty through policies of 'co-development' in bi-lateral programmes between Mali and Senegal and France, Spain and Italy. Hein de Haas (2007) described co-development programmes as "de facto 'return and stay at home' policies" (de Haas 2007: 289), since their primary goal was the circumvention of immigration. But there are also examples from Malian and Senegalese diaspora organisations whose members maintain strong relationships with their villages of origin and contribute significantly to the latter's development in the form of remittances as well as investments in water and energy supply systems, health care and school facilities (Scheffran et al. 2012).

Yet, the findings of our social-empirical study revealed that migration to Europe is rare (see Figs. 9.3 and 9.4) and that the majority of movements take place within the countries or the West African region. Therefore, the governments of Senegal and Mali face the challenge to develop adequate policies for sustainable regional development that consider the role of migration. In this regard, the set of Poverty Reduction Strategy Papers (PRSP) are important policy instruments. PRSP have been introduced in Mali and in Senegal and represent mid-term political strategies affecting education policy, the health sector, rural development policies, and environmental policies (for a detailed description see Hummel 2015). While the role of international and internal migration for development and poverty reduction is differently treated in the PRSPs in Mali and Senegal, the PRSPs of both countries suggest that rural development initiatives constitute important means to address internal migration. These initiatives should particularly focus on the improvement of living conditions and professional skills of the youth (Black and Sward 2009). The governments of Mali and Senegal have introduced several programmes for regional rural development, of which some explicitly seek to repel rural out-migration. One example is the Return to Agriculture Programme (Retour vers l'agriculture', REVA) in Senegal, which was established in 2006 in response to an increase in rural outmigration. It aims at a modernisation of agriculture and the creation of attractive job opportunities for young people which allow them to stay in their villages or to return home. So far, the impacts of such programmes are ambiguous. It must be considered that rural development measures can also lead to increased migration because they provide people with the incomes and monetary means that are necessary to migrate. As de Haas (2007: 833) has argued, "Poverty reduction is not in itself a migration-reducing strategy (…); alleviating absolute poverty and achieving some degree of 'development' in the form of increasing income, education and access to information not only enable but also motivate more people to go abroad. As long as aspirations increase faster than the livelihood opportunities in sending regions and countries, social and economic development will tend to coincide with sustained or increased out-migration".

Thus, some young people might decide to stay in their villages if they can benefit from an occupation in agriculture that generates adequate incomes. Our social-empirical analysis however revealed that particularly for young and better educated people farming is not very attractive; instead, they aspire to an occupation outside the agricultural sector (van der Land and Hummel 2013). Given these findings, programmes for rural development that focus only on improvements in the agricultural sector seem to fall short of people's demands, particularly those of the younger generation. Equally important for rural development strategies are non-farming employment opportunities, notably to provide incentives for people with higher education and formation. As our findings reveal, the social-ecological transformations in the study areas are associated with new patterns of relationships between rural and urban developments. Therefore, 'rural-urban linkages' (Bah et al. 2003; Tacoli 2003), including not only the improvement of employment opportunities, but also the enhancement of basic social services and infrastructure, should be taken into account by developing policy measures and regional planning.

9.7 Critical Discussion of Migration as an Adaptation Strategy

9.7.1 Migration as an Adaptation Strategy

Within the nexus of climate change, environmental changes and migration, the latter is often regarded as an adaptation strategy to the former, and in this sense as a response to occurred or expected climatic and environmental changes (Rademacher-Schultz et al. 2014). This view is substantiated by a number of studies (McLeman and Smit 2006; Banerjee et al. 2012; IPCC 2014a), some of which explicitly refer to the Sahel (Findley 1994; Niang et al. 2014), and it can also be derived from the results of the *micle* project. Despite this evidence, our findings further show that this view has to be critically discussed, because it bears the risk that historical and cultural characteristics of migration may be overlooked.

First of all, it has to be clarified for whom migration can serve as an adaptation strategy. This can be regarded in at least two respects: First, the question arises whether migratory movements are an individual or a collective adaptation strategy. On the basis of the qualitative and quantitative surveys we conducted, migration can primarily be considered as a strategy for families or households to diversify their income. The reported cooperation between households as well as further studies indicates that to a certain extent this can also be conferred on the community level (Gioli et al. 2014). Second, it is questionable who is able to take advantage of this strategy. As Adger et al. (2009) and Gioli et al. (2014) note, there are social and economic restrictions to adaptive behaviours. In this context, it is also important to point out the difference between adaptive and coping measures. While the former is a long-term strategy to place the household's income on a broader basis and to fall back on remittances in case of unfavourable conditions like crop failures, a coping measure can be seen as an immediate response to bad conditions (Rademacher-Schulz et al. 2014). Our findings (see Sect. 9.5.2: Analytic and diagnostic reasoning) show that this distinction leads to differing patterns of migration regarding its duration and destination. An effective strategy for a long-lasting adaptation to climate change is education, which increases the possibilities for diversifying the household's income. It is clear from our results that those households with a higher educational level and in a better economic situation (can) support migration of family members to acquire education (van der Land and Hummel 2013).

Moreover, the conditions that cause families to think about adaptation strategies should not be reduced to environmental and climatic influences, but especially political and economic conditions affecting the families' livelihood have to be considered, in order not to depoliticise the discourse. Also the further diverse strategies to compensate for bad harvests should be regarded. Within the study area these are especially selling of animals, fruits, herbs and wood, gardening (especially in Bandiagara), taking up a loan and mutual aid between neighbours (Hummel 2015).

Finally, coming back to historical and cultural characteristics, familial concerns are not unilaterally restricted to sustenance, nor are individual prospects and wishes

irrelevant for migration decisions (Findley 1994). Further, migratory movements have always been and are likely to remain a normal phenomenon in everyday life in the study area. The academic challenge is to disclose these different factors that often come together and mutually overlap (Black et al. 2011).

9.7.2 Overlap of Social and Environmental Factors

The results of the analysis show that both social and environmental factors have a significant effect on the migration pattern for the interviewed persons at the project regions of Linguère and Bandiagara. Although these dependencies of migration patterns have been reported in other studies as well (e.g., Findley 1994; Afifi 2011; Black et al. 2011), our modelling approach is one of the few attempts to integrate social and natural scientific data for analysis and provides results that go beyond the mere stating of changing patterns. As argued on the basis of the results of our analysis, changes in the social-ecological conditions are linked to changes in migration pattern and thus to the responses of the people. Here, social factors dominate the environmental factors as they apparently exhibit a higher degree of relevance for migration decisions in the given setting. This would not hold true for environmental extremes which are not considered here. Two reasons for the dominance of social factors have been identified: first, migration decisions only partly depend on motives like sustenance and employment which clearly relate to environmental conditions for rural societies. The majority of motives for migration like education, family (familial reasons), curiosity and tradition are strongly shaped by socio-cultural aspirations. Here, social dynamics with communication, institutions, norms and rules, but also the effects of urbanisation and modernity play decisive roles in the decision processes. Second, social factors can mask environmental factors behind them. This is the case if motives for migration are seen in the background of their obvious social influences, but without reflecting, differentiating or explicating the environmental factors behind them (cf. Afifi 2011). The effect is that environmental factors are in the second or third order, meaning that they are overstamped in their importance and relevance by social factors. In effect, environmental factors are part of a complex chain of interactions (Veronis and McLeman 2014)—which can also be seen within the network structure of the BBNs. The analysis of systematic structural dependencies is difficult for such factors of higher order because data and information are subject to a high degree of uncertainty but also ignorance due to their inherent complexity.

Although social factors seem to outbalance the environmental ones, the latter should not be underestimated in their importance for migration decisions. Situations of climatically and environmentally induced stress can lead to conflicts and affect norms and rules, but may also change the attractiveness of alternative livelihoods. Those interrelations need to be considered in the discussion and development of future policies.

9.7.3 Policy Considerations and Outlook

The findings of our study confirm that climatic and environmental changes can indeed have effects on the mobility of the people (see Sect. 9.5.2: Analytic and diagnostic reasoning). However, the relationship between climate, environment and migration is complex, and environmental stress is usually not the most important factor causing people to migrate.

Mobility is traditionally a part of the culture and every day life in West Africa, and thus the suppression of migration does not represent an adequate political option. Instead, policies should make use of the positive potential of migration for sustainable regional development. Such policies could build upon already existing "co-development" approaches which support the transfer of remittances, knowledge, as well as investments of migrants in the areas of origin. In the rural areas, investments in sustainable agriculture are necessary, which should be accompanied by measures that create income and employment opportunities, not just within agriculture, but also in other economic sectors. Therefore, integrated regional development strategies which focus on linkages between urban and rural areas are required. For example, they should consider infrastructure development and the promotion of integrated land and water resources management for the prevention of land degradation. Furthermore, chances in life, particularly for the young generation, need to be increased, including better education opportunities. Against this background, there is the need for cross-sectoral strategies which integrate issues of migration, socio-economic development and environment, and which consider the participation of relevant societal actors and stakeholders.

In summary, the positive effect of migration on the adaptive capacities of households could be further supported by governments and administration in order to build up infrastructure for transport, public health, IT, etc. This could be a key to making communities less dependent on agriculture, which means that migration serves as a long-term strategy for securing wellbeing instead of a short-term response. In this case, migration also develops into a persistent societal response regarding the effects of climate change and land degradation.

Acknowledgements The research project *micle* "Climate Change, Changes to the Environment and Migration in Sahel—Social-ecological conditions of population movements in Mali and Senegal" was funded by the German Federal Ministry for Education and Research (BMBF) from September 2010 until April 2014 (grant numbers 01UV1007A/B) and by the Biodiversity and Climate Research Centre (BiK-F), Frankfurt Main. We express our sincere thanks to our colleagues Victoria van der Land and Diana Kaiser from ISOE, Martin Doevenspeck, Cyrus Samimi, Martin Brandt and Clemens Romankiewicz from University Bayreuth and to our co-operation partners Point Sud Centre for Research on Local Knowledge, Bamako, Mali and LARTES/IFAN Laboratory for Research on Economic and Social Transformations, Fundamental Institute of Black Africa, Cheikh Anta Diop University Dakar, Senegal.

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Chapter 10
The Risk Frontier: Perceiving Social Transformations in Rural and Peri-urban West Africa Through a Territorial Lens

Karsten Schulz and Rapti Siriwardane

Abstract Addressing the distinct overemphasis on rural agricultural spaces that undergirds much of the literature on local riskscapes in West Africa, the chapter seeks to elucidate how households that live on the fringes of rapidly transforming peri-urban spaces are caught in a double bind of institutional and spatial marginality. Drawing on a comparative empirical study in northern Ghana, the chapter argues that peri-urban households are facing socio-environmental risks that are similar to those experienced by their rural counterparts, while at the same time being subjected to interrelated institutional and material transformations which define such spaces as dynamic risk frontiers. In order to compare the institutional dynamics between rural and peri-urban territories, the study advances a 'territorialization of risk' framework that explores the social production of risk against the backdrop of changing institutional and communal structures.

Keywords Territorialization · Risk · Communal reliance · Social transformation · West Africa

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J.A. Yaro and J. Hesselberg (eds.), *Adaptation to Climate Change and Variability in Rural West Africa*, DOI 10.1007/978-3-319-31499-0_10

10.1 Introduction

> The built form creates a predisposition in us to particular spatial functions and practices, from which social identities are ascribed whether or not we choose to contest, subvert, or reject them (…) This is certainly the case in modern day West African countries, which are challenged with spatial and social structures that are the result of at least three superimposed cultural stratifications: the traditional and the pre-industrial phase, the colonial experience, and the postcolonial economical-political structure.
>
> —E. Amoo-Adare *Spatial Literacy: Contemporary Asante Women's Place-making* (2013, p. 45)

On an ordinary day during the dry season, clusters of women and men can be seen dotted along the narrow banks of a small canal in Bolgatanga Damweo, judiciously tending to their crops and tomato seedlings. Indeed, this ostensibly bucolic scene may appear innocuously mundane at first. However, what marks apart sites such as the riparian strips alongside the small brook that cuts across the neighborhood of Bolgatanga Damweo from similar small-scale agricultural spaces in northern Ghana is the fact that these sites constitute the fringes of peri-urban provincial areas. In these liminal spaces, small-scale agricultural practices among non-farming groups occur merely among resource poor households living at the margins of flood plains and bustling schoolyards, next to unfinished concrete buildings and at the outskirts of urban built environments.

At first glance, the 'farmers' of Bolgatanga Damweo may seem no different from most rural agricultural households, particularly when living lives precariously within so-called marginality hotspots, beset by heavy rains, seasonal flooding and droughts that are exacerbated by climate change and variability. During most years, reports of property damage, harvest loss or even drowning during a deluge or flash flood are hardly uncommon in this area. Nevertheless, the scene witnessed along the river banks in Bolgatanga Damweo unsettles a host of assumptions regarding communal life in rural spaces, particularly when considering the rapid expansion of urban and peri-urban spaces across West Africa. Moreover, it directs attention toward deeper analyses of largely unexplored fringes and edges, metaphorically imagined in contemporary scholarship through boundaries and *borderscapes* (Sennett 2012), and often characterized as sites of flux and rapid change, of liminal movements and flows, and of loosely networked social relations. It is this very 'in-betweenness' that sparks our engagement with the confluence of not only risk and uncertainty, but also of novelty and the transformation of communal relations.

Taking northern Ghana as a case study, we ask how differently households located in rapidly transforming peri-urban spaces experience socio-environmental risks compared to rural faming households. In particular, we investigate a fundamental assumption in comparative urban-rural scholarship, namely that a considerable change of social relations and patterns of communal reliance is currently taking shape in peri-urban spaces in the Global South (see, for instance, Mabin et al. 2013; Yaro 2013b). To advance a conceptual frame that traverses essentialist binaries which simply demarcate the urban from the rural and the modern from the

traditional, we aim to engage more closely with the social production of risk and the concept of dynamic territorialization. We start with the premise that at the heart of human coping and adaptation are notions of risk and uncertainty that serve as primary sense-making devices in configuring nature-society relations. While multiple cultural-cognitive, normative and historically instituted understandings of risk and uncertainty are integral to the human condition, they also shape and embody grand narratives of institutional change and transformation that increasingly pervade global debates on climate change and variability (Future Earth 2014; Cooper and Pratten 2015; Schulz and Siriwardane 2015).

In the light of the multiple and complex relationships between notions of risk and social transformation, we first interrogate the value of studying peri-urban spaces in relation to their rural 'other'. We seek to advance a particular heuristic lens through which the dynamic construction of territories can be studied, not simply as spatially bounded categories, but also as social networks that are generative in themselves. Moreover, in revisiting the 'territorialization of risk' framework (Rebotier 2012), we argue that diverse sense-making practices which influence the historical and institutional production of territories have largely remained unexplored in contemporary climate change adaptation scholarship. While both the territorialization and discursive production of risks have been emphasized, there is little engagement with how the formation of spaces and their practices of sense-making serve to produce *subjects at risk*, not merely in material and discursive terms but also through institutional processes that are symbolic and relational. To this end, we assess how changing patterns of power and institutional reliance produce hybrid risk frontiers in spaces of 'in-betweenness' such as peri-urban landscapes. To distill the inherent differences between peri-urban and rural territories, we compare two communities in northern Ghana, one in Bolgatanga Damweo, characterized by its dynamic peri-urbanity, against a rural agricultural space in Zaare Amoabiisi. We posit that a two-step analysis is needed to understand how exactly peri-urban spaces, despite their promise of opportunity and greater occupational and social mobility, are simultaneously constituted as new *risk frontiers*.

The first analytical step necessitates a closer engagement with the formation of peri-urban spaces as territories, or to put it differently, with the (re-)production of territorial edges and fringes through institutional practices. The second step calls for an empirical analysis of peri-urban territories in the light of their manifold boundaries and borderscapes which shape social relations. These lines of differentiation which define peri-urban spaces as dynamic risk frontiers may be distinguished from rural spaces not only by how novel their riskscapes are, but also by virtue of their bricolage-like institutional landscape through which 'old' or known vulnerabilities and uncertainties are interspersed and gain renewed salience through their mixing.

10.2 The Social Production of Peri-urban Territories

Research on peri-urban spaces, particularly in West Africa, is still in its formative stages. Bodies of scholarship implicating peri-urban spaces, or critically exploring peri-urbanity as a condition of everyday lived life, tend to be relatively disparate. These diverse bodies of work also reveal how the rural-urban interface has been varyingly interpreted. Interdisciplinary research on changing housing and land markets, economic agglomeration and resource-dependent livelihoods, for example within the context of urban farming and informal irrigation systems, have tended to adopt spatially defined views of urban and rural spaces in which human migration, investment flows and the market economy are cast as having played a profoundly decisive role in West Africa's rapid rate of urbanization (Gough and Yankson 2000; Mbiba and Huchzermeyer 2002; Drechsel et al. 2006; Simon and Thompson 2006; Ubink 2008). Arguably, Mike Davis' seminal essay 'Planet of Slums' (2006) bears some degree of influence on the ways in which peri-urbanity as a social condition is imagined, for example through thematic currents implicating the informal economy, spatial sprawl, abject poverty, and human struggle. Peri-urban spaces, then, are sites at the periphery, the very antithesis of the vibrant cosmopolitan metropolis, but nonetheless spaces that are dynamic enough to have emerged out of the rural hinterlands, suggestive of an unceasing identity of mutability and volatility. However, while there is certainly scholarly interest in studying peri-urban spaces in West Africa, there still exists a lacuna in relation to how these particular spaces come to be defined through institutional processes of *territorialization*. Considering the immense attention that is paid to rural areas and agricultural practices within scholarship on West Africa, there is certainly more room for a deeper discussion of how peri-urban territories come to be constituted in institutional terms, particularly with regard to their exteriority from the metropolis and their visible differentiation from—and exchange with—the rural hinterlands. More recently, a vibrant body of work has begun to emerge in sub-disciplines such as urban anthropology and postcolonial theory, exploring the socio-cultural meanings and power relations that shape the politicized production of lived space as well as the diverse manifestations of African modernities (Trefon 2009; Meyers 2010; Amoo-Adare 2013; Mabin et al. 2013).

Nevertheless, before analyzing peri-urban territories in terms of their defining properties, it first needs to be asked how the notion of 'territory' itself can be conceptualized. Etymologically, the late Middle English term territory developed out of the Latin term 'territorium' (associated with *terra* or land). Historically, a territory thus signified a spatially defined boundary that fell under the jurisdiction of a Roman city or town. Implicitly then, the notion of territoriality pervades conceptions of the peri-urban, given that peri-urban areas lie at the fringes of municipal or administrative boundary lines. However, territories themselves are certainly more than merely bounded spatial configurations that are produced as static exteriorities. Overall, territories and processes of territorialization have been associated with various tropes that not only denote classification, demarcation, consolidation and

constraint, but also dynamism, fluidity, movement, emplacement and multiple frames of cultural identification and wider cosmological belongings. Within these diverse strands of scholarship, debates around the complementary dynamics of de-/re-territorialization have occasionally surfaced, particularly in recurring attempts at formulating a critique of neoliberal globalization (Hardt and Negri 2000; Elden 2006). What has been reiterated in these debates is how institutionalized traditions and their intergenerational sedimentation inhibit a clean departure from routinized and normative systems of practice and belief which profoundly pattern everyday sociality and collective articulations of our (often spatially related) emotional affections or antagonisms. Through our collective social institutions, territories invariably come to life, either as firmly grounded material constructs, or as ideational devices.

Thus, as a way forward and to allow for a more fine-grained analysis of dynamic territorialization, we initially adopt the distinction made by urban anthropologist Richard Sennett (2012) between two types of edges—*boundaries* and *borders*. According to Sennett, boundaries are characterized by their relative impermeability, whereas borders constitute porous membranes that allow for flows and movements. Borders are seen to create spaces of exchange where hybrid forms of sociality are produced. As thresholds or spaces of liminality, they inevitably offer and constitute material as well as symbolic frontiers by virtue of their 'in-betweenness'. For example, peri-urban farming spaces along the riverine banks in Bolgatanga, despite their ubiquity, inevitably entail borderscapes. Here, local forms of communal relations are subtly transformed by globalized cultural influences, market relations and growing individualism, while still existing at the edges of metropolitan institutional configurations.

Meanwhile, agriculture in West Africa has often been framed as a singularly rural enterprise. Despite the fact that there is a growing interest in peri-urban horticulture and farming (Gyasi et al. 2014), academic and policy analyses only pay scant attention to the sociopolitical and institutional entanglements in these distinct spaces of in-betweenness. Yet it is the very quality of the institutionalized lines of demarcation and differentiation in a given social territory that profoundly determines practices of reliance and reciprocity, thereby also influencing wider social relationships. However, as Sennett himself cautioned, fluid border encounters are not intrinsically healthier or more socially advantageous than those produced by boundaries. Hence it is at this point that we seek to engage more thoroughly with the *territorialization of risk* framework in order to provide a suitable analytical lens that allows for the integration of cultural-cognitive, ideational and material aspects of risk, while simultaneously engaging with the shortcomings of existing territorialization approaches in the context of political ecology and human geography scholarship.

10.3 The Territorialization of Risk

It is now widely accepted among political ecologists and disaster risk management scholars that quick-hit indicator-based assessments of so-called 'natural' disasters are barely sufficient to determine how complex social vulnerabilities are produced (Cannon 1994; Klinenberg 2006; O'Brien 2012). A major criticism that has been levelled against apolitical and managerial interpretations of risk is that a deeper engagement with structural aspects of existing power imbalances is usually avoided, and that risk is erroneously placed 'in the hazard itself' (Ribot 2014, p. 677). Instead, one might rather think of identifying *risk* in terms of the late modern 'risk society' (Beck 2009) and as one of the most important interpretive frames through which 'organizations make sense of their environment and act upon it' (Ericson 2007, p. 11). Especially in the context of climate change and variability, risk has become a highly influential discursive paradigm which governs the institutionalized organization of 'relevant' knowledge in scientific and political debates. The multiple ways in which risk—and therefore implicitly hazards, vulnerability and adaptive responses—are discursively articulated is thus a crucial aspect that determines how power takes effect. The rationale behind this discursive-material understanding of risk is the simple fact that 'language matters deeply for analysis, interpretation and action' (Ribot 2011, p. 1160). In other words, pervasive discursive paradigms directly affect and transform social reality, for instance by framing and contextualizing causality, and in defining who or what is considered risky, and who or what is at risk. In communicating and monitoring risk, and by directing organizational strategies and resources, discourses about risk also provide interpretations of circumstances and appropriate means that constitute political claims for action. In this sense, discourses are more-than-language (a dimension often described as the *dispositif*, in Foucauldian terms), since the 'objective truth' about risk is socially created through shared normative definitions of reality, but not independent of contextual circumstances and practices.

A useful concept that engages with the discursive-material production of risk is the notion of territorialization. Drawing on theoretical insights from political, geographical, anthropological and sociological studies, the 'territorialization of risk' framework directs attention to how risks are constituted spatially, materially, symbolically and discursively (Fig. 10.1). This means that, on the one hand, the territorialization of risk seeks to explain how nature-society relations are simultaneously shaped and mediated by the concrete *materiality* of ecological systems and (natural) resource flows. On the other, the framework emphasizes how nature-society relations are determined by *social signification* that is by cultural-cognitive, normative and discursive frames of meaning-making. Accordingly, the territorialization of risk implies the inherent *politicization* of risk through the creation of territorial spaces as well as related struggles 'to inscribe meaning' (Rebotier 2012, p. 392). Here, the interplay of administrative boundary lines, institutional responsibilities and jurisdictions, together with what constitutes an in-group and out-group, profoundly determines pockets and patterns of risk and human vulnerability, both real and imagined.

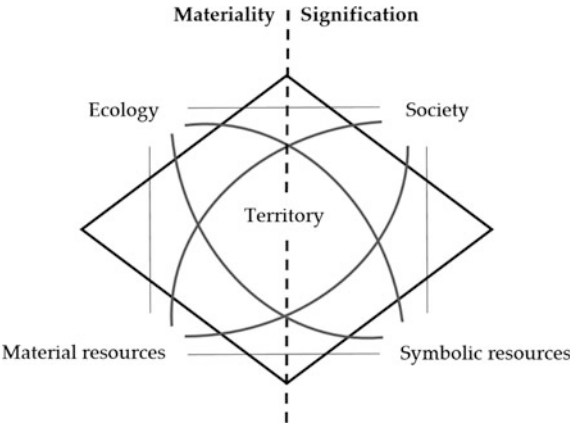

Fig. 10.1 The territorialization of risk (inspired by Rebotier 2012)

However, while the notion of territorialization provides a useful analytical lens in studying the intersectionality of diverse risks, particularly when considering peri-urban margins and rural-urban interlinkages, the existing framework introduced by Rebotier (2012) also points towards several theoretical gaps and shortcomings. First, the use of territory as a core concept is relatively limited to perceptions of spaces as being bounded off. In this respect, the dynamics of thresholds and crisscrossed flows and networks through time and space seem muted. Second, if the physical environment, institutions and social territories share an iterative relationship, this fact still leaves us with broader questions of how exactly subjects at risk are co-produced. Arguably then, the territorialization concept may succumb to a pervasive spatial fallacy, in the sense that emotions, power-ridden social relations, diverse cosmologies and practices of sense-making remain relatively concealed amidst bureaucratic and technological procedures of (capitalist) territorial organization and resource flows.

10.4 Overview of the Research Area

The field sites that have been visited for this study are situated in the Upper East Region of Ghana (UER) which is located in the northeastern part of the country (Fig. 10.2). The region is bordered to the east by Togo and to the north by Burkina Faso. The UER also has internal borders to the west with the Upper West Region and to the south with the Northern Region. According to latest census data the population of the UER is 1,046,545, which accounts for 4.2 % of the national total (Ghana Statistical Service 2013, p. 8). The climate in the UER is classified as tropical and has two distinct seasons, a long dry season that stretches from October to April, and a rainy season that runs from May to September, with a mean annual rainfall between 800 and 1.100 mm (Ghana Statistical Service 2013, p. 2). Administratively, the region is split into thirteen districts that are largely

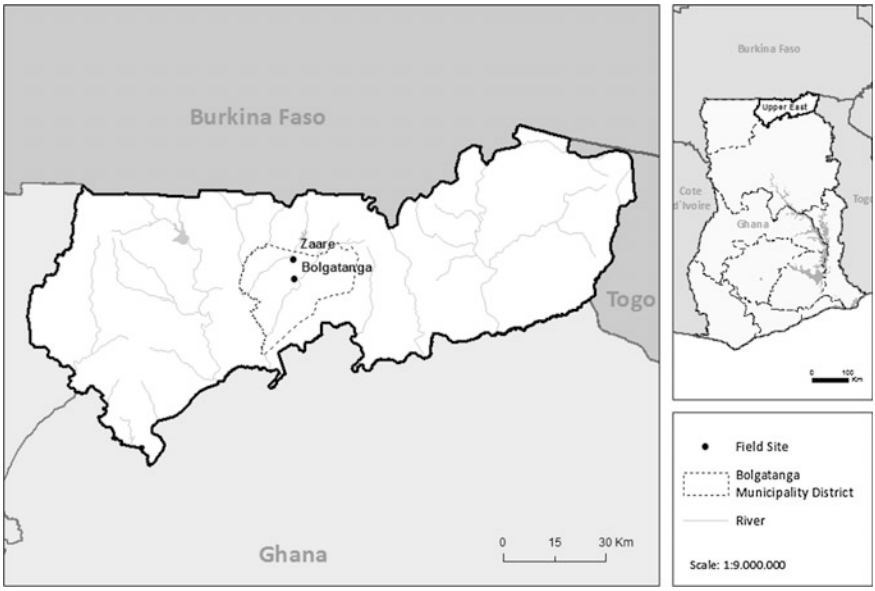

Fig. 10.2 Research area

autonomous in terms of project management and implementation. In addition to the official authorities of the state administration, chieftaincy and other forms of customary social institutions are also widely accepted and a major medium for community mobilization. The largest ethnic groups in the area are the Mole-Dagbon, Gurma, Grusi and Mande-Busanga (Ghana Statistical Service 2013, p. 34).

The political landscape in the UER is shaped by the strong presence of international development organizations, non-governmental organizations, and civil society organizations. The major urban center and capital of the region is the city of Bolgatanga, which is also the seat of the Regional Coordinating Council. Economic activities in the UER are characterized by low levels of income diversification and 83.7 % of households are primarily engaged in agricultural activities (Ghana Statistical Service 2012, p. 80). This means that the development of adaptation and risk management strategies to reduce the impacts of climate variability on local livelihoods is of utmost importance, since most of the region's agricultural output is dependent on precipitation and thus highly vulnerable to climate change and increased variability. Changes in the intra-seasonal variability of rainfall are likely to have the most severe impact on peoples' food security and livelihoods, as they may negatively affect the production of both cash and staple crops (Yaro 2013a). Compared to 1990s levels, dry spells during the rainy season have become more frequent and intense while the onset of the rainy season has shifted from April toward May (Laux et al. 2008; Rademacher-Schulz and Salifu 2012). Heavy rainstorms and flash floods also occur regularly during the rainy season, occasionally resulting in the loss of lives. Especially in riparian areas along the White

Volta, flood events are further exacerbated when excess water of the Bagré Dam in Burkina Faso is released into the Nakanbé River (the Burkinabe stretch of the White Volta). In combination, these hazards lead to the interruption of economic activities, increased health risks, displacement, harvest losses, and to infrastructure and property damage. Moreover, they have a negative impact on food and nutrition security in the region, since crops that are grown during the rainy season serve as the basis for households' food supply throughout the year.

Nevertheless, due to the complexity of these interrelated risks, a simplistic relationship between environmental change, weather extremes and human vulnerability should not be assumed, since environmental hazards may simply exacerbate poverty-induced vulnerabilities. Data collected between 2005 and 2006 by the fifth round of the Ghana Living Standards Survey (GLSS 5) show that the UER is one of the poorest regions of the country and falls short with regard to most indicators available to measure socioeconomic development, such as infrastructure provision, education and the accessibility of social services. The percentage of households in the UER which belong to the 'lowest quintile' (mean annual household income below 728 GHS) is 54.8 %, while 19.1 % of households fall into the 'second lowest quintile' (mean annual household income below 1020 GHS) (GLSS 5 2008, p. 107). Housing quality is well below national standard and electricity is available to only a quarter (24.1 %) of the region's population (Ghana Statistical Service 2013, p. 149). Thus, in spite of the impressive progress that has been made in Ghana with regard to poverty reduction and economic development over the last two decades, the situation in the north is still characterized by income insecurity; limited number, variation, and quality of household assets; as well as often poor conditions of health. Arable land is scarce due to high population pressure and the resulting environmental degradation, while chronic food and nutrition insecurity remains prevalent in the region, particularly during the so called 'lean season' which starts in late March and normally peaks in June and July. Available data illustrate that approximately 28 % of the regional population can be categorized as either moderately or severely food insecure (CFSVA 2012, p. 2). In sum, these factors are likely to magnify the effects of even 'minor' climate related hazards.

Within the context of generalized poverty, risk exposure also disaggregates along gender and age lines. In particular, women, who are largely concentrated in the two 'hotspots' of poverty in Ghana, namely agriculture and the informal economy, are said to form the majority of the poor (ILO 2005). This, it is often claimed, is a consequence of social categorization and cultural factors such as limited access to productive resources (e.g., land) (Quaye 2008). In addition, the young and disabled are subjected to the same cultural norms that deny access to productive resources to women ('social invisibility'), while the aged are also at a disadvantage, particularly if they have no functioning social security nets (Chant and Jones 2005; Vanderpuye-Orgle and Barrett 2009). Nevertheless, generalizations about complex social relationships need to be treated very cautiously as they may perpetuate pervasive assumptions such as the 'feminization' of poverty and conceal realities such as the fact that poverty is spatially disparate, highly context specific, and dependent on the methods used to measure it; the concept of absolute

poverty, for instance, may not account for more nuanced inequality changes (Annim et al. 2012). Localized statistical data also show, for example, that the UER is the only region in Ghana where female-held farms are generally larger than those held by males (FAO 2012, p. 27). In summary, however, the research conducted for this study confirms that gender inequality is a crucial determinant of social vulnerability. Generally, women are more dependent on natural resources for their livelihoods, while access to these resources is still mediated by traditional gender roles which tend to disadvantage women.

Historically, the relative neglect and 'underdevelopment' of the UER have been attributed to colonial legacies, failed development policies and 'neoliberal' structural transformations that gradually changed the economic and socio-cultural character of the region, particularly towards trajectories of greater liberalization and individualization (Yaro 2013b, c). At the same time, statistical data for the UER indicate that population loss through labor migration proceeds 'at a fast rate' (Ghana Statistical Service 2013, p. 169). This tendency of outmigration can certainly be ascribed to concomitant economic, environmental and population pressures. However, outmigration from the north also has deep-seated cultural and historical roots which need to be taken into account, such as societal expectations and customary payments related to marriage arrangements (Sow et al. 2014).

10.5 Methodology and Field Sites

Primary data collection for this study took place between August 2012 and February 2013 in the Bolgatanga Municipality District (BMD) of the UER. A sequential mixed-methods approach (Creswell 2014) was applied, combining a quantitative survey in two local communities (n = 185) with qualitative research methods such as facilitated group discussions and in-depth interviews. Damweo, a fringe neighborhood of the regional capital Bolgatanga, was chosen as a focus area for the peri-urban component of the study, whereas the village of Zaare Amoabiisi was selected as a rural field site (Fig. 10.2). Since no reliable information about the total number of households was available for both communities, the collection of household data was preceded by an enumeration exercise. In total, 93 out of 309 households were surveyed in Bolgatanga Damweo, whereas 92 out of 98 households were interviewed in Zaare Amoabiisi, based on a simple random sampling approach. The sample choice closely reflects the almost even distribution between urban (49.8 %) and rural (50.2 %) populations in the BMD (Ghana Statistical Service 2013, p. 27).

Economically, the main occupations in the BMD comprise subsistence as well as cash crop farming, hunting, fishing, agroforestry and handicrafts (UNDP Ghana 2010). Livestock rearing includes sheep, goats, cattle, pigs, and poultry such as guinea fowl. District-wide, 67.1 % of all households are engaged in agriculture.[1]

[1]Calculations based on data for the year 2012 obtained from the Ministry of Food and Agriculture (MoFA Bolgatanga) and the Ghana Statistical Service (GSS).

Land holdings are comparatively small, approximately between 1.0 and 3.0 ha on average, and plots are often scattered (UNDP Ghana 2010, p. 26). Farming households in the area are normally well attuned to dealing with harsh environmental conditions and climatic variability that are typical for the region. Except for irrigation farming, common adaptation strategies that are used by rural farming households include the changing of diets, planting dates and crop varieties as well as water storage for vegetable farming and the construction of wells and boreholes during drought periods (Laube et al. 2012; Antwi-Agyei et al. 2014). To the extent possible, rural farm households also rely on informal credit and other systems of reciprocity while seeking to diversify their income through non-farm activities such as hunting, fishing, weaving, brewing, shea butter processing and petty-trading.

Peri-urban households, by contrast, are perceived as being less engaged in customary forms of agricultural production on family farmlands due to the increasing commercialization of land ownership and growing inequity in the allocation of land (Yaro 2012). Many peri-urban dwellers have therefore engaged in seasonal migration to distant bush farms. Available research also shows that the potential for small-scale agricultural production and horticulture in peri-urban spaces is limited as a result of low levels of water availability and quality, rising market prices and increased environmental degradation (Cofie and Drechsel 2007; Gyasi et al. 2014).

What remains a novel phenomenon for both rural and peri-urban households, in other words, is not so much the need to adapt to climatic variability as such, but rather the unprecedented combination of increasing ecological pressures together with political and socio-economic marginalization that leads to a situation in which the adaptiveness of particular social groups and individuals is frequently outweighed. Societal tensions related to economic liberalization, in particular, also point to the increasing conflict potential of competing class-based identity politics being played out between the new middle classes and the rural and peri-urban poor (Allen 2014). Consequently, special attention has been given to the impacts of changing socio-cultural institutions and economic relations during in-depth interviews and group discussions with respondents in both Damweo and Zaare. Questions that emerged from the quantitative survey with respect to the differences between rural and peri-urban settings were followed up during individual interviews, particularly with regard to how exactly ‘subjects at risk’ are co-produced through the interplay of climate-related and institutional risk factors. The core motivation behind this comparative approach was to illustrate how the territorialization of risk approach can be used as an analytical lens to explore adaptive processes. Instead of simply portraying people as passive victims of ‘natural’ hazards, the structural aspects of risk have been given emphasis. A second major advantage of this approach is that it goes beyond deficit-centered analyses of specific ‘barriers’ to adaptation. It rather focuses on territorialization as a historically situated, power driven and therefore potentially productive process that transcends place-based and time-bound notions of risk and determines adaptive outcomes. Moreover, the discursive-material framing of territorialization takes into account that adaptation needs to be interpreted through a specific cultural-cognitive

lens suited to local risk perceptions and social environments where climate change and variability are not necessarily among the most pressing concerns for most people (Nyantakyi-Frimpong and Bezner-Kerr 2015). While analyses of risk perceptions in northern Ghana indicate that environmental change and variability indeed play a significant role in people's livelihood practices and sense of belonging, the *causes* of such changes are often individually attributed to supernatural phenomena such as ancestral retribution or divine punishment for moral transgression (Eguavoen 2013). Therefore, a more comprehensive analysis of territorialization processes requires an engagement with the very dynamics that are embedded in changing patterns of social relations and administrative-institutional safety nets to which households have recourse.

10.6 Findings and Analysis

10.6.1 Perceptions of Social-Environmental Risks

The analysis of our survey data initially revealed a close resemblance between the risk factors that were perceived to be of particular importance among rural and peri-urban households. Participants in Zaare Amoabiisi and Bolgatanga Damweo consistently reported that they were negatively affected by erratic precipitation patterns and the late onset of the rainy season (see Fig. 10.3). Other risk factors that were frequently mentioned by both rural and peri-urban households included rainstorms, floods, and infectious diseases. Rural households considered agricultural risks such as dry spells, crop diseases, and risks related to animal husbandry particularly relevant, while these risks were deemed much less important by peri-urban households.

A possible explanation for these diverging perceptions of risk is the increased contribution of non-farm income to peri-urban livelihoods. Only 7.5 % of peri-urban

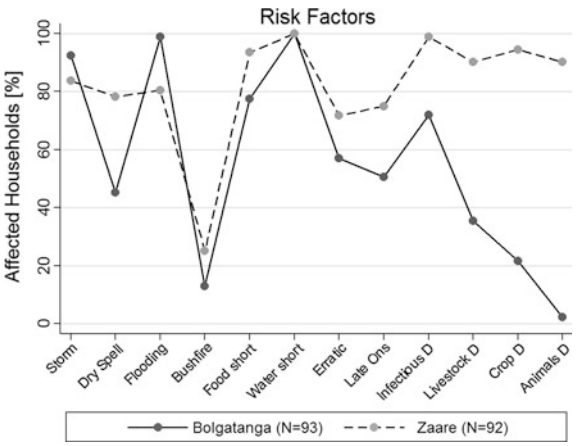

Fig. 10.3 Perception of risk factors [indicators (from *left to right*): storms, dry spells, flooding, bushfire, food shortages, water shortages, erratic rainfall patterns, late onset of the rainy season, infectious diseases, livestock diseases, crop diseases, animals destroying crops]

households perceived farming activities as their main source of livelihood, whereas the number for rural households was significantly higher at 96.7 %. However, the higher occurrence of non-farm activities in peri-urban spaces is not necessarily more advantageous for individuals since livelihood diversification does not automatically translate into higher wages and income security. Group discussions with both female and male peri-urban dwellers of different age groups confirmed that unemployment and low paying jobs in the informal economy are still the norm in Bolgatanga Damweo, despite the fact that peri-urban households are frequently engaged in horticulture and small-scale farming activities to supplement their income and increase food security. Invariably, the qualitative interviews added important insights to the quantitative survey results, inasmuch as the higher dependence of peri-urban non-farming households on fluctuating food and fuel prices and unstable urban job markets emerge as additional factors impacting on peri-urban riskscapes.

The excerpt below, from an interview with a 52-year-old female petty trader in Damweo, reveals how the commercialization and low availability of agricultural land intersect with the precariousness of securing a stable income:

> Some people are farming next to the canal, but it is not a good place (…) The tomatoes are often spoiled because of drought or floods. We also suffer from high market prices for food, gas and fuel. I do a little bit of trading to support myself, but it's not enough.

Augmenting this sentiment, a 36-year-old male teacher describes the housing situation in Damweo:

> We are lucky that our house is on a higher level and the water does not come here. The houses by the canal are flooded every year. Some houses remain empty in the rainy season, but many of the people who live here cannot move elsewhere. They are poor or need to take care of their relatives. Some people also started to build a house here (…) There are many old people and students as well.

The above quotations illustrate that high climate variability together with a growing reliance on monetary forms of exchange to buy additional food supplies on the market put peri-urban households under increased economic pressure. Moreover, district-level data for the BMD show that the urban population experiences a higher rate of unemployment than the rural population (Table 10.1). These findings challenge the overall presumption that urban households 'are more likely to be engaged in regular employment' and thus more protected against seasonal changes in food access (compare CFSVA 2012, p. 27). By contrast, our survey results reveal that the number of households in marginalized peri-urban settings who suffer from food and water shortages is nearly as high as those in the rural hinterlands (Fig. 10.3).

Table 10.1 Unemployment rate among population 15 years and older

Bolgatanga municipality	Total population 15 years and older	Total rate	Urban population 15 years and older	Urban rate	Rural population 15 years and older	Rural rate
	82.913	**3.8** %	42.923	**5.3** %	39.990	**2.2** %

Source Ghana statistical service (2012), population and housing census

10.6.2 Changing Patterns of Institutional Reliance in Peri-urban Spaces

The notion of communal reliance refers to the sustained incentive and ability for in-group support systems that form as a result of trust, reciprocity and exchange, particularly during times of hardship. Structures of communal reliance are seen to be rapidly changing in peri-urban spaces and are often conceived through the lens of neoliberalization, social erosion, and communal disintegration (Mohan 2002; Yaro 2013b). In sum, the mushrooming of peri-urban enclaves and the social fabric of these communal spaces point towards the concentration of vulnerable groups such as the urban poor, the young and the elderly at the fringes of rapidly growing urban settlements.

Previous research nevertheless suggests that conditions of peri-urbanity also improve access to infrastructure and social services despite the strong influence of social stratification in newly emerging peri-urban territories (Gyasi et al. 2014). However, comparative data between Bolgatanga and Zaare paint a less cohesive picture concerning structural and institutional support mechanisms. After we explored the networks that helped participants to cope with the aforementioned socio-environmental risks, our findings revealed that patterns of marginality in peri-urban spaces were even more pronounced than those in the rural hinterlands, particularly with regard to the institutional factors that determine communal reliance (Fig. 10.4). Since only 7.5 % of the peri-urban households interviewed engage in agricultural activities, it remains clear that farming-related institutional support mechanisms such as access to extension services, tractors and chemical fertilizers play a less pronounced role. What is surprising nonetheless is that communally embedded institutions such as traditional authorities and faith-based support networks feature far less prominently in the social imaginaries of peri-urban households. Empirical data also show that access to agricultural services and products such as machines, seeds and inorganic fertilizers is still fundamentally limited in both rural and urban spaces, keeping agricultural productivity at comparatively low levels. Moreover, access to formal and informal credit schemes was found to be equally low across rural and peri-urban settings, given the fact that resource poor households often lack the financial or social capital that may enable them to provide collateral security or participate in informal savings groups to diversify their income. When the simultaneous transformation of institutional networks in newly emerging peri-urban territories is taken into account, less visible sites of socio-political marginality and economic precariousness become increasingly salient against the backdrop of accelerated urbanization.

While institutional networks mediate access and the utilization of material and symbolic resources, these very resources also shape the ways in which peri-urban households gain access to and are able to sustain social networks that shape their

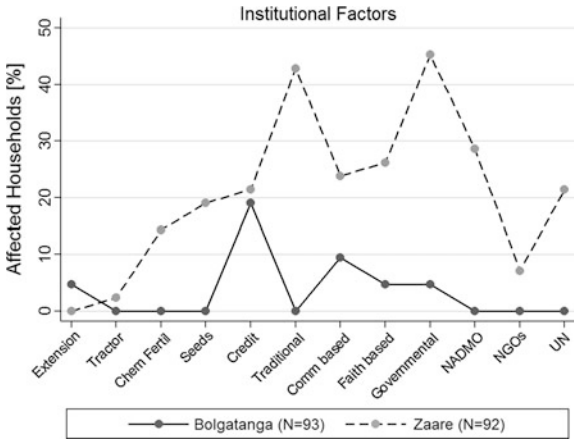

Fig. 10.4 Patterns of institutional reliance [indicators (from *left to right*): provision of agricultural extension services, availability of tractor, availability of chemical fertilizer, availability of seeds, access to formal and informal credit, support from traditional institutions, support from community-based institutions, support from faith-based institutions, governmental support, specific support from NADMO, support from non-governmental organizations, support from the United Nations system]

ability to cope and adapt. Tellingly, the paucity of communal safety mechanisms is mirrored by severe limitations in formal institutional support as evidenced across multiple organizational bases, including the Ghana National Disaster Management Organization (NADMO), United Nations agencies, and other non-governmental organizations. Processes of dynamic territorialization therefore become manifest in the ways in which particular social spaces are rendered politically (in-)visible within institutional frames of place-based 'riskiness' and marginality. During a group discussion with government officials at the NADMO regional headquarters in Bolgatanga, participants referred to the flooding incidents in Bolgatanga as an 'annual ritual' while the negative impacts of flooding were partly attributed to a 'lack of education' concerning flood risk awareness. Other institutional drivers of flood risk that were frequently mentioned by government officials included insufficient urban planning, inadequate infrastructure and limited institutional capacity. Official organizational discourses about peri-urban territories thus reflect a symptomatic view of risk that underemphasizes the systemic root causes of politically produced power asymmetries. Concomitantly, while marginality traps and patterns of food insecurity experienced in peri-urban spaces may largely equal those among households in rural areas, the poverty of institutional support mechanisms in regions like Bolgatanga Damweo illustrates the precarious double-bind that low-income and food insecure peri-urban households find themselves in.

10.7 Conclusion

In this chapter, we compare peri-urban and rural households in northern Ghana with a view to isolating the climate-related risks and institutional factors that shape their perceived social realities. Our main argument rests on the fact that formerly rural territories are rapidly transforming into marginalized urban fringes which we refer to as new *risk frontiers*. In exploring the territorialization of risk in these newly emerging peri-urban areas, we discuss the social impact of institutional orderings of space, materially as well as in terms of social relations. In sum, our findings show that in order to understand how risk is produced across rural and peri-urban settings, social dynamics arising from changing communal networks and institutional support mechanisms need to be more comprehensively integrated into adaptation policy and practice. Taking the case of Bolgatanga Damweo as an example, we find that households in the borderscapes of rapidly transforming urban spaces are more adversely affected by multiple socio-environmental risks than those in rural spaces. Not only are peri-urban households exposed to the same social and environmental risks as their rural counterparts, they are also marginalized by virtue of their relative invisibility within communal networks, policy agendas and development programming. Thus, our main contention with existing literature on risk and adaptation in northern Ghana arises from a potentially problematic overemphasis on rural agriculture and rural 'marginality hotspots' that governs much of this work. In sum, we contend that complex social vulnerabilities are shaped by more than just spatial situatedness and exposure to environmental change and variability that mark off social marginality.

Consequently, to better understand how the production of peri-urban territories intersects with socio-environmental risk, the notion of dynamic 'territorialization' is conceptualized as a networked institutional process which frequently transcends time-bound and place-based notions of risk. In advancing a 'territorialization of risk' framework, we not only draw attention to the need to analyze differentiated livelihood functions and access to material resources that mediate situated risk, but also point towards the salience of exploring the interplay and emergent properties of complex institutional configurations within the context of peri-urbanism as an everyday lived reality.

Acknowledgements This research was financially supported through a fieldwork grant from the Dr. Hermann Eiselen Doctoral Programm of the Foundation fiat panis and by the German Federal Ministry of Education and Research (BMBF) under the project WaterPower (reference number 01 LN 1316 A). Moreover, we thank the West African Science Service Center on Climate Change and Adapted Land Use (WASCAL) for their generous logistical support.

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Chapter 11
Toward Ecosystem-Based Adaptation to Climate Change in West Africa: The Potential Contributions of Non-governmental Organizations

Kofi Akamani

Abstract There is a growing consensus that climate change is occurring and that anthropogenic factors are contributing significantly to it. While past policies emphasized climate change mitigation, the anticipated impacts of climate change such as floods and drought call for a significant boost in adaptation policies in order to ensure sustainable development. However, conventional top-down, sectoral approaches to climate change adaptation also have potential adverse social and ecological consequences that threaten long term sustainability goals. Managing the impacts of climate change requires the coordination of efforts across multiple scales and sectors. This realization has led to the turn toward ecosystem-based adaptation which adopts a multi-sectoral approach to sustaining healthy ecosystems as a means of reducing vulnerability and enhancing the resilience of social and ecological systems to climate change impacts and other drivers of change. Although the concept of ecosystem-based adaptation appears promising, the transition from conventional climate change adaptation policies toward ecosystem-based adaptation in West Africa has been slow. This chapter examines the key features of the ecosystem-based adaptation approach, as well as its potential to enhance climate change resilience in the West African context. The chapter also discusses the potential roles of non-governmental organizations (NGOs) in enhancing awareness, generating interest, creating opportunities, and building capacities for enhancing the transition toward ecosystem-based adaptation. In view of the strengths and weaknesses of NGOs, the chapter concludes that the successful transition toward ecosystem-based adaptation requires adaptive governance mechanisms for connecting state representatives, as well as communities and the private sector across multiple levels in an on-going process of learning and adapting to change.

Keywords Adaptation · Adaptive governance · Climate change · Resilience · Transformation · Vulnerability · West Africa

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J.A. Yaro and J. Hesselberg (eds.), *Adaptation to Climate Change and Variability in Rural West Africa*, DOI 10.1007/978-3-319-31499-0_11

11.1 Introduction

In its recent assessment report, the Intergovernmental Panel on Climate Change (IPCC) identified climate change as a threat to sustainable development (IPCC 2014). The IPCC report notes that "Human influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history" (IPCC 2014: 2). Although the greenhouse gas emissions contributing to climate change are mainly from the developed countries, a disproportionate burden of the impacts of current and future changes in climate is likely to be suffered by societies in less developed countries (Mertz et al. 2009a; Eakin et al. 2014), especially rural resource-dependent communities and their households (Agrawal and Perrin 2008). While rural resource-dependent communities in the developing world have been adapting to variability in climate and other drivers of change for generations (Berman et al. 2012), the impacts of future changes in climate are likely to be beyond the past experience of human societies (Adger et al. 2003; Boko et al. 2007). The high dependence of most developing countries on climate-sensitive resources, as well as their limited institutional, technological and economic capacity to adapt to climate change, contributes to their susceptibility to harm from climate change (Downing et al. 1997; Mertz et al. 2009). In these countries, the impacts of climate change are often exacerbated by the simultaneous impacts of other non-climate related drivers of change, including social, economic and environmental factors emanating from multiple scales (Bunce et al. 2010; Mertz et al. 2010; Yaro 2013).

Past policies on climate change focused primarily on mitigation strategies aimed at reducing the anthropogenic causes of climate change, such as greenhouse gas emissions from fossil fuels (Füssel 2007). However, recent years have brought about the realization that mitigation alone is insufficient. Based on past emissions already in the atmosphere, manifestations of climate change are likely to be experienced for several generations irrespective of the success of current mitigation measures (Downing et al. 1997; Mertz et al. 2009a). There is also the realization that reductions in greenhouse gas emissions through current negotiations at the global level are unlikely to occur at the rate needed to reduce dangerous climate change (Ostrom 2010; Eriksen et al. 2011). Therefore, enhancing the survival of humanity in the face of a changing climate calls for adaptation measures. Adaptation to climate change refers to the processes, actions or outcomes associated with how societies learn and adjust socio-economic and political structures to reduce the adverse impacts of climate change and to take advantage of opportunities created by changing climatic conditions (Adger et al. 2003; Smith and Wandel 2006; Eriksen et al. 2011). Policies that reconcile mitigation and adaptation measures are more likely to succeed in addressing the climate challenge and enhancing sustainability (Fussel 2007; IPCC 2014).

Policies on climate change adaptation have recently come under careful scrutiny as the synergies and trade-offs between climate change adaptation interventions and other sectors across space and time are becoming clearer (Eriksen et al. 2011).

Current adaptation interventions frequently adopt a top-down planning approach which entails designing and leading projects from the outside (Brown 2011). Such centralized approaches are likely to lead to undesirable outcomes due to their ineffectiveness, lack of flexibility, and potential disempowerment of participants (Adger et al. 2011). Also, the strong reliance on western science and technological solutions that characterize most adaptation interventions leaves little room for the integration of local knowledge (Nyong et al. 2007; Eriksen et al. 2011). Importantly, adaptation interventions are often based on narrowly defined problems and goals without adequate consideration of feedback (Adger et al. 2011), thus leading to outcomes that are contradictory to sustainability goals, such as the perpetuation of social conflicts and inequality (Carr 2008; Sovacool et al. 2015), and adverse impacts on local and global ecosystems (Turner et al. 2010; Fezzi et al. 2015). In discussing the adverse impacts of adaptation policies on other sectors, Barnett and O'Neill (2010) used the concept of maladaptation to represent "action taken ostensibly to avoid or reduce vulnerability to climate change that impacts adversely on, or increases the vulnerability of other systems, sectors or social groups" (p. 211).

In response to the shortfalls of conventional adaptation policies, there is a trend toward the search for integrative frameworks that consider policies on climate change as part of the broader effort on development and poverty reduction (Mertz et al. 2009). The awareness that not all adaptation is good and that some adaptation measures are unsustainable has given rise to the concept of sustainable adaptation which refers to adaptation measures that result in long term social equity and ecological sustainability (Brown 2011; Eriksen and Brown 2011). In their elaboration on the concept of sustainable adaptation, Eriksen et al. (2011) suggested a list of policy considerations for sustainable adaptation: recognition of the climate change vulnerability context; appreciation of the diversity of values and interests at stake; integration of local ecological knowledge into adaptation policies; and consideration of cross-scale linkages between local and global process. While the concept of sustainable adaptation appears promising, Brown (2011) has cautioned against the potential for the concept to be co-opted into a reformist agenda aimed at maintaining the status quo rather than promoting radical changes in climate change policy responses. Thus, fundamental societal transformations are required to promote climate change adaptation policies that also contribute to sustainable development (Eriksen and Brown 2011; IPCC 2014). Given that climate change is just one of a number of local and global processes that fuel poverty and underdevelopment, such societal transformations will need to be multi-dimensional, encompassing a rethinking of conventional ideas and practices across social, economic, institutional, informational, and technological domains (Brown 2011; Olsson et al. 2014; Patterson et al. 2015).

In furtherance of the search for more sustainable approaches to climate change adaptation, the concept of ecosystem-based adaptation has been receiving attention among academics and policy-makers in the climate policy arena (Vignola et al. 2009; Wertz-Kanounnikoff et al. 2011; Munang et al. 2013). Ecosystem-based adaptation refers to "adaptation policies and measures that take into account the role

of ecosystem services in reducing the vulnerability of society to climate change, in a multi-sectoral and multi-scale approach" (Vignola et al. 2009: 692). Ecosystem-based adaptation to climate change offers an integrated approach to managing ecosystems with the aim of enhancing the resilience and reducing the vulnerability of social and ecological systems to climate change impacts and other drivers of change (Colls et al. 2009; Vignola et al. 2009). In spite of its promise, the transition toward ecosystem-based adaptation to climate change in Africa has been slow (Niang et al. 2014). The effective implementation of ecosystem-based management approaches requires adaptive governance institutions that connect actors across multiple levels and serves as a mechanism for managing conflicts and uncertainties in the adaptation process (Folke et al. 2005; Niang et al. 2014). However, the governance and institutional dimensions of climate change adaptation have generally received little attention in the literature (Bauer et al. 2011). Like other emerging concepts on coupled human-environment interactions (Olsson and Galaz 2009), important issues worth exploring on ecosystem-based adaptation include the effectiveness of this new mechanism in reducing vulnerability and building resilience to climate change, and the mechanisms by which a transformation from the conventional top-down, sectoral approach to climate change adaptation toward a more collaborative and multi-sectoral ecosystem-based adaptation can be navigated.

The purpose of this chapter is not to undertake a comprehensive review of the literature on climate change adaptation in West Africa. Rather, it examines the potential benefits of the concept of ecosystem-based adaptation as a means of building resilience and reducing vulnerability to climate change in West Africa, as well as the institutional considerations in enhancing the transition toward ecosystem-based adaptation in the sub-region. In the ensuing section, a brief overview of climate change resilience and vulnerability in the West African sub-region will be provided. This section will highlight the exposure and sensitivity of the region to climate change impacts, as well as limitations in the capacity for coping, adaptation and transformation. Next, the key attributes of ecosystem-based adaptation and their potential contributions to reducing vulnerability and building resilience to climate change will be discussed. The subsequent section will explore the potential contributions of non-governmental organizations (NGOs) in enhancing the transition toward ecosystem-based adaptation in West Africa. Given the shortfalls associated with the centralized approaches to dealing with the climate change challenge (Ostrom 2010; Adger et al. 2011), the role of NGOs and other representatives of the private sector in policies on climate change deserves greater attention (Cole 2015). This section argues that NGOs have the potential to contribute to the provision of information, incentives, resources and opportunities for the transition toward ecosystem-based adaptation in West Africa. However, like all institutions and organizations, NGOs have their strengths and weaknesses. Ultimately, success in the transition toward ecosystem-based adaptation will likely be enhanced if the role of NGOs is situated within an adaptive governance framework that involves the roles of government representatives, communities, and the private sector. Concluding remarks will then be provided in the final section of the paper.

11.2 Resilience and Vulnerability to Climate Change Impacts in West Africa

Climate change is expected to present numerous challenges as well as some opportunities to various sectors and social groups. Adequate preparation will be needed to take advantage of the opportunities and to reduce the adverse impacts (Marshall et al. 2010). Resilience and vulnerability represent two alternative frameworks in the analysis of societal responses to climate change. Adger (2006: 268) defines vulnerability as "the state of susceptibility to harm from exposure to stresses associated with environmental and social change and from the absence of capacity to adapt." The vulnerability of a system to climate change is a function of its exposure and sensitivity, as well as the capacity to adapt (Adger et al. 2003). For instance, the African continent is considered one of the most vulnerable to the impacts of climate change, and this vulnerability is a result of its exposure and sensitivity to climate change impacts and other stresses, as well as its low adaptive capacity (Boko et al. 2007).

Climate change exposure refers to the degree to which a system experiences changes in climate. Exposure is largely determined by the attributes of changes in climate, such as the magnitude, frequency, and duration of weather events (Marshall et al. 2010). In Africa, observed and projected climate change show that temperature has been rising over the last 50–100 years, and will continue to increase by 2–6 °C over the next 100 years (Hulme et al. 2001; Niang et al. 2014). However, rainfall patterns have been characterized by high variability and the direction and magnitude of future changes in regional rainfall are uncertain (Hulme et al. 2001). In the specific case of West Africa, temperatures have been shown to be rising over the last 50 years, and are expected to rise faster than the global average in the 21st century (Niang et al. 2014). On the other hand, rainfall patterns in the region have been highly variable over the decades, fluctuating between extremely wet and dry years, with the most fluctuations occurring in the Sahel (Giannini et al. 2008). Overall, West Africa has experienced a decline in annual rainfall since the late 1960s (Boko et al. 2007), but projected changes in precipitation patterns in the region are less robust (Niang et al. 2014). For instance, regional climate simulations in the Volta Region of West Africa show that projected change in precipitation between 2030 and 2039 range from −20 to +50 % depending on the region studied (Jung and Kunstmann 2007).

A system's sensitivity to climate change refers to the extent to which the system is affected, either positively or negatively, by climate change (Perez et al. 2010). In Africa, the interaction between climate change and other anthropogenic drivers of change, such as population growth, urbanization and land use change, is expected to have various impacts on aquatic and terrestrial ecosystems, as well as agriculture, food security, human health, human settlements and infrastructure, among other sectors (Boko et al. 2007; Niang et al. 2014). In West Africa in particular, the impact of climate change is expected to result in agricultural losses of between 2 and 4 % of GDP by 2100. Projected rises in sea levels and flooding are also

expected to threaten 40 % of the population of West Africa that live in coastal cities, while also degrading coastal ecosystems that serve as habitat for some endangered species in the region (Boko et al. 2007).

Besides exposure and sensitivity, vulnerability is also shaped by the level of resilience of the system (Turner et al. 2003; Adger 2006). Resilience in social-ecological systems refers to: the amount of disturbance a system can absorb while maintaining its structures and functions; the capacity for self-organization; and the capacity for learning and adaptation (Carpenter et al. 2001; Folke et al. 2002). Social-ecological responses to drivers of change such as climate change impacts can occur in the form of coping, adaptation, and transformation (Kofinas and Chapin 2009). Coping mechanisms refer to short-term emergency responses usually undertaken by individuals and households at small spatial scales to reduce harm in the face of a driver of change (Berkes and Jolly 2001). Adaptation represents more fundamental changes undertaken to take advantage of opportunities and to reduce harm from drivers of change (Berkes and Jolly 2001; Mertz et al. 2009). However, social-ecological systems may sometimes be trapped in undesirable situations where coping and adaptation may not be enough. In such instances, transformative changes are required.

Transformability is the capacity of a social-ecological system to transition into an entirely different state when existing conditions become untenable (Nelson et al. 2007; Folke et al. 2010). Social-ecological transformation entails the crossing of social and ecological thresholds, thus resulting in a new social-ecological system (Nelson et al. 2007). There is great difficulty in deliberately initiating transformative changes across large scale social-ecological systems (Folke et al. 2010). Such difficulties may stem from the path-dependent effects of prior adaptations which may occur in the form of resistance from vested interests who are benefitting from the status quo, sunk costs in physical and institutional infrastructure, and the interlocking complementarities among different components of the existing regime that make change almost impossible (Heinmiller 2009; Adger et al. 2011; Cody et al. 2015).

The requirements for building resilience and reducing vulnerability are generally met through the availability of effective institutions and governance systems, as well as access to various types of resources such as knowledge and technology, physical capital, human capital, social capital, economic capital, and natural capital (Adger et al. 2003, 2011; Tompkins and Adger 2004; Walker et al. 2006). Hence, differences in the capacity to adapt to climate change impacts and other drivers of change could be attributed to the social and institutional relationships that account for differential access to the various types of capital assets (Yaro et al. 2010; Akamani 2012; Akamani and Hall 2015). From this theoretical perspective, the rich endowment in various natural resources, healthy social networks, and the availability of traditional mechanisms for coping with climate change and variability all contribute positively to Africa's climate change adaptive capacity (Niang et al. 2014). These positive aspects notwithstanding, significant constraints to climate change adaptation still exist on the African continent in general, and in West Africa in particular.

First, there is the lack of reliable data to inform policies on climate change adaptation, particularly at the local level. Climate change is a global phenomenon, yet adaptation to climate change is local and context-specific (Agrawal and Perrin 2008; Eakin et al. 2014). While climate change models offer robust predictions at larger scales, predictions at lower scales, such as the local and regional levels, are less robust (Millar et al. 2007). In West Africa in particular, climate change predictions are marked by high levels of uncertainty, especially with regard to projected rainfall patterns (Jung and Kunstmann 2007). Enhancing the reliability and accessibility of climate change information remains a pressing need (Niang et al. 2014).

A second constraint relates to the inadequacy of enabling policies and institutions for climate change adaptation. Effective institutions play a critical role in societal responses to climate change impacts and other drivers of change by enhancing access to information and resources, as well as providing incentives and opportunities for change (Berkes and Jolly 2001; Agrawal and Perrin 2008; Akamani et al. 2015). However, loopholes in the institutional mechanisms in Africa make them ineffective in dealing with complex climate change issues (Boko et al. 2007). While African countries have gained rich experience in adaptation planning through the preparation of National Adaptation Programmes of Action (NAPAs), their focus has been narrowly sectoral rather than integrative, and most of them remain unfunded (Niang et al. 2014).

Finally, the capacity for climate change adaptation in West Africa is constrained by limitations in the availability of and access to essential capital assets (Boko et al. 2007). Natural capital in the region is adversely impacted by the high exposure to harsh climatic elements, such as the drought in the 1970s and 1980s. In northern Nigeria, farmlands and homes are frequently buried by sand from the Sahara desert, with adverse implications for food security and socio-economic well-being (Adesina and Odekunle 2011). Institutional constraints to natural capital also affect adaptive capacity. In Ghana, for instance, traditional inheritance and land tenure systems have adverse impacts on the adaptive capacity of women and migrants through their influence on access to natural resources (World Bank 2010). These constraints relating to natural capital in the West African sub-region are further compounded by high levels of poverty, limited access to credit, illiteracy, and poor infrastructure, among other factors (Nyong et al. 2007; Metz et al. 2009; Adesina and Odekunle 2011). The underlying causes of the region's underdevelopment which undermine its adaptive capacity cut across multiple spatial and temporal scales, including the adverse effects of colonial and post-colonial development policies, adverse effects of the current global economy, corruption among local politicians, violent conflicts and political instability (Boko et al. 2007; Sendzimir et al. 2011).

In all, this section has explained that the vulnerability of West Africa to climate change impacts stems from the exposure and sensitivity of its people, ecosystems and infrastructure to climate change impacts, as well as the limited access to information, resources and appropriate institutional mechanisms for adaptation and transformation. Thus, the region appears to be caught in a social-ecological trap that

is both undesirable and difficult to escape from. The next section of the chapter will examine the emerging ecosystem-based adaptation approach as an approach for building resilience and reducing vulnerability in the region.

11.3 Ecosystem-Based Adaptation to Climate Change

Ecosystem-based adaptation to climate change is a relatively recent concept that constitutes part of the broader discussion on ecosystem-based approaches to resource management (Travers et al. 2012; Munang et al. 2013). Ecosystem-based adaptation draws from insights on climate change adaptation and ecosystem management (Travers et al. 2012). The turn toward ecosystem-based adaptation reflects growing appreciation of the importance of healthy ecosystems and the ecosystem services they produce in sustaining human well-being and resilience in the face of climate change (Vignola et al. 2009; Wertz-Kanounnikoff et al. 2011). Travers et al. (2012) define ecosystem-based adaptation as "The use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people and communities adapt to the negative effects of climate change at local, national, regional and global levels" (p. 8). Ecosystem-based adaptation holds promise as a means of building resilience and reducing vulnerability against climate and non-climate risks while providing multiple benefits such as livelihood enhancement and poverty alleviation (Colls et al. 2009; Munang et al. 2013). Here, we identify the assumptions, goals, knowledge and institutional dimensions of the ecosystem-based adaptation concept and discuss their potential contributions to overcoming the shortfalls in conventional approaches to climate change adaptation.

11.3.1 Complexity and Adaptive Management

Brooks et al. (2009) have argued that current approaches to climate change adaptation have been shaped by the flawed assumptions of predictability that underpin conventional models on development and the environment. Similarly, Adger et al. (2013) have critiqued the assumption of "simple cause-and-effect relationships" that inform climate change adaptation interventions. In the conventional approach to development and the environment, humans and ecosystems have traditionally been treated as separate from each other, and nature is often assumed to be predictable and controllable (Holling and Meffe 1996; Folke et al. 2002; Berkes 2007). Policies based on assumptions of prediction and control have frequently led to adverse unintended consequences across a range of resource management arenas (Holling 2012). In the field of forest policy, for instance, sustained-yield forest management policies that emphasized the predictable supply of timber in much of the 20th century ultimately resulted in the vulnerability of forest ecosystems and forest-dependent communities (Cortner and Moote 1999; Kelly and Bliss 2009).

Given the complexity and uncertainties associated with climate change (Gough and Shackley 2001; Millar et al. 2007), a fundamental change in assumptions is needed to enhance sustainable adaptation (Brown 2011).

Contrary to conventional adaptation policies, ecosystem-based adaptation is based on a systems perspective on human-environment interactions that calls for adaptive management (Travers et al. 2012). Ecosystem-based management is informed by the resilience perspective which holds that social and ecological systems are intricately interconnected in a dynamic and co-evolving fashion, and that these interactions occur across multiple spatial and temporal scales (Folke 2007; Folke et al. 2011). Such coupled social-ecological systems are characterized by surprise, path-dependency, emergence, and self-organization that depict the attributes of complex adaptive systems (Folke 2006; Liu et al. 2007). These attributes of social-ecological systems have been modeled in Holling's (2001) panarchy concept which depicts social-ecological systems as nested sets of adaptive cycles. An adaptive cycle is a model of the four phases of growth, conservation, release, and re-organization that all social-ecological systems constantly pass through rather than operating around a single equilibrium (Carpenter et al. 2001). Managing for the sustainability of such complex social-ecological systems requires building their resilience to deal with surprise through adaptive management rather than maintaining stability (Folke 2006; Folke et al. 2010; Walker 2012). Adaptive management is an approach to resource management that treats the decision-making and implementation processes as experiments aimed at generating knowledge about the system (Lee 2001; Chapin et al. 2009). The adaptive management processes also emphasizes monitoring of the resource management process, as well as maintaining the flexibility to integrate new knowledge into subsequent decisions in an ongoing process of learning to deal with uncertainties (Pahl-Wostl et al. 2007; Allen et al. 2011).

These changing assumptions are beginning to shape climate change adaptation policies in Africa. The growing awareness that successful adaptation to climate change requires building resilience to deal with uncertainties is resulting in a shift from the previous emphasis on technological solutions toward broader policies that emphasize resilience in many African countries (Niang et al. 2014). In Ghana for instance, the National Climate Change Adaptation Strategy explicitly emphasizes building the country's resilience to current and future climate change impacts as its basic goal. The document further recommends a "learning by doing" approach to the implementation of adaptation strategies (UNDP 2013). Consistent with passive forms of adaptive management (Allan and Curtis 2005), the document discusses the development of indicators for monitoring and evaluation in the implementation of adaptation strategies. However, systematic procedures for experimentation and learning in line with active adaptive management in ecosystem-based management (Allan and Curtis 2005; Folke et al. 2011) are not explicit in the report. Given the knowledge gaps and uncertainties within which adaptation planning in West Africa must occur, greater emphasis on adaptive management is needed in planning efforts. However, in moving toward adaptive management, countries in West Africa need to learn from the shortfalls in the application of the concept in the developed

world. Failures in the implementation of active adaptive management often stem from the lack of willingness of decision makers to recognize and embrace complexity and uncertainty (Walters 2007). Given the lack of prioritization of climate change adaptation in some African countries (Niang et al. 2014), the political will to implement adaptive management is likely to be limited. Failures in adaptive management have also been attributed to the adoption of technocratic approaches that offer limited opportunities for stakeholder participation, as well as inadequate consideration of social values and nonscientific knowledge (McLain and Lee 1996; Gunderson and Light 2006; Huitema et al. 2009; Allen and Gunderson 2011). The lack of appropriate indicators and adequate resources for monitoring (Walters 2007; Chapin et al. 2009) is also likely to be a constraint to adaptive management in the West African context.

11.3.2 Multi-sectoral Decision-Making

In conventional sustained-yield resource management approaches, emphasis is typically placed on the maximization of benefits from a single resource without consideration for impacts on other sectors (Cortner and Moote 1999; Chapin et al. 2009). Similarly, current adaptation planning largely follows a narrow sectoral approach (Adger et al. 2011). Throughout Africa, several countries have initiated planning processes for developing NAPAs. However, most of them adopt a sectoral approach with little integration among the various sectors (Niang et al. 2014). Climate change interacts with other stressors in an unpredictable manner across multiple spatial and temporal scales. As such, the application of narrow sectoral planning approaches to climate change adaptation policy has the potential to lead to unintended consequences and maladaptive outcomes (Adger et al. 2011; Eriksen et al. 2011). For instance, policies promoting biofuels as alternatives to fossil fuels have resulted in a range of unintended consequences, including land grabbing, food insecurity, and conflict in the developing world (Tsikata and Yaro 2011; Olsson et al. 2014). Promoting sustainable adaptation requires integrated approaches that account for the trade-offs and adverse consequences of adaptation on other sectors (Eriksen et al. 2011).

The holistic scope of ecosystem-based adaptation offers opportunities for addressing these multi-sectoral linkages in climate change adaptation planning (Travers et al. 2012). The focus of ecosystem-based resource management is not on managing the social, economic, and ecological components in isolation from one another, but an integration of all of them in pursuit of long term sustainability (Loomis 2002; Folke et al. 2011). Similarly, ecosystem-based adaptation entails integrated management goals that require coordinated management across multiple sectors and scales (Vignola et al. 2009; Travers et al. 2012). Ecosystem-based adaptation encapsulates a broad range of management interventions, including preservation, conservation, and restoration of forests, water resources and agricultural landscapes that are expected to contribute to climate change mitigation and

adaptation efforts, as well as livelihood enhancement, poverty reduction, biodiversity conservation, and sustainable economic development (Colls et al. 2009; Munang et al. 2013). While the pursuit of integrated resource management goals is not new, the emerging literature on ecosystem-based management emphasizes the use of political solutions to reconcile trade-offs among the competing values and interests held by various stakeholders rather than attempting to resolve these conflicts by relying solely on technical solutions (Dietz et al. 2003; Nelson et al. 2008). Such integrated planning approaches represent an effective way to ensure stakeholder representation and adequate consideration of the diversity of stakeholder values and interests (Tompkins and Adger 2004; Eriksen et al. 2011).

In Africa, progress is being made toward the adoption of integrated approaches to developing NAPAs, as well as land use planning, water resource management and other sectors (Niang et al. 2014). In Ghana, for instance, the preparation of the National Climate Change Adaptation Strategy was explicitly based on multi-sectoral and integrative principles. The process started with the preparation of sector specific adaptation plans based on sectoral vulnerability and adaptation assessments, following which a new method was developed to facilitate the analysis of cross-sectoral impacts during the preparation of the country's overall adaptation strategy (Kemp-Benedict and Agyemang-Bonsu 2008). Known as the "Akropong Approach," this method provides an efficient and effective way of analyzing cross-sectoral relationships through deliberation among experts representing the various sectors in the climate change adaptation planning process. Consistent with Dietz et al.'s (2003) concept of analytic deliberation, the "Akropong Approach" holds promise for managing conflicting values and knowledge uncertainties through the combination of scientific analysis and public deliberation. However, the emphasis on sectoral expert representatives risks marginalizing less dominant values and interests. Adger et al. (2013) have highlighted the general neglect of cultural values in current adaptation interventions, and this is likely to be the case in Ghana's adaptation planning process. In all, several factors inhibit the full adoption of integrated decision-making approaches to climate change adaptation planning on the African continent, including the lack of prioritization of climate change adaptation, the disconnect between national level adaptation policies and autonomous adaptation at lower levels, and fragmentation of policy and institutional frameworks in various sectors (Niang et al. 2014). Beside these institutional issues, the potential for conflicts, lack of data on costs and benefits, and limited financial and technical capacities (Colls et al. 2009; Naumann et al. 2011) are potential constraints to integrated decision-making in ecosystem-based adaptation in West Africa.

11.3.3 Holistic Knowledge Systems

Conventional adaptation policies have also been critiqued for being expert-driven and narrowly focused on the search for technological solutions (Brooks et al. 2009; Colls et al. 2009; Brown 2011). This represents a missed opportunity to utilize local

knowledge (Nyong et al. 2007; Adger et al. 2013), as well as the social sciences (Agrawal et al. 2012) in climate change research. Local communities in the Sahel and other parts of West Africa have demonstrated remarkable resilience to climate variability in the past (Adger et al. 2003; Nyong et al. 2007; Gyampoh et al. 2009), yet the local and traditional knowledge communities have accumulated through adaptation to past climate change impacts in the region has not been adequately explored in climate policy (Nyong et al. 2007; Mertz et al. 2009). In Ghana, for instance, no mechanisms for integrating local and traditional knowledge with scientific knowledge are evident in the "Akropong Approach" to adaptation planning that was used in the development of the country's National Climate Change Adaptation Strategy. Hence, the process and outcomes of the adaptation planning strategy appear to favor the views of experts trained in western science. In view of the challenges in modelling the impacts of climate change in West Africa (Jung and Kunstmann 2007), integrating local knowledge with scientific knowledge could enhance prospects for sustainable adaptation (Nyong et al. 2007; Eriksen et al. 2011).

Ecosystem-based approaches to resource management depart from the conventional reliance on reductionist and positivist science that often marginalized local knowledge (Cortner and Moote 1999). Ecosystem-based resource management requires the integration of diverse sources of knowledge. Such knowledge integration occurs both vertically among researchers, resource managers and stakeholders, as well as horizontally among scientists from diverse disciplines, thus giving rise to a holistic understanding of complex human-environment interactions (Endter-Wada et al. 1998; Lélé and Norgaard 2005). This creates opportunities for the recognition and utilization of the local and traditional knowledge that local resource users have accumulated over time (Olsson and Folke 2001). Recent insights into ecosystem-based adaptation to climate change particularly emphasize the importance of integrating multiple sources of knowledge (Travers et al. 2012), including the knowledge of local communities in climate change adaptation efforts (Colls et al. 2009). While the importance of local and traditional knowledge in enhancing efficiency, participation and sustainability in climate change adaptation policy is increasingly gaining recognition in Africa (Boko et al. 2007), current challenges include threats to the reliability of traditional knowledge in predicting rapid changes in climate, potential loss of traditional knowledge due to decline in intergenerational transmission, and practical obstacles to utilizing traditional knowledge in climate change adaptation policy (Yaro et al. 2010; Niang et al. 2014).

11.3.4 Adaptive Governance Mechanisms

Institutions comprise the formal rules and informal social norms that shape human interactions with one another and with their environment (North 1990; Agrawal and Perrin 2008). The top-down approach to current climate change mitigation and

adaptation policies has been critiqued for its ineffectiveness in promoting cooperation, its lack of flexibility, its failure to build trust and so forth (Ostrom 2010; Adger et al. 2011; Cole 2015). The application of top-down approaches to managing complex social-ecological systems also has the potential to result in mismatches between adaptation interventions and the scales at which problems occur (Cash et al. 2006; Folke 2007; Adger et al. 2011). Climate change adaptation is a multi-level phenomenon involving the interaction among actors across various levels from the individual to global organizations (Adger et al. 2005; Eriksen et al. 2011). Enhancing successful adaptation to climate change calls for diverse institutions that connect stakeholders for addressing issues across multiple scales (Bauer et al. 2011; Brown 2011).

It has been argued that adaptive governance is the most promising institutional mechanism for ecosystem-based management (Folke et al. 2005, 2011). Adaptive governance institutions connect actors across multiple scales in a flexible collaborative decision-making process that addresses knowledge uncertainties and value conflicts (Dietz et al. 2003; Nelson et al. 2008; Akamani and Wilson 2011). Adaptive governance is also posited as the most appropriate institutional mechanism for facilitating transformations in social-ecological systems (Walker 2012; Olsson et al. 2014). The institutional structures of adaptive governance have been described as polycentric (Marshall 2008). Polycentric institutions are composed of multiple over-lapping centers of decision-making authority with some degree of autonomy and diversity at each level (Ostrom 2010; Koontz et al. 2015). Polycentric institutions provide several benefits that are of relevance to climate change adaptation, including enhancing communication and sharing information across scales, mobilizing resources among dispersed actors, promoting interactions that build trust and social capital, providing opportunities for participation at the local level, enhancing learning through experimentation, and providing redundancies that serve as insurance against failures (Ostrom 2010; Cole 2015; Koontz et al. 2015).

In Africa, adaptive governance is increasingly being recognized as an essential framework for ecosystem-based adaptation to climate change impacts (Niang et al. 2014). In Ghana, for instance, the transition to a democratic and decentralized governance system in the 1990s provided an enabling policy environment for adaptive governance. Consequently, the institutional structures and processes for the development and implementation of the National Climate Change Adaptation Strategy could be said to be polycentric, involving representatives of diverse organizations nested across multiple levels from the national to the local community level. At the apex of the institutional structure in climate change adaptation planning efforts are national level organizations such as the Ministry of Environment, Science and Technology and the National Climate Change Committee. Working together, these two organizations are responsible for establishing the institutional framework for the National Climate Change Adaptation Strategy, coordinating with other representatives of government and non-state actors, integrating climate change adaptation into other national priorities, providing resources for implementation, as well as overseeing monitoring and evaluation programs. These

national level organizations coordinate with other organizations at the sub-national level such as the Reginal Coordination Councils at the regional level, the District Assemblies at the district level, and the Town/Area councils and Unit Committees at the local community level. While the national level organizations are responsible for the development of the National Climate Change Adaptation Strategy, it is at the sub-national level that actual implementation takes place (UNDP 2013). Within this polycentric institutional structure, recent efforts toward the mainstreaming of climate change adaptation into district development plans represent important steps toward adaptive governance in Ghana (Niang et al. 2014).

Adaptive governance must, however, not be seen as a panacea (Koontz et al. 2015). Change toward adaptive governance and ecosystem management can be constrained by the perpetuation of top-down decision-making processes, as well as resistance from powerful interests (Huitema et al. 2009). The polycentric structure of adaptive governance regimes can also give rise to high potential for conflicts, duplication of functions, and high transaction costs (Huitema et al. 2009; Koontz et al. 2015). Outcomes of the transition toward adaptive governance are also uncertain, with potential for domination by powerful elites, thereby perpetuating pre-existing inequalities and power imbalances (Chapin et al. 2009; Huitema et al. 2009; Koontz et al. 2015). In the case of Africa, policy considerations for enhancing adaptive governance for ecosystem-based adaptation include improving coordination among the various organizations representing government and non-state actors, enhancing strong local institutions, and promoting broad-based awareness and understanding of ecosystem-based adaptation as an integral component of national development efforts (Niang et al. 2014).

11.4 The Role of NGOs in Ecosystem-Based Adaptation

The previous sections of this chapter have highlighted the shortfalls of conventional approaches to climate change adaptation in West Africa, as well as the benefits of ecosystem-based adaptation. In view of the low adaptive capacity of West African countries discussed earlier, transformational changes toward ecosystem-based adaptation are required for building climate change resilience (Niang et al. 2014). Insights from the literature on adaptive governance and social-ecological transformation suggest that such transformative changes require broad-based awareness among stakeholders, stakeholder motivation for change, the ability to act, and opportunities for regime change (McLain and Lee 1996; Lambin 2005; Walker et al. 2006). The adaptive governance approach has room for states, communities and the private sector (Dietz et al. 2003). However, the role of the private sector in climate change policy has not been adequately explored (Cole 2015). Here, we focus on the potential roles of NGOs, as members of the private sector, in facilitating the transformation toward ecosystem-based adaptation to climate change in West Africa.

Since the 1970s, NGOs have been receiving attention as major actors in the development process, especially in less developed countries. The rise of NGOs is thought to fill an important gap created by the declining role of the state as a result of the rise of neoliberal thinking as manifested in the implementation of Structural Adjustment Programs, reduction in public expenditure and decline in state-provided services, as well as the general ineffectiveness of state institutions due to corruption, poor governance, limited capacity and so forth (Banks and Hulme 2012). Within this context, discussions on NGOs highlight their potential contributions to positive social change through enhanced efficiency in the allocation of societal resources, promotion of good governance through bottom-up participatory approaches, and empowerment of local communities (Edwards and Hulme 1998; Leonard and Pelling 2010; Ahlborg and Sjöstedt 2015). In the context of climate change adaptation, NGOs can play essential roles that national governments may be unwilling or unable to perform, such as gathering and sharing of information to create awareness, creating opportunities for action, and building capacities (Gouch and Shackley 2001; Szarka 2014). Here, we emphasize the potential contributions of NGOs to policy change toward ecosystem-based adaptation.

First, ecosystem-based adaptation is a recent concept and much work is needed in communicating information to raise awareness on its potential benefits (Naumann et al. 2011). Existing gaps in scientific knowledge on climate change impacts as well as the neglect of local and traditional knowledge constitute major barriers to awareness creation. Local and international NGOs focusing on research or campaigns can play a critical role in generating and disseminating knowledge to create public awareness about climate change impacts as well as contributing to the search for innovative solutions (Gough and Shackley 2001; Szarka 2013). Of critical importance is the need to explore opportunities for integrating local and traditional knowledge into the science of ecosystem-based adaptation to climate change (Colls et al. 2009). In Ghana, for instance, NGOs can complement the role of national organizations in the integration of science and non-scientific knowledge to create awareness on ecosystem-based adaptation and other innovations on climate change adaptation.

Second, innovative mechanisms for generating economic and non-economic incentives are required for enhancing stakeholders' interest in supporting ecosystem-based adaptation policies and programs (Vignola et al. 2009). Participants in every policy process have diverse motivations, ranging from economic to non-economic. Participants will support policy change only when they perceive that the new regime will leave them better off than their current state (Ostrom 2009). Through their research activities and the use of the media, NGOs can significantly contribute to developing and disseminating creative policy options on climate change adaptation that are likely to generate support (Gough and Shackley 2001). In this regard, promoting ecosystem-based adaptation as a viable policy option in West Africa will require the communication of information to raise awareness among resource managers, policy-makers and ordinary citizens on the potential benefits entailed in the holistic scope of the concept (Naumann et al. 2011). Ghana's National Climate Change Adaptation Strategy, for instance, already contains most of the essential

elements of ecosystem-based adaptation, although the strategy is not explicitly informed by the concept. The role of NGOs will be essential in generating support at all levels for ecosystem-based adaptation policies in the country.

Third, given the capacity constraints in engaging stakeholders in ecosystem-based adaptation processes (Naumann et al. 2011), NGOs could play a critical role in building capacities for community participation (Vignola et al. 2009). As service providers, the contributions of NGOs to capacity-building efforts might include the development of human capital through training programs, livelihood enhancement, and the development of physical and institutional infrastructure (Banks and Hulme 2012). In Ghana, for instance, such capacity-building efforts at the community and district levels, where relevant institutions are usually weak or non-existent, could significantly enhance the success of the National Climate Change Adaptation Strategy. The ability of NGOs to undertake such initiatives will depend on innovative funding mechanisms from diverse sources over an extended period of time (Ahlborg and Sjöstedt 2015).

Finally, NGOs can contribute to creating opportunities for policy change in the climate arena by advocating for legislation that provides an enabling policy environment for climate change adaptation and mitigation (Szarka 2014). NGOs can also create opportunities for community participation in the policy formulation and implementation process by providing expertise in policy dialogue and mediation of disputes (Gough and Shackley 2001), as well as overseeing the implementation of specific programs (Szarka 2013). Given the diversity of values at stake in ecosystem-based adaptation processes, conflict is an inherent part of decision-making in such a context (Colls et al. 2009). This calls for effective mechanisms for managing conflicting values and interests. NGOs can contribute to the search for political solutions to conflicting interests and values in integrated decision-making processes by acting as neutral third party mediators and facilitators in negotiations involving communities, states and market. Of critical importance is the need for the empowerment of marginalized groups such as resource-dependent communities to ensure their interests are safeguarded in negotiation processes (Vignola et al. 2009). In Ghana, NGOs could contribute to broadening the range of stakeholders involved in the "Akropong Approach" to adaptation planning beyond the current emphasis on experts representing the various sectors. Such an inclusive process offers more promise for integrating neglected values and non-scientific knowledge, as well as enhancing stakeholder commitment to policy implementation.

While NGOs have important roles to play in ecosystem-based adaptation efforts, their potential shortfalls also deserve attention. Banks and Hulme (2012) have argued that NGOs have over the years over-emphasized their role as service providers, thus paying inadequate attention to their critical roles in policy advocacy on behalf of the marginalized in society. The heavy reliance of NGOs on official aid and the strings that come with it has also been critiqued for weakening the downward accountability and legitimacy of NGOs to local communities (Edwards and Hulme 1998), as well as reducing the flexibility and opportunities for experimentation and innovation by NGOs (Banks and Hulme 2012). Finally, most NGOs appear to be concentrated in developed political systems (Edwards and Hulme 1998).

Given the unfavorable socio-economic and political environment in most parts of West Africa, not many capable local NGOs may be available to contribute to climate change adaptation efforts. For instance, a recent survey of NGOs in the Anambra State of Nigeria found that the majority of them either did not know about climate change impacts, or did not consider them a priority (Iwuchukwu et al. 2014). The overreliance on external NGOs in the sub-region could have adverse implications for the sustainability and context-specificity of adaptation interventions. Thus, creating an enabling policy environment for the nurturing of well-functioning civil society is an appropriate starting point for enhancing the role of NGOs in climate change adaptation efforts in the West African sub-region.

11.5 Conclusion

Recent decades have seen increased emphasis on climate change adaptation to complement mitigation efforts. However, it is increasingly being realized that conventional top-down, sectoral approaches to climate change adaptation could lead to maladaptive outcomes, and that alternative pathways are needed to promote sustainable adaptation. Ecosystem-based adaptation offers an integrated approach to maintaining healthy ecosystems as a means of enhancing the resilience of social and ecological systems to climate and non-climate risks, as well as the provision of various socio-economic benefits. The ecosystem-based adaptation approach is particularly promising for climate change adaptation efforts in West Africa where the majority live in poor resource-dependent communities. An analysis of the key features of ecosystem-based adaptation revealed that an opportunity exists for meeting these requirements through ongoing national adaptation planning initiatives in Ghana and other countries in West Africa, although these potentials remain under-utilized. This chapter has explored the complementary role that NGOs, as representatives of the private sector, could play in facilitating the transition toward ecosystem-based adaptation in West Africa. The paper has argued that NGOs have the potential to enhance the awareness, motivation, capacity and opportunities for communities to participate in ecosystem-based adaptation efforts across scales. However, NGOs also have inherent weaknesses that threaten their ability to perform these expected roles. Managing transitions in complex social-ecological systems is a multi-level phenomenon that requires the role of diverse actors and organizations across scales. In all, an adaptive governance approach that connects state representatives, communities and the private sector across scales appears to offer more promise for enhancing successful transitions toward ecosystem-based adaptation to climate change in West Africa.

Acknowledgements I would like to thank the editor, Dr. Joseph Yaro, for inviting me to work on this interesting topic. I am also grateful to the reviewers for their critical and helpful comments that contributed to enhancing the quality of the chapter. Funding for this project came from the College of Agricultural Sciences at Southern Illinois University, Carbondale.

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Chapter 12
Mapping Social Capital for Adaptation to Climatic Variability in a Savannah Ecosystem of Ghana

G.A.B. Yiran

Abstract In view of current climate variability and change and the projected increase in extreme events, adaptation to climate risks is vital. For effective adaptation, all resources (economic, social and environmental) have to be utilised. However, not much of social capital is captured in adaptation policy and planning. The under utilisation of social capital exacerbated by inadequate data documentation has created a knowledge gap which this chapter addressed by mapping. This was done by examining the variables used by the people to adapt to climate variability and change and then quantifying them for mapping. A household survey, focus group discussions and in-depth interviews were used to identify the variables of social capital and how they are used in the adaptation process. About 10 variables were identified and verified from existing literature before quantification. Some of the variables were quantified using secondary data while others were scored. The resultant map shows spatial variation of social capital, with Builsa North and South and Bongo Districts possessing the highest social capital while Bawku Municipality possesses the lowest. This social capital can be enhanced for adaptation with policy support. It is therefore recommended that state agencies tasked with adaptation policy formulation should consider social capital as a policy option. Also, the variables of social capital perceived to be weakening should be revitalised through sensitisation by local authorities and NGOs.

Keywords Social capital · Mapping · Savannah ecosystem · Adaptation planning

12.1 Introduction

Climate variability and change (CVC) has become one of the topical issues in current global discourses (e.g., Druyan 2011; DOE, U.S. 2012; see also reports of IPCC 2014). Indeed, the World Bank, UN agencies and other international

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J.A. Yaro and J. Hesselberg (eds.), *Adaptation to Climate Change and Variability in Rural West Africa*, DOI 10.1007/978-3-319-31499-0_12

researchers have highlighted the view that the single most important influencer of development in the 21st century and beyond, if not adequately addressed, would be climate-related (UNFCCC 2005; World Bank 2013). Consequently, the IPCC (2014) has projected increases in temperature, though with spatial variation. Over West Africa, temperatures are projected to increase between 3 and 6 °C above the late 20th Century baseline by the end of the 21st Century (Meehl et al. 2007; Fontaine et al. 2011; Diallo et al. 2012; Monerie et al. 2012). Rainfall projections are mixed in terms of amplitude and direction, partly because of the failure of global simulation models to determine convective rainfall events in West Africa (see IPCC 2014). Ghana, being part of the sub-region, also experiences the variations in temperature and mixed predictions of rainfall events.

In Ghana, studies have shown that mean annual temperatures have risen by about 1 °C since 1960, with a more rapid rate of increase in the Guinea and Sudan savannahs (hereafter referred to as interior savannah) of Northern Ghana than the rest of the country (Stanturf et al. 2011). Climatologically, such changes in temperature do not only affect rainfall patterns, but more importantly, most rainfall related activities (IPCC 2014). Other studies have also shown that rainfall in Ghana has since 1960 been highly variable, though with a downward trend (Nkrumah et al. 2014). Stanturf et al. (2011) predict mean temperatures in the interior savannah to rise by about 3 °C by 2080. Projected precipitation in the country is variable, showing both decreases and increases. The decreases range from 25 to 28 %, while increases range from 24 to 32 % of wet season rainfall (Stanturf et al. 2011). The decreases are expected to occur in the early part whereas the increases are expected to occur in the latter part of the rainy season. The high variability implies high likelihood of occurrence of severe droughts/dry spells and a small delay in the monsoon, floods and heavy rainfall events. Variabilities of these climatic variables (temperature and rainfall) and their extremes (droughts/dry spells with associated high temperatures, flooding and heavy rainfall events) affect livelihoods, especially those that are climate sensitive (e.g., agriculture and food security, health, water and energy).

Agriculture, a major economic activity of the people, is highly climate sensitive as it depends largely on rainfall (Gyasi et al. 2014). Yiran (2014) did a trend analysis of crop failure from 1992 to 2012 in the Upper East Region of Ghana and found that crop yield failures were higher during years with droughts and/or floods. Records from MOFA (2010) show a declining trend in livestock production in the area. Indeed, the twin events of droughts and floods in 2007 caused severe losses of crops, livestock, lives and property, and displaced so many people in northern Ghana that the government declared a state of emergency in the area (IRIN 2007). Provisional figures a few days after the event indicated that more than 275,000 people were affected, with more than 20 lives lost and over 20,000 homes destroyed (IRIN 2007). Loss of agricultural production is also linked to food insecurity in the area as majority of the people depend on farm produce for household food consumption (Akudugu et al. 2012; Yaro 2013; Gyasi et al. 2014; Kasei et al. 2014). Food security is particularly a problem as demand for food is increasing in the wake of negative impacts of CVC on agriculture (Gyasi et al. 2014).

Other studies have linked the occurrence of some diseases to CVC and related extremes (UNDP 2010; Asante and Amuakwah-Mensah, 2015) while poverty is also indirectly linked to climate change through agricultural losses (Al-Hassan and Poulton 2009; Diao 2010). In the face of these challenges, people in the interior savannah are adapting to climate using the resources at their disposal (Armah et al. 2010; Yaro 2013). In fact, Yiran (2014) found that people in the interior savannah are struggling to adapt to the impacts of CVC and extremes and therefore have high spatial vulnerabilities. Thus, to achieve the sustainable development goals, the people have to be supported to adapt effectively by increasing their adaptive capacity.

Adaptive capacity is conceived to be shaped by the interactions of environmental, social, cultural, political and economic forces (Gitz and Meybeck 2012). Most studies that have assessed adaptive capacity conclude that it is low in poor communities (Adger et al. 2003; Morton 2007). Without downplaying the significance of these studies, one obvious omission is the inadequate articulation of social capital as a policy option for adaptation to CVC within poor communities. One of the reasons for the inadequate inclusion of social capital in adaptation policy is that it cannot be measured economically (see Navarro 2002; Haynes 2009) and therefore cannot be compared with adaptive capacity indicators which are valued economically. However, social capital is playing a critical role in the adaptation process of people in the interior savannah as external support is often inadequate and arrives late (Yiran and Stringer 2015). The under utilisation of social capital in adaptation policy, which is exacerbated by inadequate data documentation has created a knowledge gap which this chapter seeks to address through mapping. Most social capital mapping exercises are not spatially oriented. Social capital mapping is usually based on the community mapping concept which refers to inventorying community resources or assets in a community or an abstract representation of relationships within a community without reference to a geographic grid (Michigan State University 1999). This chapter therefore adds the spatial dimension to social capital mapping. Spatial mapping is expected to visually highlight spatial variations and the levels of social capital and provide policy makers the opportunity to strategies adaptation options to enhance adaptive capacities in the savannah ecological zone. This is particularly important as Ghana is resource constrained and has numerous competing demands (Yiran and Stringer 2015). In Ghana, though policy is formulated at the national level, it is implemented at the district level and therefore visualising social capital spatially at the district level will show the strengths and weaknesses of the districts for effective policy formulation.

In climate change research, poor communities are usually assumed to have low adaptive capacity, so that adaptive capacity assessments are conducted like needs assessments which prefer solutions from outside the communities—a top-down approach to development (Nelson et al. 2008). Local people are seen as people with special needs to be met by external agents rather than as part of the solution. In the process, local knowledge and other resources, especially social capital are inadequately utilised in the adaptation strategies and policies.

12.1.1 Conceptualising Social Capital

Over the past years, social capital has received a lot of attention. However, the concept has been criticised by many researchers for various reasons, notably that it is not a capital as it cannot be measured economically (see Navarro 2002; Haynes 2009). The intention is not to add to the debate but to adopt a working definition that will aid the present study. Several definitions of social capital exist. For example, Bourdieu (1985: 248) defined social capital as "the aggregate of the actual or potential resources which are linked to possession of a durable network of more or less institutionalised relationships of mutual acquaintance or recognition". Putnam (1996) also defined the term as "networks, norms, and trust that enable participants to act together more effectively to pursue shared objectives" (cited in Harper 2002: 2). These definitions resonate well with Adger's (2001) statement that societies have inherent adaptive capacities bound up in their ability to collectively act. Putnam's definition given above can be considered the micro level analysis which is important for the present study as it focuses on the local level.

Social capital has been very useful in many fields such as work place, education, health, community development, etc. (Hitt et al. 2002; McGrath and Sparks 2005; Wilton 2012). A study by OECD (2010) demonstrated that communities with stronger growth in social capital had better improvement in health seeking behaviour and outcomes than those with stronger economic growth. This therefore suggests that climate change adaptation strategies could equally benefit from social capital. However, exactly how much social capital is available at the local level for climate change adaptation is not known. The objective of this chapter therefore was to identify and measure indicators of social capital for mapping. This was achieved by examining and quantifying the social systems or variables used practically by the people in adapting to CVC before governmental/external assistance arrives.

12.1.2 Measuring and Mapping Social Capital

One of the reasons for insufficient documentation of social capital at the local level is the difficulty in measuring it directly. Conceptualising social capital along the dimensions proposed by Grootaert and van Bastelaer (2001) move a step towards measuring social capital. They proposed three dimensions: the scope (i.e., the unit of observation: micro, meso and macro); the forms or manifestations and the channels which represent the assets (material and immaterial). The forms of social capital influence development through the interactions of two types of social capital: the structural, which facilitates information sharing and collective action/decision making; and the cognitive, which captures shared norms, beliefs, attitudes and values (Grootaert and van Bastelaer 2001). Several proxies have been developed based on this and other concepts to measure social capital. In this work, the framework for measuring social capital is adopted from Scrivens and Smith (2013) and summarised in Table 12.1.

Table 12.1 Categories of social capital

Category of social capital	Description
Personal relationships (family system, neighbourliness)	refer to people's networks (i.e., the people they know) and the social behaviours that contribute to establishing and maintaining those networks, such as spending time with others, or exchanging news by telephone or email. This category concerns the extent, structure, density and components of individuals' social networks
Social network support (remittances, sharing/gifts, skills, local knowledge/practices)	Refers to the level of resources or support that people can draw from their personal relationships, i.e., what they do for other individuals on a personal basis. It refers to emotional, material, practical, financial, intellectual or professional resources that are available to each individual through his/her personal social networks. Social network support can help people both to "get by" in times of need and to "get ahead", by improving their position both in absolute and relative terms
Civic engagement (e.g., community participation, group membership)	Concerns activities through which people contribute to civic and community life, e.g., volunteering, clubs, political participation, taking action on local issues and other forms of community engagement. This category facilitates analysis of the impact of civic engagement on other outcomes as well as identifying the drivers of civic engagement
Trust and cooperative norms (land availability for inheritance, NGOs)	Refers to the trust, social norms and shared values that underpin societal functioning and enable mutually beneficial cooperation. The concept is fundamentally concerned with those intangible factors embodied in people's social norms and expectations that contribute directly to better social and economic outcomes. This category addresses the question of what elements of the informal structure and functioning of society have a 'productive' role, where the term productive is understood in both economic and social terms

Source Scrivens and Smith (2013:20)

This framework aims to cover all the dimensions of social capital at the local level. The variables indicated (in brackets) were found to be related to the various categories of social capital in Table 12.1 and in the literature. Measurement or quantification of social capital has been done either using secondary sources or scoring/ranking (e.g., Morrissey et al. 2005; Adam 2008; Sabatini 2009; Rocco and Suhrcke 2012). Proxies (indicators) have to be quantified because mapping is a quantitative exercise (Damm 2010; Yiran 2014). It is worth noting that social

capital has been mapped in many developed countries for health and well-being promotions (see Mittelmark et al. 2007; Adam 2008). These mapping exercises, though at the macro (state and higher) level, have proved useful for health service planning.

12.2 Methodology

Mapping involves the use of quantitative indicators. Thus, the first stage involved identification and quantification of social capital indicators existing in the communities. Here, the field survey was conducted to collect information on social variables that are used by the local people to adapt to CVC. Literature was then consulted to verify these variables and to examine how they have been used in other studies. This was done because, according to Grootaert and van Bastelaer (2001), indicators of social capital vary geographically and therefore what is considered an indicator for social capital in one country may not be an indicator in another country or society. It is worth noting that several proxies of social capital exist but those presented here were those specifically used by local people to adapt to CVC. The next sub-sections will discuss the choice of the study area, sources and data and mapping methodology.

12.2.1 Choice of Study Area

The criteria used for selecting the area were poverty, as it is said that the poor lack capacity to adapt (IPCC 2014), and history of exposure to climatic extremes, which provided test cases of how people are adapting. The study area, the Upper East Region (UER) (Fig. 12.1), was chosen because it is the poorest region in Ghana with more than 89 % of its inhabitants classed publicly as poor (Ghana Statistical Service et al. 2009). Most of the poor people depend on their own farm produce for household food supplies and are therefore vulnerable to CVC (Yiran 2014). The UER receives the lowest rainfall in the savannah zone of Ghana (Logah et al. 2013). Still, rainfed agriculture is the major economic activity. The poverty status of the region is attributed to failed agricultural production due largely to an unreliable rainfall pattern (MOFA 2007). The region also experiences all the hazards that occur in a savannah and is the first to be flooded when dams are spilled in nearby Burkina Faso. Furthermore, the UER is dominated by Guinea savannah and Sudan savannah (a degraded form of the Guinea savannah) which are fragile and believed to be degrading even further (Yiran et al. 2012). Thus, it serves as a good case to understand the kinds of social capital people employ to adapt to the hazards of the savannah ecosystem.

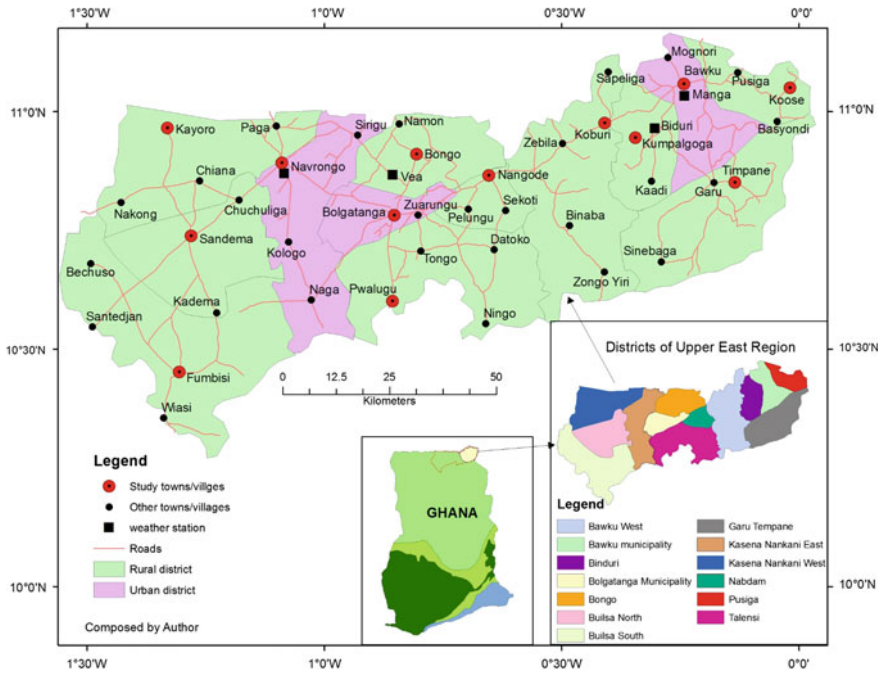

Fig. 12.1 Map showing the upper east and its location in the Savannah ecological zone

12.2.2 Sources and Data

The study adopted a mixed methods approach to collect primary and secondary data and analyse the social capital used to meet multi-hazards over a 30 year period (1983–2012). This period was chosen because it is the warmest period in the last 1400 years (IPCC 2014). The combinations of methods and data provided the research with verification and validation of data while minimising the inadequacies found in any method (see also Teye 2012).

For example, the quantitative data used to quantify the indicators were largely taken from secondary sources and therefore increased the reliability and validity of the results. Combinations of multiple methods (i.e., triangulation) have also been used in Europe for measuring social capital and proved useful (Mittelmark et al. 2007).

With the interviews, the household survey was conducted first, followed by the focus group discussions (FGDs) and in-depth interviews (IDIs). For the household survey, a multi-stage sampling procedure was adopted. First, 13 towns/villages, one for each district, were randomly selected using a procedure similar to restricted random sampling (Stevens and Olsen 2004). In this case, the three big urban towns (Bolgatanga, Bawku and Navrongo) were purposively selected to ensure that the study captured varying urban characteristics in the region. A list of villages in each

of the remaining districts was thoroughly mixed and one selected randomly. A condition that a selected village should be at least 10 km from another by road was applied, ensuring a good spatial distribution (see Fig. 12.1). The districts in the region are divided along major ethnic groups and therefore values and norms derived from one village will generally reflect that of the entire district. It must be mentioned that the initial village selected for the study in the Binduri District was Kaadi, but due to a mechanical fault on the way, the researcher had to use the nearby village, Kumpalgoga, instead. However, residents of Kumpalgoga did not have direct interaction with the nearest selected village, Kubore, as they are separated by the White Volta. Responses from Kumpalgoga proved useful for the study.

The next stage involved selecting households from the communities. Each community was divided into 4 quadrants and households randomly sampled from each quadrant, ensuring spatial coverage as much as possible. A total of 210 households were sampled using a formula proposed by Fox et al. (2007). With the exception of the big urban areas which were sampled in higher numbers based on the function of the town (regional, municipal or district capital), all other villages were assigned an equal number of 15 each. The sample was distributed this way because at the time of the survey, the number of households in each district was not known which made it impossible to distribute the sample proportionally. The sample was spread to cover as many ethnic groups as possible, especially the main ethnic groups, since norms and some practices vary from culture to culture.

Five FGDs were held in Navrongo, Bongo, Kumpalgoga, Tempane and Koose with the number of participants ranging between 12 and 15. Although the intention was to hold a FGD in each of the 13 towns/villages, discussions were halted after the fifth FGD because the data collected were similar and the discussions were considered to have reached a saturation point (Rebar et al. 2011). Participants in the FGDs comprised people with different backgrounds, experiences and gender. They include farmers, professionals, opinion leaders and youth. Each factor mentioned was discussed and a consensus reached. Proceedings were manually recorded by the researcher and an assistant, and the results were synthesised at the venue after each meeting. Ten (10) individuals in each town/village were also purposively selected for IDI, based on similar characteristics as above but with priority given to those who have been severely affected by CVC. All responses in the local language were translated into English. To cover, as much as possible, many people with diverse backgrounds, the selection of participants for all interviews was done such that no individual participated in more than one interview. Secondary data from various institutions and other published sources were collected to supplement the primary data in quantifying some of the indicators.

12.2.3 Mapping

The identified indicators were then converted to geographic layers for mapping. This was done using the district boundary layer because the basic unit of planning

in Ghana is the district and most secondary data are collected at the district level. Thus, the district is the unit of analysis. The geographic layers were then converted from vector data to raster data as this is considered more suitable for spatial analysis (Malczewski 2000, cited in Yiran 2014). After rasterisation, data were normalised and brought to a uniform dimension to avoid problems with mixed units. The rescale method (Eq. 12.1) was used to normalise the indicators.

$$\text{Normalised value} = \frac{\text{value to be normalised} - \text{minimum}}{\text{maximum} - \text{minimum}} \tag{12.1}$$

Equation 12.1 rescales all values in the data to range between 0 and 1 (Nardo et al. 2005). The rescale method was chosen because it avoids the use of positive and negative values of an indicator in the aggregation process. This makes interpretation of the composite index simpler and easier. After normalisation, the indicators were aggregated to obtain a single composite social capital index using Eq. 12.2. Equal weights were used in the aggregation process since it was difficult to determine the importance of indicators from the people (Nardo et al. 2005).

$$\text{CI} = \sum_{q=1}^{Q} W_q I_q \tag{12.2}$$

where CI = composite index, q = sub-indicator, Q = total number of indicators, W = weight and I = normalised indicator.

The final stage involved the evaluation of the indicators by performing robust and sensitivity analyses on the normalisation and aggregation methods and indicators themselves. This is done because according to Nardo et al. (2005) "good modeling practices require that the modeler provides an evaluation of the confidence in the model, assessing the uncertainties associated with the modeling process and the subjective choices undertaken, since the quality of a model depends on the soundness of its assumptions" (page 81). The robustness of the rescaling method was tested by using the standardised score (Eq. 12.3) normalisation which normalises indicators to have a mean of 0 and a standard deviation of 1 (Nardo et al. 2005).

$$\text{Standard score} = \frac{Value - mean}{standarddeviation}. \tag{12.3}$$

The normalised standardised score values for each indicator were aggregated by the weighted sum method and the composite index compared with the rescaled index. The geometric aggregation (Eq. 12.4) was used to test the robustness of the weighted sum method (Nardo et al. 2005).

$$\text{CI} = \prod_{q=1}^{Q} I_q^w \tag{12.4}$$

A sensitivity analysis was performed to determine the contributions, qualitatively and quantitatively, of the different sources of variation in the assumptions of using an indicator to the variation in the output and the dependence of the composite indicator upon the information used to compose it (Damm 2010). This was done by eliminating an indicator at a time and aggregating them. Mean volatilities [i.e., the standard deviations of the ranks of indicators (Groh et al. 2007)] of all methods and tests were computed to determine the significance of the variations. The next section presents the results.

12.3 Results

As stated earlier, mapping requires quantitative indicators and therefore proxies identified were quantified and used as indicators. The indicators were quantified either through scoring by participants in the survey or using data from relevant institutions and published data. Scoring of social capital indicators has been done in many studies (e.g., Morrissey et al. 2005). Though scoring may be subjective, the subjectivity was minimised by averaging the scores from all respondents for a particular indicator. This section is divided into 2. The first part presents the variables that were used as proxies for social capital and the data used to quantify them, and the second part the aggregated map of social capital.

12.3.1 Identifying and Quantifying Social Capital Indicators

12.3.1.1 Personal Relations Indicators

The respondents indicated they derive a lot of social capital from the family system. The family provides several benefits and support such as care for the aged and disabled, land for farming, childcare and even seeds for planting. Analyses of all interviews reveal that the family system (both nuclear and extended) is still strong and could be relied on in times of need. The family (both nuclear and extended) bonds and reliability to get assistance from the system were measured by averaging the number of times in the last 12 months that each respondent received assistance from their family members when they were in difficulty (see Fig. 12.2). Sabatini (2009) used a similar procedure to measure bonding social capital in Italy.

Outside the family, the people also considered their neighbours as important social capital, especially when hazards or disasters occur. Data from all FDGs indicate that in instances of hazards, people whose houses are damaged or destroyed are offered temporary accommodation by their neighbours or family members. Some also assist in evacuation of the weak/injured and contribute labour to rebuild or reroof the affected rooms. These kinds of assistance including money

were mentioned in the FGDs and IDIs as evidenced in a statement by an old lady in Kayoro: "*when my room collapsed, my husband's brother's son accommodated me until he fixed my room for me. When he was constructing it, the extended family members and some of our neighbours came to help. So to me, our kind of support is very beneficial to us, especially the most vulnerable, as we get assistance in many respects including feeding*". All (in both FGDs and IDIs), however, admitted that their help was insufficient to cover losses, though it cushioned the initial shock. This psychological relief fostered family and neighbourhood bonds and was a valuable benefit. But respondents perceived that this help from neighbours was dwindling. Self-help in urban areas was perceived to be dwindling faster than in the villages.

The head of an NGO in Bolgatanga stated that "*the dominance of same ethnic or family members in a neighbourhood fosters self-help in the villages more than in the towns which are cosmopolitan. People in towns sometimes don't even know their neighbours*". All respondents in the IDIs in the big towns admitted not knowing most of the people within their neighbourhood and having little interaction with other people they are not familiar with. Their responses indicate that over time people in compound houses are able to make a few friends in the neighbourhood while those in gated houses may live a lifetime without knowing their next door neighbours. Thus the level (not necessarily quantum) of assistance that can be obtained from neighbours and the satisfaction of belongingness were used to score the neighbourhood indicator from 1 to 4, where 1 represents a low level; 2—a moderate level, 3—a high level and 4—a very high level (see Fig. 12.2). This type of proxy measuring the extent to which a household would receive assistance from neighbours has been included in the social capital—integrated questionnaire (Grootaert et al. 2004).

12.3.1.2 Social Support Network Indicators

Receiving or sending remittances was considered very vital for adaptation as many relied on it, especially during the lean season, to buy food. For example, a widow in Fumbisi mentioned that "*nearly all my upkeep come from my children who live and work elsewhere because I am no longer strong to engage in any business*". An Accountant in Bawku also stated that "*I send money to my family members in the village every month to buy food, pay their children's school fees and take care of other needs*". Since receiving was higher than sending as more than 80 % of respondents indicated receiving rather than sending, the percentage of households receiving remittances was used to quantify this proxy and was obtained from the WFP (2012) report. This is a financial benefit derived from social network support (Scrivens and Smith 2013).

Livestock is an important asset that serves various purposes including economic and cultural. In the questionnaire survey, more than 90 % of all respondents sell livestock to buy food or inputs, or to meet other financial or cultural needs. It was unanimously stated in all FGDs that they share livestock during festivals. An elderly person in Pwalugu stated that "*the essence of sharing, especially guinea*

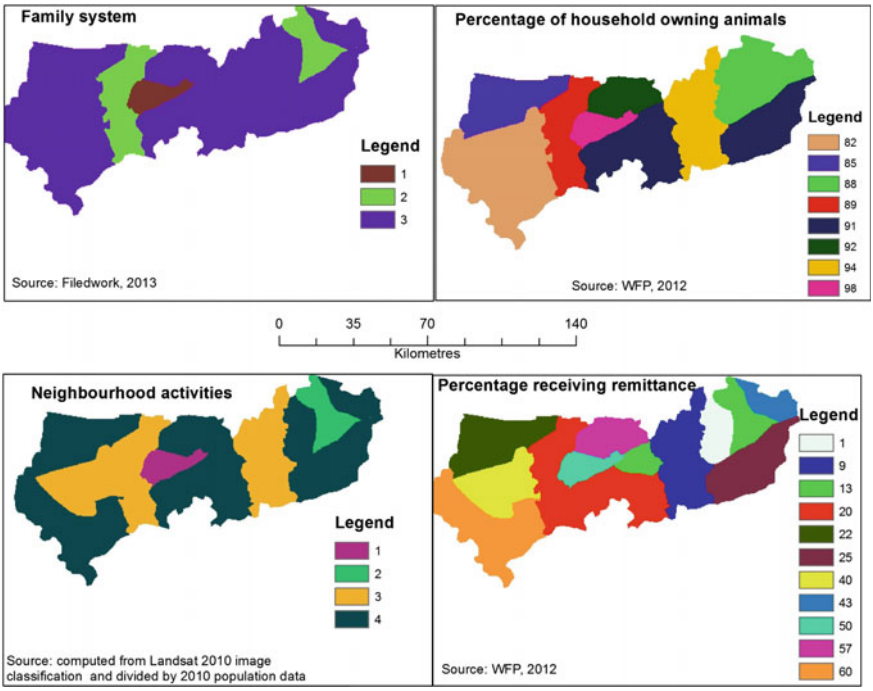

Fig. 12.2 Data used to map indicators

fowls during festivals is to show love to our family members and friends and also provide for those we think cannot afford to celebrate the festival". A widow in Nangodi confirmed this practice by stating "*I have received guinea fowls from people here on several occasions*". The majority believed this sharing increases the bond they have as a family and community. Livestock was also used by family members in all communities to pay bride prices and perform sacrifices. Thus livestock ownership signified both social network support and corporate norms (Scrivens and Smith 2013). The percentage of households that owned animals was obtained from the WFP (2012) report and used (see Fig. 12.2).

The level of skills and training was used as a proxy because from the interviews, it was gathered that the skills of individuals are put to use when properties, especially houses are affected. Respondents also indicated that they train the younger ones, thus offering them income generating or employable skills and making them relevant to society. In an interview with a dress maker in Bawku, she stated that "*I have trained many young girls in this area and all those I passed out have their shops and also training others*". Data for skills were obtained from the 2010 census report (Ghana Statistical Service 2013). Although skills are considered human capital (Kwon 2009), they were used because they form part of Scrivens and Smith's (2013) social network support where people put their professional knowledge and experience to use for the benefit of others. Also, some kinds of

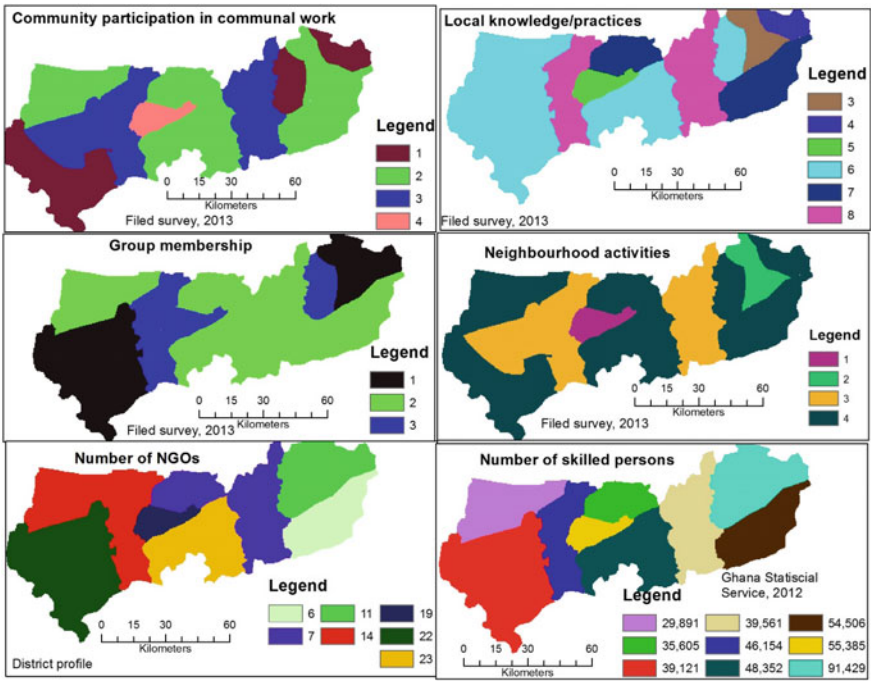

Fig. 12.3 Data used to map indicators

human capital act to support social capital (OECD 2001). Over the years, the people, by learning and doing, have gathered substantial knowledge and experience about their environment which they apply for their own benefit. These include desilting, cleaning, soil conservation practices, erosion control, health prevention practices, flood recession farming and dry season gardening. The number of practices respondents stated were counted and used to map local knowledge (see Fig. 12.3). Similar reasons above were considered for the use of this form of human capital.

12.3.1.3 Civic/Community Engagement Indicator

Farmer groups and market women's associations not only boost economic activities of the people but also strengthen collective efforts generally. In the FDG in Kumpalgoga, the people mentioned that they are organised into groups through which they access credit from BESSFAR (a Rural Bank) for their businesses (farming and trading). The group members have become like a family, being each other's keeper and assist each other, especially those who are hard hit. These groups, according to the people, are formed by people who trust each other, especially when it comes to repayment of loans. Similar groupings existed in other

villages where group members offer varied assistance to each other. In an IDI in Bolgatanga, a Christian member stated that "*in my church, we have societies which people are encouraged to join and each society has a welfare scheme for members in addition to the one by the church herself*".

Some religious groups also offer assistance to non-members in the form of food aid and others. For example, a young widow in Nangodi stated that "*I have received food aid from the catholic church on many occasions especially during the lean season*". More than 60 % of respondents in each town/village belonged to a group (sectional, religious, farmer, trade, etc.). The sense of belongingness, trust and the assurance of receiving assistance from a group were used to score group membership from 1 to 3 for low, medium and high respectively (see Fig. 12.3). The sense of belongingness, participation in voluntary organisations, involvement in groups, providing help to others and group homogeneity (e.g., cultural or ethnicity, religion) were among factors considered for measuring community participation, civil engagement and commitment in Canada (Bryant and Norris 2002).

The community members also organise to undertake communal work. Interviewees in the big towns mentioned cleanup exercises as a major form of communal work. The villagers also mobilise and contribute communal labour for community projects. However, from all FDGs, it was a unanimous view that the communal spirit of the villages is dwindling. The reasons assigned were a mix of factors including money inducements by some NGOs, politics, education, individualism, modernisation, the use of technology and poverty. For example, an elderly man in Pwalugu, noted that "*when I was a young man, anytime there was a community work, a word comes from the chief's palace and everybody jumps on it, but now very few people turn out. Most people feel they should be paid*". In all FDGs it was stated that a good number of people still participate in community development projects and where community members are made aware from the onset that their contributions to the project is communal labour, more people participate. The ability to organise and undertake communal work based on a history of such activities was scored 1–4 for low, moderate, high and very high communal work spirit respectively (see Fig. 12.3). Some of these measures were included in Sabatini's (2009) measures of linking social capital and Grootaert et al.'s (2004) social capital—integrated questionnaire.

12.3.1.4 Corporate Norms

From analysis of the questionnaire, land, the base of economic activity in UER, is accessed largely by inheritance. More than 65 % of the respondents got access to land through inheritance. Women were regarded as part of their husbands' family and got land through that lineage. The rest got land either by borrowing, buying, and renting or through a combination of these. However, as the population grows, land may become scarce since land is fixed. This is evidenced in a statement of a respondent in Bolgatanga that "*I travel to other places to get additional land for farming because our family land has been used for residential purposes and the one*

left is so small that it cannot support the family". Thus, land availability was used as a proxy. It was quantified by dividing unoccupied land (i.e., land with no building, road, protected area, or waterbody on it), extracted from a 2010 Landsat image classification, by the population of the district using the 2010 census figures (Ghana Statistical Service 2013) (see Fig. 12.3). Although land is considered a natural form of capital, its mode of acquisition (inheritance) is an integral part of the culture or norms of the people which can be considered as cognitive social capital (Grootaert et al. 2004). NGOs operate in the area and were regarded as vital social capital by the respondents. According to them, NGOs offer food aid, health care, financial assistance, advocacy and capacity building and bring developmental projects to them. The number of NGOs operating in a district was obtained from the district profile and used (see Fig. 12.3). Sabatini (2009) considered these organisations as corporate social capital.

12.3.2 Mapping

The map produced by aggregating all the social capital indicators is shown in Fig. 12.4. As can be seen in Fig. 12.4, there are variations in social capital by district, ranging from 0.32 to 0.68. The districts with the highest capitals are Bongo,

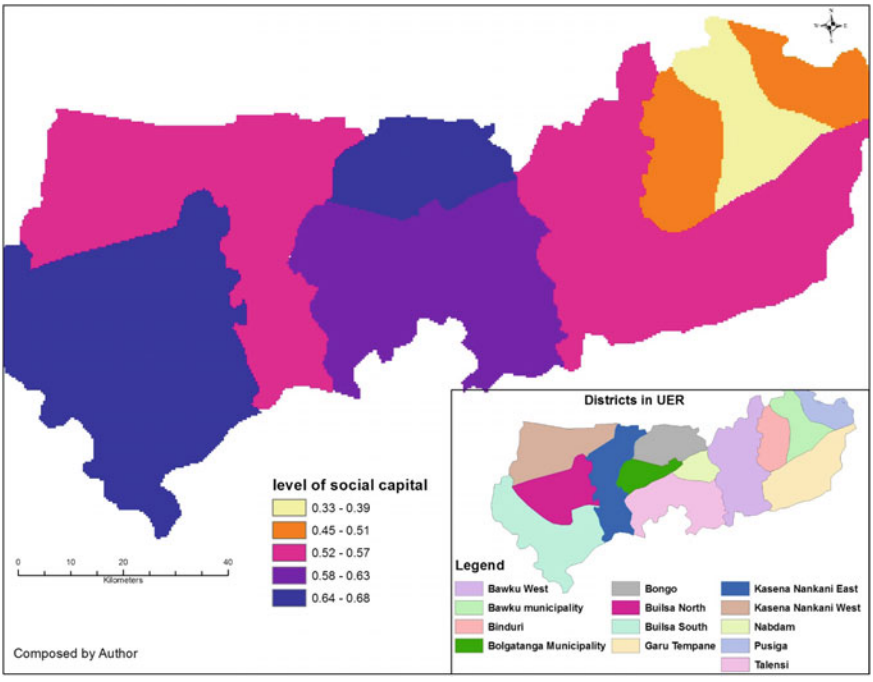

Fig. 12.4 Social capital of the upper east region

Builsa North and South while Bawku Municipal has very low capital. The rest fall in between. The evaluation of indicators and methods produced mean volatilities for all tests below 0.4. If the mean volatility of any method or index is above 0.5, then the difference is significant and the method is not robust, or the index is sensitive to a particular indicator (Damm 2010). Thus, results were good and can be relied upon. To overcome information loss due to compression of data to lie within 0 and 1, and to surmount the difficulty in interpreting dimensionless indices, reference was always made to the original data that are used to compose the index in the discussions (Abson et al. 2012; Yiran 2014).

12.4 Discussion

Generally, all districts have social capital which can complement other adaptive capacities. These forms of capital have always been relied on and were found by Yiran and Stringer (2015) to be more reliable than external (government and NGOs) aid. According to Yiran and Stringer (2015), external aid is usually insufficient and arrives late, but aid/assistance from family and neighbours is timely and cushions victims from initial shocks. This corroborated the assertions of most respondents that support from family members in particular relieved them psychologically. The map (Fig. 12.4) shows that social capital varies even at the local level. The range may be narrow (0.3–0.7) but it supports the theory that social capital is variable at any spatial level.

As shown in Figs. 12.2 and 12.3, the various indicators of social capital vary. The variations resulted in the composite index varying from district to district. The major contributor to the variations is the family system. Family support is still strong especially in the rural areas. There is much trust in the family system in the rural areas and this is reflected in their value systems, relationships and remittances. This is because of the stronger bonds that exist in families, especially between parents and children as noted by Parcel and Menaghan (1993). Families share and give items (food, land, livestock and other items) and help each other. This increases the bond between family members. Sharing, giving and helping are found to be associated with an increased sense of dignity and positive feelings (Wilton 2012). Studies have shown that people, especially the aged and orphaned children, depend on the extended family system for basic needs including food (Mokomane 2012; Jæger 2013; Tanga 2013). This is particularly important in adapting to climate change and related extremes as affected people can rely on family members for survival. The family is the unit upon which communities, especially the rural ones are built. Thus, the Builsa North and South and Bongo Districts which had the highest aggregate social capital exhibited stronger family related proxies (e.g., remittances, land availability, family system, neighbours and animal ownership). However, low remittances and land availability made the social capital of Talensi and Nabdam Districts slightly lower than the above districts and put the Talensi and Nabdam at the second level.

As population grows, families will be fragmented and property, especially land, has to be divided in accordance with the inheritance system and this may result in conflicts which tear the family apart. Tsikata and Seini (2004) noted the occurrence of conflicts arising from land and chieftaincy among several communities in Northern Ghana. Cox et al. (2014) also found that conflicts deepen, among other things, social fragmentation and mistrust. These greatly affect social cohesion and social support such as provision of temporary accommodation, sharing of food especially during festive periods and the lean season, communal work and other kinds of support which are vital for adaptation. The conflict in Bawku Municipality could greatly explain its lowest social capital. This conflict had spillover effects on Pusiga and Binduri Districts which were recently carved out of Bawku Central District, and this could also be the major reason for their low social capital. Some people in these districts are also reported to be migrant farmers (Yiran and Stringer 2015), a situation which partially contributes to their low social capital.

The strong bonds derived from the family system also make people respect family/community norms. The entire community/village is seen as one big family with one lineage which is reinforced during funerals and festivals. Thus, nobody is expected to do something that will harm a family member or a close associate (McGrath and Sparks 2005). This most likely increases neighbour assistance and participation in group or community activities. Increased neighbourliness, group activities and community engagement are very useful for adaptation as family, neighbours or community members will always be the first to offer assistance. They are also useful because CVC impacts are experienced over a wide space, thus affecting many people, and adapting will require a concerted effort from all concerned. However, the breakdown of the family system will most likely affect family support and communal activities and hence adaptation greatly. Korboe et al. (2011) have warned of potential destitution due to the declining extended family system.

A consequence of the breakdown of the family system is reduced trust of each other. Although trust was not measured or scored directly, it was always used as one of the variables to score the indicators. Trust declined faster in urban than in rural areas because urban areas are increasingly becoming cosmopolitan. This supports the findings of many studies that the relationship between generalised trust and diversity is negative (Costa and Khan 2003; Alesina and La Ferrara 2005; Stolle et al. 2008). Reduced trust also accounted for the low social capital of Bolgatanga and Bawku Municipalities and Kassena-Nankana East District. However, in these urban areas new families are built along religious lines and other groupings, generating a new kind of trust among members. These new families act like family members, caring for each other. Trust can increase the interactions among people and thereby increase community spirit and participation in community activities (Costa and Khan 2003). Increased interaction among people may also lead to increased information sharing which can be vital for adaptation. Bryan et al. (2007) found that there is more information sharing through social and informal networks than formal means. In the study area, information is shared

largely by word of mouth between friends and family members, especially in rural areas where access to print and electronic media is limited (Yiran and Stringer 2015).

Related to increased community engagement is community participation in project planning and implementation. The contribution of communal labour increased where community members were involved in the planning phase of the projects or were made aware of their responsibilities toward the realisation of the projects. This underscores the importance of community participation, especially for adaptation to CVC as reported by several studies (e.g., Nelson et al. 2008; Stringer et al. 2012). Community members have over the years gained substantial knowledge by learning and doing which can be useful for adaptation planning. Community/local knowledge played out strongly in the Bwaku West, Binduri, Nangodi, Builsa North and South Districts where people use various means to adapt to different types of climatic hazards. However, Kajan et al. (2011) stated that when people or communities are acknowledged they are willing to contribute more, and that emphasising the necessity of communal actions will foster a sense of belonging and hence social capital will be strengthened. Thus, through community engagement with government and development partners, some of these experiences and knowledge, especially those that are community specific, can be ulitised to enhance adaptation to CVC.

12.5 Conclusion

Generally, all districts have social capital that can be built on for effective and sustainable adaptation to CVC. As found in the study, Bongo and Builsa North and South Districts ranked highest, followed by Bolgatanga, Talensi and Nabdam. The third group comprised Kassena-Nankana East and West, Bawku West and Garu-Tempane followed by Binduri and Pusiga. Bawku Municipal occupied the bottom. The study shows that social capital varies among the districts, thus extending the thesis of geographic variation of social capital further to the micro level. Methodologically, the chapter has also contributed in integrating methods of measuring social capital with a mapping methodology developed for vulnerability studies. This makes it possible to visualize the variations of social capital at any spatial level. The mapping has also produced a single index combining all indicators of social capital using weights. Weights represent the relative contributions of indicators to the adaptation process and also provide the opportunity to include as many variables as possible. The single index shows the level of social capital in each district that can be used to enhance adaptation. The results also show that most of the proxies used to map social capital of the various districts are being used to adapt to CVC. Therefore social capital is relevant and should be mainstreamed into state policy to aid the people to adapt effectively to CVC. It is therefore recommended that state agencies and development partners interested in adaptation policy and implementation should include social capital. Revitalising and harnessing the

proxies that are perceived to be dwindling may not require substantial financial resources as they are already part of the cultural setting. Therefore Ghana's Environmental Protection agency, in collaboration with state institutions such as the National Commission for civic Education and the Information Services Department should continuously sensitise the people on the need to maintain the social systems. As society is dynamic, this capital will change over time and therefore it needs to be measured periodically for sustainable adaptation policy planning.

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Chapter 13
Conclusions: Emerging Issues and Recommendations

Jan Hesselberg and Joseph A. Yaro

The IPCC (2014a) states that for hundreds of years the weather has generally been unpredictable in the developing world. Rainfall has been erratic and different lengths of drought periods have been "normal" in many places. This also applies to rural West Africa. Furthermore, there is a spatial differentiation in weather variability, with some areas more prone than others to this variability and its negative effects on people's livelihoods. Also in West Africa the degree of negative impact of weather variability on society is different across space, with drier areas typically more exposed than wetter ones. Climate change has already aggravated this situation according to IPCC (2014b). This is thoroughly described in Chaps. 2 and 3 of the present book.

The few existing studies of old people's life experiences of droughts and rainfall change support the climate change trends described in the IPCC reports (Amadou et al. 2015; Bawakyillenuo et al. 2014; Teye et al. 2015; Yila and Resurreccion 2013). Towards 2050 climate change will have even a stronger negative influence on especially agriculture and the income and life of particularly small- and medium-scale farm households *regardless* of a possible implementation of mitigation actions following the agreement achieved in COP21 in Paris in December 2015 (United Nations 2015). Extreme weather events will be more frequent and more intense, rainfall will be less, temperatures higher, drought spells of longer durations, and violent winds more common. The Sahel climate zone will spread gradually southward and westward (Marc et al. 2015). In short, in most places in rural West Africa a difficult weather variability situation will become even more

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J.A. Yaro and J. Hesselberg (eds.), *Adaptation to Climate Change and Variability in Rural West Africa*, DOI 10.1007/978-3-319-31499-0_13

difficult due to climate change. Although there will be some spatially uneven effects with some areas getting more rainfall, for instance, the net effect for West Africa is expected to be negative. Thus, people's traditional adaptation and coping strategies will have to be strengthened and renewed. Novel strategies must also be found to ensure first and foremost an avoidance of a deteriorating level of living (O'Brien and Selboe 2015a). Traditional adaptation measures are described in Chap. 6 in the case of farmers in the savannah agro-ecological zone of northern Ghana. The adaptation capacity of farmers depends, among other things, on their local level knowledge. The question for the future is: to what degree is this knowledge adequate for the added consequences of climate change? Since climate change hits the poorest and women (those least responsible for it) hardest, fundamental structural transformation in production and distribution of goods and services should be made in all countries in West Africa (Resurreccion 2013; Hallegatte et al. 2016).

A starting point for creative thinking on climate change adaptation in rural West Africa should be to avoid limited sectoral views and to move towards an integrative multi-sectoral approach that regards agriculture, ecosystem management, rural development, and other aspects of rural community well-being as interconnected systems. Pursuing such a holistic approach also calls for coordination among formal and informal institutional mechanisms, such as local networks of reciprocity and formal public social protection arrangements. Furthermore, multiactivity at individual and household levels has been widespread in most rural areas for a long time (Hesselberg 1985). This also applies to West Africa. In Chap. 5 it is shown that farmers in northern Ghana are multiactive by engaging in off-farm economic activities due to climate change and weather variability. However, even during periods of favourable rainfall patterns, farm households engage in non-agricultural economic activities both locally and/or in towns in order to increase their income. Thus, these activities are not only a kind of stress-driven income diversification (Djurfeldt and Djurfeldt 2013).

A common phenomenon in the developing world, which is also found throughout West Africa, is the gradual disappearance of traditional ways in which rural communities share risks. An example of this is included in Chap. 10 regarding northern Ghana. These networks, which often comprise several neighbouring communities, that is, they constitute multi-local social security (Djurfeldt 2014), are not fully replaced by formal systems organized by governments. Informal safety nets (Heltberg et al. 2015) used to be sufficient for most households in periods of moderate severity of weather variability events. Today there is a double squeeze of reduced commitment to local level reciprocity among households *and* more severe weather events caused by the fact that traditional weather variability is being enhanced by climate change. Chapter 12 discusses how to strengthen local adaptation capacity by supporting social capital in small rural communities. A finding in northern Ghana is that improving social capital in one community may lead to conflicts with neighbouring communities, thus increasing cross-community conflicts over natural resources.

Labour migration and to a more limited degree permanent migration from rural areas have for a long time been a strategy of individuals and households to

accumulate wealth. Migration is also a coping strategy for climate-related stress (Rademacher-Schulz et al. 2014). When a household anticipates a bad harvest, efforts to earn money in an urban area and remit it back home for consumption purposes are also common in West Africa. This is a household strategy caused by expected food shortage due to climate change and traditional weather variability. However, as shown in Chap. 9 regarding Mali and Senegal, there is seldom one reason for rural outmigration. Although economic causes may be dominant, environmental factors also do influence migration patterns.

In sum, the point is that for small-scale farming households, relying solely on agriculture or being multiactive, or depending on local and multi-local safety networks, together with relatively new public social security policies, are seldom sufficient to sustain even a low level of living. To expect both a sufficient strengthening of local level community commitments and a rapid increase in welfare arrangement organized by governments is unrealistic, politically speaking. Thus, it is difficult to foresee a solution that can retain the livelihoods and income levels of poor farmers, not to mention a reduction of rural poverty in general. There is a high probability that the rate of outmigration from rural areas in West Africa will increase quite substantially in future.

The challenge for the world now is how to find technological and political ways in which both to decarbonize energy systems and eliminate poverty. A continuation of the present dependence on fossil fuels and without a fundamental change in the global economic system will drive the world to climate change tipping points with irreversible catastrophic results (Klein 2014). Thus, a radical transformation of society is necessary. A continued neo-liberal approach that relies on the "free market" as a solution is not sustainable. The way forward must be to find strategies for mitigating climate change impacts while *also* helping poor people, that is, without depriving them of development. Strategies that only ameliorate environmental problems, and which may have negative consequences for the poor, should not be seen as appropriate. A fundamental problem is how such necessary change can be implemented when economic and other politically powerful elites may lose some of their status. To address this problem requires a new role for the state as well as regional and global cooperation that focuses on the twin-goals of environment and poverty simultaneously. For rich industrialized countries this may entail a "selective [economic] degrowth" (O'Brien and Selboe 2015b), which would represent a difficult political and social adjustment challenge. Without such an adjustment it seems impossible to envisage a process of the necessary industrial growth with modern clean technology in poorer countries.

Regional market integration among countries at approximately the same level of economic development in West Africa is important to increase the rate of industrialization in each and every country in the region (Ayuk and Kabore 2013). Further industrialization and urbanization in West Africa are necessary both to alleviate the pressure on agricultural land and to create employment. Poor farmers need to expand their cultivation in order to escape poverty. Furthermore, those rural poor who prefer to leave their home places need urban employment opportunities created by industrial and service development. The World Bank, for instance,

points to the necessity of resettling people due to climate change since farming yields are likely to fall quite drastically in some areas in rural West Africa (Marc et al. 2015). It is then fortunate that it is simpler to reduce the negative impact of climate change on people's livelihoods in urban than in rural areas.

Undoubtedly, rich industrialized countries in the North should reduce their greenhouse gas (GHG) emissions more rapidly in the near future than is the case today in order for countries such as China and India to reduce their greenhouse gas slowly but relatively soon. The rest, the poorest countries, can cut their greehouse gas emissions later after having industrialized through ecological and technological leap-frogging. This does not imply pollution first, clean up later. The Green Climate Fund for, among other things, clean technology, must become substantial enough to facilitate industrial growth in poor countries in an environmentally friendly way. Thus, the mantra should be "clean technology now". This will, however, include the difficult political question of private patent rights.

The negative change in the West African monsoon (Eriksen et al. 2015; Sylla et al. Chap. 3) is an example of imminent climate change. Already agricultural losses are experienced in, for instance, maize and wheat yields. Such yield declines will be more severe and more frequent in future (WWF 2015). Thus, food production and agriculture in general must change so that land and water sources are not degraded and the impact on GHG emissions is minimized. Chapter 11 discusses at length the need for climate-smart agriculture in particular and for ecosystem-based adaptation in general. Traditional adaptation measures in cultivation among farmers in Benin and Burkina Faso are described in Chap. 4 with an emphasis on how these ways of coping respond to seasonal variations in rainfall successfully. The different experience and perception of risk between rural and peri-urban people is shown in northern Ghana in Chap. 10. Generally, current mitigation activities to lower global GHG emissions are only incremental. In addition, the positive adaptations undertaken now to reduce disaster risks do not represent a process that benefits all people. Much more radical societal change is needed, and more rapidly. We believe that strategies and policies to mitigate direct and indirect effects of climate change cannot be expected to come only "from above", that is, from politicians and cooperation among governments and economic elites. Global environmental movements also have an essential role to play in the solution, not least in pressuring those in power to act sooner rather than later. Thus, the adoption of adaptation measures has to be based on a process of change both "from below" and "from above". In our view, it is not realistic to expect that the necessary collective actions will spring from global climate change conferences. Local adaptation and mitigation activities by people themselves are a must. It is thus imperative that adaptation and mitigation policies are seen by the poor and near poor as benefiting them. Moreover, paradoxically enough, in order to enlist the cooperation of economic elites and the otherwise powerful in society, it is necessary that these people also see that proposed changes will benefit them both in the short and in the longer term. Furthermore, collective action including both rich and poor people will probably require quite a drastic reduction in income inequality in most countries, also in West Africa. Equity matters because it is required for a society's

cooperation in meeting climate change challenges (Climate Equity Reference Project 2015). These facts underlie the enormously difficult task ahead in formulating strategies for climate change amelioration.

It must not be forgotten in this debate that although climate change will have somewhat different content and severity over space and time, it will always be embedded in global, national and local trends of change, both physical and societal. Thus, it is unlikely that the solution to climate change and its effects on rural livelihoods is only technical innovations and inventions (Weichselgartner and Kelman 2015). There exists no single factor or easy to fix solution that does not threaten the present global economic system. Moreover, several aspects of society and people's lives will be affected by the adoption of mitigation activities, and then political and other conflicts are likely to arise. To foresee and analyse such possible conflicts is essential. For instance, resistance to necessary change in underlying structures of vulnerability and risk should be expected not only from rich people, who may lose some of their privileges, but also from ordinary people afraid of being unable to retain their accustomed sources of meagre income. The needed mitigation and adaptation strategies to climate change should thus also include poor people's life aspirations. This is brought out in Chap. 8 which focuses on the importance of education as an adaptation measure. Furthermore, it is important to remember that most policies and strategies that focus on solving a problem for some people typically have some negative effects for others and/or may impact negatively on everybody, or primarily the poor, on other aspects than those being addressed. Additional policies should therefore be implemented to tackle such unintended consequences.

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