



KNOMAD WORKING PAPER 25

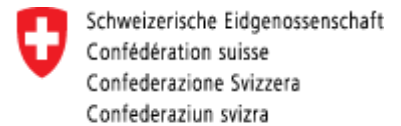
Vulnerability and Resilience in West Africa: Understanding Human Mobility in the Context of Land Degradation

Barbara Bendandi

Marco Venier

April 2017





**Swiss Agency for Development
and Cooperation SDC**



The KNOMAD Working Paper Series disseminates work in progress under the Global Knowledge Partnership on Migration and Development (KNOMAD). A global hub of knowledge and policy expertise on migration and development, KNOMAD aims to create and synthesize multidisciplinary knowledge and evidence; generate a menu of policy options for migration policy makers; and provide technical assistance and capacity building for pilot projects, evaluation of policies, and data collection.

KNOMAD is supported by a multi-donor trust fund established by the World Bank. Germany's Federal Ministry of Economic Cooperation and Development (BMZ), Sweden's Ministry of Justice, Migration and Asylum Policy, and the Swiss Agency for Development and Cooperation (SDC) are the contributors to the trust fund.

The views expressed in this paper do not represent the views of the World Bank or the sponsoring organizations. Please cite the work as follows: Name/s of Authors, Year, Title of Paper, KNOMAD Working Paper No.

All queries should be addressed to KNOMAD@worldbank.org. KNOMAD working papers and a host of other resources on migration are available at www.KNOMAD.org.

Vulnerability and Resilience in West Africa: Understanding Human Mobility in the Context of Land Degradation*

Barbara Bendandi and Marco Venier†

Abstract

The loss of productive land is often one of the key drivers of human mobility. Land degradation might lead to increases in migration because of the need to diversify incomes, but it can also cause reduced mobility by eroding the financial or physical assets and capital required to finance migration. When on-site adaptation is either impossible or undesirable, migration allows people to modify their exposure to climate and environmental stressors. On one hand, temporary and circular labour migration, internal and international remittances, and family relocation are among the most common strategies used throughout history, and increasingly so in the past decades, to cope with harsh climatic variations, increasingly hostile natural environments, and natural disasters. On the other hand, land abandonment and out-migration can lead to further isolation and marginalization of both vulnerable rural populations (increasing their vulnerability if migration occurs in unplanned ways) and migrants who relocate toward areas of high environmental risk, such as resource-scarce or urban areas within insecure expanding cities. Based on existing evidence on the West Africa region, the research in this paper aims at gaining a better understanding of how land degradation interacts with drivers of migration by analysing the factors determining vulnerability at individual, household, and community levels, as well as those factors affecting capacities—whether inherent or acquired—and strategies that contribute to building resilience.

Keywords: Land degradation, migration, West Africa, resilience, adaptation

*Paper produced for KNOMAD's Thematic Working Group (TWG) on Environmental Change and Migration. KNOMAD is headed by Dilip Ratha; the Environmental Change and Migration TWG is chaired by Susan Martin; and the focal point in the KNOMAD Secretariat is Hanspeter Wyss. The authors would like to thank the Migration, Environment and Climate Change (MECC) division of the International Organization for Migration (IOM). The paper also benefited from editing by Susanne Melde and Lorenzo Guadagno (IOM).

† Barbara Bendandi works as Policy Officer on migration for the United Nations Convention to Combat Desertification (UNCCD). She earned a master's degree at Columbia University (New York) and is pursuing a Ph.D. in Science and Management of Climate Change at Ca' Foscari University (Venice). Marco Venier is a Communications and M&E Specialist at the United Nations Office on Drugs and Crime, based in Dakar, Senegal. He holds a master's degree in Global Politics from the London School of Economics and Political Science (LSE).

Table of Contents

1. Introduction.....	1
2. West Africa: Vulnerable Livelihood Systems in Degrading Lands	3
2.1. Reduced Water Availability	5
2.2. Decreased Land Productivity.....	6
2.3. Groundwater Salinization.....	6
2.4. Increased Vulnerable Conditions and Unsafe Paths: Cases across the Region.....	7
3. Resilient Pathways toward Adaptation	9
3.1. A Theoretical Framework for Ecosystems and Mobility.....	9
3.2. Mobility Patterns in West Africa	12
4. Policy Recommendations and Roads Ahead	14
References.....	17

1. Introduction

Slow-onset hazards are chronic events that gradually perpetuate their impacts on livelihoods and ecosystems,¹ in contrast to severe sudden-onset events. Although the effects of gradual changes are less easy to perceive because they can only be measured over a long period, they tend to affect a larger number of people. Often characterized by incremental changes over time, land degradation and sea level rise are difficult to measure and predict with any level of precision because thresholds and recovery potential are uncertain (UNEP 2006).

Many would argue that there is no agreed-upon definition for land degradation, and it is often understood to be a subjective term or classification contingent upon the values and priorities of relevant stakeholders (Caspari et al. 2014). The United Nations Convention to Combat Desertification (UNCCD) has defined it as the loss or reduction of biological or economic productivity and complexity to capture the most important dimensions of sustainable development (UNGA 2012), given that social and cultural benefits are linked to one or both types of productivity.

Considering that land is a main source of livelihoods in most developing countries, land degradation is a highly relevant factor influencing vulnerability and resilience—it affects individuals' daily lives, disrupting the basic survival assets of rural populations, particularly small-scale, resource-poor farmers. In response to circumstances where livelihoods or habitats are slowly eroded, land-dependent people are faced with varying choices for seeking new ways to ensure sufficient food for everyone.

According to Tschakert (2006), the concept of resilience originates in ecology and is used to define the capacity of a system to absorb sudden changes and disturbances while maintaining its function and control (Gunderson and Holling 2002). If adaptive capacity, that is, the capacity for renewal and reorganization and the element of learning in response to disturbance (Carpenter et al. 2001), is a key element of resilience, vulnerability can be considered its flipside. Folke (2002) similarly defines vulnerability as declining or lost adaptive capacity that lowers the ability of social actors to absorb change.

With the current state of knowledge, proving that certain types of migration occur exclusively in response to slow-onset events is methodologically challenging. Although it is a multi-causal phenomenon, populations have historically resorted to human mobility to reduce exposure to external stressors and cope with or adapt to the lack of resources (IOM 2014a). This view challenges the notion of vulnerable groups as “passive victims” and highlights people’s strategic responses (Tschakert 2006) to adverse conditions, including depletion of land-based assets and unpredictability of climate variability. In rural contexts, resilience strategies help provide an

1. The Cancun Agreements (UNFCCC 2011, decision 1/CP.16) use the term “slow onset events” to describe sea level rise, increasing temperatures, ocean acidification, glacial retreat and related impacts, salinization, land and forest degradation, loss of biodiversity, and desertification.

understanding of and prediction of responses to slow changes and climate variability, as well as people's capacity to adapt to future changes (Burton et al. 2002; Smit et al. 2000).

West Africa is a case in point for both analysing vulnerability through the lens of slow-onset events and mapping resilience strategies that use migration as a response to changing conditions. Broadly exposed to land degradation and vulnerable socioeconomic systems, the region features the highest intraregional mobility worldwide; 76 percent of migrants crossing national borders remained within the region in 2010 (UN DESA 2012). It is estimated that one West African out of three—about 100 million people—lives outside his or her village of birth (de Haas 2007). The high rate of human mobility is also due to the freedom of movement afforded to the citizens of the 15 member states of the Economic Community of West African States (ECOWAS).²

The main purpose of this study is to analyse how land degradation influences vulnerable ecological systems, shaping decisions to undertake mobility as a means for increasing resilience at the individual, household, and community levels in selected countries in West Africa, such as Burkina Faso, Chad, Ghana, Mali, Nigeria and Senegal. To this end, the report focuses on vulnerability of smallholder systems to provide evidence that land degradation might cause threshold scenarios in which on-site adaptation is no longer suitable or desirable. Finally, while considering the limits of context-specific behaviours and conditions, the paper discusses resilience-driven mobility choices by taking a trade-off perspective on availability of and access to resources, institutional networks, and social capital.

The aim is to formulate recommendations policy makers can use to (1) recognize when mobility is a response to harsh environmental conditions and (2) foster resilience strategies that consider addressing local vulnerabilities, migration, or intermediate solutions.

Section 2 analyses threshold scenarios by discussing examples of increased vulnerability caused by recurring West African land degradation processes such as reduced water availability, decreased land productivity, and groundwater salinization. Several resilience strategies involving migration of one or more household members are presented in section 3 to provide an overview of different scenarios, including failure in adaptation. Section 4 discusses how to foster positive resilience strategies and address situations of increased vulnerability. The paper concludes by stating the need to provide appropriate incentives, such as access to credit and land tenure, conducive to developing solutions that reduce vulnerability (caused by the lack of assets necessary for survival or unsafe migration routes) and promote resilience.

Although the effects of land degradation in West Africa have been studied (Agrawal and Perrin 2009; Caspari et al. 2014; IPCC 2007; among others), the research on adaptation so far has predominantly emphasized technical and infrastructural adaptive strategies, and given only

2. Founded in May 1975 through the signing of the Treaty of Lagos, ECOWAS's overarching goal is to promote and facilitate economic cooperation throughout the region. Member states comprise Benin, Burkina Faso, Cabo Verde, Côte d'Ivoire, The Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togo. Mauritania and Chad are not part of ECOWAS although they are geographically located in the West Africa region.

limited consideration to adaptation strategies, including mobility, used by the most vulnerable individuals and groups (Tschakert 2006). This paper attempts to fill this gap and complement existing adaptation studies by placing “mobility choices” at the center of the analysis.

Most of the studies on West Africa discuss either regional trends or local cases, often lacking reliable and comparable national-level data and analysis (Dow 2005; Sarr 2012; Warner and van der Geest 2013; Wouterse 2008). In light of the current state of the literature in the region, this analysis drew from a selection based on geographical criteria and relevant geophysical processes to infer possible recurring scenarios. The conceptual approach is based on the premise that context-specific cases contain lessons for policy makers and can provide useful insights for possibly wider and systematic approaches.

2. West Africa: Vulnerable Livelihood Systems in Degrading Lands

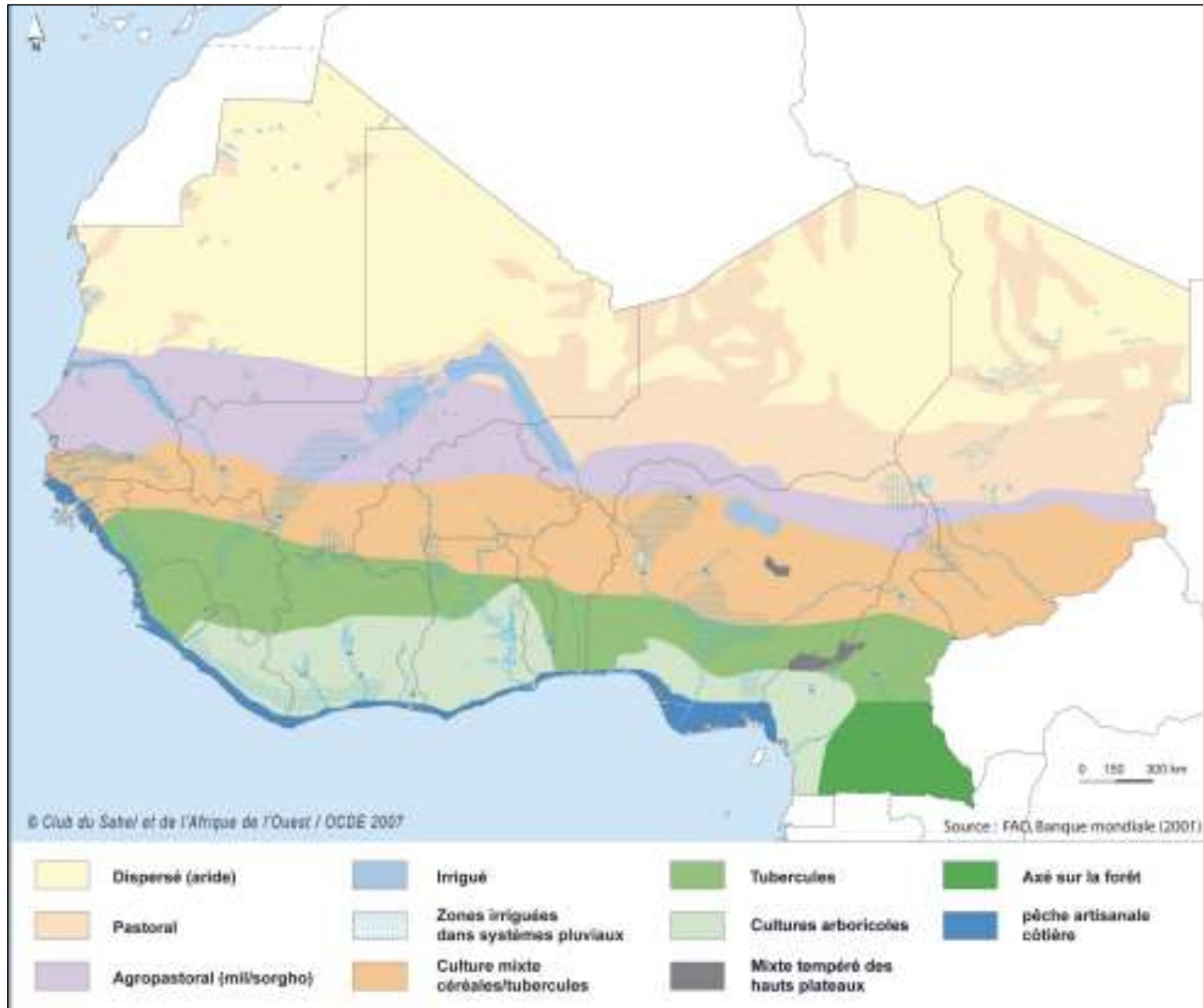
With the aim of understanding how land degradation influences the most vulnerable populations, this section examines different types of slow-onset events in West Africa, with a focus on identifying thresholds for habitability and survival.

Vulnerability as a measure of the degree to which an entity may be hurt or influenced has been applied to different contexts: food security, poverty, and natural and climate studies (Leichenko and O'Brien 2002). Within the climate literature, the most vulnerable are considered to be those who are most exposed to hazards, have limited adaptive capacity, and are least resilient (Bohle, Downing, and Watts 1994). At the individual and household levels, the degree of vulnerability might depend on a number of variables, such as lack of knowledge or skills (Warner and van der Geest 2013), low educational attainment (Van der Land and Hummel 2013), poverty, gender, age, ethnicity and religion. Social systems can also be made vulnerable by a combination of factors such as corruption, high inequality, civil and ethnic conflict, land privatization, and population growth (Niang et al. 2014).

For the purposes of investigating the thresholds of land degradation at a micro level (individuals, households, and communities), this study focuses on the vulnerability of rural systems. Like other systems, rural systems' levels of vulnerability depend on their ability to adjust to changing internal demands and external circumstances (Carpenter and Brock 2008). However, if a rural area's ecological resources are not resilient, conditions for ecosystem services and agriculture can deteriorate, and the vulnerability of the rural area increases (Schouten, van der Heide, and Heijman 2009).

Agriculture is often the main source of livelihoods for underprivileged people. While farming systems can be delimited with various levels of detail, the Food and Agriculture Organization's (FAO's) analysis of farming systems and poverty identifies 15 major systems in Sub-Saharan Africa, nine of which exist, to varying degrees, in the ECOWAS states (Dixon, Gulliver, and Gibbon 2001). These farming systems (map 1) are pastoral, arid land farming, agropastoral millet/sorghum, cereal-root crop mixed, root crop, tree crop, coastal artisanal fishing, irrigation, and some irrigation in rainfed areas (Dixon, Gulliver, and Gibbon 2001).

Map 1 Farming systems in West Africa



Source : Club du Sahel et de l'Afrique de l'Ouest/OECD 2007.

These systems depend on climate variability and have been exposed to repeated cycle of drought and floods have affected the region throughout the history (Mohamed, Duivenbooden, and Aboussalam 2002). As outlined by various reports of the Intergovernmental Panel on Climate Change, West Africa is expected to suffer tremendously from the impacts of temperature increases,³ decreased rainfall, and coastal erosion (IPCC 2007, 2014). However, the projections for the future are quite uncertain, with some models predicting a significant increase in rainfall, others a decrease, and others no significant change. For example, there is large consensus that one of the major climate change impacts in the region will be on rainfall, making it more variable and less reliable. However, rainfall change is projected to be 20 percent above or below average depending on which model is used (Sarr 2012).

Moreover, these changes have different effects in the different agro-ecological zones. In the Sahel, runoff coefficients have increased because of a deterioration of land cover; in the savannah, however, reduced rainfall has generally resulted in reduced river flow, although the decrease is much less than would be expected based on past observations (Oguntunde et al. 2006). In the Volta Basin, the main impact of the shifts in the rainy season is likely to be greater ground and surface water availability (van Giesen et al. 2008).

While recognizing the high level of uncertainty of the occurrence of future changes and their effects, thresholds for increased or unbearable levels of vulnerability caused by land degradation are investigated in the three most common processes affecting the systems of the region: (1) reduced water availability, (2) decreased land productivity, and (3) groundwater salinization.

2.1. Reduced Water Availability

Water supply problems inherently accentuate vulnerability, given that access to water is essential for maintaining good health and the ability to cope with other stresses (Dow 2005). West African countries are highly water interdependent: each one of them—with the exception of the Cape Verde islands—shares at least one transboundary river basin. Indeed, the region's major watercourses (the rivers Niger, Senegal, and Gambia) ensure the transfer of freshwater from wet to arid areas since they have their sources in high rainfall areas and flow through the Sahelian zone, which experiences chronic rainfall deficits (Niasse 2005). The Sahelian areas have been subject to a rainfall deficit since 1970 that led to strong fluctuations in river discharge with a negative trend from 1960 to 2010 (Descroix et al., 2013). Mahe et al. (2013) underlined that a -20 % decrease in rainfall generally results in a decrease of -60 % in runoff, although the effect of the rainfall drop is nonlinear over much of West Africa.

One of the most commonly used indicators of *water stress* is per capita water availability (UNEP et al. 2000). When per capita availability drops below 1,700 cubic meters per year, water stress or the potential for disruptive water shortages can frequently occur. *Water scarcity* is a more

3. Near-surface temperatures reportedly increased over West Africa and the Sahel in the past 50 years, a trend that is expected to continue in the future, rendering the region a hotspot of climate change, with “unprecedented climates...projected to occur earliest (late 2030s to early 2040s)” (Niang et al. 2014, 1209).

serious situation, and is defined as per capita availability of less than 1,000 cubic meters per year, with severe consequences for food production, health, sanitation, economic development, and loss of ecosystems (Dow 2005).

Such low levels of water availability have become a crucial problem for West Africa, causing depletion of assets and impoverishment (Scheffran et al. 2012). The greater exploitation of water resources and the associated water scarcity coupled with the growing concern that future climate change will exacerbate the frequency, severity, and duration of drought events have drawn increased attention (Wilhite and Pulwarty 2005). Despite centuries of experience adapting to harsh natural conditions (Mertz et al. 2009), the vulnerability of these systems and their populations have become of great concern, bringing water scarcity and drought risk management to the forefront of different policy and security discussions.

2.2. Decreased Land Productivity

The issue of decreased land productivity and crop yields threatens the survival of a large number of individuals and livelihoods in the region. This phenomenon results from a combination of environmental and human stressors (Niang et al. 2014; Samimi and Brandt 2012). The loss of forest cover, increasing use of intensive cultivation practices, and natural hazards, such as drought, contribute to a decline in soil quality and fertility and an associated decline in ecological resilience as recovery from these traits becomes progressively difficult (Dow 2005).

For arid lands, pastoral, and agropastoral farming systems, drought is the major source of vulnerability. Poverty is widespread among households of the arid lands, pastoral, and agropastoral systems, but less diffused among those engaged in farming (Dixon, Gulliver, and Gibbon 2001). Less-well-off households with less productive land and fewer alternative income sources are more exposed to food insecurity.

Another issue related to reduced land productivity is pastoralism, generally concentrated in the northern arid and semi-arid regions. This practice is based on moving herds south during the dry seasons and back north during the rainy seasons. In the northern parts of Mali and Niger, overgrazing and trampling have reduced the vegetation cover and increased the potential for erosion. In drought circumstances, pastoralists travel farther with their herds, at times resulting in land conflicts with agriculturalists (Dixon, Gulliver, and Gibbon 2001). In addition, seasonal mobility is becoming harder to maintain as the amount of cultivated land is increasingly adding pressure on grazing areas (Dow 2005).

2.3. Groundwater Salinization

An important stressor at play in the region is sea level rise, with its ensuing coastal erosion and groundwater salinization affecting agricultural livelihoods. Salinization of agricultural land, which is exacerbated by extraction of groundwater, lowers the productivity of the land and decreases freshwater security. A rise in sea level could also lead to permanent inundation of lands used for food production, along with changes to marine and freshwater ecosystems affecting fish populations and fish-dependent livelihoods (Foresight 2011).

This phenomenon is aggravated by the fact that coastal areas have the highest population concentrations and are frequently the most urbanized in West Africa (OECD 2008). Some 40 percent of West Africa's population is concentrated in coastal cities vulnerable to sea level rise, and the IPCC estimates that by 2020 more than 50 million people will inhabit the coast from the Niger delta in Nigeria to Accra (IPCC 2007).

Coastal erosion due to sea level rise has already begun to affect farmers through saltwater encroachment. The disruption of traditional ways of life creates further vulnerability for the entire population, sometimes leading its members to switch to monoculture. This dependence on a single crop puts households and communities at the mercy of irregular harvests (Cook and Vizy 2006). In Guinea Bissau, salt intrusion in the coastal land caused a need for crop substitution, which created further food insecurity and made populations more vulnerable to price fluctuations (Barry and others 2007).

According to Appeaning Addo et al. (2011), more than 200 meters of coastal land in Ghana could be lost around Accra by 2100. A large population and considerable private property and infrastructure will be at risk of gradual inundation and high tidal waves. With regard to health, coastal inundation may foster the spread of disease in the communities through the stagnant flood waters. Appeaning Addo et al.'s (2011) survey reveals that about 57 percent of the population in the area has suffered flood damage, mainly involving property losses and the displacement of people from their homes. Moreover, communities seem to be aware that the sea is rising and the beaches are eroding, which has caused a number of people to abandon their coastal communities, an accelerating trend that is expected to continue (Appeaning Addo et al. 2011).

When livelihoods are threatened beyond certain thresholds, families might have to choose to migrate in ways that increase vulnerability for both themselves and, in some cases, the populations in their destinations. If not appropriately addressed, these multiple challenges can generate further instability because migrants might cross paths with other groups in precarious situations. The literature shows how the increasing number of people periodically relocating could lead to tension over access to scarce resources such as water and productive land (Werz and Conley 2012).

2.4. Increased Vulnerable Conditions and Unsafe Paths: Cases across the Region

With no attempt to quantify tipping points, the three land-degradation scenarios discussed above describe settings characterized by prolonged and high exposure to hazards. Examples of how land degradation creates increased vulnerability prompting mobility and potential for unsafe conditions, clashes, and conflicts are plentiful across the region.

In certain cases land degradation only affects the livelihoods of a portion of the population, but at other times it can cause irreversible systemic consequences, thus increasing the vulnerability of entire communities. Rapid desertification is believed to have caused the abandonment of more than 200 villages in northern Nigeria: 1,350 square miles of the country's land is turned into desert

each year, driving farmers and herders southward away from the Sahel (Brown and Crawford 2009).

With regard to possible conflicts caused by slow depletion of resources, Niase (2005) describes how the Komadugu Yobe River Basin—a tributary of Lake Chad situated in northern Nigeria—has experienced severe impacts of climate change and variability. In addition, two upstream dams have diverted a substantial share of the river flow for domestic use and irrigation. In response to the significant decrease of the average annual flow, the middle and downstream states of Jigawa, Yobe, and Borno complained with more and more vehemence about the lack of fairness in apportioning the water between Kano (the upstream state) and other states on the river. The government of Nigeria had to establish an interministerial coordinating committee to deal with conflicting water demands and address the growing tensions in the basin. In the meantime, farmers from middle and downstream states engaged in “water warfare” by digging channels to deviate as much water as possible to their farms, which deeply disorganized the natural drainage of the whole basin.

The expansion of West African cities might be extremely dangerous for newcomers without established social networks. The number of inhabitants of West Africa more than tripled during the past 45 years, and the urban population increase tenfold over the same period. The issue of human mobility acquires renewed importance given that the ongoing tendencies toward population growth and urbanization are expected to continue (OECD 2006, 9–10). In addition to their exposure to precarious infrastructure, health hazards, and urban violence, an estimated 40 percent of new migrants arriving in Dakar throughout the past decade live in zones with high flood potential (Sakho and Dial 2010; McMichael, Barnett, and McMichael 2012; Foresight 2011). Moreover, rural northern populations in Nigeria exposed to desertification increasingly flee and move to cities and megacities like Lagos—home to more than 10 million people—where the connection between land degradation and the instability caused by insurgent or criminal groups seems to be at play. In this context, disaffected unemployed youth may have incentives to join groups involved in organized crime and illicit activities (such as drug cartels or even Boko Haram) (Werz and Conley 2012).

Other potential sources of increased vulnerability and tension come from changes in the routes of nomadic populations, caused by frequent drought. As shown by the case of the Peul Mbororo of Chad, some communities have to travel longer and unknown routes, rife with the risks of livestock theft and abduction of family members (IOM 2012, 51–53). For them, new patterns of mobility are the best available survival strategy, but this search exposes them to encounters and potential clashes with other populations who might not be willing to share their resources (Oppenheimer et al. 2014). The nomadic populations also played a central role in the 2007 Tuareg rebellion in Niger. In that case, drought added pressure to an already delicate economic and security situation, which facilitated the recruitment of disenfranchised youth by Al-Qaeda and other insurgent groups, prompting the government to deploy 4,000 troops (Werz and Conley 2012).

In places of origin, mass migration of working-age people could be the cause of agricultural de-intensification and ensuing land abandonment and degradation, negatively affecting those left behind (Foresight 2011; Hunter and Nawrotzki 2016). Evidence suggests that as a result of this lost labor, households are less able to halt land degradation (Foresight 2011). In Senegal, in the region of Linguère, which is situated in the northern part of the country, 80 percent of the population relies on agricultural activities that are coming under increasing pressure from land degradation and drought (van der Land and Fourier 2012). As a result, many are leaving the region, leading to further land degradation and decreased crop yields caused by the lack of labor induced by heavy outmigration (Romankiewicz and Doevenspeck 2015).

Both high mobility and the lack thereof can increase vulnerability. For example, in Ghana, where household members used to migrate only once a year during the dry season, increasing evidence points to the existence of a second migration cycle for a number of rural communities, taking place during the rainy season and thus reducing availability of local labor and exacerbating the problem of early depletion of home-grown food stocks (Rademacher-Schulz, Schraven, and Mahama 2014). In contrast, in Tougou, Burkina Faso, where farmers once used to migrate toward the cocoa plantations of Côte d'Ivoire, reduced mobility opportunities led to decreasing the number of daily meals as a mechanism to cope with diminished crop yields (Barbier et al. 2009; Warner and Afifi 2013). Analyses of migratory dynamics over extended periods in Senegal reveal that about two-thirds (62 percent) of rural people have never migrated and are chronically poor, leading to the conclusion that the rural chronically poor are sedentary (Fall and Cissé 2013, 193).

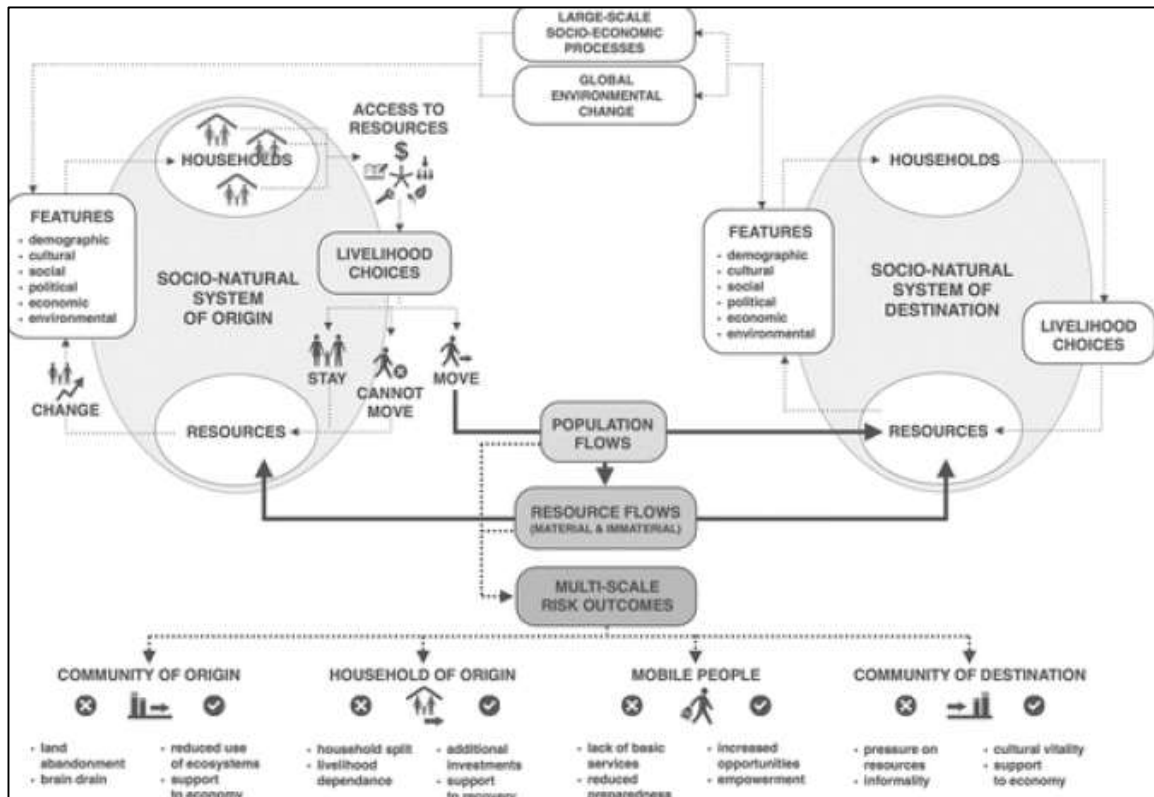
3. Resilient Pathways toward Adaptation

To build resilience, a set of strengths and resources are needed that must be coupled with a certain degree of self-organization and ability to learn while maintaining the system's structure and function (Nelson, Adger, and Brown 2007). Highly influenced by development and technology levels, along with social factors, these sets of assets and aptitudes that allow "societies to survive, flourish and maintain their quality of life" are addressed in the literature as *coping* and *adaptive capacity* (Nelson, Adger, and Brown 2007, 399) When on-site adaptation is not a cost-effective possibility, for example, the degree of land degradation makes rehabilitation too expensive, a change in location for either some or all members of the household is necessary to secure vulnerable livelihoods and achieve resilience.

3.1. A Theoretical Framework for Ecosystems and Mobility

The visual framework in figure 1 illustrates how deeply related the decision to undertake migration is with ecosystems, both in origin and destination places.

Figure 1 Risk impacts from human mobility between socio-environmental ecosystems



Source: Guadagno, 2016

This framework shows how approaches to resilience change at different levels—both within and among ecosystems—and mobility choices are interlinked with (rather than being solely dependent upon) environmental stressors. A particular mix of environmental factors with economic, political, social, and cultural variables (West, Roncoli, and Quattara 2008) influences “diversification” (ex ante) and “response” (in season and ex post) coping and adaptive strategies.

Unlike sudden natural disasters, land degradation gives small-scale household producers the opportunity to reflect upon the multiple hazards they face, perceive positive and negative aspects of events, and assess their capacity to adapt to future change. Depending on a subjective assessment of risks and vulnerability, which are also related to availability of and access to natural resources, households make certain adjustments in their choices for production and consumption and decisions to remain or move. Coping strategies can be grouped into three broad categories: (1) ex ante risk management options, (2) in-season adjustment in response to specific shocks as they evolve, and (3) ex post risk management options that minimize the livelihood impacts of adverse conditions (Cooper et al. 2008). Among all possible responses and strategies, the framework in this paper focuses on mobility responses to perceived natural asset depletion and highlights the trade-off between the challenges of staying and the opportunities and challenges of leaving.

Mobility can take several forms, including *internal, regional, and intercontinental migration*;⁴ *relocation* (conserving the same livelihood in a different place or country); and *short-term* (less than 12 months; includes *seasonal migration*) and *long-term migration*. Decisions to undertake one of these options depends on a multiplicity of contextual factors, and different migration categories are often interlinked. While section 2 discussed vulnerability factors, this section focuses on drivers that lead individuals and households to a “trade-off” decision between remaining in their communities and localities of origin or seeking opportunities for resilience elsewhere.

a. Remittances. The availability of remittances as a potential source of resilience is undoubtedly a key determinant of decisions to migrate; remittances flows might either allow households to build capacity for on-site adaptation or finance future migration (Awumbila et al. 2014). Cross-border remittances are normally more substantial (on a per capita basis) than internal ones because of the stronger currencies and higher salaries provided in industrialized countries. International migrants’ investments can provide employment opportunities that motivate both internal rural-urban and rural-rural migration (Tacoli 2011; Barrios, Bertinelli, and Strobl 2006).

b. Availability of job opportunities elsewhere during slack periods. Temporary mobility is generally undertaken by labour migrants over short distances, often circular (or seasonal), with migrants returning to their communities of origin at the end of the dry season. In areas where working-age people migrate internationally or to cities, the void in the labour force can in turn attract rural-rural migration from neighbouring communities (Barrios, Bertinelli, and Strobl 2006; Tacoli 2011). This type of resilience strategy is expected to increase as environmental stressors intensify (Tacoli 2011). Higher frequency of drought tends to strengthen short-cycle circulation more than longer-term migration (Findley 1994; Hunter and Nawrotzki 2016).

c. Availability of and access to resources elsewhere. As the impact of environmental stressors on livelihoods intensifies, temporary migration is replaced by permanent migration, often involving the entire household (Scheffran, Marmer, and Sow 2011). When resources in the places of origin are perceived as being irreversibly damaged, the availability of productive lands elsewhere can be an incentive for families to relocate. In this case, tenure is a key factor in the decision: lack of tenure security in places of origin and access to land rights in destination places are key determinants in migration decisions. Shifts in rules of access and entitlement may affect people’s ability to count on these resources in coping strategies. Customary land tenure and usufruct rights systems help people cope by creating opportunities for temporary and seasonal migration, allowing the use of particular plants for food during periods of stress, and supporting other flexible opportunities for resource use (Dow 2005).

4. While international migration includes both regional and intercontinental migratory flows, a number of authors refer to “South-North” migration as international. For clarity, any reference in this paper to international migratory flows that are not also intercontinental are called “regional,” whereas “international migration” is synonymous with “intercontinental” unless explicitly stated otherwise.

d. Information and networks. Migration requires a minimum level of information, contacts, and resources. Migrants' networks abroad may be a motivation and source of help for others to follow, especially in the occurrence of recognized shocks such as a prolonged period of drought. Most available evidence on the link between drought and migration points to reductions in international migration and increases in internal mobility (Findley 1994; Lilleør and van den Broeck 2011). Those moving as a consequence of decreased crop yields do not have the means to engage in expensive journeys and, for this reason, normally remain within a short distance of their places of origin (Goff, Zarin, and Goodman 2012).

3.2. Mobility Patterns in West Africa

Within Sub-Saharan Africa, West Africa has a long tradition of human mobility, which intensified particularly during the colonial period. After independence, this population mobility turned into labour migration for wage work. In recent times movement across national borders within West Africa has been facilitated by the ECOWAS, which also promotes the creation of a common market and the abolishment of all kinds of discrimination and seeks to guarantee the rights of residence, establishment, and free entrepreneurship for any citizen from any of the member states (Konseiga 2005). The Club du Sahel and the OECD undertook a regional study of the long-term prospects for West Africa, highlighting the three prevailing patterns of human mobility: (1) from north to south; (2) from inland to the coast; and (3) from rural to urban areas (Club du Sahel 1990).

Temporary and seasonal migration out of arid and semi-arid regions during dry seasons reduces pressures on food stores in the sending community and, in countries like Côte d'Ivoire, migrant labor is an important part of tree crop (for example, coffee or cacao) farming systems (Dow 2005). However, a growing number of academics have begun studying these phenomena for their potential to provide coping mechanisms and resilience to slow-onset events (McLeman and Smit 2006; Agrawal and Perrin 2009; Barnett and O'Neill 2012).

There are a variety of different manifestations of the above-mentioned types of mobility in West Africa, including movement across all distances—intercontinental, intraregional, and internal—and for all durations—permanent, temporary, and seasonal (Awumbila et al. 2014, 19).

Whether to build resilience to land degradation or to sea level rise, internal migration in West Africa is the most common type of mobility that occurs after worsening climatic conditions. Although a common resilience strategy in some countries, not all West African individuals and communities heavily affected by drought are keen on crossing national borders.

Precise figures about remittances are difficult to obtain because of the informality of most channels used in the region, characterized by weak or non-existent financial systems and a general distrust of formal channels. However, the African Development Bank estimates that in 2014, remittance inflows to the ECOWAS region may have reached as much as US\$ 26 billion accounting for 3.2% of the region's GDP (AFDB, 2015). The magnitude of these transfers, which make West Africa the second recipient sub-region on the continent, reflects the size of the West African diaspora, estimated at 9.1 million people in 2011, or 2.6% of the population of the region. As outlined in a recent assessment of labour migration within the ECOWAS region, anecdotal

evidence suggests that a portion of remittances flows is allocated to investments in agricultural land, equipment, and small-scale businesses that benefit the entire community (Awumbila et al. 2014). Evidence from Ghana and Burkina Faso suggests that remittances are used to increase resilience in vulnerable rural areas by supporting adaptation within the farming sector, through, for instance, investments in livestock (Deshingkar 2011; Wouterse 2008).

While a sizeable portion of migration flows in West Africa are characterized by seasonal or occasional return to the place of origin, some migrants choose to permanently relocate within their host countries and communities. Among the successful cases of indefinite relocation, that of Mauritians settling in Senegal and Mali after the severe drought in 1983–85 is significant. Some 12,000 Mauritians still reside in Mali, and they are essentially self-supporting through agricultural activity, growing maize, peanuts, and other crops and enjoying the same rights and access to public services as the nationals (World Bank Group 2014).

A gender approach to mobility patterns caused by environmental stressors in West Africa is not easy to establish because it is mostly based on cultural features rather than on migration drivers themselves. For instance, during the dry season, Niger exhibits long-established patterns of internal mobility dominated by young men migrating south and returning to their land during the rainy season (Mounkaïla 2002), while women are often left behind. This pattern at times results in decreasing yields because of a lack of labour in the fields (Warner and Afifi 2013; Ober 2014). In contrast, Senegal features cases of successful adaptation in which internal seasonal movements are composed of a majority (roughly 60 percent) of women (van der Land and Fourier 2012).

In terms of policy approaches, West African countries seem to have quite widely recognized the links between migration and climate change. In fact, 8 out of the 10 West African countries considered by Sward and Codjoe (2012) discuss drought-induced migration in their National Adaptation Programs of Action, pointing to the predominantly internal dimension of the phenomenon. Indeed, among the countries most affected by drought in the region, Burkina Faso, Ghana, Niger, and Senegal have all experienced important amounts of internal mobility (Coulibaly-Tandian and Sakho 2014; Jonsson 2010.)

Although some countries, such as Rwanda and Uganda for instance have taken steps to recognize the importance of rehabilitating lands and promoting diaspora investment schemes, a clear connection between the two issues seems not to be in place so far (Sward and Codjoe 2012). Although ECOWAS is the only regional union in Africa allowing free movement across borders for its citizens, country-level policies have not promoted migration as a possible solution for fostering adaptation and growth and addressing vulnerability in areas where land is no longer productive.

West Africa is a resource-filled region with an unbalanced distribution of natural assets throughout its different agro-ecological areas. Many associate the challenges of the region with those of the Sahel, disregarding the savannah zones, where interesting re-greening experiments, aimed at rehabilitating land through sustainable reforestation practices have been put in place. Van Giesen et al. (2008) document that because of increased levels of river flow and groundwater recharge, extension of irrigated agriculture into the dry season is possible through better exploitation of groundwater in shallow aquifers. For example, he suggests that construction of

small reservoirs to locally supply rural populations with water for irrigation, cattle, household use, and fisheries could be feasible in some parts of West Africa, not only in semi-humid areas. These reservoirs can be found in semi-arid areas around the world. The most significant positive socioeconomic aspect of small reservoir development is that they allow for productive use of labour in the dry season and partly reduce large seasonal migration fluxes from the countryside to the larger cities.

4. Policy Recommendations and Roads Ahead

By analysing the causes of vulnerability at the individual, household, and community levels, this study sheds light on the interconnected factors at play in the environment-migration nexus. Indeed, in some cases the possibility of on-site adaptation exists, but it seems to hinge on the provision of rights and incentives, such as access to land and access to credit, that are not available to a large portion of exposed West African communities. When these are absent, mobility can be either an avenue for adaptation, or a coping strategy that ensures short-term means for survival and revenue diversification.

Although the abilities and choices of these individuals and households depend on their level of exposure to environmental stressors—which interact with socioeconomic, political, and cultural factors to determine their vulnerability—it is the trade-off between perceived threats and offered opportunities that determines decisions to stay or migrate. The question is, where are these opportunities for resilience and livelihood diversification offered: on-site, in the next habitable and productive area, or internationally?

All decisions are context dependent and are influenced by perceptions of hazards and of opportunities. The decision to undertake migration as a coping strategy is the result of free choice and of aspirations for a safer and better life. The challenges associated with migrating are sometimes associated with the conditions of journeys and (the lack of) opportunities in places of destination.

The role of policy makers is to attenuate the negative consequences of migration and promote the enabling conditions for these paths to be less exposed to further threat by offering opportunities for building resilience. Decision makers and policy makers should consider the following aspects while shaping their interventions:

- Migration has historically been part of West African society. “No migration” is not an option: migration will continue to occur, and policies that try to inhibit migration in the context of environmental change are more likely to ultimately lead to difficult situations of increased vulnerability (Foresight 2011).
- A very high percentage of West African livelihood systems are land dependent (agriculture, water management, cattle herding, forestry, and so on).
- If journeys are undertaken in desperate conditions, the issues at stake are the loss of human lives and assets (including abandoned lands at risk of irreversible degradation) as well as insecurity during transit and at destinations.

- Migration is an adaptation strategy, as recognized by the IPCC 5th Assessment Report of 2014, and as such can be supported by the financial structures and funds devoted to adaptation that will be available for developing countries' governments.

West African governments and their partners should take advantage of the current debate to define adaptation frameworks and to shape policies and interventions that consider mobility to be part of the solution for reducing vulnerability and building resilience at individual, household, and community levels.

Therefore, a number of general recommendations can be issued to orient local, national, and supranational authorities toward rethinking migration and adaptation in the context of land degradation and climate change.

1. **Map available land.** Land might not be available where migration originates; however, shortening migration paths can contribute to reducing vulnerability. For instance, the Directorate General for Senegalese Abroad signed an agreement with the governmental agency for agricultural development and employment, ANIDA (*Agence Nationale d'Insertion et de Développement Agricole*), to reserve 25% of the land rehabilitated for migrants (Thiam 2013). To do so, available lands had to be accurately mapped by considering existing tenure rights, estimated rehabilitation costs as well as political engagement both at national and local level.
2. **Increase labour opportunities in rural and land-based sectors,** in recognition that failure to adapt in cities is sometimes due to the lack of required skills. Urban unemployed are often former land workers. Empirical findings based on surveys in Sierra Leone and Nigeria conducted by Byerlee et al (1977) support the potential for reducing the rural exodus while increasing growth and employment in rural areas. The evidence assembled in these studies indicates that by (i) granting adequate product pricing and salaries, (ii) promoting agriculture and rural small-industries (that employs labour in agricultural slack periods), and (iii) disseminating the right technologies would reduce rural-urban migration.
3. **Provide incentives and access to credit.** Credit for agriculture is high risk, especially in drought-prone areas. Senegal has already begun to provide guarantee funds to banks and financial institutions for absorbing these risks and promoting access to credit schemes with particularly low interest rates for investment in agriculture. Different funds, such as the *Fonds de Garantie pour les Investissements des Sénégalais de l'Extérieur* (FOGARISE) and the *Fonds d'Sppui aux Investissements des Sénégalais de l'Extérieur* (FAISE), have prioritized members of the diaspora among the potential beneficiaries of these credit schemes (IFAD, 2016). Further efforts have to be made to find a way to also include internal migrants and ECOWAS citizens.
4. **Increase consideration of transnational networks.** Remittances of international migrants are sometimes used to finance journeys of families and friends (Gerdes, 2007). Some of these journeys are through regular channels, but others occur in highly unsafe conditions. Engaging members of the diaspora, who are generally wealthier and have more

entrepreneurial capacity than their relatives seeking to leave, by offering investment opportunities in their countries of origin might help reduce irregular migration.

5. **Provide access to land tenure and land rights.** Tenure and land rights are important factors for attracting both investment and labour to safe and productive areas. A number of countries in West Africa are currently undertaking land reforms: Benin, Burkina Faso, Cote d'Ivoire, Mali and Mauritania (World Bank 2015). The new land tenure systems ought to address the increasing trends of rural-rural and rural-urban migration and the ensuing labour availability issues and potential risks of additional vulnerability.
6. **Research.** Efforts to integrate the social science dimension into the preponderant physical science approach in the adaptation research community should be increased; that is, resilience-driven mobility solutions should be supported and situations of further vulnerability should be prevented by basing efforts on sound social and anthropological evidence. Further questions for research are where are the thresholds that lead people to unsafe paths and increased conditions of vulnerability, and what are the trade-offs between leaving and staying?

In conclusion, one of the main neglected problems in West Africa is labour scarcity where the capitalization of agriculture is low. Where labour migration is key not only for economic development but also for household resilience, governmental policies should facilitate migration by taking into account the degree of land degradation, specific seasonal effects as well as expected drought. For example, such policies could provide better agricultural opportunities where land can still be rehabilitated and facilitate circular migration programs from rural areas and neighbouring countries. In other words, the enabling conditions for the capitalization of agriculture should include increasing employment opportunities and migration, based on the evidence that mobility will always be an adaptation strategy, when needed. The best option for governments to address these issues and avoid perceiving them as security concerns would be to provide incentives for shorter migration paths and land rehabilitation, creating win-win opportunities for those who stay, those who leave, and those who receive.

References

- African Development Bank. 2015. "Remittances from West Africa's Diaspora: financial and social transfers for regional development". <http://www.afdb.org/en/blogs/measuring-the-pulse-of-economic-transformation-in-west-africa/post/remittances-from-west-africas-diaspora-financial-and-social-transfers-for-regional-development-14614/>. Accessed on 09/06/2016
- Agrawal, A., and N. Perrin. 2009. "Climate Adaptation, Local Institutions and Rural Livelihoods." In *Adapting to Climate Change: Thresholds, Values, Governance*, edited by W. N. Adger. Cambridge: Cambridge University Press.
- Appeaning Addo, K., L. Larbi, B. Amisigo, and P. K. Ofori-Danson. 2011. "Impacts of Coastal Inundation Due to Climate Change in a CLUSTER of Urban Coastal Communities in Ghana, West Africa." *Remote Sensing* 3 (12): 2029–50.
- Awumbila, Mariama, Yaw Benneh, Joseph Kofi Teye, and George Atiim. 2014. *Across Artificial Borders: An Assessment of Labour Migration in the ECOWAS Region*. ACPOBS/2014/PUB05. Brussels: ACP Observatory on Migration.
- Barbier, B., H. Yacoumba, H. Karambiri, M. Zorome, and B. Some. 2009. "Human Vulnerability to Climate Variability in the Sahel: Farmers' Adaptation Strategies in Northern Burkina Faso." *Environmental Management* 43: 790–803.
- Barrios, Salvador, Luisito Bertinelli, and Eric Strobl. 2006. "Climatic Change and Rural-Urban Migration: The Case of Sub-Saharan Africa." CORE Discussion Papers 2006046, Université catholique de Louvain, Center for Operations Research and Econometrics (CORE).
- Barry, B.-S., E. G. E. Creppy, E. Gacitua-Mario, and Q. Wodon. 2007. *Conflict, Livelihoods, and Poverty in Guinea Bissau*. Washington, DC: World Bank.
- Barnett, J., and S. J. O'Neill. 2012. "Islands, Resettlement and Adaptation." *Nature Climate Change* 2: 8–10.
- Béné, C., et al. "Resilience: new utopia or new tyranny? Reflection about the potentials and limits of the concept of resilience in relation to vulnerability reduction programmes." (2012).
- Birkmann, J. "Measuring vulnerability to promote disaster-resilient societies: Conceptual frameworks and definitions." *Measuring vulnerability to natural hazards: Towards disaster resilient societies* (2006): 9-54.
- Bohle, H. G., T. E. Downing, and M. J. Watts. 1994. "Climate Change and Social Vulnerability: Toward a Sociology and Geography of Food Insecurity." *Global Environmental Change* 4 (1): 37–48.
- Brown, O. and A. Crawford. 2009. "Climate Change and Security in Africa. A Study for the Nordic-African Foreign Ministers Meeting". *Institute for Sustainable Development*.
- Burton, I., S. Huq, B. Lim, O. Pilifosova and E.L. Schipper, 2002. "From impacts assessment to adaptation priorities: the shaping of adaptation policy." *Clim. Policy*, 2, 145-159

- Byerlee, D., C.K. Eicher, C. Liedholm and D. S.C. Spencer, 1977. "Rural Employment in Tropical Africa: Summary of Findings". *African Rural Economy Program Working Paper*
- Cannon, Terry, and Detlef Müller-Mahn. "Vulnerability, resilience and development discourses in context of climate change." *Natural hazards* 55.3 (2010): 621-635.
- Carpenter, S. R., and W. A. Brock. 2008. "Adaptive Capacity and Traps." *Ecology and Society* 13 (2): 40.
- Carpenter, S. R., B. Walker, J. M. Anderies, and N. Abel. 2001. "From Metaphor to Measurement: Resilience of What to What?" *Ecosystems* 4 (8): 765–81.
- Caspari, T., S. Alexander, B. ten Brink, and L. Laestadius. 2014. "Review of the Global Assessments of Land and Ecosystem Degradation and Their Relevance in Achieving the Land-Based Aichi Biodiversity Targets." Technical report prepared for the secretariat of the Convention on Biological Diversity. UNEP/CBD/COP.
- Club du Sahel et de l'Afrique de l'Ouest/OECD. 1990. West African systems of production and trade in livestock products." Technical Paper d/90/351: Paris: OECD/CILSS.
- Club du Sahel. 2007. <http://www.oecd.org/fr/csao/publications/42464831.jpg>
- Cook, K. H., and E. K. Vizy. 2006. "Coupled Model Simulations of the West African Monsoon System: 20th and 21st Century Simulations." *Journal of Climate* 19: 3681–793.
- Cooper, P. J. M., J. Dimes, K. P. C. Rao, B. Shapiro, B. Shiferawa, and S. Twomlow. 2008. "Coping Better with Current Climatic Variability in the Rain-Fed Farming Systems of Sub-Saharan Africa: An Essential First Step in Adapting to Future Climate Change?" *Agriculture, Ecosystem and Environment* 126 (1–2): 24–35.
- Coulibaly-Tandian, O. K., and P. Sakho. 2014. "Cas du Senegal." In *Impact des changements environnementaux sur les migrations humaines : Etude de cas : Sénégal et Côte d'Ivoire*, edited by M. T. Thiam and J. Crowley. Rapport d'Étude de l'Institut des Sciences de l'Environnement (ISE), Université Cheikh Anta Diop, United Nations Educational, Scientific and Cultural Organization (UNESCO).
- de Haas, H. 2007. "The Myth of Invasion: Irregular Migration from West Africa to Maghreb to the European Union." International Migration Institute, Alexandria, Egypt.
- Descroix, L., I. B. Moussa, P. Genthon, D. Sighomnou, G. Mahé, I. Mamadou, J.-P. Vandervaere, E. Gautier, O. F. Maiga, J.-L. Rajot, M. M. Abdou, N. Dessay, A. Ingatan, I. Noma, K.S. Yéro, H. Karambiri, R. Fensholt, J. Albergel, and J.-C. Olivry "Impact of Drought and Land – Use Changes on Surface – Water Quality and Quantity: The Sahelian Paradox, Curr. Perspect. Contam. Hydrol. Water Res. Sustain. " in *Current Perspectives in Contaminant Hydrology and Water Resources Sustainability*, chap. 10, edited by: Bradley, P. M., 243–271.

Deshingkar, Priya. 2011. "Are There Examples of Remittances Being Used to Build Local Resilience to Environmental Change, Especially through Investment in Soil and Water Conservation or Broader Agriculture?" UK Foresight Scientific Review 13, U.K. Government Office for Science.

Dixon, J., A. Gulliver, and D. Gibbon. 2001. *Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World*. Rome: FAO; Washington, DC: World Bank.

Djoudi, H., and M. Brockhaus. "Is adaptation to climate change gender neutral? Lessons from communities dependent on livestock and forests in northern Mali." *International Forestry Review* 13.2 (2011): 123-135.

Djoudi, H, Maria Brockhaus, and Bruno Locatelli. "Once there was a lake: vulnerability to environmental changes in northern Mali." *Regional Environmental Change* 13.3 (2013): 493-508.

Turner, M.D., 2010. Climate change and social resilience: "adaptive" conflict in the Sahel. Paper Prepared for the Berkeley Environmental Politics Workshop 2009–2010 (accessed 17.10.11).

Dow, K. 2005. "Vulnerability Profile of West Africa." Poverty and Vulnerability Programme, Stockholm Environment Institute, Stockholm.

Fall, Abdou Salam, and Rokhaya Cissé. 2013. "Migratory Dynamics over Half a Century in Senegal: A Longitudinal Perspective over Four Generations." *International Relations and Diplomacy* 1 (3): 189–201.

Findley, Sally E. 1994. "Does Drought Increase Migration? A Study of Migration from Rural Mali during the 1983–1985 Drought." *International Migration Review* 28 (3): 539–53.

Folke, K. 2002. "Social-Ecological Resilience and Behavioral Responses." Interdisciplinary Centre for Research on Natural Resources and the Environment, Stockholm University.

Foresight. 2011. "Migration and Global Environmental Change." Final Project Report, the Government Office for Science, London.

Gaillard, J. "Vulnerability, capacity and resilience: perspectives for climate and development policy." *Journal of International Development* 22.2 (2010): 218-232.

Gerdes, F. 2007. "Country Profile. Senegal". Migration Focus. Website last access on 10/06/2016.

Goff, L., H. Zarin, and S. Goodman. 2012. "Climate-Induced Migration from Northern Africa to Europe: Security Challenges and Opportunities." *Brown Journal of World Affairs* 43 (2).

Guadagno, L. 2016, forthcoming. "Human Mobility in a SocioEnvironmental Context: Complex Effects on Environmental Risk", Springer

Gunderson, L. H., and C. S. Holling, eds. 2002. *Panarchy: Understanding Transformations in Human and Natural Systems*. Washington, DC: Island Press.

Hunter, Lori M., and Raphael Nawrotzki. 2016. "Migration and the Environment." In *International Handbook of Migration and Population Distribution*, edited by Michael J. White, 465–84. New York: Springer.

- IFAD (International Fund for Agricultural Development). 2016. "Engagement des communautés de la diaspora pour soutenir l'emploi des jeunes au Sénégal et au Maroc", note de cadrage
- IOM (International Organization for Migration). 2012. *International Dialogue on Migration : Climate Change, Environmental Degradation and Migration*. Geneva: International Organization for Migration.
- . 2014a. *IOM Outlook on Migration, Environment and Climate Change*. Geneva: International Organization for Migration. http://publications.iom.int/bookstore/free/MECC_Outlook.pdf.
- . 2014b. *Migration, Environment and Climate Change: Evidence for Policy (MECLEP) GLOSSARY*. Geneva: International Organization for Migration.
- IPCC (Intergovernmental Panel on Climate Change). 2014. *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. New York: Cambridge University Press.
- Jonsson, G. 2010. "The Environmental Factor in Migration Dynamics: A Review of African Case Studies." International Migration Institute, James Martin 21st Century School, University of Oxford.
- Leichenko, R., and K. O'Brien. 2002. "The Dynamics of Rural Vulnerability to Global Change: The Case of Southern Africa." *Mitigation and Adaptation Strategies for Global Change* 7 (1): 1–18
- Lilleør, H. B., and K. van den Broeck. 2011. "Drivers of Migration and Climate Change in LDCs." *Global Environmental Change* 21 (Suppl 1): S70–S81.
- Mahe, G., G. Lienou, L. Descroix, F. Bamba, J. E. Paturel, A. Laraque, M. Meddi, H. Habaieb, O. Adeaga, C. Dieulin, F. Chahnez Kotti, and K. Khomsi. 2013 "The rivers of Africa: witness of climate change and human impact on the environment", *Hydrol. Process.*, 27, 2105–2114
- Manyena, Siambabala Bernard. "The concept of resilience revisited." *Disasters* 30.4 (2006): 434-450
- McLeman, R., and B. Smit. 2006. "Vulnerability to Climate Change Hazards and Risks: Crop and Flood Insurance." *Canadian Geographer* 50 (2): 217–26.
- McMichael, C., J. Barnett, and A. J. McMichael. 2012. "An Ill Wind? Climate Change, Migration, and Health." *Environmental Health Perspectives* 120 (5): 646–54.
- Mertz, O., C. Mbow, A. Reenberg, and A. Diouf. 2009. "Farmers' perceptions of climate change and agricultural adaptation strategies in rural Sahel." *Environmental Management* 43:804-816.
- Mertz, O., C. Mbow, J. Nielsen, A. Maiga, D. Diallo, A. Reenberg, A. Diouf, and others. 2010. "Climate Factors Play a Limited Role for Past Adaptation Strategies in West Africa." *Ecology and Society* 15 (4): 25.

- Mertz, O., C. Mbow, A. Reenberg, L. Genesio, E. F. Lambin, S. D'haen, M. Zorom, et al. 2011. "Adaptation Strategies and Climate Vulnerability in the Sudano-Sahelian Region of West Africa." *Atmospheric Science Letters* 12 (1): 104–8.
- Mohamed, B. N., V. Duivenbooden, and S. Aboussalam. 2002. "Impact of Climate Change on Agricultural Production in the Sahel-Part 1. Methodological Approach and Case Study for Millet in Niger." *Climate Change* 54 (3): 327–48.
- Mounkaïla, H. 2002. « De la migration circulaire à l'abandon du territoire local dans le Zarmaganda (Niger). » *Revue européenne des migrations internationales* 18.2.
- Nelson, Donald R., W. Neil Adger, and Katrina Brown. 2007. "Adaptation to Environmental Change: Contributions of a Resilience Framework." *Annual Review of Environment and Resources* 32: 395–419.
- Niang, I., O. C. Ruppel, M. A. Abdrabo, A. Essel, C. Lennard, J. Padgham, and P. Urquhart. 2014. "Africa." In *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. New York: Cambridge University Press.
- Niasse, M. 2005. "Climate-Induced Water Conflict Risks in West Africa: Recognizing and Coping with Increasing Climate Impacts on Shared Watercourses." Prepared for an international workshop on "Human Security and Climate Change," Asker, Norway, June 21–23.
- Niasse, M., A. Afouda and A. Amani. 2004. *Reducing West Africa's Vulnerability to Climate Impacts on Water Resources, Wetlands and Desertification: Elements for a Regional Strategy for Preparedness and Adaptation*. IUCN, Gland, Switzerland and Cambridge, UK. xviii + 66pp.
- Ober, K. 2014. "How the IPCC Views Migration: An Assessment of Migration in the IPCC AR5." TransRe Fact Sheet No. 1, Department of Geography, University of Bonn.
- O'Brien, K, Tim Quinlan, and Gina Ziervogel. "Vulnerability interventions in the context of multiple stressors: lessons from the Southern Africa Vulnerability Initiative (SAVI)." *environmental science & policy* 12.1 (2009): 23-32.
- OECD (Organisation for Economic Co-operation and Development). 2006. *International Migration Outlook*. Paris: OECD Publishing.
- . 2008. "Climate and Climate Change." In *Atlas on Regional Integration in West Africa*. Sahel and West Africa Club (SWAC) and Organisation for Economic Co-operation and Development (OECD), and Economic Community of West African States (ECOWAS). www.atlas-westafrica.org.
- Oguntunde, P. G., J. Friesen, N. van de Giesen, and H. G. Savenije. 2006. "Hydroclimatology of the Volta River Basin in West Africa: Trends and Variability from 1901 to 2002." *Physics and Chemistry of the Earth* 31 (18): 1180–88.
- Oppenheimer, M., M. Campos, R. Warren, J. Birkmann, G. Luber, B. C. O'Neill, and K. Takahashi. 2014. "Emergent Risks and Key Vulnerabilities." In *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the*

Fifth Assessment Report of the Intergovernmental Panel on Climate Change. New York: Cambridge University Press.

Rademacher-Schulz, Christina, Benjamin Schraven, and Edward Salifu Mahama. 2014. "Time Matters: Shifting Seasonal Migration in Northern Ghana in Response to Rainfall Variability and Food Insecurity." *Climate and Development* 6 (1).

Martin Doevenspeck. 2015. "Climate and Mobility in the West African Sahel: Conceptualising the Local Dimensions of the Environment and Migration Nexus." In *Grounding Global Climate Change: Contributions from the Social and Cultural Sciences*, edited by H. Greschke and J. Tischler. Dordrecht: Springer.

Sakho, Papa, and Fatou Binetou Dial. 2010. "Cadre general des migrations senegalaises." Robert Schuman Centre for Advanced Studies.

Samimi, C., and M. Brandt. 2012. "Environment and Migration in the Sahel." In *Climate Change, Environment and Migration in the Sahel: Selected Issues with a Focus on Mali and Senegal*, edited by D. Hummel, M. Doevenspeck, and C. Samimi, 20–36. MICLE Working Paper 1. Frankfurt: Migration, Climate, and Environment.

Sarr, Benôit. 2012. "Present and Future Climate Change in the Semi-Arid Region of West Africa: A Crucial Input for Practical Adaptation in Agriculture." *Atmospheric Science Letters* 13 (2): 108–12.

Scheffran, J., E. Marmer, and P. Sow. 2011. "Migration as a Resource for Resilience and Innovation in Climate Adaptation: Social Networks and Co-Development in Northwest Africa." *Applied Geography* 33 (April): 119–27.

Scheffran, J., M. Brzoska, J. Kominek, P. M. Link, J. Schilling. 2012 "Climate Change and Violent Conflict." *Science* 18 May 2012: Vol. 336, Issue 6083: 869-871.

Schouten, M., M. van der Heide, and W. Heijman. 2009. "Resilience of Social-Ecological Systems in European Rural Areas: Theory and Prospects." Paper prepared for presentation at the 113th EAAE Seminar "The Role of Knowledge, Innovation and Human Capital in Multifunctional Agriculture and Territorial Rural Development." Belgrade, Republic of Serbia, December 9–11.

Smit, B., I. Burton, R.J.T. Klein, and J. Wandel, 2000. "An anatomy of adaptation to climate change and variability." *Climatic Change*, 45, 223-251

Sward, J., and S. N. A. Codjoe. 2012. "Human Mobility and Climate Change Adaptation Policy: A Review of Migration in National Adaptation Programmes of Action (NAPAs)." Research Program Consortium Working Paper 6, Migrating out of Poverty, University of Sussex, Brighton.

Tacoli, C. 2011. "Not Only Climate Change: Mobility, Vulnerability and Socio-Economic Transformations in Environmentally-Fragile Areas of Bolivia, Senegal and Tanzania." International Institute for Environment and Development, London.

Tiam, M. 2013. "Pour faciliter la reinsertion economique des senegalais de l'exterieur: Le ministere des Affaires etrangeres signe deux conventions avec l'Anida et l'Ana", newspiece of the 07/05/2013, accessed on 09/06/2016

Tschakert, P. 2006. "Views from the Vulnerable: Understanding Climatic and Other Stressors in the Sahel." *Global Environmental Change* 17 (3–4): 381–96.

UN DESA (United Nations Department of Economic and Social Affairs). 2012. "Migrants by Origin and Destination: The Role of South-South Migration." Population Facts 2012/3, UN DESA, New York.

UNGA, 2012 "The future we want". United Nations General Assembly Resolution 66/288 http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/66/288

UNEP (United Nations Environment Programme). 2000. World Resources 2000-2001. Washington, D.C.: WRI, World Resources Institute.

———. 2006. *Global Deserts Outlook*. Nairobi: United Nations Environment Programme Division of Early Warning and Assessment.

UNFCCC (United Nations Framework Convention on Climate Change). 2011. "Decisions Adopted by the Conference of the Parties." United Nations Framework Convention on Climate Change, Decision 1/CP.16.: The Cancun Agreements: Outcome of the Work of the Ad Hoc Working Group on Long-Term Cooperative Action under the Convention.

van der Land, Victoria, and Joel Fourier. 2012. "Focus Senegal." In *Climate Change, Environment and Migration in the Sahel: Selected Issues with a Focus on Mali and Senegal*, edited by D. Hummel, M. Doevenspeck, and C. Samimi. MICLE Working Paper 1, Frankfurt.

van der Land, Victoria, and Diana Hummel. 2013. "Vulnerability and the Role of Education in Environmentally Induced Migration in Mali and Senegal." *Ecology and Society* 18 (4): 14.

van Giesen, N., W. Andah, M. Andreini, B. Barry, G. Jung, H. Kunstmann, W. Laube, P. Laux, and J. Liebe. 2008. "Adapting to Climate Change in West Africa." Paper prepared for Expo Zaragoza 2008.

Warner, K., and T. Afifi. 2013. "Where the Rain Falls: Climate Change, Food and Livelihood Security and Migration." United Nations University Institute for Environment and Human Security, Tokyo.

Warner, K., and K. van der Geest. 2013. "Loss and Damage from Climate Change: Local-Level Evidence from Nine Vulnerable Countries." *International Journal of Global Warming* 5 (4): 367–86.

Werz, M., and L. Conley. 2012. *Climate Change, Migration and Conflict in Northwest Africa*. Washington, DC: Center for American Progress.

West, Collin Thor, Carla Roncoli, and Frederic Ouattara. 2008. "Local Perceptions and Regional Climate Trends on the Central Plateau of Burkina Faso." *Land Degradation and Development* 19 (3): 289–304.

Wilhite, D. A., and R. S. Pulwarty. 2005. "Drought and water crises: Lessons learned and the road ahead" in *Drought and Water Crises: Science, Technology, and Management Issues*: 389– 398.

World Bank Group. 2015. "Land tenure reform in francophone West Africa", IBRD-IDA website, last access on 10/06/2016

———.2014. "Forced Displacement of and Potential Solutions for Internally Displaced Persons (IDPs) and Refugees in the Sahel: Burkina Faso, Chad, Mali, Mauritania, and Niger." Washington, DC: World Bank.

Wouterse, F. S. 2008. "Migration, Poverty and Inequality. Evidence from Burkina Faso." Discussion Paper 00786, International Food Policy Research Institute, Washington, DC.

