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The Impact of Vulnerability and Resilience to Environmental Changes on Mobility Patterns in West Africa[a]

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Summary:

From the Sahel to its coasts, West Africa is witnessing a variety of impacts of climate change, including sea level rise, soil salinization, floods, drought, and desertification, while simultaneously suffering other forms of environmental degradation. Together, these environmental changes are significantly influencing migration patterns in and out of West Africa. The following paper therefore analyzes *vulnerability* and *resilience* to environmental changes as they affect and are affected by mobility patterns in the region. However, we assert that the impact of environmental changes cannot be isolated from other political, social, economic and demographic pressures that together drive human mobility. In a region where natural resources form the foundation of livelihoods and food security (e.g. fishing and agriculture), the relationship between environmental changes and socio-economic vulnerabilities is of particular concern. This paper therefore draws from four distinct case studies in order to grasp the variegated and cumulative vulnerability and resilience among local populations as they relate to internal and intra-regional migration.

1. Introduction

West Africa is one of the most dynamic regions in which to examine the human impacts of climate change. From the Sahel to its coasts, it faces the many manifestations of climate change, including sea level rise, soil salinization, floods, drought, desertification, intensifying winds and heat waves (IPCC 2014; DARA 2013). Moreover, the consequences of climate change are only one part of current processes of environmental degradation affecting the region. Taken together, these environmental changes are significantly influencing mobility patterns in West Africa. Yet, while environmental degradation acts as one driver of regional mobility, it cannot be isolated from other political, social, economic and demographic pressures that together shape migration patterns. In a region where natural resources (e.g. fishing and agriculture) form the foundation of livelihoods and food security, the relationship between environmental changes and socio-economic vulnerabilities is of particular concern. This relationship needs to be understood within a context of

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cumulated vulnerabilities where not only direct but also indirect environmental degradation are considered.

This paper provides an analysis of *vulnerability* and *resilience* to environmental changes in relation to mobility patterns in West Africa. The 2014 IPCC report defined *vulnerability* as "the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt" and *resilience* as "the capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation."

In the following, we first provide an overview of environmental change (slow-onset processes and sudden climatic events), before detailing its role in driving internal and international mobility. As the relationship between vulnerability, resilience and mobility in the region cannot be adequately addressed without considering the variations among and within populations, we draw from four case studies based on our extensive field experiences in West African countries. Each case study takes a distinct methodological, disciplinary and theoretical approach to the direct and indirect impacts of environmental degradation on the vulnerability and resilience of communities, households, and individuals and their relationship with migration. Differentiated vulnerability and resulting mobility patterns among the studied populations result from such factors as dependence on natural resources, financial and social capital, physical location and habitat (e.g. coast or desert, urban or rural residence), and locals' perceptions of environmental changes.

2. Current environmental trends in West Africa

West African countries are exposed to many natural disasters; although not a novelty in the region, a significant increase in the frequency and intensity of disasters has been observed in recent decades. The occurrence of floods, droughts, strong winds, and heat waves are the most tangible extreme weather events affecting populations (DARA 2013). The increase in their frequency and intensity has been attributed to global warming (IPCC 2012). According to the most recent data from the International Disaster Database of the Centre for Research on the Epidemiology of Disasters (CRED 2015), natural disasters such as droughts and floods have affected over 28 million people in West Africa from 2010 to 2014. Furthermore, strong coastal erosion and sea level rise are further compounding the vulnerability of populations along the entire coast, from Mauritania to Nigeria (UEMOA 2010). At the same time, desertification and soil erosion are continuously augmenting as a result of the aforementioned climatic events (Stringer et al. 2011), adding pressure to food insecurity and thus further exacerbating the vulnerability of local populations.

A recent study on livelihood security in West Africa lead by the United Nations Environment Programme (UNEP) identified 19 'climate hotspots' in the region (UNEP 2011). These areas are the most severely affected by natural disasters and climate change and therefore require targeted planning for adaptation and other monitoring activities. These hotspots are mainly located in the central part of the

Sahel, Niger, Burkina Faso, northern and coastal Ghana, as well as in northern Togo, Benin and Nigeria and often straddle international borders, highlighting that risk management requires an inter-state response. All these areas have been heavily hit by floods in recent years, but they also recorded significant increasing temperature and a substantial increase in the frequency of droughts. The latter primarily affect the most arid countries (Mauritania - Mali - Niger axis), which account for nearly 90% of drought victims (50 million cumulative people) since 2000 in West Africa (Gemenne et al. 2014). These recent changes are affecting the livelihoods of millions of people who depend directly on natural resources.

Agriculture is the main livelihood of West African populations. The agricultural sector employs 60% of the workforce while it contributes only 35% of GDP (Abdulai et al. 2013). The national economies in this region are particularly vulnerable to climate change because the populations are heavily dependent on rain-fed agriculture. The effects of climate change are strongly felt by rural people, regardless of their geographical position and the reporting rainfall zone. A majority suffers from a decrease in the length of the rainy season due to a delay of the starting date and an earlier end, an increase in extreme rainfall events and dry periods within the rainy seasons that may compromise agricultural production. This perception of climate change follows a North-South gradient. Thus, a majority of farmers in the Sahelian arid zone believe that precipitation changes have occurred during the last 20-30 years, while in wetter areas (Guinean zone) effects were felt during the last decade (Ozer and Perrin 2014).

According to UN estimations, the population of West Africa increased from 86 million in 1961 to 340 million people in 2014, and is expected to increase to 815 million people by 2050 (FAO 2014). Mainly urban areas will be affected by excessive demographic growth. Indeed, the urban population accounted for 16% (14 million) of the total population in 1961, 47% (159 million) in 2014 and is expected to reach 66% (534 million) in 2050. The annual floods reflect the explosive growth of cities, poverty and the lack of urban planning policies. More specifically, human activities are responsible for the increased flooding due to urban sprawl in risk areas (floodplains of rivers, depression areas, axes serving as natural outlet of the water, etc.). Nouakchott, Ouagadougou, Cotonou, Dakar, and Niamey are some examples of cities more and more regularly affected by flooding, as are a large number of primary and secondary cities of all countries of the West African Region (Ould Sidi Cheikh et al. 2007; and Descroix al. 2013). According to the newest report from the Intergovernmental Panel on Climate Change, the cities of developing countries with health services, housing and disposal systems of good quality water will more easily adapt to climate change (IPCC 2014), but this unfortunately is not the case among West African cities.In 2005, 168 countries have signed the Hyogo Framework for Action (HFA) and agreed to establish action plans to reduce the risks of natural disasters by 2015 (UNISDR 2011). According to UNISDR, more than half of African countries have established frameworks but as these countries have too few resources to devote to it, few have actually implemented policies and plans to reduce disaster risk.

Current projections show that Sub-Saharan Africa will be the most affected area by climate change, along with small island states, coastal and deltaic regions (Gemenne 2011). The last IPCC report mentions that temperatures could rise by 3°C to 6°C in

some parts of Africa, including the Sahel, by 2100 (IPCC 2014), which is likely to be accompanied by a significant increase in natural disasters. The recurrence of extreme events makes people more vulnerable. Adverse effects are expected on major crop production and livestock, the availability of drinking water, and will probably cause the collapse of the fishing industry. In addition, climate change contributes to food insecurity and worsening health problems (IPCC 2014). Faced with these threats, policy responses are urgently needed because the effects of global warming are a serious obstacle to development and regional resilience.

3. Environmental context as a driver of migration in West Africa

Population movements, including displacement, in West Africa are caused by a variety of factors such as economic crises, armed conflict, generalized violence, violations of human rights, large-scale development projects and natural disasters (Ferris and Stark 2012). Although at the legal level, it is important to distinguish between "forced" and "voluntary" migration, it remains difficult to make this distinction, especially in the case of environmental changes (Laczko and Aghazarm 2009). In this context, whether migration is a forced movement or adaptation strategy will depend on a number of factors such as the type of climate shock, the characteristics of the affected population and the capacity of institutions (local, national and international) to prevent the effects adverse climatic shocks (Coniglio and Pesce 2010).

Floods are among the most frequent natural disasters in the region and population displacement resulting constitute one of the most visible examples of displacement. The number of people affected by floods in West Africa has increased steadily since 1980. According to statistics from the EM-DAT data (CRED 2015), floods have affected (without necessarily moving) 13.6 million people in West Africa over the past decade (2004-2013). In total, 600,000 people were affected by the 2009 floods in Burkina Faso, Ghana, Niger, Senegal and Sierra Leone. Just in Burkina Faso; 150,000 people were displaced by the floods. In Benin, at least 20,000 people were displaced by floods in 2009 and in November 2010 and 150,000 people lost their homes (Ferris and Stark 2012). According to estimates by the Internal Displacement Monitoring Centre (IDMC), in Nigeria, 6,818,000 people have been displaced due to natural disasters between 2008 and 2012. The devastating floods of September and October 2012 caused the displacement of 6,112,000 people in this country, or 3.6% of the total population. Thousands of homes, bridges and other infrastructure as well as large agricultural areas were completely devastated (IDMC 2013).

Sea level rise will also impact population movements in the region. According to estimates, the number of people threatened by coastal flooding will dramatically increase along the Gulf of Guinea, the Senegalese and Gambian coasts (UNESCO 2012). In West Africa, 40% of the population live in coastal cities and it is expected that 500 km of coastline between Accra and the Niger Delta will be megacities of more than 50 million people by 2020 (Hewawasam 2002). Studies have shown that among African port cities most exposed to rising sea levels, six are in West Africa (Lagos, Abidjan, Lomé, Conakry, Dakar, Accra) (Nichols et al. 2008). Cotonou and Nouakchott are also very vulnerable to rising sea levels (Dossou 2007; Ould Sidi

Cheick et al. 2007; Ozer et al. 2013.). This rise in sea level can also cause soil salinization and thus damage land, agricultural productivity and food security.

Although most mobility due to natural disasters occurs within national boundaries, studies have shown that rural communities affected by drought and slow-onset events can cross borders especially where borders are more permeable such as the Sahel (Seck 1996; Findley 1994). Mobility due to economic, social and political vulnerability can have indirect effects on resilience to environmental factors, just as environmental factors may aggravate existing and fragile social, political, and environmental conditions. For example, the drought that ravaged the Sahelian region in 2012, combined with the political instability and conflict occurring in the north of Mali, displaced hundreds of thousands of people to the drought-affected communities in the south and in neighbouring countries. A special feature of West Africa is its unusually high level of intra-regional migration, with the highest number of mobile peoples of any region in the world. According to the bilateral migration matrix, developed by the World Bank (2010a), over 58% of migration flows in West Africa take place within the sub-region. This is compared to 30.9%, 21%, 1.8% and 24.8% in East Africa, Central Africa, North Africa and the southern part of the continent, respectively. The importance of intra-regional migration in West Africa can be partly explained by the creation in the late 1970s of an area of free movement of people within the Economic Community of African States West (ECOWAS). In fact, migration between West African countries are mostly from neighboring countries (World Bank 2010b). It is the only region of Africa where intra-regional migration is greater than outward migration (34.5%, mainly to Europe) (Ndiaye and Robin 2010). With some 8.4 million people, West Africa also has the largest stock of migrants of any sub-region in the world (UN DESA 2009). Political, social and environmental crises existing in the region will only be exacerbated by the effects of climate change in the coming years, likely leading to more frequent migration (IOM 2014) in the region. The growing rural exodus will put more pressure on cities already vulnerable to climate change while simultaneously decreasing their resilience capacities.

4. Case studies

4.1. The impact of perceptions of rainfall changes on population movements in West Africa

4.1.1. Context

Climate change has been affecting the economic and social vulnerability of populations for decades, particularly in West Africa where the populations are largely dependent on rain-fed agriculture (Juana et al. 2013). Economic losses, damages to water resources, decreases in crop production and mortality are some of the direct and/or indirect impacts that must be mentioned (Crétat et al. 2014; Meehl et al. 2000; Mouhamed et al. 2013). Are such impacts due to increasing frequency of extreme events and climate variability, to growing vulnerability or to both (Easterling et al., 2000)? It is currently difficult to answer this question with thorough empirical evidence. What is more certain is that populations must adapt to environmental changes. In arid and semi-arid areas, adaptation strategies to climate change

implemented by farming communities vary according to region and depend on a multitude of factors, including cultural ones (Adger et al. 2009; Nielsen and Reenberg 2010). Temporary or permanent migrations are part of these households' adaptation strategies to maintain their standard of living through the diversification of livelihoods (McLeman and Hunter 2010; Wouterse and Taylor 2008). There is an increasing number of studies about impacts of environmental changes on migration but they are based on objective determination of environmental changes. Populations' migratory responses are made based on their perceptions of environmental changes and their own vulnerability to them; thus, taking into account the perception of change by local populations can improve the understanding of the environment-migration nexus and help to understand the magnitude and character of future migration patterns.

This study therefore compared the perceptions of rainfall changes experienced by people in different climatic regions of West Africa with the actual trends recorded in the same period. Then, assuming that migration decisions are made based on the perception of changes rather than changes themselves, the second objective was to assess migration intentions as direct responses to future climate change in order to consider the importance of migration in this region in the coming decades.

4.1.2. Methods

A systematic literature review (request by keywords) was carried out using the Scopus and Google Scholar databases since 2000 to find studies on perceptions of rainfall change in West Africa. A distinction was made between studies in arid zones (300-500 mm) and in semi-arid zones (500-900 mm). The data on the intention to migrate was taken from socio-economic surveys of the AMMA[1] project conducted in five West African countries between November 2007 and June 2008. Questions related to intentions to migrate, either temporarily or permanently, in response to three potential situations – a drought, a more arid climate and a more humid climate – were posed to 1342 households distributed in two climatic zones (Mertz et al. 2011). We analyze the main strategies considered by respondents in case of rainfall change and assess the place of the intention to migrate among them.

4.1.3. Findings

Perception of rainfall change vs observed trends

Globally, two methods are used in the studies of populations' perceptions of climate change: interviews (Tab.1) and focus groups (Tab.2). The most important change felt by populations is a decrease in total annual rainfall but populations also perceived a decrease in the length of the rainy season (later starting date and earlier end date), an increase in dry spells during the rainy season and in periodic droughts and irregular rainfall (Tab.1 and Tab.2). These perceptions have the same trends in the two climatic zones but are somewhat more pronounced in the arid zone than in the semi-arid zone.

Table 1: Perception of change in rainfall in arid and semi-arid zones of West Africa (% of interviewed people - if the total is not 100%, the rest is 'without opinion')

		Arid zone			Semi-arid zone		
		↘	Stable	↗	↘	Stable	↗
Total annual rainfall	(Akponikpè et al., 2010)	91	2	2	61	4	21

	(Mertz et al., 2009)				82	5	13
	(Mertz et al., 2012)	83	4	13	82	10	8
	(Diessner, 2012)	90	6	3			
Length of the wet season	(Akponikpè et al., 2010)	91	2	4	61	6	14
	(Nielsen and Reenberg, 2010)	60	6	26			
	(Mertz et al., 2012)	82	6	12	84	10	6
Dry spells during the wet season	(Akponikpè et al., 2010)	6	6	85	13	4	68
	(Nielsen and Reenberg, 2010)	14	0	74			
	(Mertz et al., 2009)				23	0	45
	(Mertz et al., 2012)	20	6	74	10	6	84
		Later	Stable	Earlier	Later	Stable	Earlier
Start of the wet season	(Akponikpè et al., 2010)	85	4	6	67	9	15
		Later	Stable	Earlier	Later	Stable	Earlier
End of the wet season	(Akponikpè et al., 2010)	70	7	11	48	13	24

Table 2: Significant changes in rainfall felt by populations in arid and semi-arid zones of West Africa according to results from focus groups (the 1st change is the most important)

		1st change	2nd change	3rd change
Arid zone	(Ouédraogo et al., 2010)	Decrease in rainfall	Changes in the onset and offset of seasons	Increase of dry spells
	(Dieye and Roy, 2012)	Decrease in rainfall	Irregular rainfall	Changes in the onset and offset of seasons
	(Tschakert, 2007)	Lack of rain	Irregular rainfall	Periodic drought
	(West et al., 2008)	Long-term decline in rainfall	Increase in rainfall variability	
Semi-arid zone	(Ouédraogo et al., 2010)	Decrease in rainfall	Changes in the onset and offset of seasons	Irregular rainfall
	(Tambo and Abdoulaye, 2013)	Decrease in rainfall and changes in the timing of rain	Changes in the timing of rain	Decrease in rainfall

There is an overall pessimistic perception of rainfall change. This negative perception, not reflected in objective data, shows mainly that populations become increasingly vulnerable. Moreover, increasing pressures of several types ((demographic, economic, environmental such as slow onset degradation processes, that is soil erosion or desertification) combine to affect the vulnerability of populations (Müller et al. 2014).

Intention to migrate in case of rainfall changes

In response to a drought, a drier climate or a wetter climate, migration is rarely the first adaptation strategy currently implemented by the surveyed population, but the intention to migrate is an important one should the situation worsen (or rather be perceived to worsen). In case of drought, respondents currently give priority to selling their livestock but several strategies are often considered together. Temporary migration has been cited as the first strategy in case of a drought by 24% of

respondents and in total, 29% of respondents intend to use temporary migration in response to a drought in the future. In the case of a drier climate, the first two cited strategies are search of new crop varieties and livestock sales. About 11% of respondents indicated that they would resort to temporary migration and 30% to permanent migration in response to a future drier climate; and temporary and permanent migration would be the first strategy for 6% and 13% of households respectively. The intention to migrate also exists but is less important in the case of a wetter climate, with only 2% and 4% of respondents saying that they would migrate temporarily or permanently in this case. When counting people who intend to migrate temporarily in a rainfall deficit situation (drought and/or drier climate), 36% of respondents plan to adopt this strategy. In total, taking into account temporary and permanent migration, more than 51% of respondents plan to migrate if rainfall conditions deteriorate in the future. However, some people who do not intend to migrate may not have a choice in the future and may have to use migration as a survival strategy. Conversely, the intention to migrate may not translate into actual movements: people who intend to migrate may find themselves unable to do so, lacking the necessary means (e.g. financial, social, and human capital).

4.1.4. Conclusion and policy implications

While researchers and stakeholders often consider the effects of climate change on the vulnerability and resilience of affected populations, this case study highlights the importance of taking into account populations' *perceptions* of climate change as it affects their vulnerability and adaptation responses. Results show that they are increasingly vulnerable when affected by non-significant actual rainfall changes. This means that the 'system' (social, demographic, economic, environmental) is less and less able to resist to different stress, even of limited magnitude. Migration decisions are more than likely made based on perception of climate change rather than objective data, a crucial insight for researchers and policymakers. Therefore, an increase in migration could occur faster than expected in this region in the next decades, calling for new policy responses in the future that have to include the resilience capacity of the entire 'system'.

4.2. Environmental Mobility and Fishing Communities in Guet Ndar, Saint-Louis (Senegal)[2]

4.2.1. Context

Senegal's coast, like many other coastal West African countries, is threatened by climate change impacts of coastal erosion, sea level rise, flooding, soil salinization, and increasing storm surges (Salem 2013). Concomitantly, the Senegalese coastal waters have witnessed changes in currents, stronger waves, depletion of fish stocks and decreases in maritime bio-diversity. These visible impacts of climate change have been compounded by man-made environmental degradation, including overfishing by national and foreign industrial vessels, and local changes to infrastructure, such as the opening of a breach in 2003 that displaced dozens of villages in the Langue de Barbarie along Senegal's northern coast (Tacoli 2011). These environmental changes threaten the livelihoods of the approximately 600,000 people directly or indirectly

working in the Senegalese fishing industry (FAO 2008), augmenting and diversifying existing mobility patterns. Yet Senegalese fishermen's mobility responses and their effects on local resilience capacities have received little attention.

4.2.2. Methods

In order to examine the migratory patterns associated with man-made environmental degradation and climate change impacts in West African fishing communities, a qualitative case study was undertaken in Guet Ndar,[3] an overcrowded fishing quarter in Saint-Louis, Senegal. Along with an extensive literature review and document analysis, the primary tools of investigation were qualitative, in-depth interviews and focus groups with fishermen (migrant and non-migrant), women working in the local fishing industry, and leaders of fishing associations. Local and national stakeholders, experts, community leaders, and researchers were also consulted in Dakar and Saint-Louis. The qualitative data was collected over a five-week period during the summer of 2014.

4.2.3. Findings

Vulnerability

In 2008, UN-Habitat designated the city of Saint-Louis as the most threatened by sea level rise in all of Africa. The fishing quarter of Guet Ndar in Saint-Louis is particularly vulnerable to environmental degradation. This stems, firstly, from the quarter's location between the Senegal River on its eastern limits and the Atlantic Ocean to its west, leaving it with no territory to expand into as the sea advances. Piles of rubble and debris where homes once stood line the coast. Currently, those who live on the 'front lines' of Guet Ndar are forced to build their own makeshift barriers to protect their homes from coastal erosion and sea level rise. In the south of Guet Ndar, women's working spaces for fish processing are now tightly cramped areas, wedged between the sea on one side and a cemetery on the other. In turn, some women have resorted to performing their work beside their homes, or commuting to a newly constructed space north of Guet Ndar near the Mauritanian border. Compounding local vulnerability, the quarter is one of the most densely populated districts in all of West Africa, with more than 25,000 inhabitants occupying an area of 1 km long and 300 m wide according to regional statistics (CLUVA 2013; Ateliers 2010). The local impacts of climate change only exacerbate overcrowding, with coastal erosion forcing the growing population into an ever-smaller space. Furthermore, without an agricultural production scheme, almost all households rely on fishing in one form or another. The local population is also heavily reliant on fish for their own subsistence, being a hallmark of the daily local diet in traditional dishes such as Thiéboudienne. Guet Ndar's inhabitants are therefore especially vulnerable to the impacts of climate change and environmental degradation as they threaten their local livelihood strategies, their lands, and their food security.

Mobility Patterns

As local livelihoods become increasingly difficult to maintain, building on a long history of fishing migration throughout West Arica, many Guet Ndarian fishermen respond by traveling northward to Mauritania (cf Sall and Morand 2008), where

infrastructure and livelihood opportunities are markedly better. While some fishermen fish irregularly just across the Senegalese-Mauritanian border or obtain one of 400 licenses granted annually to fishermen to bring catches back to Senegal, the danger of fishing irregularly stemming from conflicts with the Mauritanian coast guards led most respondents to obtain contracts with Mauritanian factories. Lacking a strong fishing tradition, factory representatives are sent to the quarter to recruit the highly experienced Guet Ndarian fishermen. The primary destinations of Guet Ndarian fishermen are Nouakchott and Nouadhibou. Although retired respondents had fished outside of Guet Ndar in Mauritania, Guinea, Guinea-Bissau, among others, the diminishment of local fish stocks due to climate change and overfishing has increased fishing migration to Mauritania and for longer durations. Whereas retired fishermen had travelled for short periods and seasonally in the past, currently active fishermen are spending 10 months or more outside of Guet Ndar. Moreover, those who stay in Guet Ndar and fish locally no longer abstain during maritime reproductive months because of the diminished returns the rest of the year and a lack of local infrastructure to preserve their catches, which in turn exacerbates maritime resource depletion.

Although fishermen preferred to remain in Guet Ndar, fishing migration to Mauritania allows them to diversify their livelihoods and earn money to support their families. Money earned by fishermen in Mauritania is sent primarily through informal channels to relatives who stay behind in Guet Ndar. These remittances supplement household income and provide for basic necessities such as food, water and shelter, demonstrating the importance of migration for improving household resilience in the community of origin by decreasing residents' reliance on the local economy. However, currency exchange rates weakened remittance potential and, additionally, differences among migrant fishermen led to varying levels of remittances. Irregular fishermen often have their equipment confiscated, are jailed and/or fined by the Mauritanian coastguard, losing any earnings or assets in the process. Poorer artisanal fishermen who take up contracts with Mauritanian factories must pay off the debts they accumulate when taking on loans for fishing equipment (boats, nets, motors, etc.), which decreases their remittance capacities. Only the more successful fishermen, who own their own, larger boats (*pirogues* of 25m) and therefore are able to generate larger catches, are able to send greater sums back to Guet Ndar. Importantly, the last group is able not only to provide their families with basic necessities, but also to relocate their families out of Guet Ndar and away from the encroaching sea. In a gradual process (sometimes taking more than a decade), remittances are used to construct homes in other coastal districts perceived to be safer from sea level rise and coastal erosion. Although local authorities have made gestures towards establishing residential developments for Guet Ndarians at danger of displacement, homes in these areas are often costly and relocation remains but a hope for the most vulnerable households to climate change and environmental degradation.

4.2.4. Conclusions and Policy Implications

Driven by residential destruction, demographic pressures and concomitant economic strife caused by maritime resource degradation, urban fishermen and their families are highly vulnerable to the current impacts of climate change, which will only exacerbate migratory pressures in the future. In order to protect these vulnerable coastal populations, firstly local and national governments must intervene to mitigate

and adapt to the effects of climate change. As is, outside of makeshift barriers, departure is often seen as the only solution for those who are able to do so. Environmental degradation is already significantly influencing both internal and international mobility patterns in Saint-Louis, Senegal. However, Guet Ndarian households' vulnerability varies and so does their capacity for migration and resilience. Active fishermen are able (if not always willing because of precarious conditions) to move up the coast in order to sustain their livelihoods, while those who are retired, elderly or whose occupations are land-based are less able to enact migration as an adaptation strategy and therefore rely on household members' labor migration. Although Senegal and Mauritania recently upped the number of annual licenses granted for people to bring fish back across the Senegal-Mauritanian border from 300 to 400, further increases could improve local populations' resilience capacities by stimulating the local economy, improving food security, and ameliorating precarious living and working conditions for migrant fishermen as well as local actors in the fishing sector. However, ongoing conflicts between the Mauritanian coast guard and Senegalese fishermen must be addressed to facilitate migration as adaptation.

But while most fishermen are able to embark on international labor migration in one form or another, only the most successful fishermen are currently able to relocate their families within Senegal. The case of Guet Ndarians therefore demonstrates the importance of integrating livelihood strategies and socio-economic status variations into vulnerability and resilience assessments and local, national and intra-regional adaptation plans. Policies and government initiatives must also make relocation available to the most vulnerable households, those in imminent danger of displacement and those without the capital to move out of harm's way. However, any efforts to relocate fishing families must be accompanied by infrastructure that recognizes their dependence on the sea, making commuting to work accessible for example.

Lastly, the enmeshment of internal and international mobility patterns exposes the importance of addressing environment-related population movements holistically and integrating local and regional solutions. As demonstrated by empirical investigation, these mobility responses are highly interrelated, and therefore call for cooperation among different levels of government and other key stakeholders.

4.3. Migratory responses to agricultural degradation and transformation in the region of Saint-Louis (Senegal)[4]

4.3.1. Context

Land remains the most fundamental productive asset in a country where over 70% of the population depends directly and indirectly on agriculture for their livelihoods (Crabtee-Condor & Cassey 2012). Climate change impacts together with lack of socio-economic assets pose considerable challenges to the resilience of Senegalese populations. These pre-existing vulnerabilities are amplified by a growing number of large-scale land acquisitions through which approximately 17% of the country's arable land has been acquired by foreign and national investors since 2008 (Sy et al. 2013).[5] Tensions between formal and customary land arrangements have significantly

increased with the interests of local communities often subordinated to those of recently arrived corporations. Despite a growing literature on the complex links between environment and migration, scant attention has been given to how environmental degradation, land rights, large-scale land acquisitions, and migration interact. In a region where both climate vulnerability and competition for land play a defining role in livelihood sustainability, how do these variables interrelate to give way to new migratory patterns? This section addresses how the combination of environmental degradation and large-scale land transactions in the region of Saint-Louis in Senegal has affected the vulnerability and resilience of populations and modified migratory dynamics.

4.3.2. Methods

Data was gathered through an intensive review of the existing literature on the topic. Media reports, academic research and NGO findings were consulted. Rural population's perceptions of large-scale land acquisitions' impacts and information on their subsequent mobility patterns were collected in July 2014 through qualitative methods (semi-structured interviews and focus groups). For this aim 45 people touched by 9 different agribusinesses[6], including village chiefs and religious authorities, were questioned. Their opinions were counterbalanced through 18 expert interviews with researchers, authorities, NGO's, journalists and peasant organisations both in Dakar and Saint-Louis. Content analysis of the gathered data allowed for the establishment of general shared perceptions on environmental vulnerability, impacts of large-scale land acquisitions, and migratory trends.

4.3.3. Findings

Environmental problems are of great concern for local populations that notice a much later arrival of the rainy season and a shorter duration of it. Even if their access to fresh water resources (Lac de Guiers and Senegal River) has allowed some of them to reduce their dependence to rainfall through irrigation systems, family farming in the region remains extremely difficult due to the lack of access to credit, state subsidies, and adequate means (pesticides, fertilizers, machinery, etc.). As a consequence of these factors, rural-exodus has historically constituted an important livelihood diversification strategy. However, the arrival of agribusinesses to the region initially spawned a return of locals that had migrated elsewhere in search of job opportunities. The promises of employment and infrastructure gave hope to populations that initially viewed private investment as a way to improve their resilience to pre-existing environmental and socio-economic vulnerabilities whilst allowing them to stay in their communities of origin. However, out-migration followed shortly due to populations' disappointment with the companies' actions. Respondents unanimously reported scarce employment opportunities, with those available being unstable, offering very low wages and not prioritising local employment. As one village chief explained: "People are leaving because they cannot find a job in the area. This should be the other way around!" Furthermore, the promises of infrastructure development (schools, roads, dispensaries, hospitals, etc) have rarely been kept. Locals, especially young men, thus continue to leave for Mauritania – especially Nouakchott – Dakar and the city of Saint-Louis. Many of the migrants have difficulties finding employment in these already socially and environmentally vulnerable cities and often

have to settle in slums, which can further reduce their resilience to future environmental shocks. Furthermore, vulnerability to climate change has been further compounded by destructive environmental practices undertaken by the agribusinesses that have led to deforestation and the pollution of their basic productive assets. The pollution of water resources and contamination of grazing lands have added increasing constraints to already vulnerable livelihoods with considerable impacts on their productivity that could lead to increasing rural-exodus in the future. As mobility is inherent to their livelihoods, it is pastoralists that have suffered the most immediate effects. With the parcelling of land and building of fences, they are now obliged to cross great distances to access grazing land and water for their herds. Conversely, women that previously migrated to Mauritania as care-workers have increasingly returned to the region in order to work for the agribusinesses. Although women equally report difficult working conditions, they claim having accepted employment because it provides them with the opportunity to stay near their families. Agribusinesses have also attracted populations mainly from the inner regions of Senegal (Fouta, Kaolack, Casamance, Fatick, Diourbel) that, given their dependence on rain-fed agriculture, are even more vulnerable to the impacts of climate change. For these populations, their lack of access to socio-economic capital is compounded by a lack of access to water resources and increased rainfall variability. Populations from these regions engage thus in seasonal labour migration as a way of diversifying their traditional livelihoods. With further projected climate change impacts on rainfall variability in the years to come, we can also expect greater in-migration from particularly environmentally vulnerable areas. Whether employment in such agribusinesses will continue to provide them with a livelihood diversification strategy remains to be seen.

4.3.4. Conclusions and policy implications

In order to fully understand how mobility will be increasingly affected by climate change impacts, it is essential to acknowledge how the environment interacts with other factors such as large-scale land acquisitions that can further increase the vulnerability of population whilst decreasing their resilience to future environmental and socio-economic shocks. In a region where rainfall variability places considerable strains on livelihoods, environmental degradation resulting from harmful corporate practices and the loss of customary land all have the potential of increasing rural-exodus whilst continuously affecting pastoralists daily mobility. Trying to artificially isolate the environmental variable from other major socio-economic and political factors will not only hinder our understanding of migration but will also translate into inadequate protection mechanisms and development policies. Findings show that the interaction between environmental vulnerability and large-scale land acquisitions can have both short-term and long-term impacts on population movements. The complex manner in which such variables interact across environmentally fragile areas show that a more nuanced understanding is needed between a “win-win” scenario – where rising employment opportunities would reduce rural exodus – and the dispossession and expulsion scenario – where people would be automatically displaced. Continued large-scale land acquisitions that overlook customary rights and fail to develop environmentally sustainable practices whilst providing viable livelihood diversification strategies for environmentally and socio-economically vulnerable populations will decrease the resilience of rural communities and affect investment viability in the long-term. Transparency in negotiations, respect for existing land

rights, sharing of benefits, environmental sustainability, and adherence to national trade policies, are the most frequently addressed challenges in global and national land governance norms.[7] Yet, such principles still fail to question agro-industrial development *per se* (Borras and Franco 2014), as if supporting other possible development pathways, such as smallholder agriculture would not be better suited to increase the resilience capacities of already environmentally vulnerable rural populations and to prevent possible forced displacement. The voluntary nature of such principles and their subsequent lack of national and local implementation remain considerable challenges that need to be urgently addressed. Finally, a better understanding of migration flows at a time when climate change will compound pre-existing vulnerabilities is essential in order to develop the social provisions and infrastructures that will make receiving areas resilient to growing demographic and environmental pressures.

4.4. The settlement dynamics of populations vulnerable to erosion in Cotonou's coastal zone (Benin)

4.4.1. Context

In the 21st century, the effects of global warming could be particularly disastrous for coastal areas, among others those located on the Gulf of Guinea in West Africa. The coast of Cotonou, the economic capital of Benin, has recorded significant coastal erosion for several decades, mainly due to the obstruction of the littoral transit by the harbour built in 1962 and the decrease in sedimentary inputs from the west due to diverse coastal protection structures. Moreover, sand quarries carried out directly on the beach have amplified erosion. Like most other coastal nations, a high proportion of the population is located on the coast. The vulnerability is exacerbated by rapid demographic growth and inadequate resources for urban development. In the future, the process will very likely be amplified by sea level rise and more frequent storms as consequences of global warming (Ozer et al. 2013).

This study examined population dynamics in a section of the coastal zone of Cotonou that is exposed to rapid erosion. The aims were to determine the vulnerability of populations in the risk zone and to analyze the responses of the authorities in order to underline the needs in the context of climate change, since global warming is responsible for sea level rise that accelerates the shoreline erosion process.

4.4.2. Methods

In order to assess the eroded area in the six kilometres directly east of the harbour infrastructures and to observe the human settlement dynamics next to the sea, multi-temporal analyses of very high-resolution satellite images from Google Earth (2002, 2011 and 2013) were carried out. We completed the analyses with field missions in September 2012, September 2013 and July 2014. These fieldworks consisted of discussions with institutional actors, local authorities and researchers and of twenty interviews with affected populations.

4.4.3. Findings

Coastal erosion and settlement dynamics

Between 1963 and 1997, the coastline retreated by 400 meters at the east of the harbour of Cotonou (CODJIA, 1997). Diachronic analyses of satellites images show that the sea eroded approximately 75 ha of land between 2002 and 2013. This corresponds to a coastline retreat of 125 meters in 12 years (Figure 1). Coastal erosion is observed up to the Nigerian border, which is 27 km east of Cotonou, with an erosion of 30 meters in 10 years recorded at the border.

Figure 1

In some zones, one observes a progressive replacement of parcelled/standing houses by makeshift houses between 2002 and 2011. Furthermore, between 2011 and 2013 images reveal a rapid destruction of some of these newly constructed houses.

Migrants and trapped populations

People with sufficient economic capital left the coastal zone when their houses were threatened by the sea. According to evidence, they relocated inland, usually to the peripheral areas of Cotonou. The people remaining were mainly fishermen and precarious populations that lack money, networks, knowledge, etc. According to interviews, fishermen (or their parents) are native to the region of Grand-Popo (on the coast 90 km to the West of Cotonou) and arrived in the coastal zone of Cotonou in the 1970s in order to have better living conditions and more employment opportunities. However, since their arrival, they made successive displacements along the coastal

zone due to the encroachment of the sea. Due to loss of assets and capital allocation for constructing a new home, their vulnerability increased with each move. In addition to fishermen, there are two other groups of precarious populations in the zone. On the one hand, there are people who lost their homes to the sea, causing them to fall into poverty. On the other hand, there are poor people who moved *into* the risk zone because they had no money to pay rent elsewhere in the city. Both groups feared being displaced by the sea. Unlike fishermen who want to stay near the shoreline for their economic activities, the other precarious populations who came from rural areas want to leave the coastal area but lack the financial capital and social networks to do so. Results highlight an increasing vulnerability of populations as the sea continues to advance and a concomitant decrease in their resilience capacities, forcing the poorest people to stay in the risk zone. Without sufficient resources or other viable alternatives, people's only adaptation strategy is to continually move within the risk zone.

Authorities' responses

In the national strategy to implement the UN Framework Convention on Climate Change, Benin proposed two adaptation options: 1) stabilizing the coastline by building groynes (rigid hydraulic structures built from an ocean shore in coastal engineering that interrupts water flows and limits the movement of sediment therefore reducing erosion), and 2) relocating activities, communications, transport, hotel infrastructures and communities out of the risk zone. Under the pressure of associations, all marine sand quarries were closed in March 2009. Since May 2014, seven groynes were built in the most exposed zone for a cost of 45.4 milliards FCFA, financed by several investors (essentially Islamic States Funds). At a scale of a groyne, positive effects are observed at the west of the structure but negative effects (fast erosion) appear at the east. However, the problem is transferred to the east of the zone where the seven groynes are placed, to the neighbouring municipality. The installation of such protection structures restores confidence to investors who are starting to build new standing houses in the zone protected by the groynes.

4.4.4. Conclusion and policy implications

There is a lack of habitat regulations and land use planning addressing settlement in the risk zone. Some laws and decrees have not been respected and others are inadequate and should be revised or updated. Additionally, there is little awareness among the local populations of existing legal mechanisms and regulations. Although the Cotonou town council wants to solve the erosion problem whilst avoiding the displacement of their residents, they have few resources within their reach. They place their hopes on the groynes but realize that their effectiveness will only be proven over time, and, furthermore, that even then the problem will be transferred to the neighboring municipality. Meanwhile, local authorities try to persuade fishermen to relocate away from the sea but do not offer compensation or assistance. However, they turn a blind eye to informal settlements because they have no alternative to propose.

In addition to the need for local solutions, coastal erosion is not confined to this zone and so the development of international cooperation with other countries in the Gulf of Guinea is necessary. Benin, like the other ten coastal countries of West Africa, has

adopted a master plan for coastal development with the support of the West African Economic and Monetary Union (UEMOA) but implementation of the recommendations must be consistent within the region. Consultation with affected populations is also needed (Teka and Vogt 2010).

5. Conclusions and Policy Recommendations

Climate change's effects on West African mobility cannot be isolated to a singular outcome. Environmental degradation, whether resulting from slow-onset changes or sudden shocks, affects populations' vulnerability and resilience capacities in complex manners. These complexities stem from, and result in, variegated and cumulative vulnerability and resilience among West African populations. Firstly, the presence of multiple environmental trends and shocks vary geographically. While desertification and droughts are of prime importance for some, floods, coastal erosion and sea-level rise are the main hazards for others. Even within local populations affected by the same climatic threats, their vulnerability and likelihood to migrate is affected by their socio-economic status (with those having some form of financial and social capital more able adapt locally and/or through migration), their dependence on natural resources, and their demographic characteristics (age, gender, etc.). The complex links that emerge between environmental degradation, vulnerability and migratory patterns are further exemplified through the added pressures of large-scale land acquisitions of agricultural land. Fishing communities equally encounter compounded environmental and socio-economic pressures with changes in maritime resources affecting livelihoods and coastal erosion and sea level rise threatening their places of residence. Together, cumulated vulnerabilities increasingly shape differentiated mobility outcomes and consequential capacities for resilience.

One of the most important findings, based on quantitative analysis, was the importance of examining vulnerability as it is *perceived* by those affected. Migratory decisions and intentions are based on the perceptions of threats, which do not always correspond with meteorologically observed climatic trends or their causes. Although not specifically presented here, qualitative work in other West African countries mirrored this finding, exposing the lack of awareness among affected populations about the causes of environmental degradation and the extent of future threats. Building resilience among local populations therefore requires assessing perceived and real vulnerability as well as educating local populations about changes to their natural environments, which can facilitate informed mobility decisions.

Furthermore, findings reveal that mobility stemming from environmental degradation is highly related to livelihood strategies and dependence on natural resources. Economic and environmental drivers of migration cannot be separated as demonstrated by fishermen in Benin and Senegal and agriculturalists and pastoralists in Senegal. While labor mobility offers an adaptive strategy for fishermen, their livelihoods restrict their mobility to coastal zones. With cultural and traditional attachments to the sea, and without skills transferable to other industries, even after successive displacements, fishermen continue to build their homes in the risk zone of Cotonou, for example. Moreover, even within the fishing sector mobility and vulnerability vary. Within the fishing sector of Guet Ndar, for example, while fishermen could rely on labor migration up the Mauritanian coast, women processing

fish and others involved in the industry on land were limited in their potential for mobility. They thus saw their livelihoods suffer from both the diminution of local fish stocks and from the advancement of the sea as it destroyed their workplaces.

Despite these challenges, migration has offered a significant tool with which local populations adapt to climate change. With local livelihoods increasingly difficult to maintain, which is only compounded by the arrival of national and international investors, out-migration of youth from rural villages in the region of Saint-Louis decreases household reliance on agriculture. Diversifying their livelihood strategies, young men and women to move into service industries in urban centers. In the opposite direction, populations that depend solely on rainfed agriculture in the interior of Senegal, particularly vulnerable to climate change, diversify their livelihoods by moving *into* these rural villages to work for agribusinesses. Similarly, on the West African coast, Guet Ndarian fishing migration to Mauritania generates remittances used to support households in the community of origin, and, for the most successful, remittances enable households to escape the threat of coastal erosion and sea level rise by building new homes in safer areas of Saint-Louis.

But mobility cannot only be seen as it increases individual and household resilience to environmental degradation. In fact, the heavy erosion of the coast of Cotonou has caused the voluntary migration of those with capital, the displacement of fishermen, but also an *in-migration* of poor populations that, despite the risk, cannot afford to live elsewhere. Their pre-existing economic vulnerability is then compounded by environmental hazards in the migratory destination. Furthermore, regional rural-to-urban migration does not always provide better conditions for migrants, who may struggle to find employment in destination areas and often move into slums and makeshift housing in urban peripheries. These living conditions can exacerbate risk to environmental and health hazards.

A holistic comprehension of how environmental vulnerabilities compound pre-existing vulnerabilities is essential in order to provide useful responses. Given the aforementioned differentiated vulnerabilities and capacities for resilience, there is no one-size-fits-all solution. Policy must be adapted and implemented according to particular populations and needs. Strategies will need to take into account geographical and climatic variations, but also socio-economic differentiated vulnerability in order to build resilience. However, that does not preclude the need for regional cooperation. While the particularity of threats may be local, climate change stimulates internal and international migration that will affect all the countries of West Africa. The region already claims some of the highest rates of intra-regional mobility in the world, facilitated by the porosity of borders within ECOWAS. However, the lack of reliable data on population dynamics in the region makes it difficult to assess vulnerability and mobility on a regional scale. It is thus essential that governments cooperate in order to collect reliable data upon which policymakers can shape long-term strategies.

Furthermore, regional authorities must work together to build the resilience of sending communities to climatic shocks, but they must also facilitate migration as an adaptation strategy by, for example, recognizing the developmental potential of remittances. In addition, to avoid adverse migration outcomes, they must prepare destination areas (especially coastal urban centers) to receive internal and international migrants. West African cities, already struggling with economic,

demographic and environmental pressures, will only see their vulnerability compounded with future climate change. Building infrastructure and establishing protection mechanisms for migrants and displaced persons is thus a necessary step in mitigating future risk.

Although not the specific focus of this paper, the forced displacement of people due to environmental shocks warrants public and political attention and intervention. The Kampala Convention is the first legally binding instrument to address the specific needs of internally displaced persons (IDPs). West African nations that have ratified the convention must now incorporate it into national legislation and develop targeted policies. If effectively implemented, its principles could help West African countries deal with current and future movements of people, caused not only by conflict, but also by natural disasters and other direct and indirect effects of climate change. The United Nations Convention on the Protection of the Rights of all Migrant Workers and Members of their Families that has also been ratified by the majority of West African countries, could equally protect populations directly or indirectly impacted by environmental degradation.

In order to diminish the negative impacts that environmental degradation poses to traditional livelihoods, land governance policies and land use plans need to take future environmental degradation into account. The protection of Housing, Land and Property Rights as well as appropriate natural resource governance (including fisheries) will increasingly condition the vulnerability and resilience of populations to climate change. While it is of the utmost importance that National Adaptation Plans (NAPs) in West Africa must incorporate mobility (Warner et al. 2014), they also offer an encouraging platform for the strengthening or establishment of appropriate institutional arrangements to address increasing environmental vulnerability and to build population's resilience to future shocks (UNFCCC 2014).

[1] African Monsoon Multidisciplinary Analyses

[2] The research leading to these results has received funding from the European Union Seventh Framework Programme *FP7/2007-2013* under *grant agreement* n° 603864.

[3] Interviews were also conducted in rural villages in the south of the Langue de Barbarie and two urban neighborhoods to the north of Guet Ndar: Ndar Toute and Goxum Baccc.

[4] This fieldwork was funded by the Belgian National Fund for Scientific Research (FNRS) within a PhD research fellowship.

[5] Whilst in the period ranging from 2000-2007 there were six private investment deals concerning 168.964 ha, 30 more deals touching 630.012ha were registered between 2008 and 2011. The total land concerned by large-scale land acquisitions is now estimated at 844.970ha (Sy et al. 2013).

[6] Anonymization of the companies involved is required since further research in the same region will provide their explicit opinions in helping counterbalance these findings. It is not the aim of this section neither to criminalize any particular company nor to state that population's perceptions alone reveal the real complexity of the matter at stake.

[7] FAO, IFAD, UNCTAD and the World Bank (PRAI) have developed sets of principles for responsible agricultural investment. The United Nations Economic Commission for Africa, the African Union, the African Development Bank, and the EU have also developed frameworks and guidelines.

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