

Compound Vulnerabilities: The Intersection of Climate Variability and HIV/AIDS in Northwestern Tanzania

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(Manuscript received 28 September 2012, in final form 1 May 2013)

ABSTRACT

Drawing on ethnographic research conducted in Nsisha, a rural village located close to the shores of Lake Victoria in northwestern Tanzania, this article analyzes how climate change and variability intersect with other stressors that affect rural livelihoods, particularly HIV/AIDS. The analysis integrates theories of vulnerability from both climate and HIV/AIDS literatures to show how these intersecting stressors compound livelihood vulnerability in complex ways. Climate change and variability are linked to declining agricultural yields and an increase in food and nutrition insecurity and poor health in this region. This situation heightens poverty and susceptibility to HIV/AIDS, compromising people's abilities to cope and adapt. Because of social dynamics, single mothers and their children are particularly affected by these compound vulnerabilities. Climate change and variability are significant contributing vulnerability factors that sustain and exacerbate asymmetrical poverty, food and nutrition insecurity, and HIV/AIDS. By describing the links between vulnerability to HIV/AIDS and climate variability, findings highlight the importance of holistic and localized approaches to adaptation, instead of trying to isolate single issues. Prioritization of multidisciplinary research focusing on the socially differentiated and gendered distribution of vulnerability specifically in regard to poverty, food and nutrition insecurity, and HIV/AIDS is recommended as a means to enrich the understanding of climate change vulnerability. Adaptation strategies should address how climatic shifts interact with generalized poverty, food and nutrition insecurity, health, and gendered vulnerability in areas most affected.

1. Introduction

Across Africa, climate change and variability pose additional stresses to smallholder farmers who already have challenging livelihoods. Widespread and gendered poverty, food and nutrition insecurity, HIV/AIDS, and agricultural transition and decline wrought by an increase in pathogens affecting people, plants, and animals; decreasing soil fertility; and diminishing farming land are among the chief challenges currently affecting the Bahaya (Githinji 2008, 2009a,b, 2011a,b; Rugalema 1999; Baijukya 2004; Rugalema et al. 2009; Rugalema and Mathieson 2009). Changing weather patterns—including unpredictable and longer-spanning dry periods; abrupt, short, and heavy rains; and a significant increase in annual rainfall in the past few decades (Kizza et al. 2009; Rowhani et al. 2011)—add to the list, synergistically intertwining with and exacerbating current agricultural

livelihood challenges in the village and region (Yanda et al. 2005; Rowhani et al. 2011; Jones et al. 2007).

The climate literature has long pointed out that complex social and biophysical dynamics interact to create human vulnerability to climate shocks (Adger 2006; Lemos et al. 2007; Boyd et al. 2008). Stillwaggon (2006) has made a similar argument regarding the complex set of factors contributing to HIV/AIDS vulnerability. The HIV/AIDS epidemic and increasing climate variability occur simultaneously in many parts of Africa, exacerbating socially differentiated and gendered poverty, food and nutrition insecurity, and poor health. As this article emphasizes, the impacts of the HIV/AIDS epidemic and climate variability are not always viewed as dramatic, acute events, such as a drought or civil war, for example, but their ongoing and intertwining nature have a tremendously debilitating effect on society, deepening wounds of poverty and asymmetry for generations. As de Waal (2006, p. 17) comments on the similarity between the HIV/AIDS epidemic and climate variability, "AIDS is more like climate change, an incremental process manifest in a quickening drumbeat of 'normal' events."

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DOI: 10.1175/WCAS-D-12-00052.1

The Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report chapter “Human Health” overwhelmingly emphasizes health considerations that are directly mediated through biophysical environmental mechanisms: temperature variability, hydrological variability, infectious diseases, etc. (Confalonieri et al. 2007). For example, much of the research on links between climate change and human health tends to focus on interactions between environmental change and changing ecologies of disease vectors, as with malaria (Jones et al. 2007; Patz et al. 2000; Yanda et al. 2005) and cholera (Tschakert 2006; Yanda et al. 2005). While the social mediation of vulnerability is widely acknowledged in the literature, on the whole, it still emphasizes direct exposure to the biophysical phenomenon as the primary consideration.

In contrast, the research presented here takes the biophysical phenomena as a starting point, analyzing how the social mediation of two apparently distinct vulnerabilities—climate and HIV/AIDS—intersect in ways such that they compound one another. The specific objectives of this study are to analyze 1) the mechanisms through which the seemingly disparate stressors of HIV/AIDS and climate variability overlap and 2) the social dynamics that create and compound vulnerability to both of them. Particular attention is given to the experiences of single women with children, who are, in general, socially and economically marginalized and thus disproportionately suffer greater vulnerability to both HIV/AIDS and climate variability. Empirical analysis of the mechanisms through which both vulnerabilities are mediated is an essential component of identifying adaptation measures, which must address the web of biophysical and social dynamics in a holistic fashion (Crane et al. 2011). This is particularly important when examining the complex and intertwining characters of poverty, HIV/AIDS vulnerability, and climate vulnerability in sub-Saharan Africa, where all three are acutely experienced.

A qualitative, ethnographic research approach is used to highlight the interactions between women’s personal agency and cultural institutions in order to closely examine the dynamics of livelihood and climate vulnerability in general (Adger 2006; Crane 2010; Roncoli et al. 2009) and particularly for the most vulnerable—single women with children (Denton 2002; Eriksen et al. 2005; Paavola 2008; C. Almekinders et al. 2010, unpublished manuscript). The choice to use a qualitative case study approach serves two purposes. First, it is meant to give voice to the experiences of real individuals in a real location, specifically single women with children, who disproportionately live the harsh everyday realities of gendered poverty. Second, by elaborating the micro-social dynamics of vulnerability and coping with climate



FIG. 1. Map of the study area (from www.fao.org).

among multiple stressors, this study describes and analyzes the real social dynamics that must be anticipated and addressed in any adaptation effort (Gallopín 2006; Smit and Wandel 2006).

2. Socioecological background

Buhaya is the cultural region situated in the northwestern corner of the Kagera region in Tanzania and is the homeland of the Bahaya people. The research for this article was conducted in the village of Nsisha in Bukoba Rural, located close to the shoreline of Lake Victoria (see Fig. 1). Bananas have served as the cultural core and staple food for centuries and hold prominent meaning in the Bahaya agricultural way of life (Schmidt 1997; Rugalema 1999; Githinji 2008, 2011a). This region is characterized by a long history of high rainfall, high population density, and intense use of the land through centuries of iron smelting, deforestation, pastoralism, and agriculture. The Bahaya agricultural system, known as the *kibanja/rutabiro/rweya*,¹ has in itself contributed

¹The *kibanja* is the banana home garden and the *rutabiro* is an outer-lying portion of the *kibanja* where secondary crops are grown. The *rweya* is the land surrounding and separating villages, which was traditionally used as grazing lands for cattle and other livestock; for growing shrubs and grasses used for fodder, thatching, and mulch; and as a buffer farmland relied on during drought where secondary and seasonal crops are grown, including potatoes, cassava, and beans.

to decreasing fertility of fragile soils prone to leaching and siltation (Schmidt 1997) because land is intensely used year-round and parcels of kibanja are bequeathed patrilineally.

In recent decades, changing ecological conditions, including decreasing soil fertility and an onset of unpredictable and heavier rain patterns, combined with diminishing farmland and a surge in banana pathogens have resulted in a dramatic decline in banana production (Baijukya 2004), leading to an increase in generalized and gendered poverty, food and nutrition insecurity, illness, and sociocultural and livelihood transition (Rugalema 1999; Githinji 2008, 2009a,b, 2011a,b). Whereas bananas grown in the kibanja, the banana home garden, once served as the traditional and staple food, which was plentiful and is the symbol of the Bahaya culture core (Rald 1975; Culwick and Culwick 1994), many Bahaya have been forced to reduce their meals, converting their diet to one based on cassava and potatoes that come from the buffer farms of the *rutabiro* and *rweya* (Rugalema 1999; Githinji 2008, 2009a,b, 2011a,b; V. Githinji 2013, unpublished manuscript).

In terms of national politics and development, this region has experienced both isolation and high rates of social permeability because of its separation from the rest of mainland Tanzania and because it shares borders with Uganda, Kenya, Rwanda, Burundi, and the second largest freshwater lake in the world, Lake Victoria. The long history of ecological vulnerability in the region combined with missing out on national development initiatives, repercussions of the Kagera War of 1978–79, and forming part of the world's first epicenters of HIV/AIDS have contributed to sociocultural disruption and widespread household poverty (Kaijage 1993; Rugalema and Mathieson 2009; Rugalema et al. 2009). In the earlier part of the century, this area was plagued by epidemics of venereal disease, including syphilis and gonorrhea (Culwick and Culwick 1994), which stigmatized the region and the Bahaya people, leaving scars of stillbirths, infertility, and shame. In the early 1980s, this region formed part of the world's first epicenter of HIV/AIDS. During the peak of the epidemic around 1987, HIV rates among people in their most productive ages reached as high as 25% (Lundberg et al. 2000), although currently the HIV/AIDS infection rate in this area is estimated at 3.7% (Rugalema and Mathieson (2009, p. 44).

Because of the effects of climatic change, seasonal temperature in the Lake Victoria area is projected to increase by 2°C by the year 2050, reaching up to a 4°C increase by 2100 (Rowhani et al. 2011; Paavola 2008). Similarly, annual precipitation has increased by 24% percent in the past century (Kizza et al. 2009, p. 132) and

is projected to increase by 50% by the year 2100 (Rowhani et al. 2011; Paavola 2008). More specifically, there has been a significant surge in rainfall during the short rains (Kizza et al. 2009, p. 132). The increase in both seasonal temperature and precipitation are expected to have negative consequences on agricultural productivity, specifically for staple foods including bananas, maize, sorghum, and rice (Rugalema and Mathieson 2009; Rowhani et al. 2011). Given that most Bahaya living in the village of Nsisha, where this research was conducted, and other rural parts of Buhaya are semisubsistent farmers, climatic change and variability pose a grave threat to their livelihood and household food security, poverty, and health status. Similar situations in which climate change is negatively affecting socioecological systems and challenging people's abilities to cope and adapt have been witnessed in other areas of sub-Saharan Africa (Boyd et al. 2008; Thornton et al. 2009) including, for example, Morogoro, Tanzania (Paavola 2008); the Saweni subvillage, Tanzania and Mbitini, Kenya (Eriksen et al. 2005); the Great Ruaha River catchment area, Tanzania (Kangalawe et al. 2011); Ethiopia and Mali (Crane 2010, 2013); and Senegal (Tschakert 2006).

3. Methodological and theoretical framing of the paper

In her groundbreaking book, *AIDS and the Ecology of Poverty*, Stillwaggon (2006) outlines a critique of HIV/AIDS research and policies based on overly narrow assumptions about the epidemiology of the disease. Rather than approaching the disease from a reductionist epidemiological perspective, Stillwaggon suggests that understanding AIDS from a holistic "ecological" perspective will produce a more accurate and relevant understanding of the dynamics that produce the epidemic. This involves a more integrated analysis of AIDS in relation to biophysical environments, social contexts, and dynamics, as well as interactions with malnutrition, infectious diseases, and parasites. Such an approach will result in an understanding of vulnerability that acknowledges complex interactions between disparate but related factors. This paper builds on Stillwaggon's argument about the ecology of AIDS, integrating the place of climate variability in the matrix of challenges and multiple stressors (Boyd et al. 2008) affecting livelihoods in vulnerable ecologies of poverty and HIV/AIDS.

Similarly, the concept of "conceptual vulnerability" is viewed in the climate literature as "a function of climatic conditions and the social, economic and political processes that determine how climate change is experienced and which shape responses available to adapt. Here, vulnerability is conceptualized as a state or condition in

process, not an outcome, continually evolving and changing” (Ford et al. 2010, p. 377). What both approaches share is a holistic theoretical and methodological lens for studying vulnerability in relation to their respective focal points: the HIV/AIDS epidemic and climate change. This paper combines the two in order to reveal a more comprehensive and nuanced understanding of the mechanisms by which the dynamics around HIV/AIDS and climate variability act synergistically, leading to socially differentiated vulnerability in impoverished contexts. Taking a decentered approach, we intend to support the design and implementation of more effective intervention strategies that acknowledge multiple and interacting vulnerability factors.

Climate change and its effects on Bahaya livelihoods were not initially a focal point of the research, but the topic was brought up constantly by informants during interviews and discussions on agriculture, poverty, nutrition, health, and HIV/AIDS. The repeated introduction of the topic of climate-induced stress by informants emphasized that increasing climate variability is closely intertwined with other challenges affecting Bahaya vulnerability, which actually contribute to and intensify many of the core livelihood challenges in the area: widespread and socially differentiated and gendered poverty, food and nutrition insecurity, poor health, and HIV/AIDS vulnerability. While Demetriades and Esplen (2009) and Denton (2002) have previously drawn connections between climate vulnerability, poverty, and gender in theoretical terms, this paper seeks to substantiate links through an empirical case study (Ford et al. 2010) exploring the intersection of HIV/AIDS vulnerability and climate vulnerability.

Ethnographic research was conducted in Nsisha, Tanzania, focusing on the gendered vulnerability to poverty, food insecurity, and HIV/AIDS. Three hundred and eleven interviews were conducted during three phases of research in 2005–06. The initial phase consisted of interviewing the head of the household—or an adult who was present—for each of the 184 households in Nsisha. The second phase focused on semistructured interviews that lasted approximately 2.5 h with 97 heads of household, including married, single, and widowed men and women. The third phase consisted of reinterviewing 30 female heads of households—15 widows and 15 nonwidows—to gain a more in-depth understanding of the connections between agricultural decline and change, food and nutrition insecurity, poverty, health, and HIV/AIDS in the village.

The results section of this paper is divided into three parts, which focus on different aspects of climate vulnerability in Buhaya. The first part discusses the effects of climate vulnerability in Buhaya on declining

agriculture and an increase in food insecurity. The second part examines how climate vulnerability intersects with and increases HIV/AIDS vulnerability. The final part of the results section shows how these compound vulnerabilities are asymmetrical along gendered lines, leading to an increase in girls’ and women’s livelihood and HIV/AIDS vulnerability. Individual narratives are used heavily in the presentation of the results to highlight vulnerability as a lived experience, rather than an abstract conceptual construct. The subsequent sections include a discussion and a conclusion, respectively.

4. Climate vulnerability in Buhaya

a. Effects on agriculture and food security

Precisely how interseasonal and intraseasonal changes in precipitation and temperature mentioned above (section 2) will synergize and ultimately affect crop production and food security in the future remains uncertain and is still in the early stages of investigation (Rowhani et al. 2011, p. 458). However, while rainfall tables and agroclimatological models can be indicative of changing patterns of climate variability and food insecurity, the social dynamics and human experience of vulnerability are better captured in the words and lives of people themselves. The residents of Nsisha report that climate variability negatively affects agricultural productivity in Nsisha in the present, adding to the general challenges most Bahaya farmers face.

For example, based on discussions with Nsishans in regard to how agricultural productivity has changed in the recent past and which specific challenges they are facing, many of the poorest Nsishans stated that the current climatic shifts pose one of their greatest agricultural challenges. Because their livelihood and household economic, food, nutrition, and health security are interlinked and depend on accurate understanding and prediction of the weather, they often have little to no buffer if their estimates and timing are wrong. An elderly widow who is rearing her two grandchildren, Asteria² commented with frustration that, “[i]n the past, we were able to predict the onset and duration of the wet and dry periods. However, these days the rainy seasons and dry seasons are unpredictable and much more severe than what we are used to.” Asteria’s observation, which was similarly echoed by several older Nsishans, substantiates the effects of changes in both interseasonal and intraseasonal climate variability. Nsishans also mentioned that, in general, there are currently longer periods of

² Pseudonyms are used throughout this article.

dry, hot seasons and shorter periods of intense, and often disastrous, rain. Nsishans consistently observed that the recent shifts in climate and precipitation are striking at the core of the Bahaya culture—the kibanja, their banana home garden, which is the cornerstone of household food security (Githinji 2011a).

Asteria was constantly working in her old age to try to eke out a living for her grandchildren, because she was their sole provider. The climatic shifts add another household challenge to her situation, threatening her household's overall economic, food, nutrition, and health security. She lacked the strength, labor, and manure needed to maintain a productive kibanja, as well as the ability to purchase agrochemicals. She was rarely able to obtain and save money from the sale of agricultural products, because she rarely had surplus to sell. This means that they were not able to purchase items such as supplemental foods, like milk, sugar, tomatoes, fish, and meat, and clothing and medicines.

Methilda, an elderly widow living alone, reminisced about life in the days when bananas were plentiful in the kibanja:

Times have changed! Farming and Bahaya life is no longer like it used to be! Bananas used to be plentiful and we ate them with every meal, every day! We shared bananas and gave them as gifts for celebrations. We used the leaves for wrapping things, steaming foods, thatching, carpeting, and many other purposes. Now, the weather and rains are chaotic and *ekiuka*—the pathogens which destroy banana plants—are destroying the kibanja and leaving us Bahaya to be poor, hungry, and with nothing! Without bananas in the kibanja, who are we? We would not be Bahaya.

Methilda's sentiments reflect the overall agricultural decline and sociocultural change occurring in Buhaya. As *ekiuka*, soil infertility, HIV/AIDS, and climatic shifts threaten Bahaya livelihoods, people are left wondering about what the future holds for their culture. A flourishing kibanja is the essence of their culture core; symbolic meanings and practical uses of banana plants are interwoven throughout their daily lives (Weiss 1996; Githinji 2011a). The decline in banana production on the kibanja symbolizes shock, change, and uncertainty, mirroring the generalized livelihood impoverishment and food, nutrition, economic, and health insecurity currently affecting many (Githinji 2008, 2011a).

Dorosella, a middle-aged single mother who inherited a very small, marginal, and unproductive kibanja and who resorted to selling banana-based beer and gin to support her young, dependent children, stated that “[t]he extreme weather these days is causing the *ekiuka* in the kibanja to be so bad that although it is shameful and we do not want to admit it, some of us resort to eating

the bananas which are supposed to be used for brewing only! But, we cook them and we eat them because that is what remains in the kibanja when we are hungry!” Dorosella and her children lived a life of vulnerability. She exclaimed that life as the sole provider to her young children was very difficult. For women like her, it was easy to fall into the trap of poverty-induced survival sex and increased risk of HIV/AIDS. However, she chose to sell—“and not drink,” she adds—brew as her main economic and livelihood survival strategy to support her household and “prevent herself from engaging in insecure and precarious relationships with men that could lead to HIV/AIDS.” She complained that people knocked on her door day and night, asking for brew to purchase or “begging to put on credit.” It was not an ideal livelihood, she admitted, and she worried how the bar-like environment affected her young children, but it was the best and only livelihood opportunity she had—outside of prostitution—given her lack of assistance and assets, the marginal and unproductive kibanja and her inability to purchase needed inputs to ward against the impacts of climate variability and *ekiuka*, and her determination to care for her children and escape HIV/AIDS in spite of their household poverty.

As Anna, an elderly widow who was taking care of her daughter who was sick with HIV/AIDS and her three grandchildren, explicitly explained,

[t]he unpredictability of the onset, duration, and intensity of dry and wet seasons is the chief problem which is causing poverty and hunger for us, because we haven't been able to accurately forecast when to plant. Sometimes we plant too soon or too late. When we plant too soon, the seeds dry up and die. When we plant too late, heavy rains wash away seeds and destroy the baby banana plants. Both situations lead to disaster—not enough good food, skipping meals, no money for anything like milk, rice, sugar, meat, medicine, and trips to the hospital! We are hungry!

For Anna, life was tiresome and worrisome. She was becoming frail, but was the sole provider to two younger generations. Erratic climate variability shifts add yet another challenge to her household's well-being. Her daughter's health was ailing, and rather than having her assistance on the kibanja, Anna diverted her energy needed on the farm for engaging in other economic livelihood strategies, such as collecting and selling grass, to care for her daughter and the grandchildren. Anna's caretaking responsibilities for her sick daughter and young grandchildren affected productivity on the kibanja and their household food, nutrition, and economic security. They lacked manure, farm labor, income, and assistance which they needed to achieve food security. They drank tea without sugar or milk and ate only once

daily. Their meals consisted mostly of roots and tubers, since bananas did not grow well on the infertile soil. Although they occasionally became ill with intestinal problems, colds, and malaria, they could not afford to go to the hospital and purchase needed medicines. They, including the sick daughter, relied on traditional medicines which were more accessible, but not always timely or effective. Anna mentioned that, because of the lack of food, the “the HIV/AIDS medications—although free—were too strong on an empty stomach and just made people sicker.”

There are numerous aspects to vulnerability in Nsisha: declining soil fertility, increasing crop disease pressure,³ and generalized poverty, to name a few. The observations made by the Nsishans above illustrate how increasingly unpredictable weather patterns add an additional livelihood challenge, because they synergize with the manifestations of poverty and HIV/AIDS, the progressively infertile soil, and the variety of pathogens that destroy banana plants—the traditional staple food and symbol of Bahayanness (Githinji 2011a).

As outlined in the case studies, Bahaya farmers are facing poverty and livelihood insecurity, a situation which heightens their vulnerability, risk, and inability to cope and adapt to the effects of additional challenges wrought by climatic change and variability events and shocks, especially for those who are already living in the most impoverished conditions and lack adequate buffers. These complex livelihood challenges synergistically intertwine, creating a reality whereby the poorest and most marginalized people are those most vulnerable to the trap of poverty, food and nutrition insecurity, and poor health. Only the households that have reliable access to important assets like livestock, cash, manure, and labor can confront the current farming challenges, attain adequate yields and maintain their household's security. These crucial livelihood assets help mitigate the effects of erratic rainfall patterns by securing the buffers—capital, agricultural inputs, seeds, farming assistance, and medicine—that ensure agricultural productivity and household economic, food, and health security.

b. The intersection of climate vulnerability and HIV/AIDS vulnerability

Climatic variability is linked to poor health, specifically to increased incidences of malaria (Jones et al. 2007; see also Patz et al. 2000) and cholera (see also Tschakert

2006) in Buhaya (Yanda et al. 2005). Cofactors like malaria and cholera increase susceptibility to HIV infection and progression to AIDS (Stillwaggon 2006). Malaria cases increase during the heavier rainy periods and in years following drought. “Malaria outbreaks have been common in years subsequent to the El Niño season (1997/98),” which are marked by a period of heavy rains that cause food shortage, and then followed by drought (Yanda et al. 2005, p. 12). Food shortages result in food and nutrition insecurity, malnutrition, compromised immunity, and heightened vulnerability to illness for the most vulnerable.

In Nsisha, people commonly refer to malaria in Luhaya, their native language, as *endwala y'omushana*, which translates to “the disease of the dry season.” Once primarily a seasonal problem, this type of malaria now occurs throughout the year (Rugalema et al. 2009, p. 445), a shift that mirrors increasing climatic variability and its longer-spanning dry periods punctuated by unpredictable and abrupt heavy rains (Rowhani et al. 2011). In addition to malarial stress, postdrought periods—associated specifically with El Niño rains—are marked by high incidence rates of malaria-related anemia that predominately affects those most vulnerable to poor health: women and children (Yanda et al. 2005; see also Denton 2002).

Similar to malaria, cholera incidence tends to be higher during the heavy rain periods, which is due to the lack of adequate sewage disposal and the overflow of latrines that contaminate water supplies. Often improper sanitation and treatment of water during wet periods leads to diarrhea, causing illnesses and outbreaks of cholera (Yanda et al. 2005; Tschakert 2006). As rainy periods have become and are predicted to be more abrupt and intense, it can be expected that cholera incidence rates will increase. Communicable diseases like malaria and cholera are not the only climate-related factors that compound vulnerability to HIV/AIDS. Food insecurity and malnutrition, which are also climate related, can likewise increase vulnerability to HIV/AIDS.

Nsishans indicate that unpredictable onset, duration, and intensity of dry and wet seasons lead to cycles of food insecurity because staple food crops, specifically bananas, do not grow well under such conditions. Food insecurity escalates economic and nutritional insecurity, since people, particularly single women with children, lack access to an adequate diet (Githinji 2009a,b, 2011b). This in turn increases vulnerability to poverty, poor health, and disease, and the cycle repeats when poor farmers like Asteria, Methilda, Dorosella, and Anna lack the buffers to break out of the cycle. The case studies of George, Lestuta, Kokoshubira, and Geti given below illustrate the synergistic and potentially cyclical

³The most prevalent pathogens affecting banana plants include banana *Fusarium* wilt (Panama disease), banana xanthomonas wilt, black sigatoka, banana weevils, and nematodes (Rugalema and Mathieson 2009).

relationship between climate variability, degrading economic resources, food and nutrition insecurity, and poor health vulnerability in the context of Nsisha, as has been found in other parts of sub-Saharan Africa (Adger 2006; Tschakert 2006; Eriksen et al. 2005; Paavola 2008; C. Almekinders et al. 2010, unpublished manuscript; Denton 2002; Brooks et al. 2005; Kangalawe et al. 2011).

Cattle were traditionally an integral part of the Bahaya agricultural system, providing fertilizer essential for the prosperity of banana plants on the kibanja. Less than a century ago, most households owned cattle and other livestock (Rugalema 1999). However, less than 18% of households in Nsisha own cattle, and most who do own only one animal. Because cattle are a disposable asset, they are sold at times of economic need, which notably include climate-linked processes—such as periods of erratic rain and crop destruction, drought, and food insecurity—but also those associated with HIV/AIDS such as chronic sickness and funerals. The case of George is one example.

George was once a prosperous mason who had been economically well-off compared to most of his neighbors in Nsisha. He had a nice home and a large, prosperous kibanja, and he owned a few cattle and small livestock. Reliable access to manure and a steady income had ensured productivity on the kibanja and agricultural surplus for selling and had buffered his household's security even during the unpredictable heavy rains and drought periods that lead to soil infertility; crop destruction; and food, nutrition, economic, and health insecurity. However, in the past five years, George's wealth, status, and disposable assets declined because of the loss of his first wife and two children to HIV/AIDS and his own worsening health and inability to work because of HIV/AIDS. His salary and resources—including livestock—dwindled as they were utilized to pay for healthcare and funerary expenses and the progressive need to purchase foods that they did not get from their kibanja because of the increasing threat of climate variability and pathogens killing off the bananas. George was unable to farm because of his bouts of sickness and progressive weakness, and his wife diverted her farming labor to tending to him and their four young children, with another child on the way. They could not keep up with the kibanja, and it was in a state of progressive decay and was becoming unproductive. Their agricultural surplus and overall food and nutrition insecurity were declining, and they lacked the buffers needed to maintain the kibanja. Climate change and variability added to their household decline because it added an extra layer of vulnerability, exacerbating their deepening poverty, food and nutrition insecurity, and poor health. The coincidence of the negative effects of

climate variability and HIV/AIDS caused significant decline in the status of George's household, from being enviably prosperous and wealthy to being on the verge of acute poverty and food insecurity like so many others in the village. However, unlike many, George was able to maintain ownership of an important buffer—a goat. Even as he was in the progressed state of HIV/AIDS, he stated that he and his family were fortunate because just maintaining ownership of one goat provided his family with nutritious milk—which he could also sell—as well as needed fertilizer for the kibanja. Although the fertilizer was scant compared to what he had when he owned several cattle and livestock, the manure helped, especially during the erratic seasons which, combined with the diverted time on the farm to tending to his sickness, decreased their agricultural productivity, leaving hardly any surplus, and their overall household poverty and food and nutrition insecurity. George and his wife state that the goat was instrumental to prolonging his life and staving off poverty in the household and on the kibanja, something that his wife, Leticia, mentioned in her lamentations at his funeral. This important asset buffered George's household economy, nutrition, and agricultural productivity on the kibanja significantly, providing necessary fertilizer, nutrition, and money, particularly during shock periods including erratic and extreme rainfall that washed away nutrients and increased soil infertility, drought, his sickness to HIV/AIDS, and during Leticia's mourning observance. After George's death, Leticia worried that she would need to sell the goat to survive the stark impoverishment that often accompanies widowhood, or worse yet, that goat would be bequeathed to an in-law. Without this buffer to the effects of climate variability and HIV/AIDS, Leticia feared that she would be living in an acute state of decline, particularly given that the kibanja was highly unproductive and that she lacked another source of income. The goat was the only asset that helped keep her household afloat and provided her some economic security and nutrition for her and her children: without the goat, her young, dependent children would be living in a deeper reality of livelihood vulnerability and poverty.

Contrary to the case of George, most Nsishans do not own cattle or other livestock. These are the same people who, in general, are most vulnerable to climatic shifts and are least able to fertilize their kibanja and confront declining agricultural productivity and increasing household economic and food and nutrition insecurity. Because HIV/AIDS decreases the ability to work and is expensive (in terms of both treatments and funerary costs), it creates a double pressure to sell off cattle for cash. This in turn contributes to decreasing soil fertility and agricultural productivity, thus increasing vulnerability to

climate events. In addition livestock being a crucial productive resource for agriculture, they also produce valuable milk, the loss of which takes a toll. Taken together, these intersecting aspects of HIV/AIDS and climate vulnerabilities subsequently combine to contribute to a spiral of food and nutrition insecurity, which in turn heightens susceptibility to illness and climate variability. Furthermore, this situation fuels cross-generational cycles of vulnerability when households lack the buffers to confront these challenges and remain trapped in poverty, as in the case of Lestuta.

Lestuta was an elderly widow who was living with her son and his new bride; Lestuta's daughter, who was sick with HIV/AIDS; and her daughter's three children. They were living in absolute poverty and rarely had enough food to eat. They ate a meal of potatoes and/or cassava and tea without sugar once or, if lucky, twice daily. Soil infertility and erratic climate variability added to their daily challenges, making farming and procuring adequate food and nutrition very difficult for them. Lestuta was aging and becoming frail and her time on the farm was diverted to taking care of her daughter and her grandchildren. They lacked a source of income and inputs needed for the soil, which had become increasingly infertile because of overuse, lack of fertilizers, the application of agrochemicals years ago which "ruined the soil," and the erratic, heavy rainfall that washed away nutrients. Lestuta observed that things would be easier if her husband was alive because, when he was, they had cows and goats, which meant reliable access to needed fertilizer for the kibanja and income to purchase meat, rice, sugar, and fish, and access to health care when needed. When he died, most of the livestock were "taken away" by in-laws—a customary patrilineal inheritance practice whereby assets are distributed among the patrilineal clan at the expense of the widow and her children—and the cow that remained soon died of disease because she could not afford the veterinary service to maintain its health. Like the many other poor households in Nsisha, Lestuta's kibanja did not produce bananas, and agricultural productivity had been progressively declining due to soil infertility, *ekiuka*, and the erratic weather patterns. Her family primarily eats meals of potatoes and cassava—the new staple foods for the poor—because banana plants are no longer thriving in this environment. They did not have access to sugar and other purchased goods, including milk, tea leaves, flour, and rice; agricultural inputs; and needed health care because they did not have a source of income. If they were better able to maintain the soil and stave off the negative effects of climate change, they would have been able to buffer against food and nutrition insecurity and deep household poverty. However, lacking a source of income and

needed fertilizers prevented them from achieving surplus produce to sell, and they lived like the most vulnerable, unable to adequately buffer against climate variability, HIV/AIDS, and the emanations of cyclical poverty which would be bequeathed to the three young, eventually orphaned and vulnerable grandchildren.

The cases of Lestuta and George illustrate the synergistic effects of HIV/AIDS and climate variability on agrarian households. Lestuta's case is important because it emphasizes that HIV/AIDS has substantial effects, even on the livelihoods and vulnerabilities of people who are not infected (Rugalema 1999; Lundberg et al. 2000; Niehof et al. 2010). Rather than depending on her daughter in old age, as is the cultural norm, Lestuta was forced to care for her daughter who was sick with HIV/AIDS and to be the sole provider for her three young grandchildren. Widowed, elderly, and frail, Lestuta's limited physical capability on the farm was diverted to caretaking, diminishing her capacity to invest sufficient time on her farm to offset the stresses of climate variability, leading to reduced food security. Had she been able to focus her energy on managing her farm, Lestuta likely would have been better able to cope with the negative effects of climate variability and would have been able to better achieve household food, nutrition, and economic security. The added challenge of climate variability exacerbated her livelihood challenges, preventing her from attaining buffers, indirectly exacerbating her family's entrenched poverty and poor nutrition and health. George's case illustrates how the decline of a household's asset base in response to HIV/AIDS-related stresses can simultaneously and similarly strip away the capacity to mitigate and buffer against the negative effects of climate variability and how owning one goat can help mitigate against the negative effects of climate variability and HIV/AIDS vulnerability. However, the cases illustrate that, when combined, vulnerability to HIV/AIDS and climate variability synergize in complex ways to create a downward spiral of economic decline, poor health, and environmental degradation. Without buffers, such as George's ownership of just one goat, the poorest of the poor, like Lestuta, experience an acute escalation of the core livelihood challenges they face: household poverty, food and nutrition insecurity, and poor health—effects exacerbated by climate variability and HIV/AIDS vulnerability.

c. Gendered and asymmetrical effects

The negative effects of climatic change and variability follow sociocultural hierarchical patterns, affecting the poorest and women asymmetrically (Githinji 2009a,b; Yanda et al. 2005; FAO 2007; Denton 2002; C. Almekinders et al. 2010, unpublished manuscript;

Paavola 2008; Eriksen et al. 2005; Demetriades and Esplen 2009; Lemos et al. 2007; Crane 2013). For example, although treated bed nets protect against mosquito bites and malaria, only the more economically well off can afford to purchase enough to protect *each* household member. Similarly, access to healthcare, medicines, and timely treatment is generally out of reach for the poorest (Rugalema 1999; Yanda et al. 2005; Githinji 2009a,b). The poorest are also more prone to living in impoverished environments lacking adequate sewage disposal and resources, such as firewood, needed for boiling and preparing water safe for consumption.

Women and children are generally more vulnerable to poor health than men because of social reasons (Sweetman 2001; Denton 2002; FAO 2005; Hecht et al. 2006; Githinji 2009a,b, 2011b). Specifically, in the context of Buhaya, women and children are more prone to malaria than men because they generally engage in weeding and are therefore more in contact with mosquito habitats (Yanda et al. 2005). Women and children also generally have poorer nutrition and health than men, because men tend to have access to more protein rich diets (Yanda et al. 2005), which assists in maintaining the immune system and fighting infections (Leonard-Green and Watson 1989). The “ecology of poverty and HIV/AIDS” concept (Stillwaggon 2006; V. Githinji 2013, unpublished manuscript) posits that a complex web of factors interact in synergistic ways to marginalize women and children. Thus, climatic change and variability compound existing dynamics pertaining to women’s disease, nutrition, and economic status (Githinji 2009a,b, 2011b; V. Githinji 2013, unpublished manuscript; Denton 2002; Eriksen et al. 2005). Kokushubira’s case further illustrates the complexity of how women’s—particularly HIV/AIDS-infected single mothers with young children—asymmetrical vulnerability to poverty, poor health, climatic shifts, and HIV/AIDS intertwine, escalating cycles of livelihood vulnerability inherited by future generations.

Kokushubira is a double HIV/AIDS widow; she lost her husband to HIV/AIDS and is also infected. She has four children, three whom live with her. When she lived with her husband, they had livestock, which enabled them to maintain soil fertility and food and nutrition security and to essentially buffer against livelihood challenges wrought by climate variability. However, his death and her burden of HIV infection and widowhood led to her and her children’s entrenched poverty and vulnerability. By the time of her husband’s death, all the livestock had been sold and the money used for funerary expenses, treatments, and food. Kokushubira did not have anyone to lean on during times of hunger and sickness. Chronically and progressively ill, Kokushubira is unable to maintain her kibanja. Three sides of the

house were falling down to the point that when it rained, puddles accumulated inside, providing a good habitat for malaria-spreading mosquitoes. Because of her position as an HIV-infected widow, she and her children were living in dire poverty, which prevented them from accessing healthcare of any kind, even for her HIV-infected child who was chronically ill and took long to recover. Although medication was free for those infected with HIV/AIDS, the only way she was able to get to the hospital was by walking several kilometers, something she was unable to do because of her increasing fragility and responsibility to her young children. Kokushubira described one of her children as “always hungry.” Unable to adequately care for this child, she sent him to live with her mother in a nearby village, where she was already helping to take care of several HIV/AIDS family orphans. In addition, her six-year-old daughter was unable to attend kindergarten because Kokushubira could not afford the monthly fee of \$0.50. Her kibanja was turning into a bush and was visibly infiltrated with stubborn weeds because her bouts of illness diverted time away from maintaining the farm. This situation was further compounded by the fact that, when she had the opportunity, she “chased money” in the form of day wage labor on people’s farms in an attempt to provide household food security in the short term.

Widowed, HIV/AIDS infected, and the sole provider to her children, Kokushubira and her children lived in intense and acute poverty. Lacking physical health, household labor, capital, manure, and other inputs needed to maintain productivity in the face of erratic climatic patterns and pathogen invasion, Kokushubira’s farm became overgrown with weeds and there was no sign of food growing in the kibanja. Given the generalized poverty in Nsisha, which was exacerbated by climate change and variability factors, and the overall agricultural decline, the paid day labor that she depended on was unreliable and increasingly scarce, exacerbating her family’s deep poverty and food and nutrition insecurity. Consequently, Kokushubira’s home was falling down and prey to mosquitoes, rain, and cold. She and her children were chronically ill and could not access healthcare, and her youngest could not attend school because of lack of money. Because children’s health is largely contingent on their mothers’ health, both are in a precarious situation (Githinji 2009a). The negative effects of climate variability, which led to a downward economic spiral in the village and to widespread agricultural decline, added an extra layer to Kokushubira’s household vulnerability, intensifying their daily lived reality of acute and entrenched poverty, hunger, and poor health. The failing physical structure of her house also intensified her family’s exposure to malarial

mosquitoes, which have intensified under changing rain regimes. The only plan she had for her children when she became too frail to care for them and passed away was to integrate them into her brother's household in a nearby village, where twelve other HIV/AIDS orphans in the family lived. The children would be moving from one impoverished context to another, and as she mentioned, "only the boys would inherit the kibanja, not her daughters, because that was still the custom in Bahaya," a reality illustrating inherited cycles of generational—and gendered—poverty. The case of Geti further elaborates how vulnerabilities can compound each other.

Geti, in her late twenties, is a single mother of four young, chronically ill children. Often ill herself, Geti fears she is infected with HIV/AIDS. She left her abusive husband and returned to live with her elderly mother and nephew, an HIV/AIDS orphan. Geti farmed the slice of the family farm she inherited, and several other marginal farmlands which she borrowed and rented from neighbors. In spite of her daily attempt to provide household food security, she frequently failed. Like many other Nsishans, Geti explained that single women with children, such as herself, are often driven to prostitution to feed their hungry children. "It is one of the only ways for single women to provision for their children amidst difficult times," she said defensively. She picked up a handful of small potatoes which were affected by disease and complained, "This handful is not enough to feed my children and me, but was all I could get today. . . no matter how much effort I put into farming, the yield is not enough these days because *ekiuka* is affecting all our food crops and the unpredictable rainy and dry periods are making farming more difficult, increasing my burdens and daily worry about how I will feed my hungry, sick children."

Geti's case illustrates how climate stress contributes to food insecurity, which in turn creates pressure to engage in poverty-induced transactional or "survival" sex, which carries a high risk factor of HIV/AIDS. This indirect chain of causality is important in understanding how the effects of climatic change converge and synergize with multiple stressors in contexts of vulnerability and threaten those who are already marginalized; poor; food, nutrition, and shelter insecure; and sickly (see also Lemos et al. 2007; Boyd et al. 2008; Ford et al. 2010; Thornton et al. 2009).

Geti is not alone in these circumstances. Coping and adapting to the myriad socioecological challenges in Nsisha can be especially daunting for single women with children. Single mothers are specifically challenged in their ability to provide for their dependents; ironically, prostitution poses as one of the only economic alternatives and coping, adapting, and livelihood diversification

strategies available to confront the challenges of food security wrought by climate vulnerability. In the process, this common survival strategy assists in perpetuating poverty, HIV/AIDS, and engendering women's and children's particular vulnerabilities. While it cannot be said that climate change directly causes vulnerability to HIV/AIDS, it does contribute indirectly, leading vulnerable women to compromise because of livelihood vulnerability. Climatic change and variability and resultant decline in food crops exacerbates livelihood stressors, adding an additional layer to women's and children's heightened vulnerability and its inherited perpetuation.

5. Discussion

Taken as a whole, the case studies from Nsisha illustrate how vulnerabilities to climate variability, HIV/AIDS, poverty, and food and nutrition insecurity intersect in myriad, complex ways to intensify socially differentiated and gendered livelihood vulnerability. The impacts of HIV/AIDS on households can reduce resilience to climate shocks through the degradation of asset bases and social networks and by diverting physical labor on the farm, compounding household food, nutrition, and economic security and health challenges. Over the long run, climate change can create conditions for stronger emergence of disease loads that stress those already infected with HIV/AIDS and those affected by acute poverty and food and nutrition insecurity. To add to this widely recognized interaction, this study has shown how cultural norms and gender dynamics interact with climate variability and HIV/AIDS in such a way that women, especially single women, are made disproportionately vulnerable to the synergistic effects of both. This is largely due to institutionalized practices that limit women's power over resources and thus limit their ability to buffer against negative impacts. The compound vulnerabilities experienced by single women subsequently have a profound effect on their children's health and well-being. Only those with buffers such as secure access to money, land, livestock, strong and supportive social networks, disposable assets, and agricultural inputs can mitigate the compound vulnerabilities posed by climate variability and HIV/AIDS.

Stillwaggon (2006) argues that social and biological factors synergistically combine to create "ecological" vulnerability to HIV/AIDS, particularly in the context of poverty. Ford's concept of "contextual vulnerability" (Ford et al. 2010) similarly states that climate vulnerability emerges from the interactions of myriad socioecological factors, leading to an uneven social distribution of vulnerability. Each approach utilizes a holistic conceptual lens to understand an important

human challenge in East Africa and elsewhere: HIV/AIDS and climate variability, respectively. One objective of both approaches is to show how vulnerability is produced and how its social distribution is uneven. Through a focus on case studies from Nsisha, Tanzania, this article combines the frameworks of Stillwaggon (2006) and Ford et al. (2010) to analyze the complex mechanisms by which climate vulnerability and HIV/AIDS vulnerability synergize.

The synthesis of the two perspectives is important because it transcends their respective topical emphases, instead starting with an empirical look at a broad spectrum of social and environmental dynamics and how they interact to create observable outcomes in relation to climate variability and HIV/AIDS, as well as livelihood security in general. While the boundaries created by administrative units, development projects, and academic disciplines often tend to separate a single topic of interest away from others, problem solving in real-world context requires addressing all intersecting dynamics in an integrated, holistic fashion. The frameworks of Stillwaggon (2006) and Ford et al. (2010) both acknowledge the benefits of holism in relation to HIV/AIDS and climate, respectively, but our synthetic analysis of the interactions between these two apparently disparate stressors pushes their holism further: socioecological change of any sort cannot be addressed using artificial topical groups. The implications for understanding and addressing climate vulnerability (or HIV/AIDS, food security, environmental degradation, etc.) are substantial: the socioecological dynamics that are relevant to adaptation are not easily understood through abstract indices or narrow indicators, but through comprehensive analysis of and engagement with the complexities of real dynamics in specific locations.

Interdisciplinary ethnographic research is well suited to unpacking the complex ways that biophysical and social factors intertwine to exacerbate livelihood vulnerabilities, as well as the ways in which they are socially distributed and mediated. Ethnographic research plays an essential role in deepening our understanding of the effects of climatic change and variability because it portrays how climatic stressors interact with other challenges and contexts in people's daily lives (Ford et al. 2010; Roncoli et al. 2009), something that is missed in aggregate or macrolevel research. By utilizing a comprehensive lens to understand the multitude of socioecological factors that intensify climate vulnerability in the context of rural livelihoods, it is possible to understand how climate and HIV/AIDS vulnerability overlap and synergize. Documenting people's life experiences and words captures how the effects of climate variability and HIV/AIDS affect livelihood vulnerability in socially

differentiated and gendered ways. These details from lived experience provide the useful information for informing the development and implementation of effective adaptation strategies for mitigating poverty, food and nutrition insecurity and poor health for the most vulnerable.

6. Conclusions

Across much of rural Africa, climate change is yet another significant and contributing factor that sustains an ecology of poverty. Vulnerabilities to various stresses—climate variability, food insecurity, social marginalization, HIV/AIDS, etc.—interact in ways that both create and compound negative effects on human well-being. Over the past 30 years, Nsisha, Tanzania, has experienced an influx of crop pathogens that have been destroying banana plants, increasingly erratic climate variability, and the ravages of the HIV/AIDS epidemic. These have combined synergistically to cause widening poverty, food and nutrition insecurity, and socially differentiated and gendered vulnerability (Githinji 2008, 2009a,b, 2011a). This situation poses great threats to achieving the millennium development goals premised on poverty reduction; food, nutrition, and health security; gender equality; and women's and children's empowerment and social advancement (FAO 2005; Hecht et al. 2006).

In response, multidisciplinary and holistic research on the socially and gendered distribution of vulnerability and the ecology of poverty should be prioritized so as to enrich our understanding of vulnerability to climatic change and variability. This research should highlight specifically how livelihoods are being affected. Measures and mediation strategies should be devised that address how climatic shifts are expected to affect generalized, socially differentiated and gendered poverty; food and nutrition insecurity; health; and HIV/AIDS vulnerability. Rather than relying on narrow climatological models, intervention strategies aimed to alleviate vulnerability need to be premised on the understanding of how the matrix of socioecological factors—including climatic change and variability; disease (human, crop, and animal); and the history of environmental change, generalized poverty, and women's marginalization—converge to sustain an ecology of poverty and compound vulnerability to multiple stressors. Climate vulnerability and adaptation are always situated in a context where numerous nonclimate factors are in play. To gain an accurate and nuanced understanding of vulnerability and adaptation, realist analysis needs to acknowledge complexity by actively utilizing a holistic perspective, integrating multiple cross currents and drivers

rather than separating them out in favor of an exclusively climatic focus.

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