Seasonal Security?

The Impact of Climate Seasonality on Livelihood and Well-being in Malawi

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INTRODUCTION

The relationship between humans and the environment is multidimensional and multidirectional. In sub-Saharan Africa, populations' connections to the climate are complicated by increased vulnerability to climate change and shocks. Specifically, the southern African country of Malawi represents a region that is highly dependent on seasonality, seasonal variation in the climate that is often cyclic in nature, for food security and wellbeing. In order to understand the vulnerability of these livelihoods to climate change, I explore the impact of seasonality on individual's food security, income, and health in a uniquely non-Western context.

Motivated from a human ecology perspective, I emphasize the interaction of social factors with one's environment. For instance, seasonality may represent an exacerbation of cumulative vulnerabilities for individuals who are already vulnerable in other ways, such as rurality or health status. The cyclic nature of seasonality tends to generate hunger seasons in regions that depend highly on smallholder agriculture.

In Malawi, the seasonal nature of rain designates when harvest occurs, but also generates a "lean season" in which individuals are in between last year's harvest and the future harvest after the rain (Ellis and Manda 2012). During this time, a number of social factors, particularly the persistent AIDS epidemic, may interact with seasonal variation to exacerbate hunger or poor health. Addressing dependency on seasonality in Malawi provides a case study for understanding how the human-environment interaction unfolds for a particularly vulnerable population. I use unique, longitudinal data from southern Malawi to ask how seasonality impacts food security, income, and self-rated health and how these relationships are exacerbated by rurality and perceptions of disease risk.

BACKGROUND

The Human-Environment Interaction

> There is no single, universally accepted way of formulating the linkage between social systems and natural systems. (Berkes, Folke, and Colding 2000: 9)

Perspectives on the relationship between humans and the environment are as diverse as they are contested. Climate researchers note that the climate is changing and social scientists address the ways in which these climate changes will disproportionately impact certain populations over others. Responsibility for climate change is also disputed. Researchers note that many developing nations, particularly in sub-Saharan Africa, contribute very little to climate change, but are at high risk of its consequences.

A number of important theories have emerged over the years as scholars have attempted to explain the complexities inherent in this human-environment relationship. While I ground much of this current work in the human ecology perspective, a number of other environmental impact theories deserve a discussion here. The two, more traditional and well-known, theories stem from the work of Malthus and Boserup. Malthusian theory posits that the exponential population increase will outpace the arithmetic food production, leading to complications with carrying capacity: “the maximum population of a given species that can be supported indefinitely in a defined habitat without permanently impairing the productivity of that habitat” (Rees 1996: 196). Yet, Malthusian theory is often criticized for being too narrowly focused and missing important contributions from social, technological, and institutional structures that may work to increase carrying capacity (De Sherbinin et al. 2007). Population growth, in this case, is problematic if and when food production cannot keep up with the pace of population growth.

Additional research on the human-environment interaction focuses on this idea that we have a finite amount of resources. Pimentel et al. (2010: 607) note that “natural resources are critically limited" and suggest that we must curb population growth. Hardin (1968) proposes that we are all in this together and that our common pool of resources is at risk of depletion if population growth is allowed to continue. We must infringe on the right to breed in order to protect the universal right to the commons. More recent common-pool scholars note that a less coercive approach to curbing population growth is preferred, as to ensure local autonomy and protect institutional diversity (Ostrom et al. 1999). A number of scholars challenge this idea of a stagnant pool or finite capacity, noting that "such limits are rarely static or quantifiable, let alone predictable and controllable" (Sayre 2008: 132). The idea that humans can influence their own carrying capacity through means other than population control stems from Boserupian theory, below.

Boserupian theory focuses intensively on the potential contributions from technology, particularly through the increase of agricultural yields (Boserup 1976). Boserup sees technology as endogenous to the "population-resource condition" (de Sherbanin et al. 2007: 4). Here, rapid population growth leads to technological innovation and economic development (Jolly 1994). Similarly, neoclassical economists agree that in developed nations population growth should spur economic growth. They argue that "capitalist nations … should be on the forefront of developing environmentally benign or even ameliorating technologies because such technologies are potentially highly profitable" (York, Rosa, and Dietz 2003: 284). These theories take a more macro approach to the human environment interaction, focusing on how structures and institutions aggravate or ameliorate the impacts of population growth on the environment.

The focus of the current project solicits a theoretical approach that emphasizes the interaction between human agency and the environment, while noting the influence of social structures and cultural milieus. The human-environment relationship is "variable, nonlinear, and unpredictable" (Leach and Fairhead 2000: 39) and the diverse dynamics operating within a community cannot be overlooked. I turn to the human ecology perspective which acknowledges human agency and culture, but notes that these factors are bounded by the environment. York, Rosa, and Dietz (2003: 283) note that human ecologists "emphasize an ecological foundation for understanding the driving forces of anthropogenic environmental impacts, with the expectation that key social and political variables may mediate, and perhaps partially counteract, those impacts but will not fundamentally overcome them." I appreciate the dual-directionality of this theory that acknowledges a causal pathway from humans to the environment and from the environment to humans (Harden 2012). The current project intends to add to this discussion on the complexity of the human-environment interaction, asking how the impact of the environment (i.e. seasonality) on individual-level outcomes is mediated by a social climate shaped by the HIV/AIDS epidemic.

Vulnerability to Climate Change

> Global climate change presents a challenge to future livelihood strategies, especially for those social groups which are currently vulnerable (Bohle, Downing, and Watts 1994: 37)

Vulnerability to climate change fascinates researchers worldwide. The concept of vulnerability is particularly important for sociologists and demographers alike as it merges population-level phenomenon with ideas of human agency and susceptibility to environmental harm. The connection between humans and the environment is embodied in the concept of vulnerability, allowing for an operationalization of this complex relationship between people and the earth that houses them.

Vulnerability can be defined as "the exposure to contingencies and stress, and difficulty coping with them. Vulnerability has thus two sides: an external side of risks, shocks and stress … and an internal side which is defenselessness, meaning a lack of means to cope without damaging loss" (Chambers 2006: 1). This definition focuses on stress and coping, more generally. The Intergovernmenttal Panel on Climate Change, specifically addressing vulnerability to climate change, defines vulnerability as "the extent to which climate change may damage or harm a system," noting that the impacts of climate change are systemic in nature and vulnerability depends on a system's capacity to adapt (Watson, Zinyowera, and Moss 1996).

Füssel (2007) took on the challenge of creating a unifying framework for measuring vulnerability to climate change. Due to the complex nature of this concept, various definitions and models of vulnerability have surfaced across disciplines. In order to unify these diverse ideas surrounding vulnerability, Fussel (2007) proposes that vulnerability be broken down into four dimensions: system, attribute of concern, hazard, and temporal reference. *System* refers to the group, sector, or region of analysis that is potentially susceptible to an environmental hazard (e.g. "a human-environment system, a population group, an economic sector, a geographical region, or a natural system" (p. 157)) . The *attribute of concern* is the specific attribute of the system that may be harmed by the environmental hazard (e.g. "human lives and health, the existence, income and cultural identity of a community, and the biodiversity" (p. 157)). The *hazard* is the environmental shock that will potentially damage the system. Lastly, Fussel (2007) defines the *temporal reference* as the time period of interest. This is particularly important for climate change research, as many impacts of hazards may change dramatically over time or my have distinct time horizons.

A number of US-based studies portray vulnerability to climate change across socioeconomic strata. Historical shocks, such as the Depression-era droughts, exemplify the ways in which the human-environment interaction is moderated by government policy and aid. McLeman et al. (2014) found that the government assistance mainly helped larger, less vulnerable farm-holders while the poorer, more vulnerable farming populations faced starvation in response to the Dust Bowl. McLeman (2010) also notes that transitions in social networks, due to migration, alter a communities' vulnerability to climate change. Analysis of a more recent environmental hazard, Hurricane Katrina, shows that social vulnerability has a "spillover" effect in highly disadvantaged areas (Myers, Slack, and Singelmann 2008). Lastly, Klinenberg (1999) provides one of the most bracing accounts of vulnerability to climate change in the Western context. The Chicago Heat Wave in 1995 demonstrates the relationship between social systems and vulnerability. Klinenberg (1999) finds that the most socially isolated individuals were at higher risk of death during the heat wave. Notably, he finds that the vulnerability of residents to the heat wave was largely structurally determined, emphasizing the political ecology of the disaster.

Researchers note a number of ways in which sub-Saharan Africa (SSA) may be particularly vulnerable to climate change; in this paper, I focus on one of the systems: agriculture. Much of sub-Saharan Africa is dependent on agriculture to sustain livelihoods and gross domestic products alike. The agricultural sector is particularly vulnerable to climate change, mainly through changes in agricultural zones and subsequent ability to produce crops. Downing (1991) notes a number of ways in which climate change may influence agriculture in SSA, including: "lengthen the growing season due to higher temperatures; reduce soil moisture due to increased evaporation demand (with or without increases in precipitation); accelerate early plant growth and reduce periods for grain filling; affect the partitioning and quality of plant biomass; affect crop pests and diseases; and entail spatial shifts in agricultural potential" (p. 368).

While these impacts are environmental, it is crucial to note that "human interaction and social structures are integral to nature and hence any distinction between social and natural systems is arbitrary" (Adger 2006: 268). This is, essentially, the crux of the human-environment interaction/human ecology theory. Vulnerability is both an exposure to the environment and a social condition (Adger 2006). Indeed, the relationship can be conceptualized as three-dimensional, consisting of sensitivity/exposure, a damage threshold, and vulnerability (Luers 2005). In this sense, vulnerability is dynamic and responsive to a number of variables. Kelly and Adger (2000: 325) state, "in the context of the global warming problem, assessing vulnerability is an important component of any attempt to define the magnitude of the threat." In order to understand the susceptibility of a system to climate change, we must first understand its current level of dependence on and vulnerability to the climate, specifically in regards to seasonality.

Seasonality

> It is a bitter irony that half of the world's hungry people are farmers.
>
> (Devereux et al. 2008: 6)

Seasonality refers to seasonal variation in climate that is often cyclic and repetitive in nature. The concept of seasonality is especially important in farm-based, agriculture-dependent societies, as income, labor, consumption, and livelihoods are dependent on seasonality (Ellis 1998). Seasonality may refer to rainy seasons, droughts, or both – and the implications of these seasonal variations in rainfall can be enormous, particularly for populations that are vulnerable in other social or political aspects. Economists, social scientists, and development researchers turn to seasonality to understand fluctuations in livelihood and wellbeing in much of sub-Saharan Africa. Seasonality provides one way of assessing varying levels of reliance on climate that may lead to increased vulnerability to the hazards of climate change.

Researchers have noted that seasonality generates "poverty traps" and that "an important cause of such traps is the seasonal nature of the smallholder agriculture" (Orr, Mwale, and Saiti-Chitsonga 2009). When a region experiences one annual rainy season then they it will also experience one annual harvest, given that no artificial forms of irrigation are utilized. One harvest equates to one planting season and one "lean season" (Ellis and Manda 2012). A lean season refers to the time between planting and harvest when a community or household must rely on the crops from last year's harvest for consumption. During the lean season, market prices for food products sky-rocket leaving impoverished farmers no other option but to cut back on food consumption, leading to hunger or starvation. As Downing (1991: 371) so aptly states: "hunger is not a random experience."

Not only is seasonality explicitly linked to hunger, but also to income and health more broadly. Wealthier farmers who may grow enough food to sell at the market may, in fact, experience increases in income during the lean season, as more families are reliant on purchasing food from markets and prices are high. On the other hand, others may see their income fall due to seasonality, as rates of underemployment are higher during cropping season (Wodon and Beegle 2006).

The impacts of seasonality may also be exacerbated by the experience or fear of seasonally variable disease, particularly malaria, and the HIV/AIDS epidemic. Contracting a life threatening or altering disease, such as malaria, when one's livelihood or wellbeing is already stretched thin may worsen the impact of the disease. The risk of contracting malaria is highest during rainy season, adding another level of complexity to the seasonality conundrum.

A disease epidemic further intensifies this relationship between seasonality and wellbeing. Masanjala notes that "the AIDS epidemic compounds the problems faced by households by increasing the likelihood of livelihood collapse due to natural disasters, *seasonal changes* and the shock of accidents or sudden illness" (2007: 1036; italics added). Not only does the HIV/AIDS epidemic create strain on resources and health, but it also generates a climate of fear and uncertainty (Trinitapoli and Yeatman 2011). The epidemic thus heightens both physical and psychological stressors. The AIDS epidemic has “created a new category of highly vulnerable households” (de Waal and Whiteside 2003: 1234).

My hypotheses are as follows,

H1: Individuals who are experiencing a rainy season will report higher levels of food insecurity, lower incomes, and worse health than individuals who are not.

H2: An increase in perceived risk of HIV/AIDS and/or Malaria will increase the impact of the rainy season on food insecurity, income, and self-rated health.

STUDY CONTEXT

The southeastern sub-Saharan African country of Malawi is a prime context for studying the impact of seasonality on livelihoods and well-being. Malawi has population of around 16 million, is largely rural (84 percent), and scores 170 out of 187 countries on the human development index (World Bank 2013; Population Reference Bureau 2014; UNDP 2013). Due in large part to the HIV/AIDS epidemic, the life expectancy at birth is only 48.3 years for men and 51.4 years (National Statistical Office 2008).

Malawi experiences a relatively consistent, annual rainy season, from December to March, followed by a harvest season, from April to July. Soil preparation and planting tend to take place from July to February, depending on the crop (Wodon and Beegle 2006). The staple crop in Malawi is maize, providing around two-thirds of daily calories for Malawians (Ndekha et al. 2000). Maize production and consumption is highly dependent on the rainy season, with Malawians experiencing a “lean season” during the rains with low availability of maize (particularly in rural areas) and skyrocketing prices (Ellis and Manda 2012). Infrastructure in Malawi is poor, with 55 percent of roadways unpaved and public transportation costly and often dangerous (CIA 2011; Cole 2004). Dirt roadways are especially susceptible to flooding from seasonal rain. The centrality of seasonality in Malawi can be seen in labor, diet, and income fluctuations, as these factors depend largely on the climate.

The impact of seasonality on economic stability and food security is exacerbated by seasonally variable disease (i.e. Malaria) and the HIV/AIDS epidemic. Over a third of Malawians contract Malaria each year and transmission is highest during the rainy season (National Statistical Office and ICF Macro 2011). Malaria is tied with Diarrheal diseases as the third leading cause of death, with 8 percent of deaths attributed to each, following lower respiratory infections (12 percent of deaths) and HIV/AIDS (25 percent of deaths) (CDC 2011). While the incidence of Malaria is directly linked to seasonality, the experience of the AIDS epidemic is indirectly linked to the burdens of seasonality through impacts on labor and resource availability (Masanjala 2007). Malawi has been especially hard hit by the AIDS epidemic and researchers have noted that Malawi's AIDS crisis is one of the world's most severe (National Statistical Office (NSO) and ORC Macro 2005). In 2010, around 10 percent of Malawi's adult population was HIV positive, with women showing higher rates of seropositivity than men (National Statistical Office and ICF Macro 2011). HIV/AIDS also "accentuates existing difficulties" by lowering incomes, increasing malnutrition, and changing dependency patterns in the household (de Waal and Whiteside 2003: 1236).

DATA & METHODS

Tsogolo La Thanzi

The data for my project come from an ongoing longitudinal study in Southern Malawi titled Tsogolo la Thanzi (TLT), which translates to "Healthy Futures." The baseline sample consists of 1,505 females and 600 male respondents aged 15 to 25 years. At baseline over 90 percent of respondents were effectively recruited for interviews. These respondents were randomly selected from census enumeration areas within 7 kilometers of the district capital, Balaka. Eight waves of data are collected across a period of three years from 2009 to 2012. The data are collected in three month intervals, providing variability in interview time, with some respondents being interviewed during rainy season in waves 2, 3, 5, 6, and 8, and other respondents interviewed in these same waves but not during rainy season.

In order to address my two hypotheses, above, I will utilize all eight waves of data to identify changes in food security, income, and self-rated health across time and season. I will measure food security by creating a scale of food insecurity. TLT asks respondents a number of general food security questions, including how often, in the last month, the respondent has limited portions, borrowed money for food, gone without food for another household member, or skipped meals. I create a scale using these four measures to indicate level of food insecurity in the past month (see Table 1 on page 13).

Income is measured in Kwacha (the local currency) and is a response to the question: "Think about all of the work that you have done in the past month which you have been paid cash or in kind. How much do you estimate you have earned in the past month?" The mean monthly income is about 2175 kwacha, or roughly 4.50 US dollars.

Fear of disease is measured as perceived risk of HIV infection within the year and perceived risk of death from malaria within lifetime. These are both probabilistic measures, ranging from 0 (no risk) to 10 (certain infection). Each respondent is given ten dried beans. In order to assess the probability that each event will occur the interviewer begins by explaining the process using simple questions, such as "how likely is it that you will go to the market tomorrow?" The respondent then places the number of beans that represent the likelihood of going to the market. After the respondent shows that they understand the iterative process, the interviewer moves on to more complex questions, such as "how likely is it that you will contract HIV/AIDS within the year?" In this way, these probabilities are comparable across respondents and across time. I will interact these terms with seasonality to see if seasonality increases the effect of perceived disease risk on livelihood and well-being.

I also include a number of time-variant controls: marital status, pregnancy, job loss, injury/accident, age, and education. Rurality is time invariant and is measured by distance to research center, as the TLT research center is in the town center and the surrounding areas become increasingly more rural the further from town one lives. In order to include rurality in the model, I interact it with a time-variant variable: rainy season.

Longitudinal Analysis

I employ longitudinal methods to test for significant change over time, as predicted by seasonality, disease risk, and time-variant controls. I use fixed effects models, to allow for measurement of the effect of time variant predictors, while controlling for the impact of time invariant ones. By using "each individual as his or her own control," fixed effects allows for the measurement of variables that change over time while controlling for "both the easily measured [time invariant] variables ... and for more difficult variables such as intelligence, parents' child-rearing practices, and genetic makeup" (Allison 2009: 2). Modeling these trends in this way is important, as I expect wellbeing and livelihood to change over time and with the season.

RESULTS

The first step in my analysis is to create a food insecurity scale using the variables seen in Table 1, below. A majority of respondents are not experiencing food insecurity; however, at any given wave, 4 to 10 percent of respondents report experiencing at least one of the food insecurity items. The scale has acceptable internal consistency (alpha=0.66) and the items have high substantive reliability. I standardize the scale so that it has a mean of zero (see Table 2, below) and the scale ranges from -0.34 to 6.15.

Table 1. Food Insecurity Scale Items, "How many times in last month…"

Variable	*0 times*	*1 time*	*2 times*	*3 times*
Limited portions	81.3%	11.9%	4.8%	2.1%
Borrowed money for food	87.3%	9.4%	3.1%	1.9%
Gone without food for other household member	94.8%	4.1%	1.0%	0.2%
Skipped meals	86.7%	11.0%	2.0%	0.3%

Scale alpha = 0.66 (Acceptable)

Table 2 also displays descriptive statistics for my three dependent variables and all of my independent variables. The mean represents the mean value or percent across all person-waves. Respondents have generally low incomes, but score relatively high on the self-rated health measure, with most respondents reporting good health. Thirty-four percent of person-waves take place during the rainy season. In general, respondents perceive themselves to be at higher risk of malaria than of HIV/AIDS. A majority of the respondents are living in a rural area. Very few respondents experience the shocks (pregnancy, job loss, and injury/accident). Less than half of person-waves are spent married (41 percent). The average age is about 20 years and respondents have, on average, 7 years of education.

Table 2. Descriptives for Dependent and Independent Variables

Variable	Mean	Std. Dev.	Min	Max
Food Insecurity Scale (standardized)	-0.03	0.68	-0.34	6.15
Income	2163.53	6083.94	0.00	100000.00
Health	3.82	0.81	1.00	5.00
Rainy season	0.34	-	0.00	1.00
Perceived malaria risk	4.40	2.79	0.00	10.00
Perceived HIV risk	2.92	3.03	0.00	10.00
Rural	0.68	-	0.00	1.00
Currently Married	0.41	-	0.00	1.00
Became pregnant	0.04	-	0.00	1.00
Lost job	0.01	-	0.00	1.00
Had injury/accident	0.04	-	0.00	1.00
Age	20.53	3.29	15.00	27.00
Years of education	7.42	2.73	0.00	13.00

The multivariate regression results can be seen in tables 3 through 5, below. Table 3 displays the results of the fixed effects regression model predicting food insecurity. Being interviewed during the rainy season is highly predictive of increased food insecurity (p<0.001) in the bivariate model (Model 1). The rainy season remains a significant predictor of increased food insecurity in the saturated model, although the effect size and significance decrease slightly. Changes in perception of disease risk do not significantly predict changes

Table 3. Fixed Effects Regression of Food Insecurity

	Model 1	**Model 2**
Rain	0.111***	0.0662*
	(0.01)	(0.03)
Malaria Risk		-0.00402
		(0.00)
Rain=0 X Malaria		-
		-
Rain=1 X Malaria		0.00566
		(0.00)
HIV Risk		0.000698
		(0.00)
Rain=0 X HIV		-
		-
Rain=1 X HIV		0.00199
		(0.00)
Rain=0 X Rural		-
		-
Rain=1 X Rural		0.0781**
		(0.02)
Currently married		-0.159***
		(0.02)
Pregnant		-0.0296
		(0.03)
Lost job		0.188*
		(0.08)
Injury/Illness		0.0861**
		(0.03)
Age		-0.143***
		(0.01)
Years of education		0.00998
		(0.02)
Constant	-0.0685***	2.863***
	(0.01)	(0.17)
N	10666	10666
AIC	15993.6	15544.5

Standard errors in parentheses
+ p<.10, * p<.05, ** p<.01, *** p<.001

in food insecurity. Living in a rural area exacerbates the impact of rainy season on food insecurity (*p*<0.01). If an individual becomes married then their level of food insecurity significantly decreased, holding all else constant. Losing one's job generates a significant increase in food insecurity, as does experiencing an injury or illness. Lastly, as a respondent ages their level of food insecurity tends to decline, controlling for all other variables in the model.

Income appears to have an interesting relationship with seasonality. In the bivariate model (see Table 4, Model 1), being interviewed during the rainy season leads to reporting significantly lower income and this is highly significant (*p*<0.001). However, in the saturated model, Model 2, rainy season falls out of significance and the coefficient declines in size. In the full model, age is the only significant predictor of change in income. With each additional year of age a respondent's income tends to increase by about 344 kwacha. The impact of age is roughly the same size and significance as the impact of rainy season in Model 1, suggesting that the bivariate model was simply picking up on the age effect and once age is controlled for the rainy season does not significantly predict change in income.

Lastly, rainy season significantly predicts changes in self-rated health (see Table 5). In the bivariate model, Model 1, being interviewed during rainy season leads to a decline in self-rated health (p<0.001). In Model 2, the full model, the effect size of rainy season increases slightly to -0.08, while the significance drops but remains significant at the 0.05 level. The self-rated health model is the only model in which change in perceived risk of disease significantly predicts change in the outcome. With each unit increase in perceived risk of HIV a respondent reports a significantly lower level of self-rated health (*p*<0.001). However, the interaction term between rainy season and perceived risk of HIV is not significant, suggesting that perceptions of HIV risk do not significantly moderate the effects of rainy season on self-reported health.

Table 4. Fixed Effects Regression of Income

	Model 1	**Model 2**
Rain	-334.5***	-78.48
	(82.71)	(204.40)
Malaria Risk		24.21
		(21.29)
Rain=0 X Malaria		-
		-
Rain=1 X Malaria		-40.9
		(31.97)
HIV Risk		17.88
		(21.14)
Rain=0 X HIV		-
		-
Rain=1 X HIV		3.158
		(29.40)
Rain=0 X Rural		-
		-
Rain=1 X Rural		-282.4
		(177.30)
Currently married		-210.5
		(207.20)
Pregnant		80.77
		(210.40)
Lost job		-855.5
		(589.70)
Injury/Illness		-20.44
		(236.30)
Age		344.2***
		(65.40)
Years of education		-123.6
		(113.00)
Constant	2277.7***	-3902.9**
	(47.58)	(1234.20)
N	10665	10665
AIC	204748.3	204719.4

Standard errors in parentheses
+ p<.10, * p<.05, ** p<.01, *** p<.001

Table 5. Fixed Effects Regression of Self-rated Health

	Model 1	**Model 2**
Rain	-0.0501***	-0.0757*
	(0.02)	(0.04)
Malaria Risk		0.0058
		(0.00)
Rain=0 X Malaria		-
		-
Rain=1 X Malaria		0.00157
		(0.01)
HIV Risk		-0.0185***
		(0.00)
Rain=0 X HIV		-
		-
Rain=1 X HIV		0.00495
		(0.01)
Rain=0 X Rural		-
		-
Rain=1 X Rural		0.00548
		(0.03)
Currently married		0.0209
		(0.04)
Pregnant		-0.0224
		(0.04)
Lost job		0.0546
		(0.11)
Injury/Illness		-0.054
		(0.04)
Age		0.0138
		(0.01)
Years of education		0.0294
		(0.02)
Constant	3.841***	3.362***
	(0.01)	(0.23)
N	10664	10664
AIC	21151.50	21131.90

Standard errors in parentheses
+ p<.10, * p<.05, ** p<.01, *** p<.001

DISCUSSION

The findings above suggest that livelihoods and wellbeing in southern Malawi depend heavily on seasonality. Experiencing a rainy season significantly changes one's level of food insecurity and self-rated health for the worse. The relationship between seasonality and income is less clear and deserves more attention. Using unique, longitudinal data from a distinctive non-Western context, I am able to assess the dependence of livelihood and wellbeing on seasonality for a population that is particularly vulnerable to climate change.

Food insecurity is shown to be highly dependent on context. I find that changes in rainy season, marital status, job status, illness/injury, and age all significantly predict change in food insecurity. Additionally, living in a rural area significantly intensifies the impact of rainy season on food insecurity. In this way, food insecurity paints a picture of vulnerable populations that become increasingly vulnerable due to seasonality. As mentioned above, the infrastructure of Malawi is quite poor with a majority of roads unpaved, particularly in rural areas. During the rainy season many of these roads are washed out leading to isolation of rural villages; thus, rural villages may experience a particularly tough lean season in which they must rely on last year's harvest and cannot access food through markets.

The income picture is less clear. In the bivariate model, rainy season significantly predicts a decrease in income; however, in the saturated model this relationship falls out of significance. Does this suggest that rainy season does not matter for income? Or, could it be that the effect of rainy season operates through distal determinants of income? Seasonality may be impacting income indirectly through other mechanisms. Future research should attempt to break down this relationship further in order to understand the mechanisms that predict income change in southern Malawi.

Seasonality remains a significant predictor of self-rated health in both the bivariate and full models. Even after controlling for perceptions of disease, the experience of a rainy season leads a respondent to report significantly lower levels of self-rated health. This could be due in part to the experience of malnutrition or the increased presence of disease in the home or village. Seasonality is the only non-health variable to significantly predict change in self-rated health, suggesting that the experience of the rainy season directly impacts one's wellbeing, or at least their perception of wellbeing.

In regards to my second hypothesis that changes in perceived risk of disease will exacerbate the effect of rainy season on my dependent variables, I fail to reject the null. The interaction terms between disease risk and rainy season are not significant predictors of change in food insecurity, income, or self-rated health. In only one model is change in perceived risk of disease a significant predictor of the outcome: change in perceived HIV risk significantly predicts change in self-rated health. These findings stress the need for more research on the proximate determinants of livelihood and wellbeing that may be themselves a result of changes in perceptions of disease risk.

The current project shows that perceptions of disease do not themselves predict changes in livelihoods and wellbeing, but this does not mean that the more broad influence of disease at the community level does not influence these outcomes. Previous research has shown the HIV/AIDS epidemic to be pervasive and generative of uncertainty. Perhaps then a more contextual measure of disease risk may be more appropriate for predicting livelihood and wellbeing.

CONCLUSION

The prerequisite to understanding a system's vulnerability to climate change is to understand the system's dependence on the climate. The experience of climate seasonality in southern Malawi represents one form of reliance on climate. I find that experiencing the rainy season significantly predicts a decrease in healthy livelihoods and wellbeing. Clearly, the residents of southern Malawi are particularly sensitive to fluctuations in climate and climate change stands to exploit this vulnerability further.

The experience of high levels of disease in a community generates fear and uncertainty, yet I found no direct link between perceptions of disease risk, seasonality, and change in livelihood and wellbeing. However, living in a rural area acts as a cumulative vulnerability, increasing the impact of rainy season on food insecurity. The current project provides an assessment of the ways in which transitions in climate and context influence changes in livelihoods and wellbeing. If these patterns continue, I concur that large-scale climate change will disproportionately impact the individuals that contribute the least to its progression.

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