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Community adaptation to climate change: exploring drought and poverty traps in Gituamba location, Kenya

Amy Sherwood*

PO Box 176, Isibania, 40414 Kenya

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Globally, many communities are vulnerable to weather-pattern variability. Climate change will act as a threat multiplier by increasing this variability. To combat growing vulnerability, strategies for adaptation must be developed. This study uses interviews and participatory research techniques to examine the effects of a year-long drought on women and poverty dynamics in Gituamba location, Kenya. It concludes that drought has the ability to create poverty traps and produce a poverty of time and energy among women. Some possible adaptation strategies include livelihood diversification, creation of cooperatives, conservation farming, and rehabilitation of communal boreholes.

Keywords: drought; Kenya; adaptation; poverty trap; climate change; coping

Introduction

Climate researchers predict that variability and uncertainty in weather patterns will increase in coming years if anthropogenic climate change is left unmitigated. Among other things, their models suggest that precipitation patterns will change, resulting in less-predictable rainfall, more-frequent severe weather events, and a greater risk of drought in many areas (Intergovernmental Panel on Climate Change [IPCC], 2007; Kumssa & Jones, 2010; Solomon, Qin, Manning, Marquis, Averyt, Tignor, Miller, & Chen 2007). This predicted increase in weather variability is particularly challenging in Africa where 70% of the population depends on agriculture as a source of livelihood, and over 95% of this agriculture is rain-fed (African Partnership Forum, 2007). Furthermore, most agrarian African populations lack access to resources necessary for safeguarding their assets, which exacerbates their vulnerability to erratic weather (Eriksen & O'Brien, 2007).

There is an urgent need to identify ways in which African communities can adapt to increased variability in weather patterns (IPCC, 2007; Liverman, 2011; Speranza, Kiteme, Ambenje, Wiesmann, & Makali, 2010). Prior research shows that adaptation measures must be tailored to address specific vulnerabilities of the community they are meant to safeguard. Existing sources of vulnerability determine a community's susceptibility to extreme weather events, such as drought. Understanding this vulnerability, and reducing it through adaptation, is just as important as understanding how weather patterns will change (Liverman, 2011). Vulnerability to risk is increasingly accepted as a central characteristic of poverty. As such, development policies should be cognizant of, and informed by,

*Email: asherwo2@gmail.com

existing sources of vulnerability and mechanisms that communities employ to mitigate it (Bhattamishra & Barrett, 2010).

Vulnerability is correlated not only with exogenous factors, such as resource availability, but also endogenous societal factors (Adger et al., 2007). The appropriateness of adaptation strategies therefore depends on the diverse options, values and goals within communities (Adger, Dessai, et al., 2007). Yohe and Tol (2002) identify eight community-specific criteria that influence adaptive capacity, including available technology, natural resources, structure of local institutions, human capital, social capital, processes employed by local decision-makers, a community's perception of the source of stress and its severity, and their ability to spread risk. Collectively, these studies suggest that creating effective adaptation policy requires an understanding of vulnerability at a household and community level. One method to investigate such vulnerability is to examine households' coping mechanisms during times of extreme weather events. This study uses interviews and participatory research techniques to examine how women in Gituamba location, Kenya adjusted their activities to cope with a year-long drought that began in 2008.

Drought coping mechanisms and vulnerability

Vulnerability to drought could act as a major determinant of future poverty dynamics, particularly as global climate change continues to alter weather patterns. To cope with drought, households currently employ diverse and dynamic coping strategies (Smucker & Wisner, 2008). A study of the 1984 drought in Kenya found that households relied on food stores, switched to horticulture, sought off-farm employment, relied on relatives that lived in urban areas, and sold livestock and other assets (Kamau, Anyango, Gitahi, Wainaina, & Downing, 1989).

A household's coping mechanisms depend on characteristics such as gender and number of working-age household members (Chambers, 1989). A household with two or more people of working age may be less constrained than a household with just one worker because two sources of income could potentially be available. If work is scarce, one person can continue to carry out household chores, while the others pursue wage labor or other income-generating activities. Gender of household members could affect coping in numerous ways; for example, some forms of wage labor are not socially acceptable livelihood strategies for women (Eriksen, Brown, & Mick, 2005).

Coping mechanisms can also reflect a household's priorities and options during a crisis. Immediate economic or food deficiencies are often the first priority, followed by maintenance of the means for long-term livelihood generation. Some coping mechanisms are thus geared toward minimizing short-term threats while others are oriented towards maintaining a long-term livelihood source. As resources dwindle, however, difficult decisions must be made about how remaining time, energy and finances are allocated. As a crisis worsens, more extreme and diverse coping methods are used. In an emergency situation, households will employ strategies that completely disregard long-term priorities, such as the sale of land by subsistence farmers (Eriksen et al., 2005).

Though coping strategies depend, in part, on household characteristics and priorities, they also depend on community dynamics. In some communities, for example, consumption of certain wild foods is so stigmatized that they will not be consumed unless a state of emergency exists, whereas in other communities the consumption of wild foods is a first line of defense to maintain food security (Smucker & Wisner, 2008). Marginalized groups, such as the poorest members of a community or women, may be excluded from collective

coping or risk management strategies (Bhattamishra & Barrett, 2010). This leaves groups with the most pre-existing constraints in even more calamitous situations, which exacerbates fundamental inequalities. Societal values and hierarchies can therefore impede or facilitate adaptation and risk management strategies (Adams, Cekan, & Sauerborn, 1998; Bhattamishra & Barrett, 2010; Eriksen et al., 2005).

Poverty traps

People living in poverty are less able to make meaningful choices to improve their lives (Sen, 1999). A household living in extreme poverty must focus solely on survival and cannot afford to expand or diversify their livelihood options and income streams. Poverty trap theory asserts that households living in poverty lack access to assets necessary for lifting themselves out of poverty. Processes that exclude a household from these assets can differ by location and may include governmental oppression, geographic isolation, limited market access, disease, or erratic weather patterns (Sachs, 2005). As such, interventions or assets needed to lift a household or community out of a poverty trap can also vary greatly. It is imperative that poverty alleviation researchers understand and account for location or community-specific constraints and challenges (Barret, Marenya, McPeak, Minten, Murithi, Oluoch-Kosura, & Wangila, 2006).

A poverty trap dynamic also implies that, for households living in poverty, economic shocks such as drought can have long-term adverse effects on well-being. Impoverished households are implicitly underinsured against such risks. Shocks to their livelihoods therefore have the potential to weaken or reduce a household's labor force, diminish productive asset bases and deplete capital reserves. For an already impoverished household, these conditions can evolve into crises independent of the initial shock (Barrett et al., 2006; Little, Stone, Mogues, Castro, & Negatu, 2006). A household weakened due to insufficient nutrition, for example, may become more susceptible to chronic disease and increased long-term medical expenses. Such crises emerge as new structural conditions that hamper efforts at economic growth and reinforce the poverty dynamic. Poverty trap theory assumes a positive correlation between wealth and returns on assets. So, as the rich continue to grow in wealth (domestically or abroad), the economic position of people living in poverty traps holds constant or declines (Azaradis, 2006; Sachs, 2005).

Objectives

This paper explores relationships between poverty traps and household coping mechanisms through a case study that examines the effects of a year-long drought on women in Gituamba, Kenya. Using participatory research techniques, this study investigates the experiences of drought survivors and explores the following hypotheses:

(1) Drought has the potential to create poverty traps in communities that depend on rain-fed agriculture.
(2) Women may be disproportionately affected by drought.
(3) Drought coping mechanisms reveal community vulnerabilities and resiliencies, and can thus inform adaptation policy.
(4) Adaptation policy should go beyond relief operations and initiate strategies that reduce vulnerability to future erratic weather patterns.

Materials and Methods

Description of 2008–2009 drought

In 2008, the short rains that normally occur from October to December failed throughout Kenya. As it became apparent that the long rains of 2009 would also fail in many parts of the country, resulting in crop failure and high livestock death, a food security crisis began to develop for millions of Kenyans. Rapid assessment reports conducted by the Kenyan Red Cross indicated that as many as ten million Kenyans could be at risk of starvation. In mid-January 2009, the Kenyan government declared a state of emergency and began to appeal to the international donor community for food aid. In addition to food shortages, many areas of the country experienced extensive drying of water sources, inflated food prices, and human-animal conflicts over resources (Kenya Red Cross, 2009; World Food Program, 2009).

In Laikipia district of the Rift Valley province in Kenya, where Gituamba is located, the situation was similar: the 2008 short rains failed in most of the district, and the 2009 long rains faltered, causing a decrease in both quantity and duration of rainfall. This decrease in overall quantity, paired with the erratic nature of the remaining rainfall, led to widespread food insecurity and water shortages throughout Gituamba (Kaguara, Beethoven, Matere, & Koskei, 2009). In early 2010, Gituamba experienced dramatic improvements in food security. Although most households had still not experienced a major harvest since the 2008–2009 drought, conditions were improving, as people began to harvest and livestock became healthier. It was during this recovery phase that fieldwork for this study was conducted.

Participatory research methods

Participatory rural appraisal (PRA) describes a diverse set of methods that provide poor people with a means to categorize, analyze, and evaluate their lives. It is based on the notion that poor people have a fundamental right to conduct their own analysis of the challenges they face (Chambers, 1995). PRA methods stipulate that researchers should seek to learn from the poor, and avoid imposing their own ideas and opinions during this process. Specific goals of PRA include gaining direct knowledge from local people, decreasing biases, optimizing tradeoffs, and postulating potential solutions (Chambers, 1994).

Participatory Poverty Assessment (PPA) is a branch of PRA that uses participatory appraisal techniques to redefine poverty and priorities through the experiences of those living in it (Brock & McGee, 2002; Chambers, 1995). Ideally, PPA enables poor people to express their experiences, needs, and desires, and subsequently influence the design of policy that addresses root causes of poverty and vulnerability within their community (Chambers, 1994; Narayan, Chambers, Shah, & Petesch, 1999). PPA has gained credibility in recent years through its use in major development efforts, such as the World Bank's 'Voices of the Poor' project (Narayan, Patel, Schafft, Rademacher, & Koch-Schulte 1999).

This study used participatory research techniques to solicit in-depth personal accounts from survivors of the 2008–2009 drought. As primary investigator, I participated in daily livelihood and recovery strategies alongside the women of Gituamba. I engaged study participants in threat and priority-ranking exercises. I also developed interview questions and well-being indicators in conjunction with residents of Gituamba.

Semi-structured interviews

This study's data and conclusions are drawn from participant observation, informal focus-group discussions with women's self-help groups, and 40 semi-structured interviews.

Interviews involved both open-ended questions and a collection of indicators related to poverty and drought. Interviews consisted of four sections: (1) general demographic data, (2) poverty and life during normal years in Gituamba, (3) coping mechanisms during the 2008–2009 drought, and (4) drought's effects on women. A snowball sampling method was used, in which prior contacts were used to solicit initial participants, and then further participants were generated through each interviewee. This approach was chosen for its ability to seek out participants who would feel comfortable sharing in-depth accounts of their lives and the 2008–2009 drought. Interviews were conducted primarily in Swahili, which the primary investigator spoke only conversationally, so a local translator was used.

Results

Household dynamics in non-drought years

In non-drought years, the primary source of livelihood for 37 of the 40 respondents was farming maize and beans. Many respondents supplemented agricultural operations with at least two secondary livelihood strategies, which most commonly included livestock keeping, casual labor, small-scale sale of household necessities, or horticulture operations. Women faced many barriers to successful income generation even in non-drought years, such as a lack of capital to purchase proper agricultural inputs, a lack of labor to properly look after crops, low wages for casual labor, crop diseases, underdeveloped transportation infrastructure, and a lack of access to markets.

When ranking and discussing threats, respondents spoke most frequently and passionately about the lack of capital, which forced women to farm with inadequate fertilizer and non-certified seed, resulting in low yields. Even if a household were able to scrape together the capital needed for sufficient inputs, unreliable markets and unfair trade relationships meant there was no guarantee they would experience a return on their investment. This uncertainty surrounding returns on staple crop agriculture was the reason most women pursued the secondary strategies mentioned above. Secondary strategies not only supplemented income but also reduced household vulnerability to threats associated with staple crop agriculture.

Despite the lack of capital, respondents' priority rankings in non-drought years suggest they were striving to improve their household's situation. In non-drought years, the most common priorities were education of children (or grandchildren), acquiring more assets such as land and livestock, starting or investing in small businesses, and completing household improvements (e.g., switching from a thatched roof to a metal one). Only two of the respondents listed food-acquisition as a first priority in non-drought years.

The fact that most respondents were able to focus their resources on priorities that expanded livelihoods or improved quality of life signals that, in non-drought years, women of Gituamba were not caught in poverty traps. They were able to successfully allocate their time, capital and energy to afford improvements in their household's income-generating activities and well-being. For most respondents, their household poverty dynamic more closely followed classical economic theory, which suggests that impoverished people experience adequate returns on assets to continually improve their situation, if only marginally (Barret, Marenya, McPeak, Minten, Murithi, Oluoch-Kosura, & Wangila, 2006).

Drought and poverty traps

The 2008–2009 drought affected respondents and their families in diverse ways, but there were three fundamental ways in which it helped create potential poverty traps. First,

Table 1. Coping mechanisms used by women in Gituamba, Kenya during the 2008–2009 drought.

Coping Mechanism	# of Women using it (of 40 interviewed)
Restricted diet	32
Casual labor	25
Sold livestock	22
Gifts from family/friends/social networks	13
Horticulture	13
Relied on non-farm salaries	8
Sold chickens	6
'Economized'	5
Outside aid (govt. or private)	4
Irrigation	4
Have children work	4
Loans	3
Rely on savings	2
Sold milk	2
Sold local brew	2
Sold chapatti (a local bread) to casual laborers	2
Sold trees	2
Sold land	2
Sold eggs	1
Lease land	1
Sold matatu (a local term for taxi)	1
Bought food from far away, sold locally	1
Borrowed farming inputs	1
Fetch water at night	1
Sell household things	1
Dug a well	1
Reduced employees	1
Sold soap	1

drought caused crop failure, which exacerbated respondents' most fundamental vulnerability, lack of capital. Maize and beans are staple foods in Gituamba, and the inability of a household to grow them for consumption means they must be purchased. Alternatively, many households invested capital resources to re-plant crops after the first sowing failed, only to experience repeated crop failure and no economic return. Second, food insecurity caused respondents and their households to restrict their diets. Thirty-two of the respondents restricted their diets (Table 1), with most eating two small meals of ugali (boiled maize meal) and tea each day. This dietary restriction decreased the productivity of labor and human capital in affected households. Finally, the drought forced households to sell their livestock and, in a few cases, land (Table 1), or resulted in livestock death, all of which reduced households' productive assets. These three outcomes created potential poverty traps for over 50% of households.

Crop failure and food insecurity during the drought acted as exclusionary mechanisms that made it even more difficult for women to access badly needed capital. For respondents with alternative livelihood options, lack of access to capital was not enough, alone, to create a trap. However, depleted assets and lowered productivity of households often served as reinforcing dynamics, which minimized or eliminated secondary livelihood strategies that women usually employed. Figure 1 illustrates this dynamic.

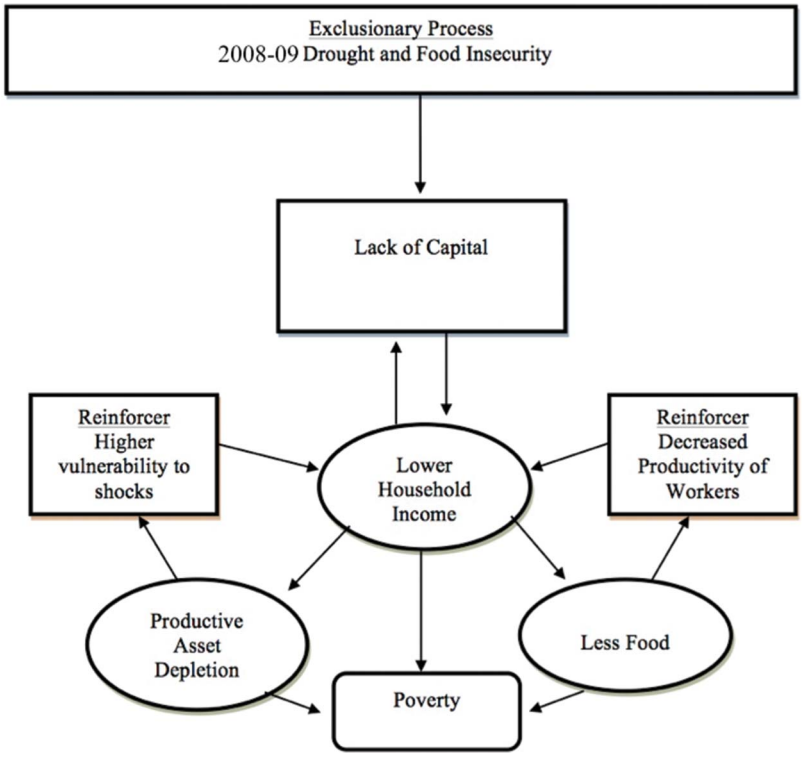

Figure 1. Poverty dynamics triggered by the 2008–2009 drought in Gituamba, Kenya.

During and immediately after the drought, many respondents lacked the capital needed for planting, so they planted less land than normal, planted late, or planted with even fewer inputs than normal. This resulted in lower than normal crop yields for the next harvest even though there was sufficient rainfall. Lower than normal yields may reinforce the poverty trap cycle for the coming year by making it difficult for a household to regain its pre-drought dietary and asset levels.

The creation of poverty traps was further reflected in a shift in many respondents' priorities during the 2008–2009 drought. When ranking drought-time priorities, 32 respondents said their first priority was acquiring food. Twelve respondents said that food was the only priority to which they could allocate resources during the drought. They spent so much of their time and resources securing food that they seldom fulfilled other obligations. The most common second priority was children: trying to keep them in school and maintaining their general well-being. Only five women listed a third priority; most women, in contrast, stated they had no resources or time leftover after addressing hunger and child welfare.

As the drought progressed, women experienced a fundamental shift away from non-drought priorities, such as improving livelihoods and increasing assets, towards survival activities like acquiring food and maintaining child welfare. This priority shift supports the idea that people who are focused on survival have very limited choices as to how they spend their time, energy and other resources (Nussbaum, 2000; Sen, 1999). This lack of meaningful choices is also an emergent characteristic of poverty traps.

Drought and women

Women of Gituamba faced other challenges during the 2008–2009 drought. As crop failure became imminent, over half of respondents sought more frequent casual labor opportunities or other off-farm work (Table 1), while still maintaining their normal household obligations. These same respondents reported they did not receive any additional help with household obligations because men were also out seeking work. Children were either in school or too weakened from an improper diet to contribute significantly to household tasks.

In addition to increased off-farm work, women had to walk further to find water, expend more effort to acquire food, and travel further to find casual employment as more and more farms became unproductive. The increased difficulty and number of obligations respondents took on, paired with an inadequate diet, resulted in a poverty of time and energy for many of them. Respondents who restricted their diet and relied heavily on casual labor as a coping mechanism struggled to manage tradeoffs between finding and purchasing food, working for low wages, and completing essential household tasks.

This poverty of time and energy also resulted in a change in community involvement. Nineteen of 32 women who described themselves as active in at least one or more community organizations said they were forced to drop community obligations during the drought. Preparing food, fetching water and caring for children are traditionally women's tasks in Gituamba. As their multiple, gender-specific, domestic obligations grew during the drought, so too did their poverty of time and energy for public involvement.

Other research has documented a similar poverty of time and energy among African women, particularly as they transition from the domestic sphere to the public sphere. May et al. (1998) found that, when South African women gained access to (or found it necessary to seek) outside work, they often received no help with existing household obligations. Jobs they were able to obtain outside the home were typically low paying, resulting in marginal economic gains. Women in Gituamba also fit this model. Those working outside the home usually earned very low wages as casual laborers on horticulture farms.

Coping mechanisms, resiliency and adaptation

Women employed many coping mechanisms to minimize and manage the effects of the 2008–2009 drought. In total, 28 unique strategies were used (Table 1). On average, each woman (or their household in general) employed four coping strategies. The three most commonly used mechanisms were dietary restriction, casual labor, and selling livestock, all of which were employed to manage food insecurity.

Although many respondents engaged in casual labor in normal years, they often did it sporadically to earn money for school fees or other expenses. In 2008–2009, it became a major source of income for 25 households, who used it to raise money for purchasing food, rather than non-essential expenses. Unfortunately, wages paid to casual workers during the drought decreased from about 200 shillings per day to 50 shillings per day. This was a result of the increased number of people looking for work.

In years of good rainfall, Gituamba is a very productive region. As a result, the community has become over-reliant on staple crop and livestock agriculture. When the rains fail, there are few options for maintaining food security and nutrition levels. Many households sold livestock during the drought as a means to purchase staple foods. Households sold 20% of their livestock holdings; another 28% of livestock died in 2008–2009. Food security is clearly Gituamba's greatest vulnerability. Addressing the community's over-reliance on staple crop and livestock agriculture will be paramount to successful adaptation.

Thirteen of the 40 households interviewed diversified their agricultural activities during the drought by participating in horticulture activities. Most of these households grew tomatoes, and had at least a bit of experience with horticulture from previous years. Four of the horticultural operations were watered using pipe irrigation systems. Nine respondents carried water to their horticulture fields. Those with pipe-irrigation harvested higher yields earlier in the season than those who hand-watered. Those with pipe-irrigated operations were therefore able to sell many tomatoes at a good price. Those with hand-watered operations harvested lower amounts, and did so later in the season. At their time of harvest, the market was flooded with tomatoes, so the price dropped significantly. This caused some of the respondents to sell their tomatoes at a loss, which was not an effective coping strategy. This demonstrates that introducing new, non-staple crop agricultural initiatives into Gituamba as a food security or income initiative may not be successful without improved supply management and price-risk management tools.

Seventeen women began selling various household and farm goods as a coping mechanism in 2008–2009. Products included homemade soap, chickens, milk, local brew, chapatti, tree seedlings and eggs. Income generated by the sale of these products was generally very low, but it was sufficient to justify continued production. The biggest challenge to this coping strategy was finding customers; many people could not afford even basic necessities. To get their products to non-drought areas, women needed capital for transportation, which they did not possess.

Another common coping mechanism included receiving help (money or food) from friends or family, primarily those living outside the drought-affected area. Adaptation policy should therefore consider how social networks and inter-community ties might be strengthened to reduce vulnerability. Even within Gituamba there is socio-economic stratification and intra-community social networks that could be drawn upon during crises. There is potential to strengthen such networks and use them for vulnerability reduction.

Little international aid was available to Gituamba in 2008–2009, in part because the region has a reputation for being fertile and productive. Only four respondents reported receiving food aid. When asked why they did not use food aid as a coping strategy, respondents said it was difficult to obtain due to a corrupt and highly-politicized distribution process. Even if they waited in line all day, they were not certain to receive aid. The high opportunity cost of their time outweighed the one or two kilograms of maize flour they might (or might not) receive.

Coping mechanisms not only help identify sources of vulnerability within a community, they also highlight areas of strength. Nine households displayed high resilience during the 2008–2009 drought. None of these nine reported any change in school attendance or health. Eight reported no change in diet, and one said they suffered only slight cutbacks in the amount of food eaten and experienced no change in the type of food they ate. All nine respondents reported no other areas of household well-being that suffered significantly during the drought.

These households were resilient due to a number of different factors. Four households were resilient due to their knowledge of irrigated agriculture and the ability to acquire necessary inputs. Formal employment was essential to the resiliency of three households, but was supplemented with productive assets and savings. One respondent was resilient due to successful business operations, market forces, and her access to credit. The final resilient household used social networks, combined with overall livelihood diversification, to increase her resiliency to drought. Future adaptation policies should consider and attempt to replicate these successful strategies: improved agricultural knowledge and infrastructure, formal employment, access to credit, and livelihood diversification.

Adaptation policy

The IPCC (2007) predicts a 20% reduction in growing season length in much of Kenya by 2050, which will put the food security of numerous communities at risk. Adaptation policy should aim to reduce vulnerability, yet also include a plan for relief operations in case they become necessary. As such, policy should combine relief, recovery, and long-term adaptation into a comprehensive plan.

Relief

Food insecurity was clearly the biggest challenge during the 2008–2009 drought. There was a severe lack of food aid in Gituamba, and a general perception that aid disbursement was riddled with corruption. Food aid may have controversial effects on local markets and farmers, but Gituamba faced a food deficit. Channeling food into the area through free aid, local markets, or food-for-work programs will be imperative during future droughts of similar severity. Reducing corruption in food aid distribution could also improve food security.

In addition to food insecurity, women faced a severe lack of time and energy during the 2008–2009 drought. Work programs that provide women a fair wage or food could help alleviate this by providing a reliable place for them to seek work. Rehabilitation of several large, communal boreholes that were originally dug in the colonial era could also alleviate women's poverty of time and energy. According to respondents, these deep boreholes would likely still contain water during a drought as severe as the one in 2008–2009. If successful, the rehabilitation of these boreholes would reduce the distance many residents have to travel to find a reliable water source, thereby making water collection a less time and energy intensive activity, particularly during drought. The Gituamba Umbrella Community Based Organization, discussed below, is working towards this goal.

One more issue to be considered when discussing relief is the depletion of livestock that most households experienced in 2008–2009. Livestock holdings in the area were reduced by 48%, either because of intentional liquidation (20%), or more troublesome, death before animals could be sold or slaughtered (28%). Death of livestock results in no gains, but rather overall net losses, for a household. A livestock-purchasing program during drought might therefore prove beneficial for many residents of Gituamba.

Recovery

The most essential piece of recovery policy is to ensure that women have enough access to capital and farming inputs to properly prepare for future growing seasons after a drought subsides. Microloans for certified seed and fertilizer could be an effective strategy for achieving this goal. These small loans must have low interest rates, however, and repayment plans that do not force households to sell their goods immediately after harvest, when prices are depressed. Ensuring that women have access to capital, farm inputs, and price-risk management options will help guarantee good yields in years following a drought. A good harvest will interrupt the creation of poverty traps, strengthen human capital by improving diets, jump start secondary income generation activities, and help reclaim productive assets lost during a drought. These loans could be made available in both normal and recovery years, as a longer-term strategy to address women's lack of capital. Research suggests that this type of microfinance is most successful when paired with training on proper use of farming inputs and improved agricultural practices (Ali-Olubandwa, Kathuri, Odero-Wanga, & Shivoga, 2011).

Long-term adaptation

To reduce vulnerability to future droughts, adaptation policy should find ways to improve households' access to capital. Access to business-related credit was instrumental in the success of at least one household that was resilient to drought in 2008–2009. Furthermore, many women expressed a desire to start small businesses during good years, but stated they did not have access to the necessary capital to cover start-up costs. Making microloans available to women interested in starting small businesses may be a successful approach (Matin & Hulme, 2003; Swain, Sanh, & Tuan, 2008).

Formation of cooperatives for selling milk, honey or horticulture crops could also prove beneficial. While improved transportation infrastructure would certainly help women sell such products, major improvements to roads and systems are unlikely in the near future. The creation of cooperatives, comprised of small-scale producers, may help overcome transportation and market barriers. By joining forces, producers would have a larger supply of the good, and thus gain bargaining power with buyers or processors. Large-scale buyers might be willing to travel to a central location in Gituamba to purchase and pick-up these goods, if available in sufficiently large quantities. This would eliminate individual households' logistical problem of transporting their goods to market. Alternatively, producers could spread the costs of transportation among many people, rather than each person being responsible for their own transportation costs.

Cooperatives could also facilitate livelihood diversification within the community, which would reduce overall vulnerability to drought. Irrigated horticulture and bee-keeping contributed to drought resiliency in 2008–2009. Development of these activities in non-drought years could empower women with built-in options for coping with drought, rather than scrambling to find casual labor and selling household assets.

In response to the 2008–2009 drought, residents created the Gituamba Umbrella Community Based Organization (GUCBO) to reduce drought vulnerability by forming a network between existing community self-help groups. A potential project for GUCBO is to use these self-help groups to establish a community grain bank. Community grain banks entail either a start-up donation of grain by an outside actor (government or Non-governmental Organization [NGO]), or they require members to make deposits of surplus grains during productive years to slowly build a store. The grain can then be consumed in times of drought or other hardship and later replenished by the consumers. An established community store could supplement members' diets during drought, which would improve not just food security, but also household productivity. Social networks were instrumental in creating resiliency in 2008–2009; a community grain bank developed and managed by GUCBO could potentially use these networks to further strengthen resiliency.

Finally, households that were resilient during the 2008–2009 drought demonstrated that irrigation has the potential to reduce vulnerability. Its effectiveness depends, however, on water availability. Improper irrigation by a few large horticulture operations could aggravate a water shortage during drought. Efficiently-designed systems for small-scale horticulture operations, in contrast, could increase households' livelihood options during times of staple-crop failure. Residents of Gituamba believe a successful irrigation system could be developed by rehabilitating a nearby groundwater source known as Kahiga Spring. A hydrological survey was beyond the scope of this study, but this option should be explored. Any irrigation initiatives should bear in mind that, under climate change, water may become even scarcer in Gituamba; in which case, irrigation could cease to be a viable adaptation strategy.

Adaptation ideas for further research

In addition to irrigated horticulture and forming cooperatives, there are several other agricultural strategies that might be successful at reducing vulnerability to drought in Gituamba. They include crop insurance, conservation agriculture, and diversifying agricultural activities to include cultivation of drought-resistant, rain-fed crops. Although these strategies were not in use in Gituamba at the time of this study, secondary research indicates they could hold potential. Each of these ideas would require further analysis and testing prior to implementation.

Conservation agriculture advocates reduced tillage, year-round soil cover, and rotational cropping (Hobbs, 2007). By eliminating the annual use of a plow, conservation agriculture reduces soil compaction and improves water infiltration. Research shows that this can mitigate water scarcity issues and reduce the likelihood of complete crop failure during drought (Hobbs, 2007; Rockstrom, Kaumbutho, Mwalley, & Temesgen, 2003). Eliminating plowing might also reduce capital requirements for farming; after all, most farmers in Gituamba pay someone to plow their land each year, or are left to do it by hand. Reducing soil disturbance and providing year-round soil cover would decrease erosion, thereby increasing organic matter and soil quality. Prior research has shown that increased infiltration, decreased erosion, and improved soil quality can result in higher crop yields, and in some cases allow for more crops to be planted throughout the year (Garcia-Torres, Benites, Martinez-Vilela, & Holgado-Cabrera, 2003; Hobbs, 2007). Yet, conservation agriculture also has barriers to entry, including increased labor for weeding or increased spending on herbicides to control weeds (Giller, Witter, Corbeels, & Tittonell, 2009). Such tradeoffs should be properly assessed before being promoted in Gituamba.

Crop and livestock insurance for small-scale farmers is just starting to become available in Kenya (Chantarat, Mude, Barrett, & Carter, 2013). For Gituamba, precipitation-based policies that pay out according to rainfall might be suitable. From a household's perspective, insurance policies would ideally compensate not only for the cost of farming inputs invested during an unsuccessful growing season, but also the estimated value of failed crops or livestock. It could be challenging to design a policy that fulfills this role, and is still affordable to farmers. It might also be challenging for households to save enough money to pay annual premiums during both non-drought and drought years (Chantarat, Mude, Barrett, & Carter, 2013; Cole, Bastian, Vyas, Wendel, & Stein, 2012). Index-based products are often used to overcome the problem of high premiums, but weather-based index products require a reasonable amount of investment in monitoring infrastructure (i.e., weather stations) from the insurer.

Rain-fed crop diversification should also be considered as an adaptation strategy. Diverse crops, even when planted at the same time, will be affected differently by precipitation patterns; this should help decrease the risk of complete crop failure (Adger, Huq, Brown, Conway, & Hulme, 2003). Incorporating drought tolerant crops, in particular, such as sorghum, millet, cowpeas and lentils, alongside traditional maize agriculture, could significantly reduce vulnerability to drought. Diversified agricultural systems provide additional benefits by lowering the risk of loss due to pest or disease outbreaks and increasing nutritional potential. However, there are barriers to diversification, including lack of knowledge about secondary crops, and lack of market incentives (Lin, 2011). As evidenced by the tomato surplus in Gituamba during drought, any crop diversification initiatives will need to be paired with strategies that increase market access and decrease price risk.

Conclusion

Adaptation to drought and climate change is likely to require a combination of household, community and, in some cases, third-party initiatives to be successful. Understanding a household's or community's sources of vulnerability, during both non-drought and drought years, is a useful means to inform adaptation policies. Vulnerability studies should aim to identify groups that are disproportionately affected by drought, recognize conditions that may cause them to enter a poverty trap, and understand options and barriers for coping effectively and escaping a drought-induced poverty trap. Comprehensive policies that involve relief, recovery, and long-term adaptation strategies are needed currently, and will become increasingly important in the face of climate change.

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