Policy Brief No. 17
October, 2015

EGERTON UNIVERSITY
TEGEMEO INSTITUTE OF AGRICULTURAL POLICY AND DEVELOPMENT

Policy Brief

Let it rain: Weather extremes and household welfare in rural Kenya

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SUMMARY

Households in rural Kenya are sensitive to weather shocks through their reliance on rain-fed agriculture and livestock. This study used the latest data sets of historical weather and household panel data collected in 2000-2007 to understand the impact of exposure to weather extremes –including periods of high and low rainfall, heat, and wind– on household welfare. We find that all types of extreme weather affect household well-being, although effects sometimes differ with income and calorie estimates. Periods of drought are the most consistently negative weather shock across different income groups and agro-ecological regions. Exposure to low rainfall reduces income from both on- and off-farm sources, though households compensate for diminished on-farm production with food purchases. The study further explores the factors that offset the negative effects of drought, and finds that access to credit and membership in a savings group render a household more resilient. Thus, policies and programs to improve access to both financial services and food markets could enhance household resilience to weather shocks.

BACKGROUND

Rural households that draw their livelihoods from agriculture are particularly sensitive to climate variability (Davies et al. 2013). Yet the extent of vulnerability is poorly understood, particularly in reference to extreme weather. Instead, most studies focus on seasonal means or aggregate rainfall, even as intra-seasonal variability can have significant consequences (Thornton et al. 2014). A better understanding of the impacts of weather shocks is necessary to identify the causes of poverty, as well as interventions to reduce vulnerability. This challenge is increasingly relevant as climate projections point to an increasing frequency and intensity of weather extremes over this century (IPCC 2014).

The effects of weather shocks on household welfare have been documented across a wide range of contexts. Temperature, precipitation, and extreme weather events are often (though not always) found to affect economic well-being (Dell et al. 2014). The literature thus rejects the hypothesis that households are able to fully protect themselves against such shocks. As well, the impact of weather shocks depends on a household's level of resilience, or its capacity to absorb and/or mitigate damage. Factors proposed to enhance resilience include access to non-farm income, asset stocks that can be liquidated, public transfers, and credit (Davies et al. 2013).

In rural Kenya, households derive their livelihoods primarily from rain-fed agriculture, leaving them sensitive to the vagaries of weather. Agriculture accounts for approximately 26% of Kenya's GDP and 75% of employment (Herrero et al. 2010). Kenya is characterized by a diverse topography and highly localized climatic patterns, which presents a need to consider geographic variation when measuring sensitivity to weather shocks. Kenya experiences minor droughts every few years, and although parts of the country are also regularly afflicted by floods, droughts affect a larger number of people.

RESEARCH QUESTIONS AND DATA

This study explores the following questions.

(1) What are the impacts of various weather shocks on household welfare in rural Kenya?
(2) Do the impacts differ for poor households, or for households in different agro-ecological regions?
(3) Through which channels do weather shocks affect household welfare?
(4) Which community or household characteristics mitigate the adverse effects of low rainfall?

The study draws from three data sources: (1) A panel data set of households in rural Kenya, collected by the Tegemeo Institute of Agricultural Policy and Development of Egerton University, Kenya; (2) a gridded data set of historical rainfall; and (3) a gridded data set of historical temperature and wind speed. Using panel econometric methods, the year-to-year fluctuations in observed weather for a given household are used to identify the effects of weather shocks on household well-being. Indicators of household welfare include monetary measures (income, poverty incidence, depth and severity) and non-monetary measures (calorie availability and energy deficiency). Weather shocks are captured as follows: Cumulative millimeter pentads (5-day periods) over 75 mm gauges the extent of high-rainfall periods during the main growing season, while cumulative millimeter pentads under 15 mm gauges the extent of low-rainfall periods. Cumulative degree days over 32 °C captures exposure to extreme heat during the daytime, and cumulative wind speed days over 5 m/s captures exposure to windy conditions.

MAIN FINDINGS:

- Of the weather shocks considered, rainfall shocks are the most relevant for household welfare in rural Kenya. Exposure to periods of low rainfall consistently lowers income, though surprisingly, does not seem to affect caloric availability (Table 1).
- Low rainfall reduces net income, particularly from crop production. While it strongly reduces the calories produced from field crops, it seems that households compensate for this shortfall with calories purchased (Table 2).

Table 1: Effects of weather shocks on household welfare

Weather shock	Income per day (per adult equivalent in 2007 Ksh)	HH is poor (=1)	Calories available per day (per adult equivalent)	HH is energy deficient (=1)
High rainfall	-6.452	0.022	260.798**	-0.015
Low rainfall	-25.602**	0.076**	-208.069	0.017
Heat stress	1.731	-0.032***	100.026	-0.011
High winds	9.712	-0.022	-5.999	0.013
Observations	3,792	3,792	3,792	3,792

*** p<0.01, ** p<0.05, * p<0.1

Note: Coefficients derived from a household fixed effects regression that includes other household controls and year fixed effects. HH categorized as poor when income per day falls below the national rural poverty line, and categorized as energy deficient when calories per day falls below 2,250 calories. High rainfall = cumulative millimeter pentads above 75 mm (100s), Low rainfall = cumulative millimeter pentads below 15 mm (100s), Heat stress = cumulative degree days above 32 °C (10s), High winds = cumulative wind speed days above 5 m/s (10s).

Table 2: Mechanisms of weather shock impact

Weather shock	Income per day (2007 Ksh)			Calories available per day			
	Crop production	Livestock	Off-farm	Field crops	Vegetables/ fruits	Livestock products	Purchased
High rainfall	-7.461	0.628	0.382	155.605	95.227*	20.05	-22.321
Low rainfall	-17.274**	1.408	-9.736	-507.005***	-13.086	-48.071*	362.716***
Heat stress	1.169	0.923	-0.362	3.203	98.545**	6.82	-5.299
High winds	9.648**	1.41	-1.347	276.584**	-95.141*	-0.977	-168.669***
Observations	3,792	3,792	3,792	3,792	3,792	3,792	3,792

*** p<0.01, ** p<0.05, * p<0.1
Note: See Table 1 note for definitions of weather shock variables

- Households in the highlands experience significantly reduced income (compared with the midlands) when exposed to high rainfall. At the same time, wind shocks are most relevant, and most damaging to food security, in the lowlands.
- The availability of credit significantly improves a household's ability to withstand the shock of low rainfall on income. The same is found for membership in a savings group and the size of a household's asset stock.

CONCLUSIONS AND IMPLICATIONS

Several lessons emerge from this study: First, while periods of rainfall deficit have a negative influence on income, this effect is not immediately evident for calorie availability. Though income is volatile, it seems that households are (to some extent) able to smooth consumption with a 'pivot' to the food market. This underscores the importance of a well-functioning food market and ease of market access for households to adjust their calorie sources in response to bad weather. Second, noting that extreme weather can affect each metric differently, this paper highlights the usefulness of considering multiple proxies of welfare.

Third, the effect of each type of weather shock clearly differs by agro-ecological region. While exposure to high rainfall does not significantly affect income in the full sample, it does harm households in the highlands. To the extent that climate change is expected to bring even more rain to this region (Herrero et al. 2010), such sensitivity to 'excess' rainfall poses a concern. Exposure to high winds also has a negligible effect in the full sample, yet is detrimental to calorie availability in the lowlands. Lowland farmers, in particular, may benefit from setting up windbreaks to mute the effects of wind-sourced erosion.

Fourth, our examination of mitigating factors that safeguard income from the effects of low rainfall reveals that access to financial services is a strikingly important coping mechanism. While asset stocks also seem relevant, the results for access to credit and membership in a savings group unambiguously highlight their role in building resilience. Improving access to financial services, including both credit provision and savings devices, could thus bolster household resilience to weather shocks.

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The full report is available from the authors upon request.
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Tegemeo Institute acknowledges support for its research programmes from key partners including the United States Agency for International Development (USAID), Michigan State University (MSU), and Egerton University, Nairobi, Kenya.

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