How does climate exacerbate root causes of conflict in Uganda? An econometric analysis

1. Objectives and research questions

There is a growing concern that the ongoing climate change will adversely affect the Ugandan households' food security status in the coming decades. The economy is considerably dependent on the climate-reliant agricultural sector (Ministry of Water and Environment 2015a; 2015b; Hepworth and Goulden 2008; The World Bank Group, 2021). The climate crisis could further intensify local conflict incidences, e.g., through resource constraints and competitions, migration, and poor agricultural harvest. Therefore, the objective of this study is twofold. First, to estimate the impact of climate shocks on household food security indicators (food expenditure and average household nutritional diversity score). Second, to identify the impacts of household's food security status and climate shocks on their conflict experience. The outcome of this study is expected to provide empirical evidence on how climate shock affects household welfare indicators (food security and conflict incidences).

The following specific research questions are addressed:

I. Do extreme climatic events and variability exacerbate households' nutritional insecurity?
II. Does food insecurity, as exacerbated by climate impacts, affect the likelihood and intensity of conflict?

2. Method and data

Our analysis addresses the research questions employing two econometric models. In the first stage, the impact of climate shock on household food security estimated using a Fixed Effect (FE) model. In the second stage, the impact of food insecurity, as exacerbated by climate impacts, on the intensity of conflict is estimated applying the Linear Probability Model (LPM). A brief econometric description of the models is presented in the Annex section.

This study uses a representative Ugandan Living Standards Measurement Study (LSMS) survey data collected in eight waves (2005/06, 2009, 2010/11, 2011/12, 2013/14, 2015/16, 2018/19, and 2019/20). These datasets contain information on households' socio-economic characteristics, conflict experience, food security, agricultural harvest, farm size, and income from farm and nonfarm sources. The study also uses geo-coded historical climate data on rainfall and temperature anomalies obtained from Climate Hazards Group InfraRed Precipitation with Station (CHIRPS).

3. Results

Table 1 presents variable description and summary statistics for selected variables. On average, each household spends around 846 USD per year on the purchase of food items. This figure excludes the value of food consumption covered from home production. Similarly, the average household dietary diversity score (AHDDS), which denotes the degree of food consumption variety in the household, shows a substantially lower value (2), out of the maximum scale (11). The conflict variable represents household's experience of any conflict incidence during a year from the survey month. We computed and used 12 months of lagged rainfall and temperature. The corresponding statistics show a value of -0.076 and -0.016, respectively. An additional summary of statistics on household's socio-economic characteristics is presented in Table 1.

Table 1: Summary statistics for the variable of interests.

Household level covariates	Obs.	Mean	Std. Dev.	Min	Max
Household head age	16,587	45	16	13	107
Household head gender	16,602	1	0	0	1
Household head formal education group*	16,424	2	1	1	3
Total cultivated land (acres)	16,702	7	68	0	7,025
Non-farm income (US$ PPP)	16,702	302	1,983	0	145,99
Household size	16,602	6	3	1	30
Settlement (urban or rural)	16,702	0.30	0.46	0	1
Food security indicators					
Annual food expenditure (US$ PPP)	16,394	846	726	0	12,56
Average household dietary diversity score (AHHDS)	16,602	2	2	0	11
Climate variables					
Rainfall anomaly - 12 months	16,702	-0.076	0.341	-1.218	1.156
Maximum Temperature anomaly - 12 months	16,702	-0.016	0.576	-1.227	1.555
Conflict variables					
Household conflict experience	14,143	1.975	0.156	1	0

***Note:** The education variable is classified as never attended, attended school in the past and currently attending.

Table 1 presents the relationship between climate and food security-related variables. The statistics show a negative association between the past 12 months rainfall anomaly and households' annual food expenditure. This supports the anticipated argument that climate shock in terms of rainfall variability could adversely affect household food security status through food expenditure. A similar association is also observed between the past 12 months temperature anomaly and household annual food expenditure. However, the correlation between climate variables (rainfall and temporary) with food expenditure and AHDDS are substantially low with a positive sign. In general, the result indicates a possible negative impact of climate shocks on household's food security status as estimated with food expenditure, but results are not clear when the dietary diversity score is used as a measure of insecurity.

Table 2. Correlation matrix for climate and food security variables

	Rainfall anomaly - 12 months	Maximum Temperature anomaly - 12 months	Annual food expenditure (US$ PPP)	Average household dietary diversity score (AHHDS)
Rainfall anomaly - 12 months	1	0.249	-0.144	0.036

Maximum Temperature anomaly - 12 months	0.249	1	-0.199	0.142
Annual food expenditure (US$ PPP)	-0.144	-0.199	1	-0.157
Average household dietary diversity score (AHHDS)	0.036	0.142	-0.157	1

Consequently, we examine the correlation between household conflict and weather shocks captured by rainfall anomaly and temperature anomaly. The correlation matrix depicted in Table 3 shows a positive association between the past 12 months rainfall anomaly and household conflict experience. However, the link between 12 months maximum temperature anomaly and household conflict experience is negative. A unit change in 12 months rainfall anomaly is associated with a 0.011 change in the probability that household experience conflict. Similarly, a unit change in 12 months maximum temperature anomaly is associated with a -0.021 change in the probability of household conflict experience. This shows that there underlying mechanisms that govern the relationship between weather shock and household conflict that need further investigation to make a sensible interpretation of the observed correlation.

Table 3. Correlation matrix for climate and conflict variables

	Rainfall anomaly - 12 months	Temperature anomaly - 12 months	Household conflict experience
Rainfall anomaly - 12 months	1	0.249	0.011
Temperature anomaly - 12 months	0.249	1	-0.021
Household conflict experience	0.011	-0.021	1

I. Do extreme climatic events and variability exacerbate households' nutritional insecurity?

We further estimated the impact of climate shocks on household food security level based on an econometric model that accounts for other potential drivers of food insecurity (see annex for the model specification). As shown in Table 4, the estimates for the past 12 months rainfall anomaly become positive and statistically insignificant. This implies rainfall induced climate shock has trivial impact in household food security status (food expenditure and AHDDS). However, 12 months maximum temperature anomaly has a positive and statistically significant effect on household food expenditure. In the case of AHDDS, past 12 months maximum temperature anomaly has negative and statistically significant effect. Accordingly, a unit increase in the past 12-months temperature anomaly reduces households AHDDS by around 3%. In general, the first stage result shows that climate shock increases the amount spent on food, but it negatively affects household's dietary diversity (manly through temperature anomaly). These estimates have two implications. First, most rural households in Uganda are practicing subsistence farming, where the average rural households cover their food demand from home production (e.g., Kraybill & Kidoido, 2009). Given this setting, the presence of any climate shock can lead to poor harvest and ultimately pushes families to spend more on food purchases. Second, climate shock also affects the variety of home food production and eventually the dietary diversity in the household. Note that household level controls, district and year fixed effects are considered in the regression.

Table 4: The impact of climate anomalies on food insecurity

Variables	Food expenditure		AHDDS	
	Coefficient	Std. Err.	Coefficient	Std. Err.
Rainfall anomaly – 12 months	0.028	0.021	0.007	0.020
Temp. anomaly – 12 months	0.045**	0.021	-0.027*	0.016
Household level controls	Yes		Yes	
District FE	Yes		Yes	
Year FE	Yes		Yes	
Observations	16,183		16,372	

Note: Standard errors are clustered at household level. *** *p<0.01*, ** *p<0.05*, * *p<0.1*.

II. Does food insecurity, as exacerbated by climate impacts, affect the likelihood and intensity of conflict?

Findings in Table 5 show that increases in food security as measured by AHDDS reduce the probability of conflict incidences. Although the estimates are small, an increase in food insecurity status significantly intensifies the chance that households experienced conflicts. This results is consistent with previous findings (Arezki & Brückner, 2011; Bellemare, 2015; Berazneva & Lee, 2013; Brück & d'Errico, 2019). Similarly, the climate variables have positive and statically significant effect on the household's conflict experience. However, our results also show that the increase in food expenditure increase the likelihood of conflict. This result is inconsistent with previous results and literature and deserves further investigation. This might be because there might exist other confounding effect that we need to control for. In our hypothesis, it is the interaction of climate with socio-economic insecurities that increases the likelihood of conflict. Therefore, to identify the complementarity nature of climate shock and food security variables, we controlled for the interaction effects of climate variables with food security indicators.

Table 5: The impact of climate and food insecurity on conflict

Variables	Conflict experienced		Variables	Conflict experienced	
	(1)	(2)		(3)	(4)
Rainfall anomaly – 12 months	0.034***	0.080***	Rainfall anomaly – 12 months	0.022***	0.021***
	(0.007)	(0.013)		(0.005)	(0006)
Temp. anomaly – 12 months	0.019**	0.025***	Temp. anomaly – 12 months	0.024***	0.016**
	(0.008)	(0.010)		(0.006)	(0.007)
Food expenditure (US$ PPP)	0.009**	0.008**	AHDDS	-0.004*	-0.004
	(0.004)	(0.004)		(0.002)	(0.002)
Rain anomaly X Food exp. (US$ PPP)		-0.008***	Rain anomaly X AHDDS		0.000
		(0.001)			(0.003)
Temp. anomaly X Food exp. (US$ PPP)		0.000	Temp. anomaly X AHDDS		0.008***
		(0.001)			(0.003)
Household level controls	Yes	Yes	Household level controls	Yes	Yes
District FE	Yes	Yes	District FE	Yes	Yes
Year FE	Yes	Yes	Year FE	Yes	Yes
Observations	16,411	16,411	Observations	16,411	16,411

Note: Standard errors in the parenthesis are clustered at household level. *** *p<0.01*, ** *p<0.05*, * *p<0.1*.

Our results show that in line with our expectations, there exists a negative and statistically significant effect from rainfall anomaly and food expenditure interaction. This suggests that increasing variability of precipitation can counteract the direct impact of food security as measured by expenditure on conflict. The final effect is in fact close to zero. On the other hand, interacting temperature anomaly with AHDDS has a positive and statically significant estimate, suggesting that the increase in temperature variability even with satisfactory levels of AHDDS will increase the likelihood of conflict.

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1. Concluding remarks

Findings of this study highlight some of the important evidence on the relationship between climate shock, food security and conflict in Uganda are interconnected. In our first stage analysis, we showed that climate shock negatively affects household's food security status (manly through temperature anomaly). Moreover, our estimates show statistically significant impacts of food security variables on the probability of conflict incidence. We also observed that the effect of food expenditure and AHDDS have a small impact on conflict incidences. These estimates could be further improved by complementing alternative conflict statistics with sufficient variation, such as the Armed Conflict Location & Event Data Project (ACLED) dataset.

References

Hepworth, Nick, and M Goulden. 2008a. "Climate Change in Uganda: Understanding the Implications and Appraising the Response." *LTS International*. Vol. 161. Edinburgh. http://www.icevirtuallibrary.com/content/article/10.1680/ener.2008.161.2.87%5Cnwww.ltsi.co.uk.

Ministry of Water and Environment. 2015a. "Economic Assessment of the Impacts of Climate Change in Uganda." Kampala. www.cdkn.org.

———. 2015b. "Uganda National Climate Change Policy." Kampala. http://ccd.go.ug/wp-content/uploads/2018/04/National-Climate-Change-Policy-April-2015.pdf.

The World Bank Group. 2021. "Climate Risk Country Profile: Uganda." Washington, DC. www.worldbank.org.Arezki, R., & Brückner, M. (2011). *Food Prices, Conflict, and Democratic Change*. http://edition.cnn.com/2008/WORLD/americas/04/14/world.food.crisis/

Bellemare, M. F. (2015). Rising Food Prices, Food Price Volatility, and Social Unrest. *American Journal of Agricultural Economics*, *97*(1), 1–21. https://doi.org/10.1093/AJAE/AAU038

Berazneva, J., & Lee, D. R. (2013). Explaining the African food riots of 2007–2008: An empirical analysis. *Food Policy*, *39*, 28–39. https://doi.org/10.1016/J.FOODPOL.2012.12.007

Brück, T., & d'Errico, M. (2019). Food security and violent conflict: Introduction to the special issue. *World Development*, *117*, 167–171. https://doi.org/10.1016/J.WORLDDEV.2019.01.007

Kraybill, D., & Kidoido, M. (2009). *Analysis of relative profitability of key Ugandan agricultural enterprises by agricultural production zone*. www.ifpri.org

Arezki, R., & Brückner, M. (2011). *Food Prices, Conflict, and Democratic Change*. http://edition.cnn.com/2008/WORLD/americas/04/14/world.food.crisis/

Bellemare, M. F. (2015). Rising Food Prices, Food Price Volatility, and Social Unrest. *American Journal of Agricultural Economics*, *97*(1), 1–21. https://doi.org/10.1093/AJAE/AAU038

Berazneva, J., & Lee, D. R. (2013). Explaining the African food riots of 2007–2008: An empirical analysis. *Food Policy*, *39*, 28–39. https://doi.org/10.1016/J.FOODPOL.2012.12.007

Brück, T., & d'Errico, M. (2019). Food security and violent conflict: Introduction to the special issue. *World Development*, *117*, 167–171. https://doi.org/10.1016/J.WORLDDEV.2019.01.007

Kraybill, D., & Kidoido, M. (2009). *Analysis of relative profitability of key Ugandan agricultural* *enterprises by agricultural production zone*. www.ifpri.org

Annex

Model

This study employs two econometric models to identify the parameters of interest. In the first stage, the impact of climate shock on household food security measures is estimated using a Fixed Effect (FE) model as follows:

$$FoodSct_{it} = \alpha + \beta RainAn_{it} + \alpha TempAn_{it} + \theta Z + \eta_i + \gamma_t + \varepsilon_{it} \quad (1)$$

where *FoodSct* represents the outcome variable (household food expenditure and average dietary diversity score), *RainAn* and *TempAn* indicate 12 months of rainfall and maximum temperature anomalies, respectively. The anomalies are the lagged positive or negative deviations of the climate variables from the long the mean (12 month prior to the survey year). The household specific socio economic characteristics are controlled by the vector *Z*. The parameters β and α captures the impact of rainfall and climate shocks on the outcome variables. The district level and year fixed effects are represented by η and γ, while ε is the error term. The subscript *t* and *I* represent the household and year, respectively.

In the second stage, the Linear Probability Model (LPM), including a district level and year fixed effects, is specified to estimate the impact of household food security status and climate shocks on the probability of conflict incidence. Thus, our LPM model is given as:

$$Conflict_{it} = \phi + \pi RainAn_{it} + \lambda TempAn_{it} + \omega FoodSct_{it} + \varphi Z + \eta_i + \gamma_t + \varepsilon_{it} \quad (2)$$

where *Conflict* denotes households conflict experience, while ϕ, π, λ, ω and φ are parameters to be estimated. The corresponding estimates are provided in Section 3.