FOCUS
Climate Security

FACTSHEET 2021/14

How does climate exacerbate root causes of conflict in Uganda?

An econometric analysis

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This factsheet gives answers on how climate exacerbates root causes of conflict in Uganda, using a two-stage econometric approach. The findings show that climate shocks negatively affect households' food security status (mainly through temperature anomaly), and that food security variables significantly impact the probability of conflict incidence.

This publication is part of a factsheet series reporting on the findings of the CGIAR FOCUS Climate Security Observatory work in Africa (Kenya, Mali, Nigeria, Senegal, Sudan, Uganda, Zimbabwe).
The research is centered around 5 questions*:

1 How does climate exacerbate root causes of conflict?

Impact pathways

Kenya Mali Nigeria Senegal Sudan Uganda Zimbabwe

Econometric analysis

Kenya Mali Nigeria Senegal Sudan Uganda Zimbabwe

Scopus analysis**

2 Where are the climate insecurities hotspots?

Spatial analysis

Kenya Mali Nigeria Senegal Sudan Uganda Zimbabwe

3 What is the underlying structure of the climate, conflict, and socio-economic system?

Network analysis

Kenya Mali Nigeria Senegal Sudan Uganda Zimbabwe

4 Are climate and security policies coherent and integrated?

Policy coherence analysis

5 Are policy makers aware of the climate security nexus?

Social media analysis

Kenya Mali Nigeria Senegal Sudan Uganda Zimbabwe

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* Questions 1, 2, 3, 5 are analyzed at country level through a Climate Risk Lens (impact pathways, economic, spatial, network and social media analyses). The policy coherence and scopus analyses are at continental level.

**Scopus is one of the largest curated abstract and citation databases, with a wide global and regional coverage of scientific journals, conference proceedings, and books. We used Scopus data for analyzing: (1) how global climate research addresses the dynamics between climate, socio-economic factors, and conflict, and (2) how the countries studied are represented in the database.

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1. OBJECTIVE AND RESEARCH QUESTIONS

There has been a growing consensus that climate change has been exacerbating conflict in developing countries (Burke et al. 2015; Mach et al. 2019). The frequent fluctuations in rainfall and temperature can disrupt agricultural production. As a consequence, the lower agricultural production can skyrocket food prices, triggering different forms of conflict across communities (e.g., Raleigh et al. 2015). Erratic climatic events could also create a space for resource competition, e.g., over water, grazing, and agricultural land rights, thereby affecting agricultural production and initiating violent conflicts within and across communities (Evans 2011; Koubi 2019).

In Uganda, climate change is predicted to impact temperature and precipitation in an erratic and unpredictable way (World Bank 2021). Temperatures are forecasted to rise by 1.8°C in the 2050s and 3.7°C in the 2090s, while precipitation is expected to increase in certain areas while decreasing in others, notably in the north and northeast (World Bank 2020). The ongoing climate change is expected to adversely affect households' food security status in Uganda especially given that the economy is heavily based on the climate-sensitive agricultural sector (Ministry of Water and Environment 2015a; 2015b; Hepworth and Goulden 2008; World Bank 2021). This ongoing climate crisis has the potential to exacerbate local conflict occurrences by exacerbating socio-economic risks, such as food insecurity, which can, in turn, increase the number of local conflicts (Burke et al. 2015; Tol 2009). Uganda has suffered civil war, armed insurgencies, ethnic conflicts, and violent transitions of power, all of which have led the country to be more exposed to climate-related security risks (Raleigh et al. 2010).

The objective of this study is threefold: first, to estimate the possible impact of climate shocks on the agricultural production loss; second, to estimate the impacts of climate shocks on household food expenditure; third, to identify the impacts of household food security status and climate shocks on the number of conflicts around the household location. By addressing these points, this study is expected to provide estimates for the impact of climate shocks on agricultural production loss, food security, and conflict incidence in Uganda.

The following specific research questions are addressed:

1. Does climate influence agricultural production loss?
2. Does agricultural production, as affected by climate, influence household food security?
3. Does food security, as exacerbated by climate impacts, affect the total number of conflicts?

2. DATA AND METHODS

This study uses nationally 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 experienced by the households, food insecurity, agricultural harvest and harvest loss, farm size, and income from farm and non-farm sources. The total harvest loss (kg) variable is generated by summing crop production loss from the two harvest seasons of the year. The food security variable is proxied by households' food expenditure (converted to US$) and is obtained from each survey wave. Food spending can be used as a measure of a household's economic vulnerability. Indeed, when forced to increase their food expenditures, households who rely primarily on agricultural production are prone to food deprivation and food insecurity (Smith at al. 2007). Thus, if households begin to spend larger amounts of their money on food due to some harvest failure, they may experience a decrease in income and, as a result, decreasing food access and consumption (Smith et al. 2007).

Data on conflict incidences are obtained from the Armed Conflict Location and Event Data Project (ACLED) database (Raleigh et al. 2010). This dataset provides comprehensive georeferenced conflict information, including locations, dates, actors, fatalities, and types of reported political violence and protest events. For this study, we constructed conflict variables (12 months after household interview in LSMS survey) by counting the total number of conflicts within 5 km, 10 km, 20 km, 30 km, 50 km and 100 km radius from the households' location. This approach incorporates all forms of conflict events based on spatial proximity rather than potentially endogenous administrative classification.

Climate data on rainfall and temperature are acquired from Climate Hazards Group InfraRed Precipitation with Station (CHIRPS). Temperature and precipitation anomalies at sub-county level have been created as standard indicators to account for spatial and temporal variations in maximum temperature and rainfall amounts using CHIRPS data (Maystadt and Ecker 2014). These indicators are designed to detect abnormal deviations from the mean of the maximum temperature and precipitation in Uganda's sub-counties. Climate lag variables have been created to capture past extreme climatic changes (3-12 months prior to the interview).

The econometric analysis is implemented in three steps. First, a log-linearized regression model is used to estimate the impact of rainfall and temperature anomalies on the total harvest loss (kg). To control for household level characteristics, we estimated an Ordinary Least Square (OLS) including time and location invariant Fixed Effects (FE). In the FE model, both the district-specific and time-variant unobserved heterogeneities are also controlled. A brief econometric description of the FE model is presented in the Annex section. In the second step, we examine the impact of agricultural harvest loss (kg) and climate anomalies on households' food security status (represented by food expenditure) applying a FE estimator. We further considered the joint impact of total harvest loss and climate anomalies by introducing their interaction term. In the third step, we used the same model to estimate the impact of food security, as exacerbated by climate impacts, on the number of conflicts around the household vicinity. We also tested whether food expenditure and climate anomalies significantly impact the number of conflicts by considering their interaction term.

3. RESULTS

Table 1 presents description and summary statistics for the variables used in the analysis. The summary statistics show that the average annual harvest per household is around 2930 kg. On the other hand, each household spends about 846 US$ per year on food items. This amount of spending must be considered in light of the subsistence nature of farming – around 70% of households rely on it as their primary source of livelihood, including food supplies (Uganda Bureau of Statistics 2017). As a result, Uganda's rising climatic variability may lead to a decrease in average household agricultural productivity, thereby compromising food security (e.g., Atube et al. 2021). According to Table 1, an average of 42 conflict incidences happened within 5 km radius from the household location, while this number raised to 165 when the radius is extended to 20 km. Table 1 also includes the summary statistics on the household's socio-economic characteristics as well as the temperature and rainfall anomalies 12 months before the household's interview.

Table 1. Summary statistics for the variable of interests

Food security indicators	Obs.	Mean	Std. Dev.	Min	Max
Total harvest loss (kg)	16,702	2930	50208	0	5004361
Annual food expenditure (US$ Purchasing Power Parity (PPP))	16,394	846.25	725.98	0	12563
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					
Total number of conflicts within 5 km buffer zone	16,702	44.2	131.6	0	665
Total number of conflicts within 10 km buffer zone	16,702	106.9	239.0	0	827
Total number of conflicts within 20 km buffer zone	16,702	165.0	302.9	0	944
Total number of conflicts within 30 km buffer zone	16,702	222.3	328.4	0	1006
Total number of conflicts within 50 km buffer zone	16,702	370.1	374.4	0	1494
Total number of conflicts within 100 km buffer zone	16,702	1122.5	756.5	0	4350
Household level covariates					
Household head age (years)	16,587	45	16	13	107
Household head gender (1=Male, 0=Female)	16,602	0.687	0.464	0	1
Marita status (1=Yes, 0=No)	16,702	0.725	0.447	0	1
Household size (number)	16,602	6	3	1	30
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
Livestock production (1=Yes, 0=No)	16,649	0.357	0.479	0	1
Settlement (urban or rural)	16,702	0.30	0.46	0	1

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

We started our analysis by assessing the correlation between food security, agricultural production, climate anomalies, and conflict variables.

There is a negative association between climate variables (rainfall and temperature anomalies) and average households food expenditure. On the other hand, total harvest loss has a positive association with the past 12 months' rainfall and temperature anomalies. The result is in line with findings in the previous studies where climate shocks impacted agricultural production (e.g., Gorettie 2019). Overall, this evidence highlights how climate variability in predominantly rainfed agriculture contributes to production loss through variability in the magnitude and timing of climate conditions. Additionally, there is a positive association between food expenditure and the total number of conflicts around the households' vicinity (counted in different buffered zones). This figure becomes larger as the length of the buffer radius increases to 20 km (Table 2).

Overall, there seems to be an indication that generally climate anomalies, food security, and conflicts have a meaningful relationship. However, the correlation values are small and warrants further causal investigation through econometric analysis controlling for several covariates. Additionally, we caution that the correlation performed assumes a linear relationship, yet, this may not be the case, and there is a need to model the relationships through econometric techniques. For brevity, we only present the results of the variables of interest. The estimation results are presented in Table 3 and Table 4.

1. Does climate influence agricultural production loss?

The impacts of rainfall and temperature anomalies on agricultural production loss are presented in Table 3 (panel a). Our OLS estimates show a positive and statistically significant effect (% level) of climate anomalies on the total harvest loss. Indeed, the presence of increasing rainfall and temperature anomalies results in an increase of total harvest loss by 0.254 kg and 0.378 kg, respectively. This result indicates that variability in climate conditions significantly impacts production loss (crop failure) in Uganda where most households are small-scale subsistence farmers who are highly dependent on rainfed agriculture (USAID and CIAT 2017).

Table 2. Correlation matrix for climate and food security variables

	Food expenditure	Harvest loss	Rain anomaly	Temp. anomaly	Conflict - 5 km	Conflict - 10 km	Conflict-20 km
Food expenditure	1						
Harvest loss	-0.001	1					
Rain anomaly	-0.144	0.006	1				
Temp. anomaly	-0.199	0.009	0.249	1			
Conflict – 5 km	0.169	-0.005	-0.054	-0.033	1		
Conflict – 10 km	0.205	-0.007	-0.065	-0.031	0.735	1	
Conflict – 20 km	0.219	-0.007	-0.065	-0.018	0.637	0.904	1

Table 3. The impact of climate on agricultural production (a) and the impact of climate on food expenditure (b)

	(a) Total harvest loss (kg)	(b) Food expenditure (US$PPP)	
	OLS	Without interaction	With interaction
Rainfall anomaly – 12 months	0.254***	0.022	0.017
	(0.039)	(0.022)	(0.022)
Temp. anomaly – 12 months	0.378***	0.052**	0.051**
	(0.029)	(0.021)	(0.021)
Total harvest loss (kg)		0.007***	0.006**
		(0.002)	(0.003)
Total harvest loss _x_Rain12			0.007**
			(0.003)
Total harvest loss _x_Temp12			-0.001
			(0.003)
Constant	-0.451**	5.585***	5.349***
	(0.192)	(0.090)	(0.086)
Controls	Yes	Yes	Yes
District FE	No	Yes	Yes
Year FE	No	Yes	Yes
Observations	16,358	16,130	16,130

Note: Panel (a) shows estimates for the determinants of harvest loss, while panel (b) represent determinants of households' food expenditure. Continues variables are linearized using the inverse hyperbolic sine (IHS) transformation method (see Bellemare and Wichman 2020). Standard errors in parentheses are clustered household level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

2. Does agricultural production loss, as affected by climate, influence household food security?

We further estimated the impact of climate anomalies and total harvest loss on household food security status applying the FE estimator. As shown in Table 3 (panel b), estimates for the past 12 months rainfall anomaly become statistically insignificant, while the 12 months maximum temperature anomaly has a positive and statistically significant effect (in both cases where the interaction between total harvest loss and climate variables are controlled for). According to the regression result, the presence of increasing 12-month temperature anomalies increases the amount of households' food expenditure by around 5%. Most rural households in Uganda practice subsistence farming, hence rural households usually fulfil most of their food requirements through home production (e.g., Kraybill and Kidoido 2009; USAID and CIAT 2017). When yields decline due to climate shocks, rural households are expected to spend more on food items because of increasing food prices. The 2017 Congo drought, which occurred during the year's first growing season and caused grain prices to double, is a consistent example of this pathway (Agence Congolaise de Presse 2017). As a result, the occurrence of weather shocks (most notably temperature anomalies) may have an impact on households' food security status in terms of

food availability and access. (Birthal et al. 2014; Qureshi 2013). It is also observed that a 1 unit increase in the total harvest loss increases households' food expenditure by 0.6 percentage point, holding other factors constant. This might be related to the allocation of an additional budget share for food consumption, which is primarily derived from the sale of excess agricultural output (Anderman et al. 2014; Carletto et al. 2017). It is also observed that the interaction of total harvest loss with rainfall anomalies is positively correlated to household food expenditure and that a 1 unit increase in both the interacted terms results in a 0.7 percentage point increase in household food expenditure. Overall, the agricultural sector in Uganda is mainly composed of small-scale subsistence farming and highly dependent on rainfed agriculture (USAID and CIAT 2017), where most of the rural households depend on their natural resources such farming land and livestock production to provide for food. Therefore, higher food expenditure can be considered an indicator of food insecurity operating mainly through the channels of food availability and access (which is also shown in previous studies, e.g., Baiphethi and Jacobs 2009).

3. Does food insecurity, as exacerbated by climate impacts, affect the total number of conflicts?

As shown in Table 4, households' food expenditure is positively correlated to the total number of conflicts across all buffer zones. For instance, a 10% increase in the households' food expenditure will increase the total number of conflicts by 1.5 in the case of a 5 km buffer zone. The results of increasing households' food expenditure show a consistent significant and positive correlation across the various conflict specifications. This result is in line with previous findings related to the impacts of food insecurity status (represented by an increasing food expenditure) on conflict incidence (e.g., Arezki and Brückner 2011; Berazneva and Lee 2013; Brück and d'Errico 2019). According to these studies, the lack of food availability and access across households causes protests and social unrest in developing countries and presents policymakers with the challenge of simultaneously addressing hunger, poverty, and political instability. The rainfall variable has a statistically insignificant effect on the total number of conflicts. From table 4, we can see that temperature has generally a negative impact on conflicts. This negative correlation is also significant for the 10, 20, 50 and 100 Km radius. Other studies have found similar results that may support in their interpretation. Helman et al. (2020), by applying a structural equation modeling, find a negative correlation of temperatures and conflict risk for Sierra Leone and Liberia. These two countries, similarly to Uganda, are characterized by a tropical and humid climate. Expectations would lead to believe that rising temperatures, and thus unpleasant environmental conditions, would increase individuals' propensity to violence. However, it is important to remember that the occurrence of conflict is heavily influenced by a number of context-specific (and conflict-specific) factors. In the case of Uganda, the findings suggest that a further rise in temperature, resulting in extremely unpleasant conditions, could have increased discomfort while decreasing the likelihood of violence (Helman et al. 2020, Baron and Bell 1976).

To identify the complementarity nature of climate shocks and food security variables, we controlled for the interaction effects of climate variables with the food security indicator. Our result shows that there is a positive effect when combining increasing rainfall anomalies and increasing households' food expenditure. Similarly, the interaction between increasing temperature anomaly and food expenditure has a positive and statistically significant impact on the conflict incidence when considering conflicts up to 20 km buffer zone. Our results align with previous literature on sub-Saharan Africa, including

Uganda, that highlights how higher food prices, and thus reduced food access among households, could instigate violent conflict across communities (e.g., Raleigh et al 2015).

Table 4. The impact of climate, food security and agricultural production on conflict

	Number of conflict in a given buffer zone					
	5 km	10 km	20 km	30 km	50 km	100 km
Rainfall anomaly – 12 months	-0.082	-0.124	-0.059	-0.082	-0.124	-0.059
	(0.080)	(0.078)	(0.049)	(0.080)	(0.078)	(0.049)
Temp. anomaly – 12 months	-0.016	-0.135**	-0.073*	-0.016	-0.135**	-0.073*
	(0.062)	(0.059)	(0.040)	(0.062)	(0.059)	(0.040)
Food expenditure (US$ PPP)	0.153***	0.084***	0.037***	0.153***	0.084***	0.037***
	(0.022)	(0.020)	(0.012)	(0.022)	(0.020)	(0.012)
Food exp. (US$ PPP) X Rain anomaly (12 months)	0.006	0.008*	0.001	0.006	0.008*	0.001
	(0.005)	(0.005)	(0.003)	(0.005)	(0.005)	(0.003)
Food exp. (US$ PPP) X Temp. anomaly	0.006	0.007*	0.009***	0.006	0.007*	0.009***
	(0.004)	(0.004)	(0.003)	(0.004)	(0.004)	(0.003)
Constant	1.132***	2.596***	4.078***	1.132***	2.596***	4.078***
	(0.262)	(0.243)	(0.152)	(0.262)	(0.243)	(0.152)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	16,130	16,130	16,130	16,130	16,130	16,130

Note: Continues variables are linearized using the inverse hyperbolic sine (IHS) transformation method. Household level clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

4. CONCLUSION

The findings of this study highlight important evidence on the relationship between climate shocks, food security, and conflict in Uganda. In the first part of the analysis, we find that climate shocks (particularly temperature anomaly) positively correlate to harvest loss, while in the second part of the analysis, we find that climate shocks positively correlate to household food insecurity (mainly through temperature anomaly). Moreover, our estimates show a statistically significant correlation between food security and conflict incidence variables. These estimates could be further improved by complementing the analysis using the spatial and instrumental econometric approach.

ANNEX

Model

This study employs three econometric models to identify the parameters of interest.

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

where $Harvest$ represents total agricultural production in the household (kg), $RainAn$ and $TempAn$ indicate 12 months of rainfall and maximum temperature anomalies, respectively. We used both the OLS (disregarding η and γ) and Fixed effects estimators in equation (1). The household specific socio-economic characteristics are controlled by the vector Z. The parameters β and α capture 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 i and t represent the household and year, respectively.

In the first and second step, we used the same model (FE) to estimate the impact of climate shocks on agricultural production and household food security measures as follows:

$$FoodSct_{it} = \alpha + \beta RainAn_{it} + \alpha TempAn_{it} + \theta Z + \eta_i + \gamma_t + \varepsilon_{it} \quad (2)$$

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-term mean (12 months prior to the survey year).

In the third step, by including a district level and year fixed effects, is specified to estimate the impact of household food security status and climate shocks on the number of conflict incidence as:

$$Conflict_{it}^{k} = \phi + \pi RainAn_{it} + \lambda TempAn_{it} + \omega FoodSct_{it} + \varphi Z + \eta_i + \gamma_t + \varepsilon_{it} \quad (3)$$

where $Conflict$ denotes total number of conflict in buffer k, while ϕ, π, λ, ω and φ are parameters to be estimated. The corresponding estimates are provided in Section 3.

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