FOCUS
Climate Security

FACTSHEET 2021/9

How does climate exacerbate root causes of conflict in Mali?

An econometric analysis

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This factsheet gives answers on how climate exacerbates root causes of conflict in Mali, using a two-stage econometric approach. The findings show that food insecurity is the mechanism through which climate change influences conflict. Climate change indirectly exacerbates conflict by adversely affecting agricultural production and food security.

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

The recent Intergovernmental Panel on Climate Change (IPCC) report identifies climate change as one of the main challenges threatening human existence (IPCC 2021). Together with other drivers, climate change threatens human life in many ways including increasing the occurrence of natural disasters, undermining livelihoods security and peace. With respect to livelihoods security and peace, an increasing stream of research over the past decades has addressed the climate-conflict nexus (Burke et al. 2009; Fjelde 2015; Froese and Schilling 2019; Helman et al. 2020). The findings of these studies are mixed, some support the argument that climate change exacerbates conflict (Burke et al. 2009; Crost et al. 2018; van Weezel 2020) while others find no effect of climate change on conflict (Bergholt and Lujala 2012; Slettebak 2012). The studies that support the argument that climate change increases conflict conclude that there is no simple and direct causal relationship, rather, the relationship between climate change and conflict is indirect, complex and dynamic with feedback loops. For instance, in Africa where a majority of the countries rely on agriculture for economic development and the main livelihood source for the majority of their households, an increase in climatic anomalies may result in reduced production leading to livelihood and food insecurities and this may in turn trigger emergence of conflict events (Couttenier and Soubeyran 2014). Similarly, reduction in food production due to climatic anomalies may lead to reducing employment opportunities and incomes, and rising food prices which may substantially increase conflicts (Fjelde 2015).

This research contributes to the growing debate about climate-conflict nexus by focusing on the question of whether climate is a threat multiplier using nationally representative data from Mali a country in the Sahel region of sub-Saharan Africa. The objective is to understand the role of climate change on conflict occurrence and the pathways through which this happens. We argue that climate anomalies negatively affect agricultural production which in turn negatively affects household food security and this triggers conflict occurrence. From the foregoing, we answer the following research questions:

1. Does climate influence agricultural production?
2. Does agricultural production, as affected by climate, influence household food security?
3. Does food insecurity, as exacerbated by climate impacts, affect the likelihood and intensity of conflict?

The next sections of the factsheet proceed as follows. Section 2 outlines the data and methods used; section 3 presents a summary of results. The final section provides the conclusion and suggestions for future research.

2. METHODS AND DATA

The analysis in this study is based on rich nationally representative household data from Mali which is administered by the Living Standards Measurement Study–Integrated Surveys on Agriculture (LSMS-ISA) of the World Bank. We use the pooled data of the two waves of Mali LSMS-ISA (2014/15 and 2017/18). The LSMS-ISA surveys collect detailed data on household characteristics, agricultural production, food security, shocks and household assets among others.

Agricultural production is derived from the agricultural production section and by the sum of harvested crops (kgs) in the two waves. Food security measures are taken from the food security section, two variables that were measured consistently in the two waves are used, (a) whether or not a household member skipped meals because of lack of resources to buy food, and (b) whether or not a household member reduced the quantities of food consumed because of lack of resources to buy food. The conflict variables were derived from the shocks section, two variables are used whether or not a household was faced with (a) violence or insecurity and (b) theft.

The climate data used come from the Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS) which contains information on maximum and minimum temperature and rainfall. We calculated both temperature and rainfall anomalies by taking into account the lagged values 12 months before the month of the survey. To calculate the climate anomalies, we applied the formula by Maystadt and Ecker (2014).

In the econometrics estimation, we conduct the analysis in three steps. First, we test whether climate anomalies affect total agricultural production controlling for the identified set of covariates. We employ a log-linear regression (OLS) to unravel this relationship. Second, we test the effect of agricultural production including its interaction with climate anomalies on food security measured by (a) skipping of meals and, (b) reducing the quantities of food consumed due to lack of resources to buy food. We employ Probit models to test these relationships.

3. RESULTS

Tables 1 and 2 presents the descriptive statistics of the variables used in the empirical models. The choice of the variables is guided by economic theory and previous literature. Between 11% and 16% of the households of the sample are food insecure, as measured by whether households had to skip meals or reduce food quantities, respectively. About 15% of the sampled households have experienced a form of conflict while about 6% have experienced theft (Table 1). Most households are headed by a married man with low level of education (Table 2).

To unpack the relationship between climate, socio-economic insecurities and conflict, we first conduct a one-to-one correlation analysis between food security, agricultural production, climate anomalies and conflict. Table 3 presents the correlation results.

Table 1. Food insecurity, climate anomalies and conflict

Food security		Full sample				
Variable	Variable description	Obs*	Mean	SD	Min	Max
Skip meals	Skipped Meals (1=skipped; 0 otherwise)	7382	0.11	0.312	0	1
Reduced food quantities	Reduced the quantity of food consumed (1=reduced; 0 otherwise)	7372	0.159	0.365	0	1
Climate anomalies						
Rain anomalies	Rain anomalies 12 months before the survey month	7382	-0.108	0.209	-0.685	0.377
Temperature anomalies	Temperature anomalies 12 months before the survey month	7382	0.214	0.271	-0.281	0.672
Conflict						
Conflict	Experienced conflict/violence/ insecurity	5068	0.151	0.358	0	1
Theft	Theft of money, goods or crops	4787	0.058	0.234	0	1

Table 2. Household characteristics

		Full sample				
Variable	Variable description	Obs*	Mean	SD	Min	Max
Age	Age of the household head	12140	50.751	14.336	14	120
Sex	Gender of the household head (1=Male; 0=Female)	12140	0.951	0.217	0	1
Household size	Number of household members	12140	10.776	7.644	1	84
Literacy	Household head able to read (1=Yes: 0= no)	12140	0.335	0.472	0	1
Marital status	Marital status (1=Yes: 0= no)	12140	0.934	0.248	0	1
Land size	Land size (ha)	12140	6.029	15.371	0	432.245
Crop harvest	Total amount of crops harvested (kgs)	12140	10.656	234.304	0	16010.2
Non-farm income	Total non-farm income per year (in USD)	12140	301.546	1951.085	0	131200
Electricity	Household connected to electricity (1=Yes: 0= no)	12140	0.228	0.420	0	1
Number of rooms	Number of rooms occupied	12140	5.409	4.286	1	40
Cereal donation	Household benefited from cereal donation	7599	0.135	0.342	0	1
Own livestock	Household owns livestock (1=Yes: 0= no)	12140	0.649	0.477	0	1
Rural-urban	Rural-urban (1=rural; 0=urban)	12140	0.763	0.425	0	1

SD = standard deviation

*The difference in the sample sizes is because not all respondents responded to all questions.

Table 3. Correlation between climate anomalies, agricultural production, food insecurity and conflict

	Skipped meals	Reduced food quantities consumed	Crop harvest	Rain anomalies 12 months before	Temperature anomalies 12 months before	Violence	Theft
Skipped meals	1						
Reduced food quantities consumed	0.779	1					
Crop harvest	0.067	0.048	1				
Rain anomalies 12 months before	0.022	0.031	0.126	1			
Temperature anomalies 12 months before	-0.080	-0.083	-0.016	0.345	1		
Violence	0.126	0.135	-0.039	0.001	-0.103	1	
Theft	0.047	0.039	-0.039	0.006	-0.020	0.269	1

Overall, the results show a mixed correlation between skipping meals, reducing quantities of food consumed and temperature anomalies occurred 12 months before the survey month. Specifically, there exists a positive correlation between; rainfall anomalies and food insecurity whereas a negative correlation is observed with temperature anomalies. Moreover, the results of correlations between food insecurity (skipping of meals and reducing quantities) and conflict (violence and theft) are positive suggesting that increasing food insecurity is correlated with higher conflict occurrence. The correlation between rain anomalies and agricultural production is positive while the correlation with temperature anomalies is negative, this suggest that increase in rainfall anomalies may increase agricultural production while increase in temperature anomalies reduce agricultural production. Correlation between conflict (violence and theft) and agricultural production generally shows a negative association indicating that increase in agricultural production reduces the conflict. Finally, the results of the correlation between climate anomalies (rainfall and temperature anomalies in the 12 months before the survey month) and conflict show mixed results. On the one hand, correlations between rainfall anomalies with conflict and theft are positive, suggesting that increasing rainfall anomalies increases the occurrence of conflict and theft. On the other hand, results of the analysis between temperature anomalies and violence and theft show a negative correlation. This suggests that an increase in temperature anomalies reduces the occurrence of violence and theft.

In sum, there seems to be an indication that generally climate anomalies increase food insecurity which in turn increases conflict occurrence. However, the mixed findings and the fact that the correlation values are small warrants further investigation through econometrics analysis controlling for several covariates. Additionally, we caution that the correlation performed assumes a linear relationship, yet, this may not be the case, there is a need to model the relationships through econometrics techniques. For brevity, we only present the results of the variables of interest. The estimation results are presented in Table 4. For the interpretation, we calculate the marginal effects of the estimated models.

Table 4. The impact of climate on agricultural production (step 1) and the impact of climate and agricultural production on food insecurity (step 2)

	Step 1 OLS		Step 2 Probit models			
	(1) Log total harvest (kgs)		(2) Skip meals		(3) Reduced quantity of food consumed	
Variables	dy/dx	Robust SE	dy/dx	Robust SE	dy/dx	Robust SE
anom_tmax_12	-1.992***	0.548	-0.164**	0.336	-0.129*	0.309
anom_rain_12	0.562	0.415	-0.061	0.226	-0.010	0.214
Log total harvest	-	-	-0.010	0.012	-0.004	0.011
Log total harvest_x_temp12	-	-	0.001	0.033	0.001	0.028
Log total harvest_x_rain12	-	-	-0.015	0.044	-0.012	0.040
Year FE	YES		YES		YES	
District FE	YES		YES		YES	
Observations	7,599		7,061		7,256	
R-squared	0.682					

Robust standard errors in parentheses clustered at household level
*** p<0.01, ** p<0.05, * p<0.1

1. Does climate influence agricultural production?

The results (Table 4 column (1)) show that increase in past temperature anomalies (12 months) by 1 unit reduces the agricultural production measured by the quantity of crops harvested (in kgs) by 199.2 kgs. This suggests that everything else held constant, increase in temperature anomalies reduces agricultural production. We do not find a significant relationship between rainfall anomalies and agricultural production.

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

The Probit model results (marginal effects) in Table 4 columns (2) and (3) specifically for the agricultural production (log total harvest) though not significant, indicate that increase in agricultural production by 1 kg reduce the probability that household will skip meals by 1 percentage point and similarly reduce the probability that households will reduce quantities of food consumed by 0.4 percentage points. This is consistent with the recent findings by Giannini et al. (2017) who found that with reduced agricultural production resulting from climate risks in Mali, households rely more frequently on detrimental nutrition-based coping strategies, such as reducing the quantity or quality of meals. Turning to climate anomalies, we find that surprisingly, temperature anomalies significantly reduce both the probability that households will skip meals by 16.6 percentage points and the probability that they will reduce the quantities of food consumed by 12.9 percentage points. This unexpected finding deserves further investigation in the context of Mali. It may be the case that in Mali, an increase in temperature relative to the normal temperature result in households receiving food support from support programs. It could also be the case that increase in temperature relative to the normal temperature do not directly affect food security status, but only through affecting agricultural production; this argument is consistent with step 1 findings that temperature anomalies reduce agricultural production. When we consider total crop harvest with the interactions with rainfall anomalies though not significant, it suggests that it reduces the probability that household will skip meals by 1.5 percentage points and also reduces the probability that it reduces the quantities of food consumed by 1.2 percentage points. This is plausible since increase in rainfall anomalies relative to other factors held constant, may increase agricultural production and thus leading to an increase in household food availability, access and affordability. On the other hand, again though not significant, the interaction between total crop harvest and temperature anomalies suggest that it increases the probability that the household will skip meals by 0.1 percentage points and also reduce the quantities of food consumed by 0.1 percentage points. This is consistent with step 1 findings that temperature anomalies reduce the agricultural production.

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

In step 3 we test the relationship between climate anomalies and conflict (violence and theft). We do this by estimating a set of probit models while controlling for household level characteristics. Additionally, we include year and location (cercle) fixed effects in the models. Two types of probit regression are estimated, (a) the effects of climate anomalies and food insecurity independently on conflict, and (b) the effect of climate anomalies and food insecurity independently and with the interaction between climate anomalies and food insecurity on conflict. The estimation results are shown in Table 5.

The results in Table 5 first show that an increase in rain anomalies (increase in wet periods) significantly reduce the conflicts, this is consistent with the findings of Maystadt and Ecker (2014). The nonsignificant effect of temperature anomalies indicate that considered independently temperature anomalies do not directly influence occurrence of conflict. Relating to food insecurity, the findings indicate that skipping meals directly increase the chances of violent events occurring by 8.1 percentage points as shown in Table 5 column 1. When skipping meals is interacted with temperature anomalies, there is a higher probability about 17.8 percentage points of violent events occurring as shown in Table 5 column 2. This indicate that temperature anomalies influence conflict through increasing food insecurity, which further support our argument that climate does not directly influence conflict.

Regarding theft as a proxy of insecurity, the results in Table 5 column 3 indicate that when only skipping meals is considered (without interaction), the probability of theft occurring increases by 4.5 percentage points. When skipping meals is interacted with temperature anomalies, there is a higher probability of about 15.5 percentage points that theft will occur (Table 5 column (4)). This could suggest that climate is an insecurity multiplier.

In Table 6 the results of the effect of reduction in quantities of food consumed is presented. The results indicate that climate anomalies are consistent as explained above in Table 5. With regard to reducing the quantity of food consumed (food insecurity), the findings show that without interaction with climate anomalies, a reduction in quantities of food consumed by 1 unit increases the chances of violent events by 8.3 percentage points (Table 6 column (1)).

Table 5. Estimation results of step 3 on the effect of skipping meals on conflicts

	Violence				Theft			
	(1) Without interaction		(2) With interaction		(3) Without interaction		(4) With interaction	
Variables	dy/dx	Robust SE	dy/dx	Robust SE	dy/dx	Robust SE	dy/dx	Robust SE
anom_tmax_12	-0.051	0.464	-0.074	0.474	-0.036	0.825	-0.046	0.824
anom_rain_12	-0.213***	0.300	-0.180***	0.332	- -0.161***	0.395	-0.140***	0.416
skip_meal	0.081***	0.103	0.056 **	0.141	0.045**	0.184	0.033	0.223
skip_meal_x_temp12	-	-	0.178 **	0.485	-	-	0.155 ***	0.557
skip_meal_x_rain12	-	-	-0.146	0.534	-	-	-0.039	0.565
Log total harvest	-0.004*	0.015	-0.146**	0.015	-0.002	0.021	-0.002	0.020
Year FE	YES		YES		YES		YES	
District FE	YES		YES		YES		YES	
Observations	4,431		4,431		4,457		4,457	

Robust SE = Robust standard errors clustered at household level
*** p<0.01, ** p<0.05, * p<0.1

When reduction in quantities of food consumed is interacted with temperature anomalies, there is a higher probability of violent events occurring by about 18.8 percentage points (Table 6 column (2)). The interaction between reduction in quantities of food consumed with rainfall anomalies indicate that there is a probability of reduction in violent events by 15.7 percentage point (Table 6 column (2)). This may be because increase in wet seasons relative to normal months may increase food production other things remaining constant, which increases food availability, access and affordability and this in turn may reduce the incentive to engage in conflict activities.

With respect to theft, results in Table 6 column (3)) indicate that when the reduction in quantities of food consumed is considered independently, the probability that theft will occur increase by about 3.7 percentage points. On the other hand, when the reduction in quantities of food consumed is interacted with temperature anomalies, there is a higher probability of theft events occurring at about 16.8 percentage points (Table 6 column (4)). This finding further augments our proposition that climate is a threat multiplier.

Overall, the results in Tables 5 and 6 show that in general if we consider temperature anomalies only, the effect on conflict is negative suggesting that temperature anomalies exclusively do not increase the probability of conflict occurrence. However, interacting temperature anomalies and food insecurity (both skipping meals and reducing the quantities of food consumed) indicate that interaction particularly increases the probability of conflict occurrence (both violence and theft). This is evidence that the relationship between climate and conflict may be indirect and complex and may depend on contextual factors.

Table 6. Estimation results of step 3 on the effect of reducing the quantity of food consumed on conflict

	Violence				Theft			
	(1) Without interaction		(2) With interaction		(3) Without interaction		(4) With interaction	
Variables	dy/dx	Robust SE	dy/dx	Robust SE	dy/dx	Robust SE	dy/dx	Robust SE
anom_tmax_12	-0.046	0.471	-0.085	0.492	-0.040	0.817	-0.057	0.819
anom_rain_12	-0.219***	0.299	-0.177***	0.340	-0.164***	0.393	-0.140***	0.412
reduced_qnty	0.083***	0.091	-0.053 ***	0.126	0.037**	0.167	0.019	0.214
reduced_ qnty_x_temp12	-	-	0.188 ***	0.461	-	-	0.168***	0.586
reduced_ qnty_x_rain12	-	-	-0.157**	0.494	-	-	-0.051	0.537
Log total harvest	-0.005**	0.014	-0.005**	0.014	-0.017	0.002	-0.002	0.020
Year FE	YES		YES		YES		YES	
District FE	YES		YES		YES		YES	
Observations	4,430		4,430		4,454		4,454	

Robust SE = Robust standard errors clustered at household level
*** p<0.01, ** p<0.05, * p<0.1

4. CONCLUSIONS

Our findings reveal that climate change is a threat multiplier, this is consistent with previous studies that have found that climate change indirectly leads to increased conflict occurrence (Crost et al. 2018; Fjelde 2015; Mach et al. 2019). We have shown that food insecurity is the mechanism through which climate change influences conflict. In other words, climate change indirectly exacerbates conflict by adversely affecting agricultural production and food security.

While we have shown that climate change affects conflict through increasing food insecurity, we have modelled the relationships independently. However, we have taken into account the interactions between climate anomalies and food insecurity to minimize the assumption that the relationships are independent. We note however that the interaction may not completely overcome the assumption of independence, thus we suggest that future studies need to consider econometric techniques that consider these complex relationships.

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CGIAR aims to address gaps in knowledge about climate change and food security for peace and security policies and operations through a unique multidisciplinary approach. Our main objective is to align evidence from the realms of climate, land, and food systems science with peacebuilding efforts already underway that address conflict through evidence-based environmental, political, and socio-economic solutions.