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ORIGINAL ARTICLE

Climate, flood, and attitudes toward violence: micro-level evidence from Karamoja, Uganda

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Abstract

Concerns about the security implications of climate change are increasing. The growing academic literature on the topic suggests that linkages between climate change and armed conflict are shaped by structural risk factors, but micro-level variation and mechanisms remain poorly understood and flood responses are hardly studied. In this paper, we strive to contribute to a better understanding of such micro-level patterns and investigate how flood exposure affects the support for violence in the Karamoja region of Uganda, which is characterized by many structural vulnerabilities to climate change and armed conflict. We use unique household-level survey panel data and investigate changes in survey responses following a destructive flood. Our study finds that flood exposure was associated with greater support for the use of violence. However, while we identify some adverse impacts of flood exposure on the perceived and actual socio-economic conditions of households and a decrease in perceptions of government support, these do not seem to mediate the estimated flood impact on support for violence against expectations. Our findings point to the limited explanatory power of natural hazards' economic impacts alone for conflict risk. Further investigation of causal mechanisms between climate hazards and conflict remains an important priority for future research.

Keywords Climate change · Armed conflict · Pastoralist conflict · Flood impacts · Attitudes to violence · Uganda

Introduction

Global temperatures will rise considerably until the end of the century. With accelerating climate change in the decades to come, the frequency of natural hazards, such as floods, storms, and droughts, will increase in parts of the world (IPCC 2021). Concerns about implications of such developments for conflict risk are growing and research on this topic has rapidly expanded over the past decade. Overall, findings on general links are mixed, and research increasingly points to a conditional relationship where climate-related hazards increase conflict risk in some contexts but not in others (Koubi 2019). Global and regional studies over long time periods have been crucial for identifying such patterns in a systematic way. However, our understanding of the specific pathways between climate and violent outcomes at the individual and community levels remains limited (Mach et al. 2020; von Uexkull and Buhaug 2021). Flood risk in particular has received comparably little attention, though flood is one of the most frequently occurring climate-related disasters (CRED 2022). This is an important knowledge gap for several reasons: first, climate-related hazard types differ in their specific impacts (Koubi et al. 2018; Ward et al. 2020). Second, without examining the micro-level, statistical associations remain black-boxed. More granular context-specific analyses are important to inform peacebuilding and conflict-prevention interventions (Mach et al. 2020; Ide et al. 2023).

In this paper, we contribute to filling these gaps. We use unique household-survey panel data from Karamoja, Uganda, which for the first time allow us to study attitudes toward violence and changes in socio-economic conditions

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at the individual level following a destructive flood. We hypothesize that flood exposure results in deteriorating perceived and actual socio-economic conditions and perceptions of the government. Drawing on established economic explanations of conflict, we further theorize that such impacts are plausible pathways to increased support for the use of violence following flood exposure in conflict-affected regions. Testing these expectations on data from Karamoja is suitable since the area has a long history of armed conflict between communal groups, resource-related disputes and violence involving government forces. Karamoja's politically and economically marginalized population mainly relies on smallholder agriculture. This region is thus a typical context of high vulnerability to climate change including to see climate translate into security risks (Koubi 2019; Buhaug and von Uexkull 2021).

In line with our overarching expectation, we find that flood exposure was associated with higher support for the use of violence in Karamoja. We also observe negative flood impacts on the socio-economic conditions of households, in particular lower perceptions of the supportiveness of the government, the increased use of coping strategies and livestock loss. However, against expectations, the results do not suggest that these flood impacts mediated the observed flood impact on attitudes toward violence in this context. We conclude that further research is needed to robustly identify specific micro-level causal pathways between natural hazards and support for violence and that natural hazards' economic impacts alone seem to have little explanatory power in this high-risk context.

Previous research

Climate change will lead to unprecedented changes that threaten societies' prosperity and stability. Since pre-industrial times, the temperature on the planet has already risen by about 1.2 degrees and is projected to further increase (WMO 2021). Climate-related hazards, such as drought and floods, are increasing and smallholder farmers, who rely on rainfall for livestock and crop production, are particularly vulnerable to climate change (Cohn et al. 2017).

Against the backdrop of these challenges, the scientific literature on the conflict implications of climate change has rapidly expanded over the past decade and often with a focus on the climate-sensitive rural economy (for recent reviews, see Koubi 2019; Buhaug and von Uexkull 2021). Research has pointed out how climate variability affects conflict dynamics through agricultural production changes and water scarcity (e.g., Caruso et al. 2016; Koren et al. 2021). Food and livestock price changes are another set of investigated climate impacts (e.g., Maystadt and Ecker 2014). Overall, the literature points to conditional relationships between climate and conflict. For example, regions with ongoing conflicts, political marginalization, economic reliance on agriculture, and low adaptive capacity see elevated conflict risk following climate-related hazards (von Uexkull et al. 2016; Koubi 2019; Ide et al. 2020; Regan and Kim 2020). While in current societies the overall impact of climate on conflict risk is judged to be rather minor relative to other factors, impacts will likely increase over the coming decades as global temperatures continue to rise (Mach et al. 2019).

Scientific research has made important progress, but there are knowledge gaps. First, specific pathways have for a long time be theorized (Barnett and Adger 2007), yet our understanding of causal mechanisms remains relatively limited (Mach et al. 2020; Hendrix et al. 2023). The few existing studies indicate that individual responses to drought are importantly shaped by contextual factors, including trust in governmental institutions (Detges 2017), the presence of resource governing institutions (Linke et al. 2018), socio-economic conditions (Vestby 2019; von Uexkull et al. 2020), and conflict-exposure (Detges 2017). Yet, even in areas with a number of risk factors in place, the few existing studies point to more complex relationships (Siddiqi 2014; Linke et al. 2015a; von Uexkull et al. 2020). Hence these micro-level studies provide some answers to the question under what conditions—rather than how—climate translates into security risks. In contrast, impact pathways at the individual level are typically assumed rather than tested (for an exception, see Vestby 2019).

Second, the implications of floods for conflict have received little attention. There are only a handful flood-related studies which focus on variations between subnational administrative units or countries which again point to context-specific relationships and partly mixed findings (Ghimire et al. 2015; Nardulli et al. 2015; Koubi et al. 2018; Ide et al. 2021; Petrova 2022). Yet, there is no micro-level work to our knowledge that allows us to observe individual and household responses. Floods are important to consider since they are among the most frequent natural hazards and in current societies close to a fifth of the world's population is estimated to be exposed to risks of severe flooding (Rentschler and Melda 2020). River and pluvial flooding is projected to further increase in the coming decades due to climate change (IPCC 2021). While slow-onset events like droughts accumulate over a longer period and often affect large areas, rapid onset events like flash floods from heavy rainfall can occur suddenly and unexpectedly and in areas that are far away from rivers. Insights from research on drought and other forms of slow-onset events is not directly transferable since opportunities for adaptation and responses to flood differ (Koubi et al. 2018; Ward et al. 2020).

Our study aims to address these gaps in earlier research. Using unique survey panel data, we for the first time are

able to track households and individuals before and after a destructive flood and study variations in attitudes to violence. We do so in a high-risk region, the conflict-affected Karamoja region of Uganda, which is characterized by many structural characteristics that earlier research suggests to increase conflict risk following climate-related hazards.

Theoretical framework

Floods cause massive damage especially in lower income countries where infrastructure systems, including drainage and flood protection, tend to be less developed. Recent estimates indicate that 132 million people living in extreme poverty are directly exposed to flood risk, the majority of them in sub-Saharan Africa (Rentschler and Melda 2020). Conflict-affected contexts are particularly vulnerable to natural hazards and in such regions there is also a high risk of violence to recur (Collier et al. 2003; Buhaug and von Uexkull 2021).

Floods may have diverse impacts on conflict risk, including dampening risk. For example, they could lead to blocked roads and hamper mobility of fighting actors just like other destructive rapid-onset disasters (Walch 2018). However, overall, we expect that floods will increase conflict risk in conflict-affected contexts due to their disruptive economic and livelihood impacts. One core mechanism connecting economic impacts and inclination to take up arms is the opportunity-cost mechanism, relating to the expected utility of engaging in a conflict. This mechanism is the theoretical backbone of many existing studies on climate and conflict and economic causes of conflict. The opportunity-cost model suggests that when expected returns from fighting outweigh income from regular economic activity, an individual's inclination and motivation to join a militia or rebel group goes up (Grossman 1991; Collier and Hoeffler 2004). With reduced well-being due to lowered income and food provision, individuals have less to lose and hence are more susceptible to recruitment by militias or criminal groups, all else equal. These economic motivations have been linked to different forms of violence, including crime, civil war and genocidal violence (Verwimp 2005; Blattman and Annan 2016).

The importance of perceptions

Perceptions matter in this relationship in different ways. Individuals vary in their ability to handle crises and recover even under the same objective conditions (Jones and d'Errico 2019; Jones and Ballon 2020). This means that equal economic impacts of a disaster are subjectively experienced differently by different individuals, who also have different perceptions about their ability to recover. If the opportunity-cost model described above is correct, this will mean that one source of variation in expected utility of conflict are differences in such perceived losses.

Perceptions also matter for an alternative explanation of the link between economic hardship and conflict. Indeed, a worsening of the economic situation may also be linked to dissatisfaction and grievances in turn resulting in higher support for violence (Rustad 2016; Dyrstad and Hillesund 2020).

An additional important aspect for political violence, both from a grievance and opportunity-cost perspective, is perceptions of the disaster response of the government. Low regard of the government's supportiveness is plausibly indicative of perceptions of having few outside options in times of crises. This means that those who do not see the government as supporting them in a disaster should have low opportunity costs to engage in conflict. In addition, poor state response to disasters may lead to economic grievances that motivate opposition directed against the government which could, together with other factors, contribute to violent uprising (Detges 2017; Buhaug et al. 2021).

In this study, we focus on support for the use of violence. Studying this outcome is relevant since there is ample experimental and observational research finding that attitudes and behavior go together: individuals who support the use of violence are also more likely to be involved in violence and attitudes can be used to predict later use of violence (Seddig and Davidov 2018; Nunes et al. 2022). Moreover, those who generally support violence will support their family and community members' use of violence, which is in turn important for driving others to take part in conflict (McDoom 2013). Notably, the economic explanations we refer to here do not point to a specific target of the violence, so support for the use of violence may include violence against the state, between communal groups or against civilians. Based on this theoretical framework we present the following hypotheses.

H1: Exposure to flood increases support for violence in fragile and violence-prone contexts
H2: The increase in support for violence following flood exposure in violence-prone contexts is mediated by deterioration in actual material well-being
H3: The increase in support for violence following flood exposure in violence-prone contexts is mediated by deterioration in perceived well-being
H4: The increase in support for violence following flood exposure in violence-prone contexts is mediated by decrease in perceived government support

Empirical context

Karamoja is located in north-eastern Uganda and spans around 27,000 square kilometers, around the size of Belgium (Stites and Howe 2019). With a total population of

1.2 million out of which 60% live in absolute poverty, this rural region is the least developed of Uganda (Uganda Bureau of Statistics 2017). Administratively, it is a sub-region further divided into districts, counties, and sub-counties. Karamoja covers three agro-ecological zones. It has arid pastoral land at the border to Kenya as well as semi-pastoral and agricultural lands. Traditionally, the local population combines mobile livestock keeping with semi-sedentary farming. Due to frequent crop failures, livestock are of great importance for sustenance. Internal migration is a traditional strategy to cope with tough life conditions in the area. This takes the form of seasonal migration of pastoralist households.

Karamoja has a long history of violence. The region saw intense fighting between communal groups until 2009 resulting in hundreds of deaths. A combination of a top-down sustained disarmament campaign initiated by the Uganda government and grass-roots peace initiatives are two reasons cited for why conflict violence decreased thereafter for a decade (Stites and Howe 2019). However, from 2019 on violence increased again. Local newspapers claim hundreds were killed in cattle raids as well as in clashes with government forces (Oketch and Otwii 2021; Reuters News 2022). Violence since the beginning of our study period in 2016 has taken form of large-scale communal raids including involving groups from across the border to Kenya, high rates of individual opportunistic theft as well as violence involving government forces against alleged raiding groups (Stites and Howe 2019; Abrahams 2020; Reuters News 2022).

Karamoja has a variable climate with persistent droughts as well as occasional floods caused by water from heavy rains running from higher to lower-lying areas. In 2018, a particularly severe flood event occurred, which is the event in focus in our study. Karamoja experienced the wettest March to May period on record in 2018 and over 180,000 Ugandans were affected (Ssekandi 2018). While crops developed normally in higher-elevation areas, in lowland areas persistent flooding and subsequent waterlogging caused crop damage and led to high pest incidences amounting to an estimated 60 to 80% crop loss (FEWS NET 2018). Further, the heavy floods hampered access to markets, hospitals, and schools. Some river banks were destroyed and river water was contaminated with waste. This caused water borne diseases, malaria and child malnutrition in addition to direct deaths in the floods (ActionAid 2018).

Research design

We study survey responses following the 2018 flood in Karamoja based on novel sub-nationally representative panel household-survey data, collected in 2016 and 2019. Households are understood as group of individuals sharing common living arrangements, which thus form a unit of individuals with shared and mutually dependent economic status and decisions. Using panel data comes with several advantages. First, we are able to track over-time changes in characteristics that we theorize shape support for violence. Panel data also has methodological advantages. Focusing on changes over time is an important safeguard to biases resulting from temporarily constant traits such as livelihoods and general incentives to misrepresent information in surveys.

Data collection and sample

Data collection in conflict-affected regions is challenging for many reasons, such as limited access to relevant population groups and high costs. Here, we overcome the logistical challenges by using data originally collected by United Nations (UN) organizations in monitoring and evaluation efforts but with activities and beneficiaries selected unrelated to the flood. The data collection aimed at collecting household-level data representative for Karamoja in 2016 with follow-up of the same household 2019. It targeted household heads. For details, see supplementary material Section A.

The most comprehensive representative sample consists of 2156 households interviewed in 2019. Out of these, the vast majority, 1965 households, were already included in 2016 (i.e., composing a balanced panel). One thousand six hundred forty in addition had the same respondents within the households in both rounds. In order to maximize representativeness, we use the panel data of households interviewed in both rounds for main models, and the individual-level panel for robustness with additional results documented in the supplementary material.

Variable operationalization

Our main measure for flood is self-reported data on flood exposure within the past 12 months. The variable *flood* is coded "1" if a respondent reports flood shock exposure in response to the question *in the last 12 months, which of the following shocks did your household experience?* and "0" otherwise (Fig. 1). Using this data has the important advantage that it allows us to capture impacts on the 53% partly mobile pastoralist households in our sample. Given mobility, it is more uncertain to what degree households in specific locations at the time of the survey really were affected. The survey data will capture this since the same households are interviewed again. We find this self-reported variable to be positively correlated with extreme rainfall in relevant months using highly disaggregated rainfall data which provides further evidence that the self-reported data is able to capture changes in the natural environment (Table A8, supplementary information).

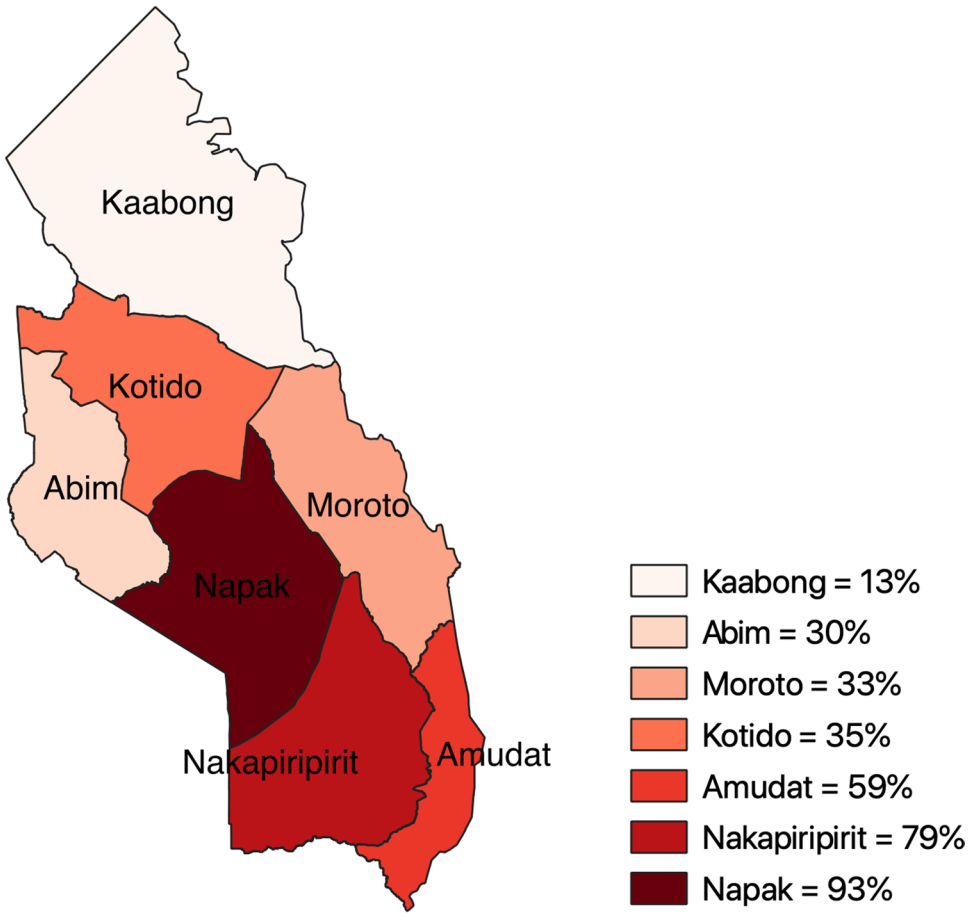

Fig. 1 Percentage of surveyed population reporting flood exposure in 2018–2019 within districts (2016 district boundaries)

Material well-being

The sources of income and material well-being generally differ across contexts and households. To be able to account for different local livelihoods, we focus on several dimensions of socio-economic conditions: crop production (*cropharvest* measured in 100 kg in the main models), livestock ownership (measured in tropical livestock units, *tlu*), and composite indices of wealth measuring assets owned by the household (*wealth index*), food security (food consumption score, *fcs*), and use of different coping strategies to shocks (coping strategy index, *csi*). *csi* measures for how many days in the past 7 days different coping strategies, such as gathering wild food and reducing meal sizes, were adopted. *csi* is adapted to local conditions being informed by FAO-led focus group discussions on relevant coping strategies to shocks conducted in Karamoja before implementing the survey.

Subjective conditions

For capturing relevant perceptions, we focus on subjective capabilities and capital drawing on resilience research (Jones and d'Errico 2019; Jones and Ballon 2020). In line with the theoretical framework and our interest in studying attitudes to violence, we mainly focus on *absorptive capacity*, *transformative capacity*, *financial* and *political capital.* The latter covers government supportiveness. Subjective capacities are measured on a five-point scale, ranging from "strongly agree" (1) to "strongly disagree" (5). Details on the variables composing the respective indices are provided in the supplementary material (Table A5 and A6, SI).

Measuring support for violence

Measuring support for violence and conflict is notoriously difficult and sensitive. In line with earlier studies (e.g., Linke et al. 2015a; Detges 2017; von Uexkull et al. 2020), we use survey questions that are adapted from the Afrobarometer, a survey routinely conducted in a number of African countries. We ask *Which statement do you agree with and how much? (1) The use of violence is never justified in Ugandan politics. (2) It is sometimes necessary to use violence in support of a just cause. (3) None of the above.* Response options for the first and second option are *support* and *strongly support*. We turn this variable into a dummy variable coded "1" for the second option, and "0" for the first and third option and missing otherwise.

Using a very similar question on political violence as earlier work is useful for accumulating of knowledge on support for

violence across contexts. This question is relatively broad but refers to the local Ugandan context to make sure it is relevant and specific enough. It focuses on political violence, which is important to exclude intra-household domestic violence and abuse which also are widespread in Karamoja (Stites and Howe 2019). Given this particular rural context and history of cattle-raiding, in alternative tests, we also investigate support for stealing in response to hunger to capture conflict behavior that is not explicitly political in nature, but that is a frequent feature of violence along communal lines (Table A9, SI). We conduct further robustness checks on alternative ways of coding responses to the main variables (Table A15, SI).

Naturally, individuals who support the use of political violence may not act upon their attitudes. However, research in social psychology finds that questions on attitudes to specific behaviors predict actual behavior in many domains, including violence, reasonably well (Seddig and Davidov 2018; Nunes et al. 2022). Not all individuals will answer truthfully to this question, which may be seen as sensitive. Overall, we expect that estimated support rates are attenuated toward zero. People who are in effect supportive of violence may be inclined to say they are not due to social desirability biases. This likely downward bias will make it harder for us to identify significant relationships.

Estimation strategy and control variables

We only have data from 2019 for many conflict-related variables, but a rich set of panel observations of material and subjective changes. Our identification strategy combines different approaches that each have particular strengths for identifying causal effects and thus are employed complementarily, to make optimal use of the rich dataset. In short, we (1) establish the direct relationship between flood exposure and support for violence in the cross-section to test the first hypothesis. We then (2) study flood impacts on material and subjective conditions using difference-in-differences (DID) estimation using a household-level panel and (3) perform a causal mediation analysis to investigate specific pathways and test the second, third and fourth hypotheses.

In the first step estimating the direct effect of flood on support for violence, y is the observed binary conflict-related outcome for respondent i, α is the intercept, β are a vector of coefficients for a set of respondent-specific variables including flood, d are district fixed effects and ε is the error term.

$$y_i = \alpha + \beta x_i + d + \varepsilon_i$$

The district fixed effects account for potential unobserved features of particular regions such as elevation and land use, which may make specific areas both conflict and flood-prone. As we are estimating the effect of flooding, i.e., hydrological processes that affect whole villages, we in addition account for spatial dependence by employing Conley standard errors, which have 10 km as cutoff point (Hsiang 2010).

As a second step, we start unpacking causal mechanisms. We estimate the flood impacts on material well-being and subjective assessments. DID is a powerful design-based method frequently used in impact assessments assuming parallel developments in the absence of a "treatment," here the flood shock (Gertler et al. 2016).

We estimate the following equation:

$$y_i = \alpha + \beta treated_i + \beta_2 time + \beta_3 treated_i * time + \beta_4 Z_i + d + \varepsilon_i$$

where y is the observed binary conflict-related outcome for respondent i, α is the intercept, β is a vector of coefficients for a set of respondent-specific variables, including *treated* which is flood-shock exposure*; time*, which is a dummy for the later survey round, as well as the interaction term which specifies the difference-in-difference estimator; controls Z, district fixed effects d. ε is the error term.

In a third step, we then estimate whether changes that are attributed to the flood in the second step were indeed associated with increased support for violence using causal mediation techniques (Imai et al. 2011). Since our unique panel data allows us to specify the *change* in the potential mediating variables over time from pre- to post-flood periods measured for exactly the same household, we should be able to pick up the potential mediating effect. We use OLS and probit and logistic regression models.

Our main choice of control variables is informed by earlier research and by balance tests (Table A2, SI). While the sample is balanced across most variables, there are a few significant differences. Flood-affected households received more aid in 2016, are less likely pastoralist and respondents are more likely female, with the latter difference only being significant at the 90% level. To account for these differences, we control for sum of formal transfers received by the household per capita, measured in 2016, logged (*log fortransfers).* This variable includes all formal transfers to the household in the preceding 12 months from different sources, e.g., food for work from NGOs and government pension funds. We also include binary variables for pastoralist livelihood (*pastoralist*) and female respondent (*female*), respectively, in main models.

In extended models, we add a battery of potential other determinants of support for violence informed by earlier survey research on this topic (Detges 2017; Linke et al. 2018). Specifically, we control for drought exposure (*drought*)[1] to account

[1] Drought is a slowly changing omnipresent condition in the region affecting almost everyone in the sample throughout the study period. This makes it important to account for drought in the statistical model, though it difficult to assess drought impacts since almost everyone reported drought exposure throughout the survey rounds (70–88% of respondents) (cf. Table A1, SI). This means that we do not have a comparison group for drought unlike for flood.

for other shocks, as well as the food consumption score (*fcs*). Lastly, we also aggregate yearly deaths from conflict and protest (*fatalities acled)* of any type during the years 2012–2016 pre-survey implementation from the ACLED dataset (Raleigh et al. 2010) and merge it at the district level with the household data. Controlling for fatalities aims to capture potential impacts of conflict exposure on attitudes toward violence.

Results

We proceed to presenting the results starting with the direct relationship of flood and attitudes toward violence and then moving on to the hypotheses on what may explain this relationship. First, in Table 1, models 1 to 3, we estimate models of support for violence using self-reported flood as independent variable. Model 1 includes only flood, and models 2 and 3 add a limited and extended set of control variables, respectively. For all models, we find flood to be positively associated with support for violence and the size of the coefficient for flood is hardly affected by the inclusion of additional variables. Since not all conflict and violence is political in Karamoja, we test the robustness of this finding to using support for stealing when going hungry and resource disputes as alternative dependent variables. The coefficients of the flood indicator in these alternative models are positive, but not significant (Table A9, SI).

Table 1 Cross-section analysis flood and support for violence

Variables	(1)	(2)	(3)
Flood	0.058***	0.059**	0.059**
	(0.023)	(0.023)	(0.025)
Drought			−0.009
			(0.023)
Pastoralist		0.010	0.008
		(0.020)	(0.018)
Female		−0.022	−0.026
		(0.023)	(0.023)
Log fortransfers		0.002	0.001
		(0.007)	(0.007)
Fcs			−0.003***
			(0.001)
Fatalities acled			0.070*
			(0.036)
Constant	−0.001	0.014	0.016
	(0.030)	(0.032)	(0.066)
District fixed effects	*Yes*	*Yes*	*Yes*
Observations	1,958	1,958	1,958
R-squared	0.193	0.194	0.211

OLS models. Conley-standard errors in parentheses

*$p<0.1$; **$p<0.05$; ***$p<0.01$

Additional control variables are interesting in themselves and provide tentative support for the relevance of economic motives for supporting violence in this area. Model 3 indicates that the food consumption score (*fcs*), a common indicator of food security, is negatively related to attitudes to violence so that respondents from comparably food secure households are less likely to support the use of violence. In contrast, drought, gender and pastoralist livelihoods and earlier fatalities in the region are not significant at conventional levels.

The impact of flood on households' material and subjective well-being

Next, we investigate flood impacts on material and subjective socio-economic conditions as a first step to identifying potential pathways to the support for violence. Here, we can fully leverage the panel dataset using the DID design.

The coefficients from the DID models are visualized in Fig. 2, and full models are presented in the appendix (Tables A10-A11). We find that flood exposure is significantly related to a decrease in livestock and to an increase in days spent on different coping strategies. Yet, flood is unrelated to crop harvests, wealth and food consumption in our sample. For livestock, the estimated flood effects of 0.3 *tlu* correspond to the loss of one pig and one goat, for example. For coping strategies, the difference corresponds to another day spent on a coping strategy to deal with food insecurity in the past seven days, such as skipping a meal.

We then turn to the subjective assessment of conditions using the same modeling choices. For interpreting Fig. 3 note here that larger numbers indicate adverse changes. For

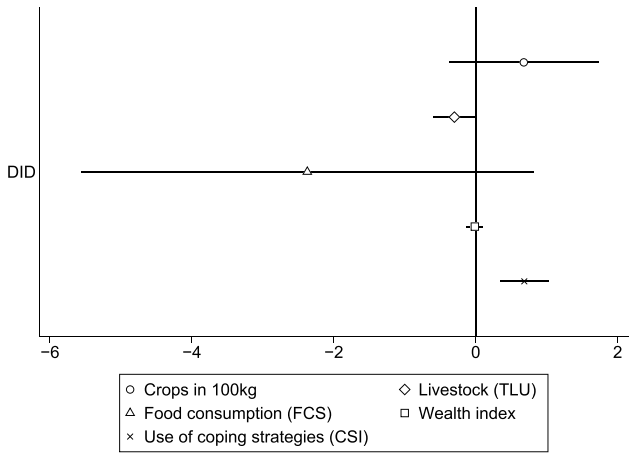

Fig. 2 Flood impacts on material conditions. DID estimator (flood × time) for different dependent variables indicated in the legend, controlling for pastoralist livelihood, log per capita formal transfers and district fixed effects, same household panel sample. Full models are provided in the appendix (Table A10)

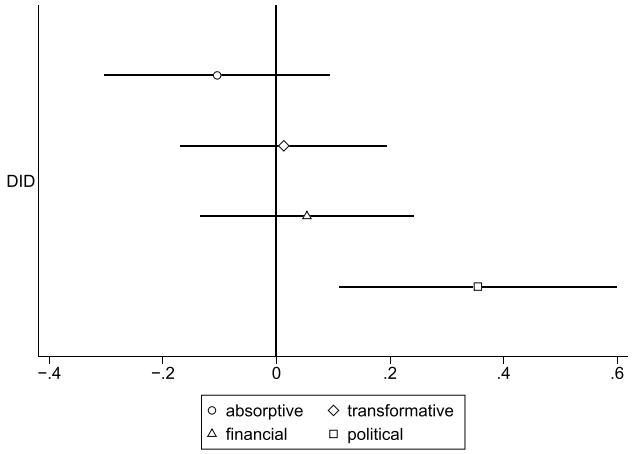

Fig. 3 Flood impacts on subjective conditions. DID estimator (flood × time) for different dependent variables indicated in the legend, controlling for pastoralist livelihood, log per capita formal transfers and district fixed effects, same household sample. Full models are provided in the appendix (Table A11)

Table 2 Causal mediation analysis of flood effects on support for violence

Mediator	Effect	Mean	[95% Conf. Interval]	
Livestock	ACME	−0.0004	−0.0024	0.0008
	Average direct effect	0.0487	0.0148	0.0862
	Total effect	0.0484	0.0138	0.0855
Coping strategies	ACME	0.0001	−0.0015	0.0019
	Average direct effect	0.0478	0.0137	0.0854
	Total effect	0.0480	0.0135	0.0853
Political capital	ACME	−0.0040	−0.0100	0.0012
	Average direct effect	0.0492	0.0152	0.0866
	Total effect	0.0456	0.0103	0.0824

Controls for (log) formal transfers in 2016, pastoralist livelihood, female respondent, district fixed effects

ACME average causal mediation effect

these models, only estimated flood effects on political capital are statistically significant with floods exposure associated with a more negative view on the responsiveness of governments and politicians in times of crises. The findings displayed here are substantively unchanged when using the same respondent sample (Table A13 and A14, SI).

Mediation analysis

In a third step, we estimate whether the changes that are attributed to the flood in the DID models above—henceforth referred to as candidate pathways—were indeed associated with increased support for violence using the causal mediation analysis model. We implement the causal mediation model using the *medeff* package, developed in Stata by Hicks and Tingley (2011). The function estimates a first-stage model in which the mediator (in our case the change in *tlu*, *csi*, and *political capital*, respectively) is regressed on the independent variable (flood) and additional covariates as in the main models; and a second-stage model that predicts the dependent variable (*support for violence*) as a function of the mediator as well as the independent variable and covariates in a probit model.[2]

In line with results visualized in Figs. 2 and 3, we estimate whether changes in livestock, coping strategies and political capital mediate the flood-attitude to violence relationship. As is visible in Table 2, none of the average causal mediation effects (*ACME*) are statistically significant. In contrast, the average direct effect of flood and total effect again indicate significantly increased support of violence for the flood-exposed. Hence, we again find that flood is associated with support for the use of violence in line with initial models on the flood-violence relationship presented in Table 1. However, contrary to our theoretical expectations, livestock losses, increasing use of coping strategies and failing trust in government support were not significant mediators of this relationship, the ACME confidence intervals always include 0.

Identifying mediation relies on strong assumptions—sequential ignorability—about both the mediator and the outcome model, which cannot be tested with the observed data (Imai et al. 2011). Sequential ignorability assumes that there are no unmeasured confounders for the intervention to mediator pathway and the mediator to outcome pathway. We therefore employ sensitivity tests to quantify how results would change if the sequential ignorability assumption was relaxed (Imai et al. 2011).

We estimate the ACME for different levels of the sensitivity parameter ρ, indicating the correlation between the residuals from the mediator and outcome model respectively. Figure 4 displays how varying levels of ρ, between − 1 and + 1, influences the ACME. A sensitivity parameter of 0 represents null hypothesized levels of residual confounding and the extremes of − 1 and 1 represent maximum hypothesized levels of residual confounding. We find that the confidence interval of the ACME (limits represented with a grey background) always includes zero for the indirect effect whatever the value of ρ. Hence, the results of the sensitivity analysis further support the absence of a significant mediation effect of the candidate mediators identified.

[2] Results on mediators are substantively unchanged with a logistic regression model (not shown), but only probit is supported in the package that allows for sensitivity analysis.

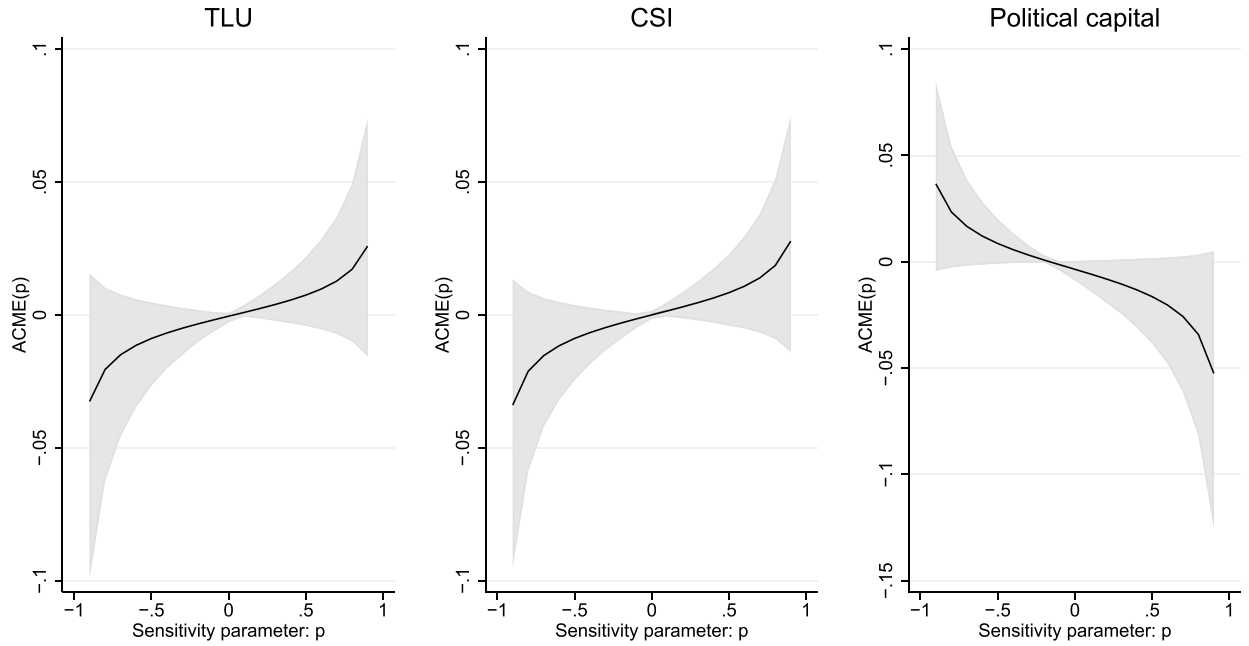

Fig. 4 Sensitivity analysis plot. The figure displays the sensitivity of the ACME with respect to the error correlation for each mediator grey shade indicates the 95% confidence interval

Conclusion

Climate change has often been referred to as threat multiplier (NATO 2021). While the term as such is debated, this study follows its underlying conceptual logic by investigating the impact of flood on support for violence in a region that is already grappling with a multitude of security and development challenges. The study provides evidence for the impact of flood on support for violence based on self-reported flood-exposure data. This is an important result given the mixed findings on flood and conflict in the few existing research works, which point to conditional relationships (e.g., Ide et al. 2021; Petrova 2022).

As a second contribution, we assess candidate pathways through which this estimated flood effect may have materialized using unique household and individual-level survey panel data. We on the one hand find that flood exposure was associated with a modest increase in the use of coping strategies, as well as loss in livestock and perceived political capital. One the other hand, against expectations, changes in these variables did not correlate as expected with support for violence and mediation analysis did not support that these factors were mediating the estimated direct, total, flood effect on attitudes to violence. In light of the theoretical framework, we therefore conclude that the estimated economic impacts of natural hazards seem to have limited explanatory power for the flood-violence relationship based on the data we have.

These mixed findings from the Karamoja region are in line with earlier research on climate-related shocks which suggests that pathways are highly context-specific and that point to the limited explanatory power of analyses focusing on economic impacts of natural hazards alone (Siddiqi 2014; Buhaug et al. 2021). Micro-level causal mechanisms between climate and conflict thus deserve further exploration in future research. Factors pointed out by other work that may be relevant in the Karamoja context are population movements into the region as well as changes in the effectiveness of informal and traditional institutions (Linke et al. 2015a; Ide et al. 2023). Further, it may be interesting to assess in a more comprehensive way how food security relates to conflict participation. The findings presented here indicated that respondents from comparably food secure households were less likely to support the use of violence.

While we were able to track hazard impacts over time in this work, which is unique in the study of climate and conflict, we at the same time acknowledge limitations. Panel data comes with important advantages for causal identification of flood impacts and the unique data allowed us to track responses over time in this study. However, we only had two rounds of survey data which limited our ability to track effects and recovery from flood impacts. Hence, further research would benefit from frequent surveys that allow for tracking impacts and recovery from climatic

hazards and changes in attitudes to—and experience of—violence. Implementing several rounds of follow-up surveys via phone or SMS could be a promising and efficient avenue forward (Jones and Ballon 2020).

What implications do our results have for explaining violent conflict? While we study attitudes and not behavior, the general link between support for and the use of violence has been established elsewhere (Linke et al. 2015b; Nunes et al. 2022). Karamoja's violent history points to mobilization potential as seen in the latest deadly cattle raids and gun violence. Based on our findings, violence could be further spurred by flooding and related climate-hazards in this marginalized region of Uganda, but focusing on dampening economic effects of hazards alone may not be effective for preventing this.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10113-023-02054-x.

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Data availability Replication files are made available at https://www.pcr.uu.se/data/replication-data/.

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