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The impact of climate variability on children: The recruitment of boys and girls by rebel groups

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Abstract

Environmental changes place severe pressure on individuals and societies. Vulnerable segments of the population, especially children, are likely to be first affected. We examine the impact of climate variability on the recruitment of children by rebel groups during conflict. We argue that changes in climate patterns increase both the supply of children willing to work as soldiers and rebel groups' demand for them. To empirically examine this association, we combine global data on temperature and precipitation shocks with information on child soldier recruitment by rebel groups. Our findings suggest that climate variability shapes child soldier recruitment in systematic and significant ways. Additionally, we show that this relationship is not gender-neutral: it has a strong impact on the level of girls recruited by rebel groups. This research has important implications for our understanding of how climate variability can influence conflict dynamics, how environmental changes may worsen the circumstances of the most vulnerable individuals of conflict-affected societies, and how a non-gender-neutral effect of climate change may materialize.

Keywords

armed conflict, child soldiering, climate variability, gender, rebel groups

Introduction

Changes in the global climate are one of the biggest global threats of the century (Xu et al., 2012). Temperature is likely to increase, rainfall patterns will change, sea levels will rise, and extreme weather events will become more frequent (IPCC, 2014). Children will especially bear the brunt of these changes. The United Nations International Children's Emergency Fund (UNICEF) estimates that 256 million more children will suffer from malnourishment because of climate change, with a further 100 million suffering from food insecurity (Harvey, 2013). The World Health Organization (WHO) suggests that climate change contributed to more than 150,000 deaths worldwide in 2000 alone (McMichael & Butler, 2004), and more than 88% of this burden occurred in children under the age of five years (Sheffield & Landrigan, 2010).

Studies examining the effect of changes in climate on children focus almost exclusively on two issues: how it affects children's physical health (malnutrition, diarrheal disease, or malaria) and how it influences children's educational attainment (e.g. Kousky, 2016; Groppo & Kraehnert, 2017). Furthermore, these studies concentrate on how climatic changes influence children in peaceful societies, thereby neglecting the fact that conflict could greatly exacerbate the effects of climate variability on children (Hanna & Oliva, 2016).

In this study, we open an important research area and analyze how change in climatic conditions can affect children living in conflict-affected areas. More precisely,

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we look at how it influences the likelihood that they get recruited by rebel groups. We argue that climate variability is likely to influence the recruitment of children to be used as soldiers in two ways.[1] First, climate variability increases the supply of children willing to join rebel groups by increasing grievances. Second, it increases the demand for children by influencing the relationship between the civilian population and rebel groups. Climate variability decreases the available resources, thereby incentivizing the demand for children because they are relatively 'cheap'. Moreover, due to existing gender inequality, and the vulnerability of females under climatic conditions (Denton, 2002), we also contend that girls bear the brunt of climate variability and are also more likely to be recruited by rebel groups.[2]

Examining the relationship between changes in climate and child soldiering is important for four interrelated reasons. First, we attempt to open an important research area that often remains unexplored: the effect of adverse climatic conditions on vulnerable populations, such as children. This has also been often overlooked in international environmental agreements and child protection policies or initiatives (Terre des Hommes, 2017). Second, recruitment can be one of the causal mechanisms linking climate variability to armed conflict. No systematic empirical studies have, however, explored this linkage. Third, the literature on child recruitment has given limited attention to the influence of climate. This is surprising as other structural exogenous factors, such as globalization, are often mentioned as important determinants of the use of child soldiers (Honwana, 2006). Fourth, few studies have addressed the gendered impact of climate stress and gender-differentiated features of climate adaption and resilience (e.g. Neumayer & Plümper, 2007; Rao et al., 2019).

To overcome these identified issues, we proceed as follows. After reviewing existing literature on child recruitment, we present our theoretical argument on the association between climate variability and child soldier recruitment. Meanwhile, we offer an illustrative case study on Sierra Leone as an application of our theoretical expectations. To examine these arguments, we discuss existing available data and our research design, and present our results. We conclude with a brief discussion of policy implications and directions for future research.

[1] Following UNICEF (2007), we define child soldiers as 'any person below 18 years of age who has been recruited or used by an armed force or armed group'. This definition does not make explicit the distinction between the recruitment or usage of children.

[2] Adverse climatic conditions are those weather conditions that deviate from a normal climate pattern.

The supply and demand of child soldiers

The number of academic studies on the causes and consequences of child soldiering is steadily growing in recent years (e.g. Gates & Reich, 2010; Tynes & Early, 2015; Haer & Böhmelt, 2016). Generally, we can structure these studies along two different strands: those that look at the supply of children and those that examine a rebel group's demand for children (e.g. Lasley & Thyne, 2015).

The strand looking at the supply of children examines the determinants and motivations that influence the likelihood that children – boys and girls alike – join armed groups. Scholars highlight structural factors such as globalization, the number of children living in a particular area, migration and settlement patterns, the securitization of refugee camps, or the proliferation of small weapons as key influencers (e.g. Achvarina & Reich, 2006; Andvig & Gates, 2010). Additionally, there are individual-level supply factors such as the lack of education, security, food resources, or family and peer pressure that may increase children's willingness to join rebels (e.g. Tynes & Early, 2015).[3] For example, children, especially girls, may join armed groups to provide for their families to whom their salaries are usually paid (Høiskar, 2001).

Scholars seeking to explain variation in child soldier usage generally consider the supply of children to be consistent within conflict zones. Consequently, supply-side arguments are unable to fully account for variation in child soldier usage across rebel groups operating in similar areas at similar periods. To explain this spatial and temporal variation, recent studies focus more on the demand side (e.g. Andvig & Gates, 2010; Haer & Böhmelt, 2016). They explore factors influencing the decision of recruiters to enlist children and why armed groups might prefer to recruit children over adults. Several factors are important to this end. First, some have argued that children are easier to mislead and indoctrinate. They are more malleable, adaptable, and obedient. Consequently, they are easier to control and retain (Beber & Blattman, 2013). Second, scholars have also

[3] The philosophical discussion about whether children can make a conscious decision to join armed groups is still inconclusive. Some have argued that children have no agency since they are not capable of understanding the consequences of joining (e.g. Singer, 2006: 62). Others contend that it is difficult to talk about 'free choice' if a child witnesses his or her parents' murder and joins to obtain food and protection (Wessells, 2006). Either way, it appears that the narrative of forced recruitment is somewhat exaggerated (Haer, Faulkner & Whitaker, 2020).

shown that using children for rebellion might also be a cost-effective solution. Recruiting (voluntary or forcibly) children reduces operational costs as they are cheaper to feed and clothe. Moreover, limiting the number of members eligible for revenue-sharing, leaders maintain more for themselves and the armed struggle (Gates, 2017; Haer, Faulkner & Whitaker, 2020). Lastly, recruiting children might give armed actors advantages on the battlefield. Their recruitment increases fighting capacity, thereby decreasing the likelihood of setback and defeat (Haer & Böhmelt, 2016). The recruitment of children is, therefore, not necessarily a strategy of the weak.

The above-mentioned demand factors are similar for boys and girls. However, we do see that some rebel groups recruit solely boys, while others also recruit girls (Haer & Böhmelt, 2018). Only recently, scholars identified some demand factors that pertain more to girls than to boys. First, girls are specifically recruited because of their strategic advantage: they are often not suspected of subversive activities, which enhances the 'element of surprise' (Thomas & Bond, 2015). This gendered effect is stronger for girls than for adult females or boys (Haer & Böhmelt, 2018). Second, girls are often used to strengthen the internal and external cohesion of a group (Donnelly, 2019). They are sometimes used for the creation of so-called 'war families' within the rebel group, which in turn induces loyalty to and interdependence of members within the group. This makes girls 'the key factor in maintaining the fight forces' (Fox, 2004: 473). At the same time, the recruitment of girls is also a strategy of controlling the civilian population. Al-Shabaab, for example, uses girls as a way of connecting local families to the fate of the group (Donnelly, 2019).

Climate variability and child soldier recruitment

Although the existing literature has discussed the influence of structural-exogenous factors such as globalization on child soldier recruitment (Honwana, 2006), few scholars and policymakers have focused on the potential influence of climate variability. Climate changes can worsen – directly or indirectly – social and political outcomes such as economic hardships, political instability, migration, or conflict (e.g. Wischnath & Buhaug, 2014; Backhaus, Martinez-Zarzoso & Muris, 2015; Carleton, Hsiang & Burke, 2016).[4]

While climate change-induced conflict is a well-studied topic, the existing evidence is inconclusive (e.g. Hsiang, Meng & Cane, 2011; Gleditsch & Buhaug, 2013; Buhaug 2014; Salehyan, 2014; Theisen, Von Uexkull, 2014; Koubi, 2019). Not only have studies produced mixed results, but they have not explored every causal mechanism. For example, recruitment as a mechanism linking climate variability to conflict has only been assumed (Walch, 2018).[5] In this study, we examine this mechanism by focusing on the linkage between climate variability and the recruitment (voluntary or forcibly) of children to be used as soldiers by rebel groups.[6] Derived from the theoretical framework on child soldiering, we claim that climate variability, directly and indirectly, influences the supply and demand for children to be used as soldiers.

To start with, climate variability exacerbates the supply of children willing to join or pressured into armed groups. It often reduces the resources available to households, especially affecting those in less developed regions with limited social safety nets whose livelihoods depend on agricultural activities. One short-term solution to overcome this lack of income is to reduce investment in their children and withdraw them from school (e.g. Björkman-Nyqvist, 2013). By withdrawing them from school, they can save a considerable fraction of their budget: schooling costs (e.g. tuition, books, school supplies, transport costs) can be around one-third of the yearly household income. Jensen (2000), for instance, shows that investments in children suffer dramatically in the presence of climate variability, with school enrolment rates significantly declining.

Withdrawing children from school to generate income in the short run has a significant impact on a child's human capital accumulation, that is, long-term earning ability (Jensen, 2000). The lack of schooling and the subsequent absence of economic opportunities might increase grievances (see also Bakaki & Hinkkainen, 2016). For instance, it might block or prolong children's transition to adulthood (Hilker & Fraser, 2009). Due to a lack of financial funds, they cannot get married, or buy property or land in certain societies. This can cause frustration and disillusionment with political actors and

[4] Climate change refers to those variations in climate that persist for a longer period, typically over decades or longer. Climate variability, on the other hand, looks at changes that occur within smaller time frames, such as a month, a season, or a year.

[5] Walch (2018), however, examines the linkage between natural disasters and recruitment in the Philippines.

[6] While rebel groups are not the only organizations that recruit children, we focus on them, since they have stronger incentives than governments to use child soldiers (Tynes & Early, 2015).

policies, ultimately leading to an increase of willingness of young people to join rebel groups in an effort to improve their own societal and economic position (Richards, 1996; Hilker & Fraser, 2009: 18; Walch, 2018). For instance, Rwandan adolescents were significantly impoverished due to a general economic decline (Newbury, 1995). It was, therefore, increasingly difficult for them to acquire the means to get married. This created huge resentment among young people, driving militia recruitment during the civil war in the early 1990s (Newbury, 1995).

Climate variability also strains and weakens the household's capacity to nurture and protect children (Brancati, 2007). First, it increases the number of people – including children – who end up living in refugee camps or settlements (IPCC, 2014). Such locations are ultimate 'fishing grounds' for recruiters to enlist children for their cause, not only because of the large number of children but also due to their lack of mobility (Brancati, 2007). Becker (2005), for example, shows that rebel groups, such as the Liberation Tigers of Tamil Eelam, conscripted scores of orphaned and homeless children from refugee camps following the 2004 Indian Ocean tsunami. Likewise, Achvarina & Reich (2006) point to a significant relationship between access to refugee camps by belligerents and the participation rates of children in conflict.

Second, children's vulnerability is also increased because of (seasonal) labor migration. A potential household's strategy to supply cash earnings in reaction to adverse climatic conditions is by seeking alternative income elsewhere (Gray & Mueller, 2012; Hermans & Garbe, 2019). In the search for economic opportunities, families are often separated and sometimes children are left behind, significantly influencing the household's capacity to protect children from recruitment.

Not only does climate variability influence the supply of children but it also raises the demand for children due to changes in the relationship between the civilian population and rebel groups. Support from civilians is crucial for a rebel group's success because they provide food, shelter, information, and safe hiding places (Wood, 2010). However, climate variability decreases the availability of some of these resources for rebel groups (Hendrix & Brinkman, 2013). For example, crop failure due to extensive droughts might diminish the amount of food civilians can offer to rebel groups. Consider the Naxalite insurgency in India. This insurgency is an ongoing conflict in the Eastern part of India between Maoist groups known as Naxalites and the Indian government. The Naxalite-affected communities rely disproportionately on rain-fed subsistence agriculture. Vanden Eyende (2018) shows that due to rainfall deficiency, which impacted rice production, the Naxalites faced problems with extracting food and intelligence from civilian communities. Communities were simply not able to feed the rebels.

As climate variability affects the availability – or the lack thereof – of resources, it is likely to influence the composition of a rebel group (Humphreys & Weinstein, 2008; Fjelde & Von Uexkull, 2012) and, in turn, the demand for children. First, children are relatively cheap: they do not consume much food and are less likely to demand large payments in comparison to adults (Gates, 2017; Haer, Faulkner & Whitaker, 2020). Child recruitment during times of economic hardships is then also a cost-effective strategy. Second, recruiting children creates a bond between the civilian population and the rebel group. Families are more likely to offer resources to a rebel group if their children are involved. The recruitment of children also creates some form of external legitimization (Donnelly, 2019) that can help the rebels through difficult economic times. Given these supply and demand mechanisms, we hypothesize that *climate variability increases the likelihood of child recruitment by rebel groups*.

However, we expect that this effect is not gender-neutral: it is likely to affect girls differently than boys (Akresh et al., 2011; Hanna & Oliva, 2016). Girls are generally considered to be more vulnerable to adverse climatic conditions due to political, economic, and social marginalization (IPCC, 2014). When faced with an income shock due to climate variability, households primarily try to shield boys from harm. That is, they practice gender discrimination by reallocating scarce resources (such as food) toward boys as an investment in future returns. Therefore, it is argued that especially girls suffer from the negative effects (e.g. WHO, 2014). Björkman-Nyqvist (2013), for example, shows that negative precipitation shocks have an immediate and negative effect on the school enrollment of girls – and not directly of boys. Consequently, girls might be more motivated and willing to find alternative sources of income.

At the same time, climate variability also influences the supply of girls due to their specific role in agricultural substance economies. In these economies, women are responsible for 80% of the food production (Nabalamba, Mubila & Alexander, 2011). They often grow, process, manage, and market food and other natural resources. Moreover, they are responsible for raising small livestock, managing vegetable gardens, and provisioning fuel and

water. Men, by contrast, are generally engaged in cash cropping and large-livestock husbandry (Nabalamba, Mubila & Alexander, 2011). Due to these distinct roles, adverse climate conditions have a particularly negative effect on females. In many parts of the world, deforestation implies that wood – the most widely used solid fuel – is located further away from the places where people live. Because women and girls are primarily responsible for collecting traditional fuels (UNDP, 2012), environmental degradation forces them to search farther afield for resources, increasing the risk of sexual harassment and recruitment by armed groups. Similar arguments can be found when discussing water scarcity. The availability of water and the deterioration of its quality force women and girls, in particular, to travel long distances to find fresh water (IPCC, 2014; WHO, 2014). Especially in areas of conflict, there are many accounts of women and girls being attacked and recruited when searching for water (Nabalamba, Mubila & Alexander, 2011). Consequently, we hypothesize that *climate variability increases the likelihood of girls being recruited as soldiers by rebel groups*.

Illustrative evidence from Sierra Leone

In the following, we focus on the Sierra Leonean civil war (1991–2002) as a likely case to illustrate how climate variability influences the recruitment of boys and girls by rebel groups. Sierra Leone is one of the most vulnerable nations affected by extreme weather conditions. The country is known for heatwaves and heavy precipitation (Busby, Smith & Krishnan, 2014). Note that agriculture is the major component of the gross domestic product (GDP) and foreign exchange earnings. It represents the main source of livelihood for approximately 70% of the population (FAO, 2009; Bangura, Lynch & Binns, 2013; Wadsworth, Jalloh & Lebbie, 2019). This means that Sierra Leone has been particularly sensitive to the economic impact of adverse climate conditions (Wadsworth, Jalloh & Lebbie, 2019).

From 1986 until the middle of the civil war, Sierra Leone experienced a decrease of more than 20% in precipitation (Miguel, Satyanath & Sergenti, 2004; Taylor, Kamarra & Bockaries 2014). As a result of these precipitation levels, agricultural production significantly declined. Despite the abundant water resources in Sierra Leone, the access has been limited not only for drinking water but also for water for agricultural purposes and irrigation. With the country's water supplies already being under pressure, changing rainfall patterns can only intensify agricultural productivity generating significant hardships for the population. This, combined with economic mismanagement and corrupt patronage-based politics, pushed a significant number of farmers into severe poverty. They were often not paid for their produce while produce prices were kept significantly low to better sustain the government's expenditures (FAO, 2009). At the same time, the income of many households was significantly reduced (Peters, 2004).

With the drying up of funds, children and young people were among the first to experience the effect of these adverse conditions: families could no longer afford school tuition, and many dropped out (Bangura, Lynch & Binns, 2013). By 1990, of the total number of girls who qualified as the potential school-going population, only 12% were enrolled at secondary schools. In the case of boys, only 22% of all boys of school-going age were enrolled (Sierra Leone Truth and Reconciliation Commission, 2004). Many of those who completed secondary school did not have any job prospects or were heavily indebted to patrons, chiefs, and village elders, making it difficult to marry or to acquire land (Peters & Richards, 2011; Mokuwa et al., 2011; Matsumoto, 2014), aspects that are socially important even at a younger age. This left many youths with no purpose, and looking for alternatives to either support their families or to try to be socially accepted among their peers and elders.

Armed groups, such as the Revolutionary United Front (RUF), recruited extensively from these swollen ranks of rural 'semi-literate village school drop-outs' hustling for a living (Peters & Richards, 1996; Peters, 2004). Many boys and girls saw joining armed groups both as a meal ticket and a substitute for education (Peters & Richards, 1998). A few others joined because they identified with the groups' discourse for democracy and a better distribution of the revenues coming from natural resources. Over the course of the conflict, however, the RUF deliberately changed its tactic by relying more often on forced recruitment (Sierra Leone Truth and Reconciliation Commission, 2004). Many commanders considered children to be good and inexpensive fighters, who were easy to control, brave, and not afraid to die, and who would readily adapt to the guerrilla war (Richards, 2003; Shepler, 2004; Sierra Leone Truth and Reconciliation Commission, 2004).

As the civil war progressed, traditional family security further broke down. Many parents and caretakers were killed or disappeared. At the same time, those people who would normally financially sponsor the rural youth, fled to safer areas, leaving boys and girls alike to fend for themselves (Peters, 2004). Some of these children found themselves without kin in refugee camps or camps for

the internally displaced population, which were often used as recruitment grounds for armed groups (Sierra Leone Truth and Reconciliation Commission, 2004; Human Rights Watch, 2005). This breakdown of family and financial security had an immense impact on the recruitment of children, and in particular that of girls (Sierra Leone Truth and Reconciliation Commission, 2004). Girls were often abducted, especially during their quest for food and income (Warren, 2012; Zack-Williams, 1999). As a former abductee explained: 'I was on my way to sell my [cakes]. One of [the rebels] told me to go with them. I replied that I was on an errand for my mother. But they took my cakes and ate them and they took me away' (Denov, 2010: 97).

Once armed groups, such as the RUF, controlled the diamond areas, child recruitment increased significantly. Children became much more involved in mining activities, ultimately seeking fortunes for their commanders (Sierra Leone Truth and Reconciliation Commission, 2004). They were useful as diamond diggers since they did not demand a large share of the profits (Haer, Faulkner & Whitaker, 2020). As a former child soldier explained: 'I also supervised the diamond mining to make sure that none of the miners stole any diamonds that were to go to the commanders' (Denov, 2010: 111).

The roots of the war in Sierra Leone have also been characterized as a 'crisis of youth' (Richards, 1996) that is partly related to successive years of adverse rainfall, which likely made agricultural labor relatively less attractive than joining armed militias for many (Miguel, Satyanath & Sergenti, 2004). This means, for instance, that children who would in principle receive education did not have the means to do so due to the economic hardships generated from the agricultural crisis. The Sierra Leone case not only illustrates the effect of climate variability in society but also shows how it affected the recruitment of children as the civil war progressed through the years.

Research design

Data and dependent variables

For the empirical analysis, our data structure follows the Non-State Actors in Armed Conflict Dataset (NSA; Cunningham, Gleditsch & Salehyan, 2009, 2013), where the unit of analysis is the rebel group-government dyad per conflict period resulting in at least 25 battle-related deaths in 1989–2010. That is, a government is combined with a rebel group in one period of time in which the attributes of this conflict do not change. As soon as there is a change in the dyad or the conflict-associated characteristics, a new conflict period is activated and, thus, a new observation is generated in the data. Hence, our analysis is bound to the incidence of a civil war.

The dependent variable captures the recruitment of children to be used as soldiers by rebel groups. It is extremely difficult to obtain accurate data on the child soldier usage of rebel groups. There are, however, some notable exceptions. Beber & Blattman (2013) code information about the use of child soldiers from 40 sub-Saharan African rebel groups. Tynes & Early (2015) also collected information on child soldier recruitment. However, they base their coding on a limited number of sources and have no data concerning the recruitment of girls. Consequently, we use the Child Soldier Data Set (CSDS) by Haer & Böhmelt (2018), which is currently the largest global dataset on child soldier recruitment.

Although the CSDS is currently the most comprehensive dataset available on the recruitment of children by armed groups, some important limitations are worth mentioning that significantly impact our empirical strategy and potentially limit causal inference. These limitations should be addressed by future research. First, the CSDS only records the level of recruitment per conflict period. Data on child recruitment per year, per rebel group, are not available. Consequently, we can say little about changes over time in the recruitment of children. Second, we have no information about the exact geographical location where these children were recruited. Most reports and newspapers do not offer this information. This makes a disaggregated analysis on the association between climate variability and child soldier recruitment challenging. Third, the CSDS dataset does not provide information about the roles (fighting or having more supportive tasks) children have once they are recruited. Based on the CSDS data, we created a nominal variable where 0 means 'no child recruitment by rebel groups during a particular conflict period', 1 means 'only boys were recruited during a particular conflict period', and the value 2 signifies that 'boys, as well as girls, were recruited by rebel groups during a particular conflict period'. In our dataset, about 47% of the rebel groups recruited boys and girls, 31% of the rebel groups recruited only boys, while 22% of the rebel groups did not recruit child soldiers at all. No rebel group in the CSDS exclusively recruited girls. Figure 1 shows the distribution of child soldier recruitment across conflict countries.

Temperature and precipitation shocks

To measure climate variability, we use data from Landis (2014) on temperature and precipitation. These data cover the period from 1948 to 2011 and come from the

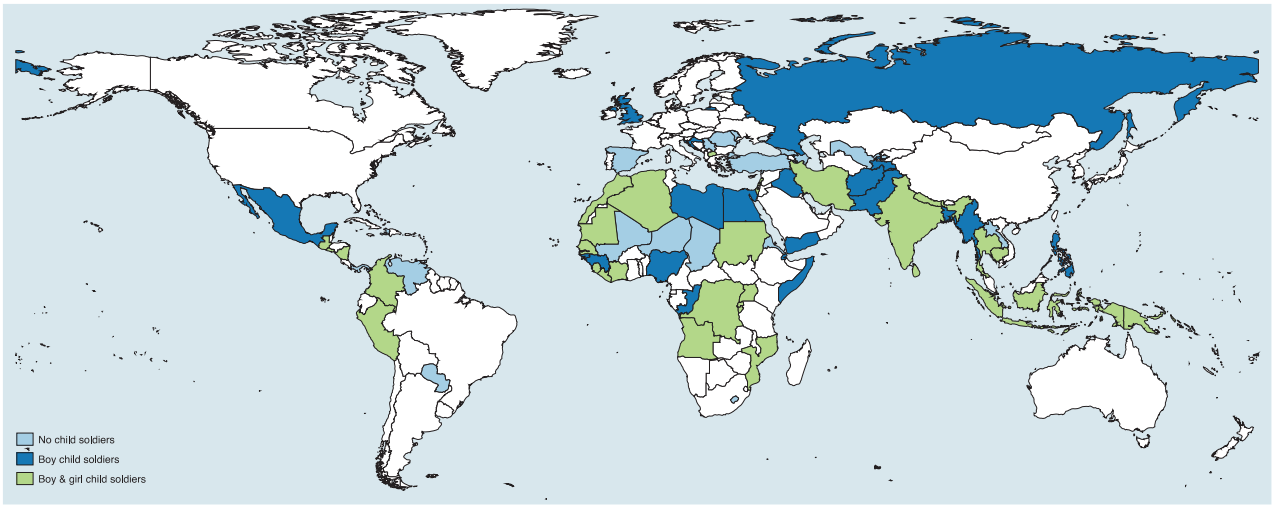

Figure 1. Distribution of child soldier recruitment categories

Child soldiers information aggregated to the country level, where a state is coded according to the highest level of child soldier (no child soldiers, only boys, or boy and girl child soldiers) recruitment by rebel groups. The analogy of this coding is based on the 'best-shot model' (e.g. Hirshleifer, 1983). The figure is made based on the location of the government involved in the conflict. The light blue color indicates no child soldiers, the dark blue color indicates recruitment only of boy soldiers, and the green color stands for recruitment of both boy and girl soldiers. Countries in white are those that were not in conflict.

National Oceanic and Atmospheric Administration, the National Center for Environmental Prediction, and the National Center for Atmospheric Research (in degrees Celsius; Kalnay et al., 1996). Existing studies debate the impact of temperature variation. However, there is some evidence to suggest that temperature changes are associated (if only indirectly) with civil conflict (e.g. Hsiang, Burke & Miguel, 2013; Burke et al., 2015). Hence, for our temperature measure, we look at positive and negative deviation from a 'normal' climate pattern (not absolute values). More precisely, we operationalize temperature shocks as the standardized monthly deviation in temperature from a country's long-term monthly mean, indicated by $(X_{itz} - X_{it\text{-}bar})/a_{it}$ where X_{itz} is the mean temperature of country i in month t in year z, $X_{it\text{–}bar}$ is the panel mean of country i's long-term monthly mean temperature (*t-bar*) for the period 1948–2011, and a_{it} is the standard deviation of that panel (Landis, 2014). Our final variable captures temperature shocks, which are a substantial (or extreme) deviation from a 'normal' climate pattern, that is, the standardized temperature deviation (Hendrix & Salehyan, 2012). As such, our measure reflects climate variability and not mere short-term changes in weather or change in climate that persist for decades or longer (Döll, 2002). To be able to combine it with our data on child soldier recruitment, we aggregate these data to the country level and take the mean of the temperature shock values over the first year of the conflict period.

Additionally, we use deviations in precipitation (negative and positive) as another climate-variability indicator. To calculate precipitation deviations, we again mirror the studies of Landis (2014) and Hendrix & Salehyan (2012) and use standardized precipitation deviations from a country's long-term monthly mean, using monthly precipitation data (mm/month) between 1979 and 2011 from the Global Precipitation Climatology Project Version 2.2. For example, in our dataset, Sri Lanka experienced the highest positive precipitation shock in 1984, which is the year in which the Mannar massacre occurred.

Control variables

Besides climate variability-related indicators, we expect other factors to influence the likelihood of child recruitment by rebel groups. These indicators are based on the existing supply and demand-side literature and are measured in the first year of the conflict period. Starting with the supply-related indicators, we control for *GDP per capita* and *Population size* using data from Gleditsch (2002). Tynes & Early (2015) argue that children in weaker states are more likely to join rebel groups. Additionally, we expect that larger populations have a larger size of the adolescent population, which might affect the level of child recruitment. We take the natural logarithm

of both indicators. Moreover, we include a measure for the level of *Democracy*. The expected impact of democracy on child soldier use is, however, unclear. Government repression might lead to an increase in child soldier recruitment by rebel groups, but authoritarian regimes may have enough control to make child recruitment by rebel groups more difficult (Lasley & Thyne, 2015). We use the modified polity indicator from Vreeland (2008), and negative (positive) values approach a purely autocratic (democratic) regime.

As for the demand-side indicators, we first control for *Conflict duration*. We expect that longer conflicts increase the likelihood that rebel groups are increasingly in need to prevail, which might increase their demand for children (Tynes & Early, 2015). We employ the natural logarithm (after adding 1) of the time (in years) elapsed since the start of a conflict-dyad-conflict period until its end. The information for this indicator is based on the Uppsala Armed Conflict Dataset (Gleditsch et al., 2002). Additionally, we control for the *Fighting capacity* of a rebel group. This is an ordinal variable where a value of 0 indicates 'low fighting capacity in comparison to the government', 1 means 'moderate capacity in comparison to the government', and 2 means 'high fighting capacity in comparison to the government'. We expect that rebel groups with low fighting capacity in comparison to the government are more likely to recruit child soldiers as they need to increase their military capacity by any means. Furthermore, we include a variable measuring a rebel group's *Territorial control*. This is a dichotomous measure of whether a rebel organization controls territory at all (coded as 1) or not (coded as 0). *Territorial control* may provide rebels with access to a variety of valuable resources. It can facilitate the recruitment of children (Kubota, 2013). The information of both *Fighting capacity* and *Territorial control* is taken from the NSA dataset (Cunningham, Gleditsch & Salehyan, 2009, 2013). We also expect that the type of conflict has an impact on rebel groups' child soldier recruitment. Given the need of rebel groups to attract international support to achieve their goal of state recognition, Lasley & Tynes (2015) contend that separatist rebellions are unlikely to use child soldiers because they are constrained by these norms. To control for this, we include a variable from the NSA data (Cunningham, Gleditsch & Salehyan, 2009, 2013) on whether a rebel group fights a *Secessionist* conflict (coded as 1) or not (coded as 0). Finally, states that have experienced no conflict for a longer period are more likely to maintain peace, and thus rebel groups might have fewer incentives to recruit children. To this end, we control for the time elapsed since the last child soldier recruitment (if any) by a rebel group using cubic polynomials (Carter & Signorino, 2010).

Table I. Descriptive statistics and VIF

Variable name	*Obs.*	*Mean*	*St. dev.*	*Min*	*Max*	*VIF*
Child soldier recruitment	312	1.24	0.80	0.00	2.00	
Temperature shock	323	0.12	0.29	−0.57	1.30	1.10
Precipitation shock	312	−0.01	0.19	−1.04	0.54	1.09
GDP per capita $_{ln}$	321	7.39	1.07	4.53	10.44	1.56
Population size $_{ln}$	315	10.09	1.89	5.92	17.69	1.42
Democracy	290	0.18	4.28	−6.00	7.00	1.48
Conflict duration$_{ln}$	324	1.01	1.00	0.00	3.70	1.07
Fighting capacity	313	0.38	0.55	0.00	2.00	1.22
Territorial control	322	0.34	0.48	0.00	1.00	1.12
Secessionist conflict	318	0.24	0.43	0.00	1.00	1.24

Variance inflation factors (VIF).

Table I summarizes the descriptive statistics for all variables employed in the analyses as well as the variance inflation factors (VIFs) of the explanatory variables. Multicollinearity is not an apparent issue since all VIFs are below the common threshold value of 5 (O'Brien, 2007).

Empirical analysis

In our empirical analysis, we examine whether climate variability (i.e. standardized deviation in temperature and precipitation) has an impact on child soldier recruitment (boys and girls) and, additionally, on the recruitment of girls. Due to our nominal dependent variable (categories of child soldier recruitment), we employ multinomial logistic regression models. We performed several tests for all specifications discussed below, but do not find evidence for a violation of the independence of irrelevant alternatives (iia) assumption.

Table II shows the results of this analysis when using the recruitment of boys as the baseline (reference) category. In Model 1, we solely depict the relationship between temperature and precipitation shocks and child soldier recruitment without any control variables. Since recruitment is driven by an interplay of supply and demand, we include all control variables in Model 2. In the first equation, we compare the likelihood of rebel groups not recruiting any children with groups that

Table II. Child soldiers and climate variability

	Model 1		*Model 2*	
	No child soldiers	*Boy & girl soldiers*	*No child soldiers*	*Boy & girl soldiers*
Temperature shock	–1.57**	1.03**	–1.79†	1.21†
	(0.74)	(0.49)	(0.91)	(0.62)
Precipitation shock	1.24	0.21	2.25†	–0.60
	(0.87)	(0.73)	(1.17)	(0.96)
Conflict duration $_{ln}$			–0.90***	0.79***
			(0.32)	(0.04)
Democracy			0.02	0.09*
			(0.06)	(0.05)
GDP per capita			–0.03	–0.26
			(0.24)	(0.19)
Fighting capacity			0.67	0.06
			(0.39)	(0.38)
Territorial control			–1.39***	0.12
			(0.53)	(0.36)
Secessionist conflict			0.19	–0.04
			(0.55)	(0.40)
Population $_{ln}$			–0.34**	–0.06
			(0.15)	(0.09)
Constant	–0.39**	0.30†	3.70	1.97
	(0.18)	(0.16)	(2.68)	(1.96)
Obs.		301		252
Pseudo Log-likelihood		–294.30		–207.19
Prob> χ^2		0.00		0.00

Multinomial logit; baseline category is boys' recruitment = 1. Variables for temporal control are included in both models. † $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

recruit solely boys. The second equation displays the likelihood that groups recruit boys and girls in comparison to rebel groups solely recruiting boys. In other words, the second equation displays the likelihood of girls also getting recruited by rebel groups.

The results show that there is a negative and statistically significant relationship between temperature deviations and no child recruitment in comparison to the recruitment of only boys. That is, more positive deviations in temperature are associated with an increase in the likelihood that boys are recruited (or, put differently, a decrease in the probability of not recruiting children). In other words, when temperature increases, it positively affects the supply of and demand for child soldiers during armed conflict. In line with our hypothesis, both models in Equation (2) show that positive temperature deviations increase the probability of recruiting both boys and girls in comparison to recruiting only boys, indicating that climate variability also affects girls.

Regarding our second climate indicator, precipitation shocks, the results are less clear. Models 1 and 2 in Table II show that positive precipitation deviations (e.g. heavy rainfall) increase the likelihood of seeing no children getting recruited compared to our baseline category of only-boys recruitment. However, precipitation shocks are not significantly related to the category of rebel groups recruiting both boys and girls. Hence, our results indicate that positive deviations in precipitation levels form an obstacle for rebel groups to recruit children.

The difference between temperature and precipitation shocks and their association with child recruitment might reflect the unclear relationship between precipitation and armed conflict. While some empirical studies find that sub-Saharan African countries are more likely to see civil conflict following adverse rainfall shocks, others do not find such a link (e.g. Miguel, Satyanath & Sergenti, 2004; Burke et al., 2009; Couttenier & Soubeyran, 2013). One reason for this might be that a sustained drought is more likely to lead to conflict in locations with rain-fed agriculture. However, due to limited information on the geographical location of where the children were recruited, we are unable to test this possible mechanism.

Figure 2 shows the simulated first differences of our core explanatory variables. These estimates show the change in the probability of recruitment when moving

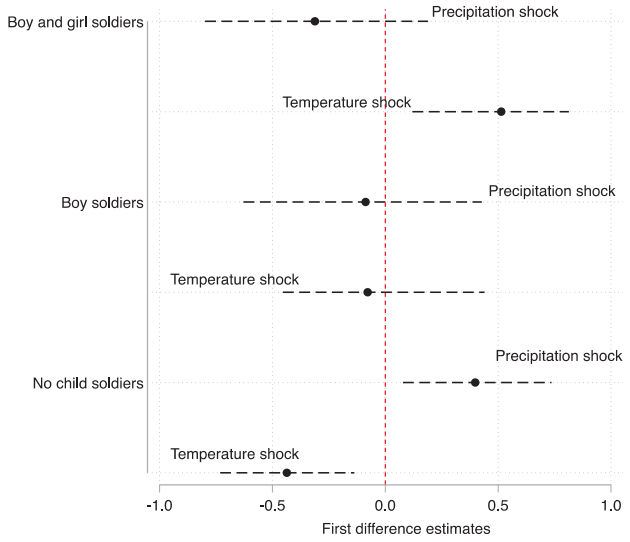

Figure 2. First difference estimates (based on Table II)

Simulated estimates are based on 1,000 draws from a multivariate normal distribution; horizontal lines indicate 95% confidence intervals; the vertical line indicates a first difference effect of 0; effects are calculated while all other variables are held constant at their median.

our climate variables from their minimum to their maximum value while holding all other variables constant at their medians. We find that there is a 40%-points decrease in seeing no child soldiers (40 percentage-points increase in seeing child soldiers) when temperature shock changes from its minimum to its maximum value (−0.57 to 1.30). In contrast, there is an increase of about 40 percentage points in not seeing any children recruited when the precipitation shock variable changes from its minimum to its maximum. When concentrating on the gender-specific categories, Figure 2 shows that the climate indicators are not significantly related to boy recruitment. However, there is a 50 percentage-points increase in the recruitment of boy and girl soldiers when temperature shock is altered from its minimum to its maximum value.

To assess whether the effects of the explanatory variables are identical across recruitment categories (no child soldiers, boys' recruitment, boys' and girls' recruitment), we focus on χ^2-test statistics (based on Table II). A statistically significant test statistic suggests that an explanatory variable exerts an impact on no child soldiers' recruitment that differs from the recruitment of both boys and girls. To this end, Table III highlights significant differences for *Temperature shock*, *Precipitation shock*, *Conflict duration, fighting capacity*, *Territorial control,* and *Population* (shown in bold). In other words, it is especially these indicators that determine whom rebels recruit: children (or not), boys, or boys and girls. This provides further evidence for our theoretical argument that temperature deviations affect boy and girl soldier recruitment in systematic ways.

Table III. Differences across categories

Coeff. for (0)– Coeff. for (2) =0	χ^2	*Prob* > χ^2
Temperature shock	7.22	**0.01**
Precipitation shock	4.56	**0.03**
Conflict duration $_{ln}$	26.49	**0.00**
Democracy	0.80	0.37
GDP per capita $_{ln}$	0.82	0.36
Fighting capacity	2.85	**0.09**
Territorial control	8.61	**0.00**
Secessionist conflict	0.11	0.74
Population $_{ln}$	3.52	**0.06**

Categories are 0 (no child soldiers) and 2 (boy and girl soldiers); significant estimates in bold.

With regards to our control variables, conflict duration is statistically significant in both equations of Model 2, indicating that the length of a conflict positively affects the likelihood that boys (first equation) and girls (second equation) are recruited. Moreover, we find a positive effect of *Democracy* on girl soldiers' recruitment: rebel groups operating in a more democratic regime are more likely to additionally recruit girls. This mirrors the argument that rebel groups in more democratic contexts are more gender-inclusive in their recruitment strategies (Wood & Thomas, 2017). Furthermore, we find that territorial control is a significant indicator for boys' recruitment, but it does not have a significant effect on the recruitment of boys and girls. This refers to the capacity of a rebel group: they perhaps do not see the need to recruit girls as well as boys.

Robustness checks

To examine the robustness of the association between climate variability and child soldier recruitment by rebel groups, we ran several additional analyses. These are especially important, given some drawbacks of the available data. The results of these analyses can be found in the Online appendix. First, we provide further visualization of our key variables and their distribution (Figure A1). Second, we cluster the standard errors by conflict period (Table A1) and control for unobserved unit-level effects at the conflict level by including fixed effects (see Table A2). No significant differences are found compared to the results presented in Table II. Third, we exclude long conflict periods from our estimation given that there is a variation in the length of conflicts. Removing long conflicts reduces unit heterogeneity that may

bias our results. In addition, we exclude very short conflicts (Table A3). Fourth, we employ an alternative way of combining our climate variability information with our data on child soldier recruitment. Instead of using the climate-related information of the first year of the conflict period, we have used the information of the final year of the conflict period (Table A4). We include several additional control variables or alternatives to existing ones. For instance, we replaced the population size variable with the size of the population up to 14 years of age to capture the supply side even more comprehensively than is done in the main analysis (Table A5). We also control for land-related productivity by adding a variable that accounts for the added value of agriculture, forestry, and fishing as a percentage of GDP from the World Bank (Table A6), and we control for the size of the country (Table A7). Moreover, we use alternative measures for child soldier recruitment. To this end, we first employ a dichotomous variable for the recruitment of child soldiers by rebel groups (Table A8). Second, we use two gradual measures of child soldiers and girl soldiers, respectively (Table A9). The results remain robust. Lastly, acknowledging the limitations of the data on child soldier recruitment, we combined the information on recruitment of child soldiers with disaggregated data on conflict events (UCDP Georeferenced Event Dataset version 21.1; Sundberg & Melander, 2013) at the first administrative level. This allows us to differentiate between regions in which many actors that recruit children are active and those in which fewer actors were active during the conflict in a given period. The results in Table A10 show that child recruitment especially occurs in those administrative units that experience temperature shocks.

Conclusion

Much research has focused on climate variability and how it might affect armed conflict (e.g. Hsiang, Meng & Cane, 2011; Theisen, Gleditsch & Buhaug, 2013; Salehyan, 2014). Our study adds to this literature by examining the impact of temperature and precipitation shocks on a conflict-related factor: child recruitment by rebel groups. By doing so, we attempt to open a new research field that is focused on examining the effect of adverse climatic conditions on subpopulations that might be particularly vulnerable: children in general and girls in particular.

Theoretically, we argue that climate variability affects the recruitment of children in two ways. First, economic and social pressures resulting from climate variability influence the supply of children willing to join these groups and their vulnerability for recruitment. Children are withdrawn from school and have fewer economic opportunities, and families are less able to protect them. Second, climate variability also increases the demand for children by rebel groups. Children are generally cheaper and demand less revenue. Additionally, we contend that climate variability not only affects the recruitment of boys but also substantially increases the likelihood of girls getting recruited.

Empirically, we have combined existing global data on temperature and precipitation shocks with information on child soldier recruitment by rebel groups. Our analysis shows that there is a significant association between positive temperature deviations and the recruitment of children by rebel groups. More importantly, we demonstrate that these shocks especially affect the recruitment of girls (in addition to boys).

Several important avenues of research exist. First, although we use the best available data to test the association between climate variability and child soldier recruitment, disaggregated data and analysis would significantly strengthen our causal mechanisms. In fact, the CSDS dataset does not offer temporal information on child soldier recruitment, and thus, we do not have yearly data on child soldier recruitment per rebel group. More precisely, more fine-grained spatial and temporal data on the recruitment of child soldiers (and their number) is necessary for a more thorough investigation. These data would allow us to exploit the variation in climate variability and link this to the recruitment of children in the short and long terms, thereby strengthening our causal inference. Second, currently, we offer several theoretical reasons that explain that climate variability is positively associated with child soldier recruitment, but we are unable to test the explanatory power of these mechanisms separately. For instance, future research should examine the interplay between loss in educational attainment due to climate variability and child recruitment or child labor. Additionally, climate variability is a rather general term that may also include other phenomena besides temperature or precipitation deviations. Therefore, we expect that short-term climatic events, such as disasters (e.g. floods, droughts, earthquakes), might also have an impact on child soldier recruitment, intensifying either the supply of or demand for child soldiers in comparison to adults.

Concerning policy implications, our work highlights the need to design policies to shield children from the harm caused by climate variability. Although climate scientists will continue to address the consequences of

climate variability and work to prevent human activity that contributes to climate variability, our research also highlights the importance of mitigation efforts. For instance, policies need to be designed that increase households' ability to undertake steps that would reduce their exposure to climate variability (for instance, change to the production of crops that are more weather-resistant), thus decreasing the supply of children willing to join rebel groups. At the same time, governments could develop and implement more policies directed to lower the demand of rebel groups for children. One way to do so is by raising the costs for child recruitment via punishing the perpetrators or setting up awareness campaigns on the negative effects it entails for children and societies. Given the implications of climate variability in conflict societies, there is a need for more ambitious policies that set priorities and overcome funding issues. At the same time, we emphasize that a more gender-specific climate policy is essential.

Replication data

The dataset, codebook, and do-files for the empirical analysis in this article, along with the Online appendix, are available at https://www.prio.org/jpr/datasets/. All analyses were conducted using Stata 14.

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