Master Thesis

MSc: Political Science (International Politics)

The 8th plague of civil war: The effect of locust swarms on civilian victimisation

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Abstract

In conflict literature, much attention has been given to the relation between food prices and conflict, as well as the effects of climate change on conflict and food security, in an attempt to explain civilian victimisation through food security. However, the effect of crop pests and diseases on violence against civilians has not been studied, despite the large proportion of worldwide crop loss caused by these factors. This study theorises that these pests pressure the local food supply and thus force armed groups to use violence in order to obtain their necessary resources from the local population. This results in the hypothesis that the occurrence of plant pests in an area increases the risk of violence against civilians by non-state actors. Specifically, this study focuses on the effects of locust swarms in four African countries: Somalia, Sudan, Ethiopia and Kenya. The hypothesis is quantitatively tested using both OLS regression and negative binomial regression. A positive correlation between locust swarm occurrence and violence against civilians is found, which holds up against both fixed effects and specific control variables. This new finding suggests that the occurrence of locust swarms shortens the time horizons for cooperation between rebels and the local population, incentivising rebels to quickly gain resources using violence rather than engaging in long-term, more peaceful cooperation.

Content

"For if you refuse (...),
behold, tomorrow I will bring locusts into your country,
and they shall cover the face of the land, so that no
one can see the land. And they shall eat what is left
to you (...), and they shall eat every tree of
yours that grows in the field, and they shall fill your
houses and the houses of all your servants and of all
the Egyptians, as neither your fathers nor your
grandfathers have seen…
(English Standard Version Bible, 2016, Ex. 10: 4-7)

Introduction

Ever since ancient times, the thought of losing crops to an all-devouring swarm of locusts must have instilled fear into the minds of farmers. Today still, locust swarms or other types of plant pests and pathogens are a real threat to food security, which can in turn drive political and social events. Past examples include the revolutions in Europe during the 1840s, as well as the fall of the Ming dynasty, which have both been partly attributed to food shortages (Vanhaute, Paping & Ó Gráda, 2006; Liu et al., 2018). In other words, the consequences of failed harvests can go far beyond the availability of food alone.

The relationship between food security and civil conflict has mainly been studied from two perspectives. The first of these focuses on effects of food prices on political instability and/or conflict (see e.g. Rezaeedaryakenari, Landis & Thies, 2020; Bellemare, 2015), and the second perspective focuses on effects of climate change on political stability and/or conflict (see e.g. Warsame et al., 2023; Sekhri & Storeygard, 2014; Salehyan & Hendrix, 2014; Koubi et al., 2012). Some literature combines the two (see Raleigh, Choi & Kniveton, 2015). However, both perspectives have their weaknesses. Food prices are influenced by government policy as well as by the availability of food itself, which blurs the relation of food prices and food security. And while crop loss due to climate change is a popular and relevant topic, it overlooks the various pests and pathogens (P&P) which globally destroy many crops and are thus important factors in providing food security. These factors, responsible for yield losses of up to 40% (Savary et al., 2019), could have similar effects on conflict to other exogenous shocks, but have not previously been related to conflict. This paper makes an attempt to fill that gap, posing the question how P&P influence violence against civilians by non-state actors. Civilian victimisation specifically is argued to be impacted by crop health, since other studies have already shown correlation between this aspect of conflict and other causes related to agriculture and food production (Rezaeedaryakenari, Landis & Thies, 2020; Bagozzi, Koren & Mukherjee, 2017; Dube & Vargas, 2013).

P&P come with considerable complexity and they are highly diverse, as are the crops they affect. This study specifically investigates the role of locust swarms in civilian victimisation across four African countries, as studying locust swarms has various advantages compared to other P&P. Besides, the 2019 locust upsurge has recently brought more attention to the subject and the need for the integration of social sciences in locust-related research (Therville et al., 2021; Retkute et al., 2021). Additionally, there is already some evidence that locust swarms can influence social-economic factors like education (De Vreyer, Guilbert & Mesplé-Somps, 2015). Therefore, this study serves a dual purpose; on one hand, it can broaden our understanding of civilian victimisation and the consequences of external shocks in conflict areas. In this context, locust pests act like one kind of external shock next to for example droughts, floods, earthquakes or hurricanes. On the other hand, it explores the social consequences of locust pests, and thus, indirectly, the possible merits of its abatement. Locust control operations require international cooperation and continuous dedication of resources, and are thus vulnerable (Therville et al., 2021; Showler & Lecoq, 2020); therefore, this study attempts to display the social consequences that swarms can have, highlighting the importance of locust control.

This study is structured as follows: first, the literature regarding civilian victimisation will be explored, which exposes the issue of P&P as significantly understudied in conflict science. The subsequent section will use this literature to formulate three causal mechanisms to describe how crop pests could impact the dynamics of conflict and rebel government. This is followed by a succinct description and justification of locust swarms as the specific pest covered in this study, as well as a justification for the selection of countries (Kenya, Somalia, Ethiopia and Sudan). Afterwards, the data collection and method of analysis is covered, after which the results are presented. Using these results, the final section then attempts to answer the research question and to provide avenues for future research. A positive correlation between crop damage by locust swarms and civilian fatalities is found, which holds up when controlled for both fixed effects and specific variables.

Civilian Victimisation: many causes?

The targeting of civilians in war may be one of its most cruel aspects. Many attempts have been made at exploring why civilians are being targeted, to what extend it is effective in achieving military or political goals, and which external factors stimulate or reduce civilian victimisation (see Balcells & Stanton, 2021).

Downes (2006) finds that there are two logics to civilian victimisation in warfare by states; first, states involved in dragging wars of attrition will target civilians in an attempt to win a war while risking little casualties of their own. Second, civilians may be targeted in contested areas, if the goal of the conflict includes territorial expansion, or if different ethnic groups claim the same territory. However, the use of violence against civilians by rebel groups may have additional purposes, especially if they are weak and lack resources (Wood, 2010).

As the use of violence against civilians is assumed to be grounded in rationality (Hoffman, 2004; Kalyvas, 2006), it can be influenced by various factors which alter for example costs, benefits, or opportunity. For instance, humanitarian intervention would increase the material incentives for looting and predation, and can be perceived as a challenge to the authority of a rebel group, thus increasing civilian victimisation (Wood & Sullivan, 2015). Likewise, there is evidence for foreign military intervention leading to increased civilian victimisation on the opposing side, and decreased civilian victimisation on the side receiving foreign reinforcement (Wood, Kathman & Gent, 2012). This fits well with Wood's (2010) general thesis that civilian victimisation can be the result of military inferiority. Several reasons are proposed: for instance, lower strength increases the difficulty of policing and maintaining control over civilians by non-violent means, and fewer available resources also means that there is less to provide to potential supporters. Air strikes also appear to increase the use of violence against civilians by their targets on the ground through causal mechanisms related to the rebel group's organisation and the psychology of the individual (Tucker, 2021). It is argued that when a clear front line is present and there is no threat of aerial bombardment, this concentrates the fighters with the highest propensity of engaging in civilian victimisation at the front lines with relatively little autonomy. When aerial bombardments are introduced, this increases the insurgents fatalities behind the front lines and increases the likelihood of low-ranking individuals getting promoted to posts where they have more autonomy to use violence against civilians. On the individual level, air strikes can cause anxiety and demoralisation, increasing the propensity of civilian victimisation (Tucker, 2021). Overall, the correlation between military losses and civilian victimisation seems to be widespread, though there is discussion on the precise causal mechanism at play (Costalli, Moro & Ruggeri, 2020; Polo & González, 2020). In general, it would appear that greater military vulnerability and weakness tends to make rebellions more likely to use violence against civilians.

However, certain characteristics of a rebel group can nuance this picture (Weinstein, 2006). When rebellions are relatively independent of local support, the propensity of civilian victimisation tends to increase (Wood, 2014). For example, foreign sponsorships or trade in gemstones, narcotics or gold decrease the insurgent's dependence on the local population and thus lowers the costs of perpetrating violence against civilians. The presence of large numbers of foreign fighters similarly increases civilian victimisation because they upset the ethnic balance in a host region, are less familiar with the local cultural norms, and decrease the rebel group's dependence of the local population for recruitment (Schwartz, 2023).

Scholars have also explored other driving factors for civilian victimisation beyond the organisational characteristics of insurgents or their military strength. Common avenues of research include armed group's relation to foreign actors, ideology, and emotional and psychological factors (Balcells & Stanton, 2021). Curtice (2021) argues that while civilian victimisation is more likely in democracies, it is more extensive in autocracies. It is argued that in democracies, civilian victimisation can help in motivating the population to use their democratic rights, but the potential cost of harming civilians rapidly increases when the abuse becomes too severe. From a more psychological perspective, there is evidence that the expectations of the behaviour of the adversary also shapes a rebel group's use of violence against civilians (Gibilisco, Kenkel & Rueda, 2022). This is reflected somewhat in Cederman et al. (2020), which focuses on the impact of ethnic targeting by government forces. Alternatively, Ahmadov & Hughes (2020) emphasise that while these factors can matter, significant variation in civilian victimisation can be explained through the armed group's ideology. Still, different ideologies may resort to similar types of violence (Kalyvas, 2006). Lastly, it should be noted that even though civilian victimisation is assumed to be grounded in rational considerations, this does not necessarily reflect or align with military strategy: often, incidents of violence are not ordered by insurgent superiors (Weinstein, 2006).

Food security and conflict

One common way to capture food security is through food prices. Food prices and their relation to civil unrest and violence have been the topic of many previous studies (see e.g. Rezaeedaryakenari, Landis & Thies, 2020; Bellemare, 2015; Weinberg & Bakker, 2015;

Raleigh, Choi & Kniveton, 2015). In general, these studies find a positive correlation between (rising) food prices and instability, violence or civilian victimisation. The methods applied here are similar to studies on price shocks of export-focussed "cash crops" or natural resources like oil and diamonds (Dube & Vargas, 2013; Rigterink, 2020). However, while elevated food prices impact the purchasing power of households and may thus cause grievances, they do not necessarily provide an accurate picture of food security, as prices are strongly influenced by government policy (Weinberg & Bakker, 2015). Governments influence prices of staple foods in particular to favourably influence purchasing power of either the urban population (artificially low prices) or the rural population (artificially high prices). Therefore, price levels may not always accurately reflect food security: if government policy pushes the price of grain down, this does not mean that grain becomes more available per se. It can even have the opposite effect, because lower food prices could reduce the incentive of cultivation of food staples in favour of cash crops. Koren & Bagozzi (2017) get around the problem of food pricing by looking at the impact of cropland itself and find that areas with high cropland experience higher civilian victimisation during times of conflict, but less during times of relative peace. This difference is explained by the lack of incentive for long-term cooperation between rebel groups and farmers during periods of conflict due to the shorter time horizon.

Another branch of research has approached the matter of food security from a climate-related perspective, arguing that climate shocks reduce harvests and can negatively influence food security (Raleigh, Choi & Kniveton, 2015). While global warming is commonly linked to conflict (Kelley et al., 2015), evidence is mixed; some studies find correlation between climate shocks and conflict (Releigh, Choi & Kniveton, 2015; Sekhri & Storeyguard, 2014; Bagozzi, Koren & Mukherjee, 2017; Salehyan & Hendrix, 2014), while others find none (Koubi et al., 2012). More broadly, Haer and Rezaeedaryakenari (2022) look at effects of natural disasters and find that there are differences between short- and long-term effects. Disasters are argued to typically decrease civilian victimisation directly following the disaster until it reaches a minimum, after which civilian victimisation goes up to a higher level than before. However, while biological disasters were included in one of the models used by Haer and Rezaeedaryakenari (2022), no studies have looked at the effect of crop pests and diseases alone on civilian victimisation. This is striking, since this factor contributes to significant losses in agricultural production, especially in vulnerable regions like Sub-Saharan Africa where they are estimated to be as much as 40%, depending on the crop type (Savary et al., 2019). Additionally, global warming and associated changing weather patterns are also expected to increase the damage due to crop pests and diseases in the future, which adds another dimension to existing studies on climate variables and conflict (IPPC Secretariat, 2021). Because of the impact of P&P on food security, this study attempts to answer how this factor influences civilian victimisation.

Theory

In order to explain the use of violence by rebel groups against populations, various assumptions have to be considered. First, it is assumed that a rebellion or armed group has an inherent disadvantage in numbers or strength compared to state forces. As a result, they become active in rural areas where the stronger state opposition can be more easily evaded (Bagozzi, 2016; Weinstein, 2006). Second, these armed groups rely mainly on the local population for their food supplies, extracting it either monetarily as tax or in natura, essentially ‘living off the land’ (Koren & Bagozzi, 2017). Generally, this is preferably done by non-violent means. Violence is used instrumentally to make up for a lack of strength or cooperation from locals (Wood, 2010). If violence is used, it is to frighten civilians and show that the government cannot protect them, which is most important for weaker groups who would not be able to coerce the local population without resorting to violence (Hoffman, 2004). The eventual goal of rebel groups concisely summarised by Kalyvas (2006, p. 104) as passive but exclusive collaboration and compliance of the local population. Third, the local population behaves in an opportunistic way. For most ordinary people in conflict areas, considerations of survival and general economic motives trump ideological preferences, while social ties can also matter (Kalyvas, 2006). Additionally, collaboration with a rebel group at a certain point in time does not exclude the possibility of defection or collaboration with the opposing side at a different time.

First, if the availability of food is high, the opportunity cost to farmers to donate part of their harvest to a local violent group is relatively low, as farmers have enough available and prices are low (Rezaeedaryakenari, Landis & Thies, 2020). Therefore, it is less likely that the violent group needs to resort to violence in order to mobilise these resources. However, plant diseases can suddenly disrupt harvests and can drastically limit food productivity of an area. The lower availability of food leads to farmers being less likely to voluntarily contribute to a violent group's efforts. Farmers hit by the pests have less food to spare and may face starvation when complying with rebel groups. Farmers who are not directly affected by pests face inflated prices, which also increases the opportunity cost of giving food away to armed groups. For these reasons, rebel groups will have a harder time collecting voluntary food contributions and therefore, they will be more likely to resort to violence to forcibly take the resources they need, or to coerce the population into compliance.

Rebels would also be more likely to use violence through a different mechanism which also affects the relation between rebels and people not directly involved in food production. As pests ruin harvests, the resources a rebel group can mobilise from the population decline, essentially making the rebel group weaker. Wood (2014) argues that as a rebel group has less to offer to the local population, incentives to cooperate voluntarily with the rebel group decline and thus, incentives to force cooperation increase. Alternatively, the rebel group may be forced to seek external resources (like foreign funding or illicit trade). This loosens their ties with and dependence on the population and thus reducing the cost of targeting the population with violence. In other words, while targeting the population with violence is undesirable when rebel groups are strong but rely on the population, crop pests can disturb this relationship through various channels, increasing the incentive and decreasing the punishment for civilian victimisation.

Lastly, a likely presence of P&P also reduces the rebel government's expectations of how fruitful cooperation with local farmers will be in the future. This causal mechanism relies on Koren & Bagozzi's (2017) argument that farmer's time horizons matter for civilian victimisation, and that where there is an incentive for long-term cooperation, there is less violence against civilians. If there is a high chance that crops fail, the production of farmers becomes unreliable, and rebel governments are incentivised to (forcibly) take as much as they can in the short term. Long-term cooperation through non-violent means is thus prevented, as the rebels can never be sure that future harvests will be as good. This mechanism suggests that P&P can influence conflict dynamics far beyond the area or time where and when they actually occur, because it changes expectations rather than just outcomes.

Thus, these three mechanisms lead to the following hypothesis:

H_1: Higher crop damage due to P&P leads to more violence against civilians.

It should be noted that there exists literature which suggests that natural disasters can act as critical turning points, and that in the wake of natural disasters, armed actors are more likely to engage in ceasefires or peace talks (Kreutz, 2012; Nemeth & Lai, 2022). As a result, violence following a natural disaster may actually be decreased. This implies that P&P can have a reverse effect to what is predicted in H_1. However, it appears unlikely that this is the case for locust pests for several reasons. First, while earthquakes or floods affect people in an geographical area with a similar threat, P&P affect people differently based on their socioeconomic circumstances. Rather than bringing together a community, food shortages may thus magnify existing economic inequality. Similarly, the damage by P&P itself can differ greatly across different farms, devastating some while leaving others relatively unaffected. Second, the crops that P&P affect are a resource that has importance to insurgents and civilians alike, and a shortage can thus create tension between groups. Finally, while other types of disasters may require large-scale cooperation in the aftermath (for example, reconstruction of buildings and clearing rubble in the case of earthquakes, or emergency healthcare in the case of a pandemic), which in turn brings people together and incentivizes peaceful cooperation, this is not usually the case for P&P, and in particular the locust pests this study focuses on (see below). Instead, P&P usually requires cooperation beforehand to prevent their manifestation. Once the locust swarms have formed and the crops are lost, there is little a community can do to recover the damage.

Locust pests

A plant pest is defined as "any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products" (IPPC Secretariat, 2021, p. 2). This naturally includes a wide range of different organisms, ranging from viruses to vertebrates, affecting different crops. In order to allow for specific research, however, this paper will limit itself to one specific kind of pest: desert locusts (*schistocerca gregaria*).

Locusts have an ancient reputation when it comes to their damage to agriculture, being mentioned by the ancient Egyptians, and in the Iliad, Bible and Mahabharata. The Food and Agriculture Organisation (FAO) of the United Nations refers to it as the "most destructive migratory pest in the world" (2020). Locust pests occur in 30 to 60 countries, many of them being amongst the poorest in the world, and many of them suffering from insecurity (Showler & Lecoq, 2021). This is generally a problem when it comes to gathering data on plant pests, since political instability, conflict, poor governance and lack of infrastructure hamper both proper pest management and data collection (Nwilene, Nwanze & Youdeowei, 2008). However, while many other pests require in situ diagnosis (which is difficult in conflict areas), locust activity can be detected and even forecasted remotely using weather and satellite data. Additionally, swarms can be reported by commoners without much knowledge on the subject (Showler, 2023). This combination of factors makes locusts a suitable case to study the relation between plant pests and violence against civilians. Besides, there is already some evidence that locust outbreaks act as negative income shocks and have social consequences. De Vreyer, Guilbert and Mesplé-Somps (2015) find that cohorts of rural children who grew up during locust plagues received less education than earlier or later cohorts. Studies like these are rare, however, which is why various authors advocate for an integration of social sciences into locust-related research (Therville et al., 2021; Lockwood & Sardo, 2021). By looking at the impact of locust pests on civilian victimisation in civil conflict, this study attempts to comply with this desire.

Naturally, this study also needs to take into account the particularities regarding the formation of locust swarms and control measures. Most importantly, the formation of locust swarms is stimulated by rainfall, and locust swarms, once formed, actively move towards areas where it has recently rained (Tratalos et al., 2010). This has caused locust swarms to be referred to as "the curse of good rains" (Friedman, 2012). In contrast, droughts can also harm agricultural output and have been linked to civil violence (Sekhri & Storeyguard, 2013; Raleigh, Choi & Kniveton, 2015; Salehyan & Hendrix, 2014). Therefore, while locust swarms may damage crops, the higher availability of water which caused them to spawn in the first place could cancel out this effect. Therefore, the possible effects of above or below average precipitation will be taken into account in this study (see below).

Secondly, control operations can be carried out to reduce the incidence or impact of locust swarms. These are generally considered to be a community or government responsibility, since the locusts can rapidly move from one farm to another and their breeding area can differ from their damage area (Therville et al., 2021). The desert locust in particular requires large-scale operations in the main breeding areas to prevent swarms, which can be challenging in areas plagued by conflict or instability (Showler & Lecoq, 2021). Additionally, large periods of relative absence of swarms can cause funding and attention to be diverted to other areas, increasing the severity when new swarms do form (Therville et al., 2021). Because locust control operations can be hampered by conflict, it would be possible that a reverse direction of causality to H_1 exists. Rather than crop damage influencing civilian victimisation, areas with high civilian victimisation also have less effective means of combating locusts and therefore are more likely to experience crop damage.

There are, however, several reasons why this is improbable to harm the validity of this study. First, where locusts move and damage crops once formed is determined mostly by rainfall rather than by the effectiveness of locust control in that particular area. Once a swarm has formed, there is little an individual farmer or community can do to prevent the loss of crops. Ethiopian farmers are reported to use 'smoke, guns, and noise' in a final effort to drive locusts away, but this is hardly effective against large swarms (Gardner, 2020). Second, reports from Ethiopia and Afghanistan (Gardner, 2020; Davies, 2023) suggest that the areas with the highest intensity of conflict do not necessarily have worse locust control than relatively peaceful areas. However, most importantly, a lagged variable for locust pest crop damage will be used in the analysis. Therefore, the possibility of reverse causality to be observed in the analysis can be largely discarded.

East Africa

In order to assess the relation between locust swarms and violence against civilians, there is a need to study violence in countries where locust swarms are relatively common occurrence. Additionally, to fit the theoretical model, which emphasises interactions between armed groups and local civilians, a country needs some degree of civil instability including violence against civilians by non-state actors. East Africa fits both of these requirements, while also allowing for some variation in the degree of conflict intensity. The countries studied are Somalia, Ethiopia, Sudan and Kenya, over a period starting in January 2010 and ending in January 2022. This period has been chosen on the basis of the availability and precision of data, the occurrence of different degrees of violence, and surging and waning incidences of locust plagues over time in the studied countries. Figures 1-3 (Showler & Lecoq, 2021, pp. 90-96) indicate the desert locust breeding areas in three of the studied countries; in contrast to the other countries, Kenya has no significant breeding areas within its own borders, but it still suffers from swarms migrating from the north.

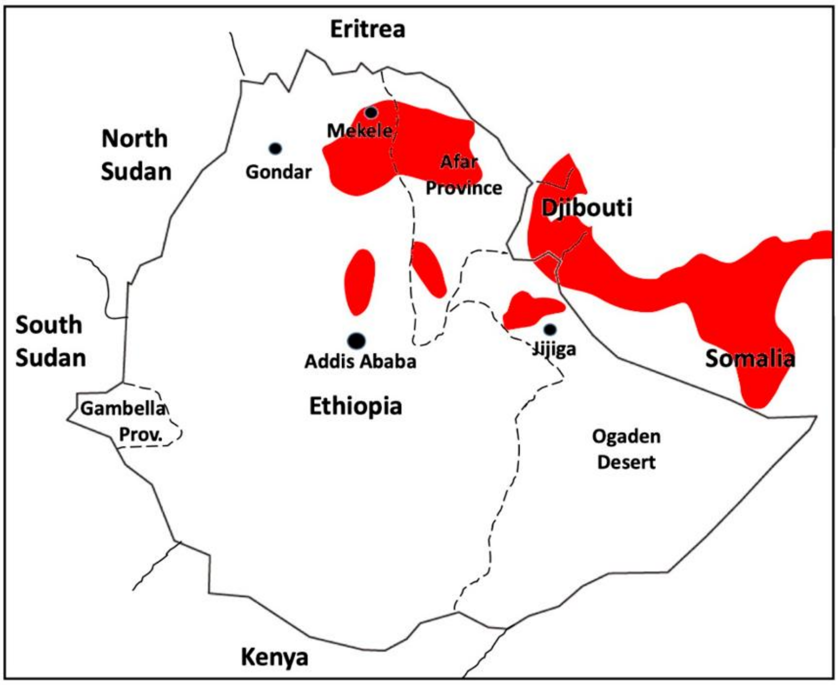

Figure 1. Locations and regions mentioned in the text in relation to desert locust activity and insecurity in Ethiopia. Primary breeding areas in red. Reprinted from "Incidence and ramifications of armed conflict in countries with major desert locust breeding areas," by A.T. Showler and M. Lecoq, 2021, *Agronomy, 11*, p. 90. Copyright [2021] by the authors.

Figure 2. Locations and regions mentioned in the text in relation to desert locust activity and insecurity in Somalia. Primary breeding areas in red. Reprinted from "Incidence and ramifications of armed conflict in countries with major desert locust breeding areas," by A.T. Showler and M. Lecoq, 2021, *Agronomy*, *11*, p. 94. Copyright [2021] by the authors.

Figure 3. Locations and regions mentioned in the text in relation to desert locust activity and insecurity in Sudan. Primary breeding areas in red. Reprinted from "Incidence and ramifications of armed conflict in countries with major desert locust breeding areas," by A.T. Showler and M. Lecoq, 2021, *Agronomy*, *11*, p. 94. Copyright [2021] by the authors.

Data and operationalisation

The dependent variable, violence against civilians, can be operationalised using data from the Armed Conflict Location and Event Data Project (Raleigh et al., 2010). The choice for this dataset is largely based on the low threshold for violent events to be included, allowing for more incidents, including ones with few or no fatalities, and thus more detailed data. Only violent actions against civilians by non-state armed actors, like rebel groups and militias, are considered. The number of fatalities as a result of these events is then aggregated for each month and each country which results in a country/month unit of analysis.

The main independent variable, the damage due to locust swarms, is measured using data from the FAO Locust Hub (2022). For every month, the total hectare of farmland damaged due to locust swarms is divided by the total area of agricultural land in the country to estimate the relative impact of the locust swarms. This method admittedly has its limitations because the locust swarms could have effected a very different area than where the violence takes place. As described above, however, there is certainly a theoretical possibility for crop damage to have effects outside the area that is actually effected. Besides, while the breeding areas of locusts are relatively fixed, the areas they swarm to are determined by recent rainfall, which is much more variable.

Locust swarms tend to form following periods of heavy precipitation. Therefore the occurrence of locust swarms could be associated with a decrease in violence, because the increased rainfall caused the swarms to form, but also improved the yields of farmers who were not affected. If the positive effect of the rainfall overshadows the negative effects of the locust swarms, this could be problematic to our theoretical model. Therefore, the analysis will control for higher or lower levels of precipitation. This is done using the dataset by Funk et al. (2015) which uses the Climate Hazards group Infrared Precipitation with Stations (CHIRPS) method to estimate the precipitation relative to the long-term average in each country.

Various controls will be introduced to account for other factors which can explain violence against civilians. Firstly, to account for increased violence resulting from violence in the previous month (autocorrelation), a lagged variable of fatalities is introduced. Secondly, attempting to separate actual agricultural damage by locust swarms and higher food prices which can also be influenced by other factors (Weinberg & Bakker, 2015; Rezaeedaryakenari, Landis & Thies, 2020), the FAO food consumer price index (FAOSTAT, 2023) will also be controlled for. Other controls variables from conflict literature include real GDP growth (Raleigh et al., 2015; Bohlken & Sergenti, 2010), population growth (Cranmer & Siverson, 2008; Myers, 1989), democracy level (Kathman & Wood, 2016) and child mortality rate (Rezaeedaryakenari, Landis & Thies, 2020; Goldstone et al., 2010) to account for the effects of increased economic activity, overpopulation, democratic outlets and development respectively. To have the control variables be suited to a country/month level of analysis and make it possible to compare the four countries together, growth percentages rather than absolute values are used for population and real GDP. This data is derived from the World Bank (2023). Lastly, fixed effects are introduced. Country fixed effects take into account country characteristics that do not extensively change over the studied time period. Month and year fixed effects account for events and trends that may for any reason cause fatalities to be higher or lower in certain years or months within the studied time period.

Table 1. Regression models for fatalities due to civilian victimisation by non-state actors.

	OLS, fatalities	NB, fatalities	OLS, fatalities	NB, fatalities
(Constant/Intercept)	150,20** (73,71)	16,61*** (2,98)	-27,17 (18,38)	16,546*** (2,978)
Relative area affected by locusts (x1000, 1-month lag)	5,56*** (1,19)	0,13*** (0,03)		
Absolute area affected by locust (x1000, 1-month lag)			0,24*** (0,04)	0,004*** (0,001)
Fatalities (lag)	0,32*** (0,04)	0,01*** (0,00)	0,33*** (0,04)	0,01*** (0,002)
Food price inflation	-0,01 (0,08)	0,00 (0,00)	-0,03 (0,07)	0,00 (0,00)
GDP growth	-0,55 (0,89)	0,04* (0,02)	-0,83 (0,52)	0,04* (0,02)
Rainfall	-0,06 (0,06)	0,00 (0,00)	-0,05 (0,06)	0,00 (0,00)
Population growth	5,67 (9,45)	-0,23 (0,20)	12,46 (8,83)	-0,23 (0,20)
Child mortality	-2,05* (0,91)	-0,15*** (0,02)	0,01 (0,15)	-0,15*** (0,02)
Fixed effects - country	Y	Y	Y	Y
Fixed effects – month/year	Y	Y	Y	Y
N	528	528	528	528
Adj. R^2	0,19		0,21	
Log Likelihood		-2098		-2096

Note: regression coefficients with standard error in brackets.

$^{***}p < 0,001$ $^{**}p < 0,01$ $^{*}p < 0,05$

Method and results

Multiple models were estimated using both ordinary least squares regression (OLS) and negative binomial regression (NB). The latter model differs from OLS in that it assumes a count data distribution with a high dispersion. It should be noted that in the OLS model, the assumption of normally distributed errors is violated, and thus, NB is the preferential model. The most robust models of the cross-national analysis, in terms of expected bias, are reported in table 1. Democracy level was removed from the analyses above as there was no available data for Somalia, leading to a large number of missing cases. However, when the democracy level variable was included, the model did not drastically change, and the democracy level variable itself was not significant (see table 1 in the appendix).

Both of the cross-national models reported in table 1 find a positive correlation between relative locust swarm damage to cropland and civilian fatalities inflicted by non-state forces one month later. This correlation is significant at a 99,9% level. Additional variables which attain significant coefficients are the lagged variable as expected, and child mortality. The latter shows a negative correlation with civilian fatalities, suggesting that higher development (lower child mortality) leads to more civilian casualties. This contradicts much prior research (Rezaeedaryakenari, Landis & Thies, 2020; Goldstone et al., 2010; Bohlken & Sergenti, 2010), though there is also literature which supports this negative correlation (Kandala et al., 2014). Still, we have to take into account that this correlation may result from two general causally unrelated trends towards lower child mortality and higher fatalities between 2010 and 2022. The same applies to GDP growth, which in the NB model shows a positive correlation with civilian fatalities, suggesting that economic growth stimulates violence against civilians, though this could be argued to be a result of a higher looting incentive or higher prices of export goods critical to rebels (Rigterink, 2020; Collier, Hoeffler & Rohner, 2008). As the effects of child mortality and GDP growth partly overlapped with fixed effects, both models were also run without fixed effects. This flipped the effects of child mortality and GDP growth to be positive and negative respectively in the NB model while remaining significant, which is more in line with theoretical expectations (see table 1 in the appendix). However, conclusions based on the control variables should be drawn with caution since their effects and significance are impacted strongly by the inclusion of fixed effects, as well as the model itself (NB/OLS).

Interpretation

The analysis shows a clear association of high relative damage to agricultural land by locusts with increased violence against civilians. This association holds up against fixed time and space effects and various control variables related to rainfall, development, food prices and economic growth. However, several limitations need to be taken into account interpreting the models. While the number of fatalities is associated with locust pests damage, the models were also run with the number of incidents as dependent variable (see appendix, table 2). In this case, the locust swarm damage variable lost its significance, while other control variables gained significance. Besides, the association of locust swarm damage and fatalities was only significant with a one-month lag; in models with longer (2-, 3-, and 4-month lag) timescale, locust damage had no significant impact (see appendix, table 3 and 4). This suggests a relatively short increase of intensity of violence (but not necessarily the propensity of violence occurring) following destructive locust pests, in a relatively short and specific timeframe. This does not directly contradict either of the theoretical explanations, but it appears to fit especially well to the time-horizon mechanism. Assuming that most people are unknowledgeable of the expected migratory path of any swarm, the news of one swarm emerging somewhere in the area could set off a chain of events where the fear of sudden crop loss shortens time horizons in a much larger area than what actually ends up getting effected by locusts. Rebels are incentivised to take whatever they can quickly, as locusts may already be on their way. This lowered incentive of long-term cooperation with locals then leads to higher violence against civilians through a similar mechanism as described by Koren & Bagozzi (2017). To further test the validity of this particular causal mechanism, the analysis was run with absolute damaged cropland (in hectare) instead of relative damaged cropland. The following line of reasoning is herein followed: if one swarm does significant damage in an area, this will impact rebel groups and farmers all around it, regardless of how productive the area is. While the threat of a locust infestation in an area with already low agricultural productivity appears greater, this matters little to the individual farmer, rebel group or militia. Indeed, model 3 and 4 in table 1 show that the effect of absolute damaged cropland is very similar to that of relative damaged cropland.

Additionally, the lack of a significant effect for food price in any of the models also suggests that it may not necessarily only be the lower availability of food which causes higher civilian victimisation; after all, if this were the case, a positive correlation between food price inflation and fatalities would be expected. Consequently, this does not fit the causal mechanism that runs through inflated opportunity costs. To test whether an effect of food prices may be absorbed by the locust swarm variable (after all, locust infestation could be associated with food price inflation), the models were run without it, but food price inflation still did not have any significant effect (see table 5 in the appendix). It should be noted that data for food price inflation and economic growth can be highly unreliable in the studied countries, causing some authors to use proxy variables instead or use other sources of data which are more directed to the local level (Shortland, Christopoulou & Makatsoris, 2013; Rezaeedaryakenari, Landis & Thies, 2020).

Lastly, the specific timeframe in which violence intensity is predicted to increase as a consequence of locust swarm damage, does cause some friction with the causal mechanism which emphasises the strength of a rebellion and their dependence on local populations. If this mechanism were at play, a larger lag between the damage by locust swarms and increased violence would be expected (or generally a less specific timeframe), as it takes some time for rebellions to lose or gain strength, and to explore new avenues of income. Therefore, the time horizon logic appears to be the most likely mechanism at play.

When placing the results from this analysis of locust swarms in the wider context of crop pests and pathogens (P&P), it would appear that similar results could be expected, with some notable differences. A possible difference between locusts and other types of P&P would be the character of locust pests as an exogenous shock that comes relatively suddenly and can also disappear for large periods in time. This cycle is actually argued to be one of the leading hurdles for effective locust control, as funding and attention is often redirected during periods of relative inactivity (Therville et al., 2021). Still, the results from this study do suggest a role for a wider array of P&P than just locusts. Overall, the theoretical mechanisms for why P&P could affect civilian victimisation are not limited to locusts: high prevalence of plant pathogens still raises opportunity costs for farmers, weakens the local dependence on farmers and shortens time horizons for cooperation. Therefore, some overlap on the role of locusts and P&P in general in conflict is to be expected, and H_1 is found to be supported.

Conclusion

Plant pests and pathogens (P&P) are responsible for a large portion of global crop loss, and thus play an important part in improving food security. However, while many other factors related to food security have been argued to influence civil conflict and civilian victimisation, this has not yet been the case for P&P. This study has made an attempt to fill this gap by studying the impact of locusts swarms on civilian victimisation by non-government actors in Somalia, Sudan, Kenya and Ethiopia. The choice of locusts as study subject is based on the relatively unbiased character of the available data, and the recent uproar in desert locust activity in Eastern Africa which has revealed the need to study the social consequences of these pests. It is theorised that the occurrence of P&P increases civilian victimisation through three possible mechanisms. Firstly, it increases opportunity costs for cooperation with rebels through a higher scarcity of food, leading to a higher propensity of violently forced cooperation. Secondly, this drives local populations and rebel groups apart, incentivising rebel groups to look for methods of acquisition that make them less reliant on local populations, thus increasing the risk of violence against said civilians. Lastly, high prevalence of P&P shortens time horizons for cooperation, discouraging long-term, relatively peaceful cooperation between rebel groups and local population because of the constant risk of crop loss. It instead encourages rebel groups to redeem whatever resources possible, possibly with violence, quickly and without hesitation.

Using negative binomial regression and ordinary least squares regression models, significant positive correlations are found between both relative and absolute damage to farmland by desert locusts and civilian victimisation by non-government actors. These results remain robust when controlled for economic, developmental, meteorological and demographic factors, as well as fixed effects in time (month, year) and space (country). These results suggest a role for P&P in the complicated and murky causes behind civilian victimisation and the mechanics of civil war. Specifically, the results appear to support the time horizon logic, and find less support for the causal mechanisms related to inflated opportunity costs and reliance on the local population. Therefore, it stresses the need for further research on this topic. For example, using a more area-specific or geo-referenced approach, including other types of pathogens or pests, or looking deeper at the relation between conflict and pest control would be suggested areas of research. While data collection has been problematic for many plant pathogens, new advances in self-learning algorithms which can detect plant diseases based on images, without the need for *in situ* inspection, could in the future provide much more extensive and less biased data on where plant pathogens emerge and the extent of their occurrence (Sambasivan & Opiyo, 2021; Harakannanavar et al., 2022).

It should be noted that there are some limitations to this study. Apart from the additive value of the previously mentioned geo-referenced data, this study does not provide qualitative evidence to confirm or clarify causal mechanisms related to locust pests and civilian victimisation. Future studies can provide insight in how farmers in conflict areas perceive the threat of locusts (or P&P in general) by providing first-hand accounts. Besides, it remains largely unclear whether and to what extent rebels are involved in locust prevention measures. Anecdotal evidence from Ethiopia suggests that a failure of the state to provide adequate locust control can delegitimize the state and provide an opportunity to rebels to gain favour from the population (Gardner, 2020). Alternatively, as locust pests tend to surge and wane over time, future quantitative research could compare periods of intense locust activity with periods of relative inactivity. This could reveal other social or economical consequences of locust pests.

At the time of writing, Moroccan locust pests in northern and north-eastern Afghanistan are threatening food security in the country. With foreign aid to Afghanistan being cut off, locust control in the country has been reduced to traditional, labour-intensive methods (Davies, 2023). This once again shows the importance of professional and large-scale locust control. While acknowledging that locust control in conflict regions can be cumbersome at best and perilous at worst, this study shows that locust control could contribute to not only higher food security, but also to a more peaceful society in conflict regions. In order to achieve this, multilateral cooperation is unavoidable (Therville et al., 2020). It still continues to be important to recognise the multiple interrelated causes that drive civil war and the behaviour of involved agents. The occurrence of P&P is to be just one of many, and likely not the most influential. Therefore, one might compare the impact of P&P on civil war to the locusts of the

8th biblical plague of Egypt, as it being just one of many curses that can drive the misery of civil war.

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Appendix

Table 1. Regression models with democracy variable included and without fixed effects

	OLS, fatalities	**NB, fatalities**	**OLS, fatalities**	**NB, fatalities**
(Constant/Intercept)	328,40** (102,36)	1,14 (8,14)	-10,20 (14,09)	2,11*** (0,28)
Relative area affected by locusts (x1000, 1-month lag)	4,43** (1,31)	0,09** (0,03)	6,11*** (1,10)	0,11*** (0,03)
Fatalities (lag)	0,26*** (0,05)	0,01*** (0,00)	0,36*** (0,04)	0,01*** (0,00)
Food price inflation	-0,13 (0,11)	0,00 (0,00)	0,03 (0,06)	0,00 (0,00)
GDP growth	-0,39 (1,12)	0,08** (0,02)	-0,56 (0,47)	-0,05*** (0,01)
Rainfall	-0,06 (0,07)	0,00 (0,00)	-0,05 (0,06)	0,00 (0,00)
Population growth	9,61 (16,30)	-0,35 (0,35)	9,54 (7,68)	0,09 (0,15)
Democracy level	8,91 (35,46)	-0,61 (0,77)		
Child mortality	-4,99* (1,96)	-0,28*** (0,05)	0,04 (0,14)	0,01** (0,00)
Fixed effects - country	Y	Y	N	N
Fixed effects – month/year	Y	Y	N	N
N	432	432	528	528
Adj. R^2	0,209		0,19	
Log Likelihood		-1605		-2169

Note: regression coefficients with standard error in brackets.
***p < 0,001 **p < 0,01 *p < 0,05

Table 2. Regression models of incidents of civilian victimisation by non-state actors

	OLS, incidents	**NB, incidents**
(Constant/Intercept)	-58,99***	14,07***
	(12,67)	(3,06)
Relative area affected by locusts	0,03	0,02
(x1000, 1-month lag)	(0,20)	(0,03)
Fatalities (lag)	0,04***	0,01***
	(0,01)	(0,00)
Food price inflation	-0,02	-0,00
	(0,01)	(0,00)
GDP growth	0,22	0,02
	(0,15)	(0,02)
Rainfall	0,00	0,00
	(0,01)	(0,00)
Population growth	11,69***	0,42*
	(1,63)	(0,20)
Child mortality	0,26	-0,05*
	(0,16)	(0,02)
Fixed effects - country	Y	Y
Fixed effects – month/year	Y	Y
N	528	528
Adj. R^2	0,71	
Log Likelihood		-1735

Note: regression coefficients with standard error in brackets.
***p < 0,001 **p < 0,01 *p < 0,05

Table 3. Regression models of 2- and 3-month lag

	OLS, fatalities	NB, fatalities	OLS, fatalities	NB, fatalities
(Constant/Intercept)	111,57 (75,57)	17,67 (3,98)	112,59 (75,52)	17,53*** (2,98)
Relative area affected by locusts (x1000, 2-month lag)	-0,18 (1,24)	0,00 (0,03)		
Relative area affected by locusts (x1000, 3-month lag)			-0,06 (1,23)	0,02 (0,03)
Fatalities (lag)	0,32*** (0,04)	0,01*** (0,00)	0,32*** (0,04)	0,01*** (0,00)
Food price inflation	-0,09 (0,08)	0,00 (0,00)	-0,09 (0,08)	0,00 (0,00)
GDP growth	-0,38 (0,91)	0,05** (0,02)	-0,38 (0,91)	0,05** (0,02)
Rainfall	-0,07 (0,06)	-0,00 (0,00)	-0,05 (0,06)	-0,00 (0,00)
Population growth	6,29 (9,66)	-0,24 (0,20)	6,29 (9,67)	-0,25 (0,20)
Child mortality	-1,58 (1,96)	-0,16*** (0,02)	-1,59 (0,93)	-0,16*** (0,02)
Fixed effects - country	Y	Y	Y	Y
Fixed effects – month/year	Y	Y	Y	Y
N	528	528	528	528
Adj. R^2	0,16		0,16	
Log Likelihood		-2110		-2110

Note: regression coefficients with standard error in brackets.

$^{***}p < 0{,}001$ $^{**}p < 0{,}01$ $^{*}p < 0{,}05$

Table 4. Regression models of 4-month lag

	OLS, fatalities	**NB, fatalities**
(Constant/Intercept)	118,01	16,82***
	(75,53)	(3,01)
Relative area affected by locusts (x1000, 4-month lag)	0,62	0,05
	(1,24)	(0,03)
Fatalities (lag)	0,32***	0,01***
	(0,04)	(0,00)
Food price inflation	-0,08	0,00
	(0,08)	(0,00)
GDP growth	-0,39	0,05*
	(0,91)	(0,02)
Rainfall	-0,07	-0,00
	(0,06)	(0,00)
Population growth	6,11	-0,25
	(9,66)	(0,20)
Child mortality	-1,65	-0,16***
	(0,93)	(0,02)
Fixed effects - country	Y	Y
Fixed effects – month/year	Y	Y
N	528	528
Adj. R^2	0,16	
Log Likelihood		-2109

Note: regression coefficients with standard error in brackets.
***p < 0,001 **p < 0,01 *p < 0,05

Table 5. Regression models of fatalities without locust pest damage

	OLS, incidents	**NB, incidents**
(Constant/Intercept)	113,05***	17,69***
	(74,81)	(2,97)
Fatalities (lag)	0,32***	0,01***
	(0,04)	(0,00)
Food price inflation	-0,09	0,00
	(0,08)	(0,00)
GDP growth	-0,38	0,05**
	(0,91)	(0,02)
Rainfall	-0,07	-0,00
	(0,06)	(0,00)
Population growth	6,27***	-0,24
	(9,65)	(0,20)
Child mortality	-1,59	-0,15***
	(0,92)	(0,02)
Fixed effects - country	Y	Y
Fixed effects – month/year	Y	Y
N	528	528
Adj. R^2	0,16	
Log Likelihood		-2110

Note: regression coefficients with standard error in brackets.
***p < 0,001 **p < 0,01 *p < 0,05