Small Changes In Climate, Big Changes In The World

Leonardo Ayala

Bel Khuu

Prattasha Islam

Kaitlyn Zhang

Abstract

This paper investigates the influence of climate change on international civil conflict. We focus on four African countries consisting of South Sudan, Algeria, Cameroon, and Ethiopia. These countries rank high among global fragility hotspots, defined as areas with high levels of socioeconomic instability, climate change vulnerability, and conflict risk. Various methods are used to visualize the severity of climate disasters, along with their economic impact and influence on conflict, which are particularly amplified within fragility hotspots. These methods include area charts of natural disasters, bar charts with timelines of conflicts color coded by intensity level, and triangle plots that indicate economic impact of natural disaster and recovery time. Findings indicate that an increase in climate disasters, particularly in droughts and floods, increases the frequency of conflicts within these four countries. In terms of policy implications, climate change resilience should be incorporated into peace building programs in order to reduce conflict risk.

Introduction

This analysis investigates the influence of climate change on international civil conflict. These interactions can occur through various mechanisms including poverty, scarce resources, migration, and other socioeconomic factors. Evidence suggests that poorer countries are disproportionately impacted. Climate change, through these mechanisms, fosters an environment that increases the risk of conflict. In terms of policy implications, the authors want to know if efforts in reducing climate change can reduce the risk of international civil conflicts. This analysis will focus on selected African countries consisting of South Sudan, Algeria, Cameroon,

and Ethiopia. We begin by establishing our theoretical framework and by reviewing several key concepts. A brief literature review is conducted. We then expand on our data, methodology, and findings demonstrated by our visualizations.

Climate change has been referred to as a "threat multiplier," as it can overburden fragile states and exacerbate socioeconomic instability (Ruettinger et al. 2015). Firstly, climate change contributes to scarcity of resources, such as food and water. Scarcity can increase competition for these resources. In regions where resource management institutions are constrained, increased tension from scarcity can lead to conflict. According to *A New Climate For Peace,* "In much of Africa, which relies overwhelmingly on rain-fed agriculture, resource conflicts are more likely to break out over land, while in the irrigated fields of Central Asia, conflicts are more likely to arise over discrete water sources." (Ruettinger et al. 2015; Unruh and Williams 2013). Building on this, customary land issues played a major role in over thirty intrastate conflicts in Africa between 1990 and 2009 (Pantuliano 2009). Moreover, this scarcity of land and agriculture increases the volatility of food prices. Food insecurity with overall increase in food prices can lead to civil unrest. For example, 14 countries in Africa experienced food riots in 2008, which had higher levels of poverty, less access to food, more urban areas, and more oppressive regimes than those countries that did not experience riots (Berazneva and Lee 2013).

Case Study

In Ethiopia, extreme global weather events in 2008-2011 triggered an international "land grab" to secure farmland and food supplies via foreign direct investment. Approximately 46 million

hectares were acquired in these land grabs, mostly in Sub Saharan Africa, with 1.2 million in Ethiopia. These land grabs lacked transparency and were often at the direct expense of surrounding local communities. The Ethiopian government engaged in forced relocation of communities which led to frequent violent conflicts. These relocations led local communities to believe that international actors were more important than local interests (Ruettinger et al. 2015).

Moreover, in regions where people are dependent on natural resources, the constraining of these resources will also influence migration patterns. The reduction of arable land and water sources needed for irrigation or grazing land, will threaten livelihoods dependent on these resources and push large numbers of rural residents to urban areas that may not be equipped with infrastructure to handle large influx of individuals. A lack of viable alternatives can create conflict and unemployment. In Turkana, Kenya, many nomadic pastoralists have turned to fishing as pasture lands have dwindled due to recurring droughts, leading to deadly conflicts between rival Kenyan tribes with Ethiopian fishermen on the other side of the lake (Yongo et al. 2011). Climate change and extreme weather events also endanger assets and increase poverty. The economic costs associated with these disasters places additional stress on already strained government systems, especially in fragile areas with a history of conflict. For example, the 2011 East African drought intensified political instability by compounding grievances between groups over the poor governance of the food crises, leading to a full-scale humanitarian crisis and incidents of violence across East Africa (Harris et al. 2013).

The countries we are examining in this paper all ranked high in global fragility hotspots, defined as countries with high levels of instability, poverty, and climate change vulnerability–all of which compound the risk of conflict (Ruettinger et al. 2015). Fragility hotspots show how these socioeconomic elements can occur jointly and amplify each other. Repeated environmental disasters increasingly limit the ability of a government to adequately respond, eroding the credibility and legitimacy of government, which weakens the social contract between the government and the people.

Case Study

South Sudan has endured four consecutive years of record breaking flooding. Two-thirds of the country is facing flooding. At least 60% of the 11 million people living in South Sudan have been impacted, and approximately 800,0000 livestock have died. There is an extreme need for adequate food, shelter, and water, and resources. Repeated disasters have muted the resilience and tools of the government disaster response system. Furthermore, many areas in South Sudan are difficult to access, cutting off many vulnerable communities from humanitarian aid. Over 2.3 million South Sudanese refugees have sought shelter in neighboring countries. South Sudan has faced civil war for most of its brief history. This humanitarian crisis has increased conflict risk and led to widespread intercommunal violence and conflict (Cheshirkov 2022).

Through a variety of data visualizations, this paper highlights the relationship between climate change and international civil conflict. The authors of this paper believe that addressing climate change can help reduce the risk of international conflict. Climate change can be viewed as a

"threat multiplier" that amplifies socioeconomic instabilities that increase the likelihood of conflict. By mitigating climate change, the subsequent effects on these socioeconomic elements–including poverty, scarce resources, migration, and price volatility–can be dampened. The overarching implications of this paper show the interconnectedness of climate change and international conflict. While there is much debate in literature regarding the strength of the relationship between climate change and international conflict via the aforementioned socioeconomic vehicles, climate change mitigation efforts will still promote overall institutional resilience. Therefore policies addressing climate change should be incorporated into peace building efforts. The intent of peace building efforts through various institutions including the Organisation for Economic Co-operation and Development (OECD), the International Federation of the Red Cross, the G7+ initiative, and the G7 governments, is to build resilient societies that can absorb and address shocks while maintaining political and social stability. Such policies fall into three categories: (1) absorptive capacity defined as coping mechanisms during periods of shocks (2) adaptive capacity, or the ability of a system to adjust, modify, or change itself to mitigate future dangers (3) transformative capacity, or the ability to create a fundamentally new system that is not susceptible to climate change (IPCC 2014). In conjunction with humanitarian aid, an integrated approach to peace building should consider these three capacity elements within development and conflict prevention programs. Moreover, it is critical to recognize that the majority of emissions come from developed countries. Developing regions disproportionately feel the impact of climate change despite contributing less to overall emissions (Guterres 2022). Thus, a concentrated and collaborative global effort is required in order to effectively reduce international conflict risk stemming from climate change.

Literature review:

Climate change is the direct consequence of human activity. More than 99% of peer-reviewed articles assert that humans are the main cause of climate change (Ramanujan 2021). The increase in the Earth's surface temperature is primarily due to the concentration of greenhouse gasses in the atmosphere. This increase in the concentration of gasses is the result of burning fossil fuels and deforestation (Adams 2010). In addition, everyday human activities like driving cars, using air conditioners and electricity all contribute to the emissions of gasses in the atmosphere. The environmental effects of climate change include the rise in sea levels from melting glaciers. A study suggests that if only 8% of the Earth's ice melts, much of the low-lying lands in the USA like Florida, New Orleans, Louisiana will be submerged under water. Low-lying countries like Bangladesh and the Netherlands are already seeing substantial increases in flood frequency (Thompson 2010). Among the countries that are most affected by climate change are generally less developed, more prone to social and political instabilities and are already facing some level of poverty. Most countries in Africa are vulnerable to climate change effects due to generally low adaptive capacity. Earthquakes, storms, floods and drought seemed to have contributed most to the percentage of economic damages as a share of GDP in the past decade for Africa (Ritchie, Rosado, and Roser 2022). These economic damages often lead to civil conflicts through events like political unrest and riots.

A 2007 IPCC report gave a list of countries that are most vulnerable to the effects of climate change (IPCC 2007). Under climate conditions where extreme weather conditions are more

prevalent, analysts believe that political conflict will be exacerbated due to dwindling resources and harsh environmental conditions. The regions that are highly sensitive to the effects of climate change according to this report are South Asia, the Middle East, and Sub-Saharan Africa. Since 1948, approximately two-thirds of all UN peacekeeping operations have been in these regions. Despite this, solutions for climate change are typically not included in peace building efforts (Matthew 2014).

In Africa, literature shows a strong historical linkage between civil war and temperature with warmer years leading to significant increases in the likelihood of war. When combined with climate model projections of future temperature trends, this historical response to temperature suggests a 54% increase in armed conflict incidence by 2030, or an additional 393,000 battle deaths. Moreover, this study found that in Africa, with 1 °C increase in the temperature, there was a 4.5% increase in civil war in the same year and a 0.9% increase in the conflict incidence in the following year (Burke 2009). The study underscored a strong relationship between temperature variables and conflict incidence.

Since the end of the Cold War, there has been a decline in conflict (Gleditsch et al. 2002; Goldstein 2011). However, conflict casualties have risen over the past several years (Pettersson and Wallensteen 2015). Research indicates that worsening climate could increase conflict casualties, especially in susceptible regions. Civil conflict in particular produces more casualties than all other forms of conflict in a given year. Although climate change itself won't cause civil conflict, the effects of climate change can make it more likely (Buhaug 2016).

An example of how the effects of climate change can be linked to civil conflict is the Syrian Civil War. The climate conditions in the region have led to historical conflicts over access to water. The UN's Food and Agriculture Organization estimates that 60% of the renewable water in Syria comes from outside the country (Frenken 2009). Syria has also experienced rapid population growth over the last several years, which stretches already scarce resources (Gleick 2014). From 2006 to 2011, Syria experienced a significant drought that led to displacement and loss of resources (Worth 2010). The mass displacement and resource loss damaged the economy which led to social and political unrest. Some of the early bouts of unrest came from a large influx of displaced agricultural workers from regions where extreme droughts devastated their livelihood (Gleick 2014). The regime's lack of resource management worsened these conditions, and the failure to address the negative economic and social effects of the drought was one of many factors that led to dissent (Saleeby 2012).

Data

The World Bank Climate Change and Development Series report suggests that by 2030, more than 100 million people will be forced to live under extreme poverty due to the ongoing increase in climate change. In order to investigate the relationship between climate and socioeconomic measures, we explored the openly accessible datasets of the IMF Climate Change Dashboard which was last updated in October 2022. From the IMF Climate Change Dashboard we decided to look at the frequency of the different types of natural disasters. We used the observations from the four countries in our analysis and the indicator variables and the years associated with them.

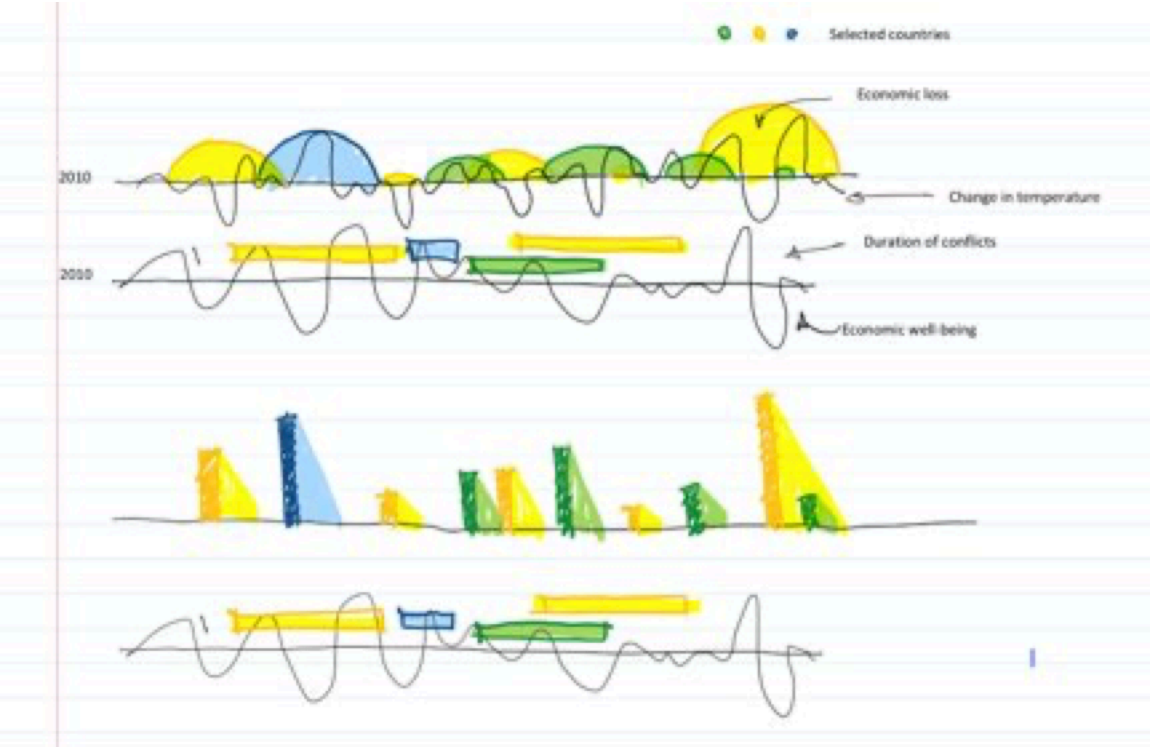
In addition, we also used the natural disasters dataset from the Our World in Data platform. The variable that we used is the total number of people affected by the natural disasters per 100,000 people, which was then scaled it to percentage to create a rate of this variable.

For international civil conflict data, we used the UCDP/PRIO Armed Conflict Dataset version 22.1, which covers armed conflicts from 1946-2021. This dataset defines conflict as "a contested incompatibility that concerns government and/or territory where the use of armed force between two parties, of which at least one is the government of a state, results in at least 25 battle-related deaths in a calendar year." We examine four countries and six opposition groups. The conflicts we focused on are civil conflicts, with or without outside state intervention. The countries we focus on include South Sudan, Algeria, Cameroon, and Ethiopia. The resistance groups we are looking into include Sudan People's Liberation Movement-in-Opposition and the National Salvation Front in Sudan, Al-Qaeda in Algeria, Oromo Liberation Front and Oromo Liberation Army in Ethiopia, and the Ambazonia Insurgents in Cameroon.The date ranges for these conflicts are from 1977-2021, although some conflicts are still ongoing.

Methodology

Our team created an original visualization inspired by a circle timeline chart in The New York Times by Kevin Quealy, which depicts the costs of U.S. natural disasters from 1980 to 2017. The years are represented on the y-axis, whereas the months are on the x-axis. This setup facilitates the understanding of yearly seasonal trends. Each natural disaster is summarized in a half circle above the year in which it occurred. Since the size of the half circles represents the cost of the

disasters, choosing half circles with reduced opacity made it easier to see overlapping events. Although it is not clear if the creator used the area of the half circles or the radius to measure with the cost, the chart had pop-ups when the cursor moved over each event to indicate the numeric cost of the disaster. This interactive component is currently outside of the team's scope in developing our visualization. Our second inspiration comes from the "Number of deaths by type of natural disaster" chart by Our World in Data. This chart shows many reasons why the teams will be careful when using a circle timeline chart, including those mentioned above, like using half circles and reducing opacity for more visibility. Our initial idea can be seen below:

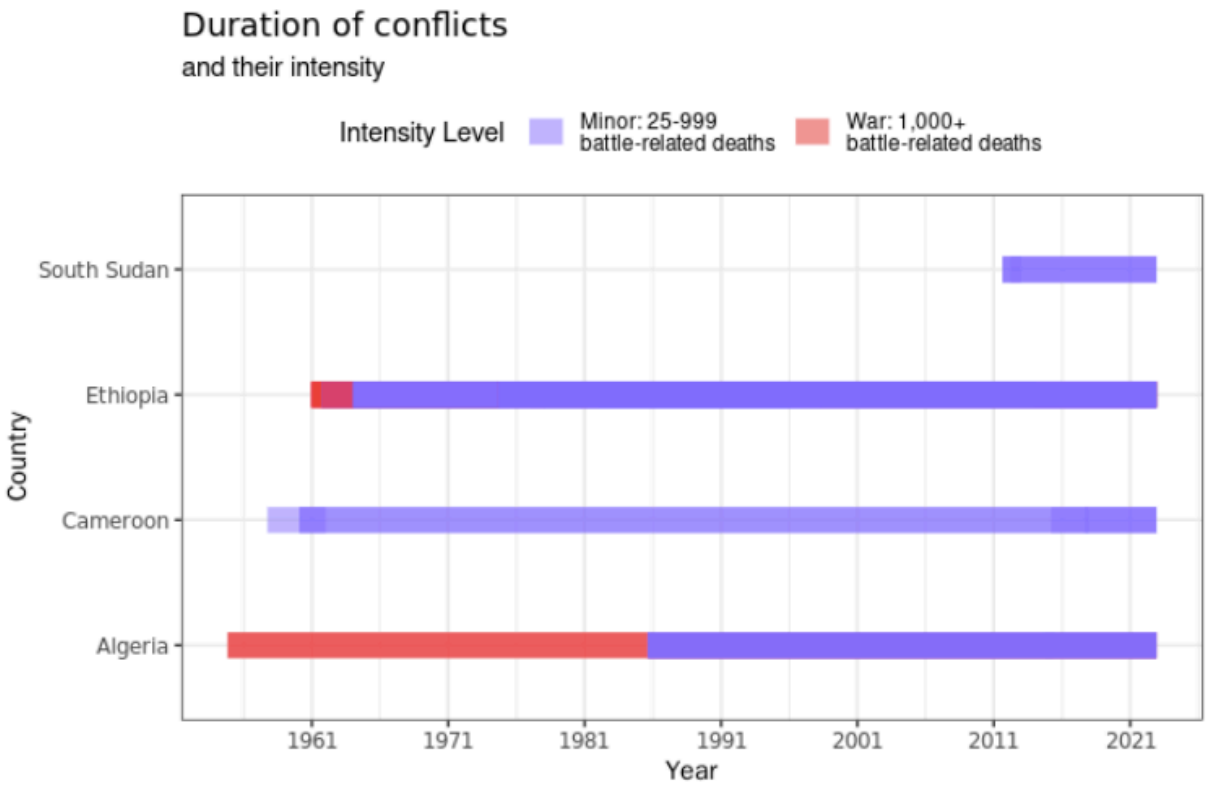


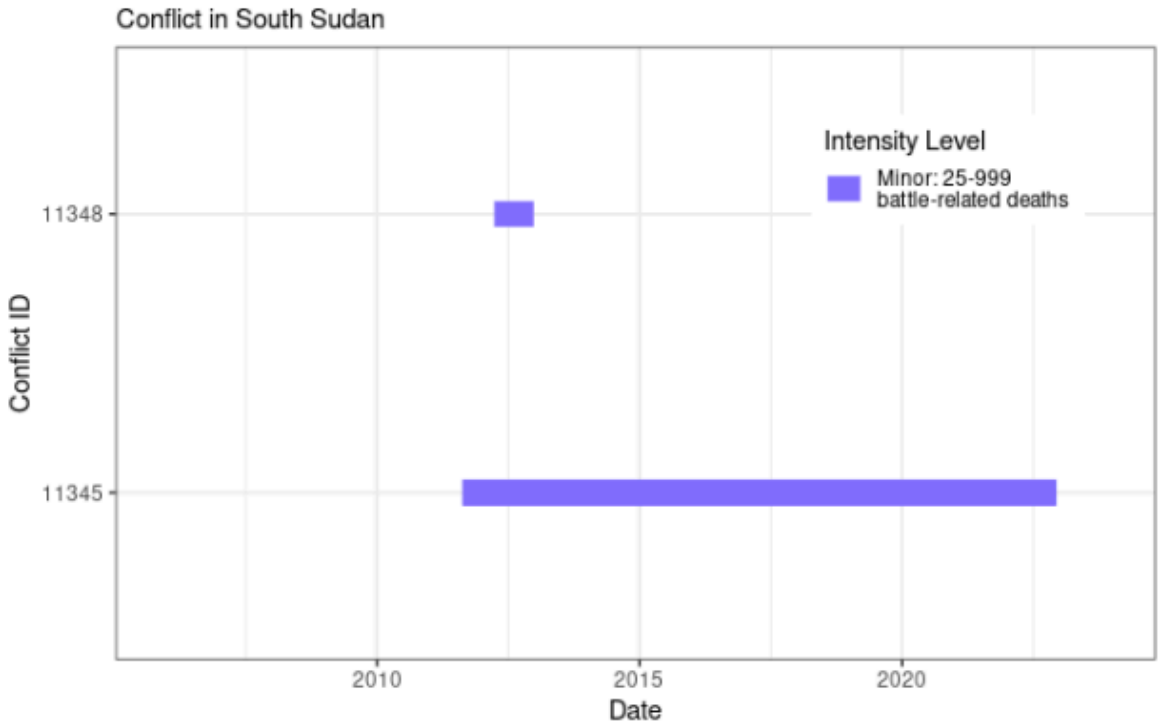
In our chart, as opposed to the semicircle plot, we created a bar chart overlaid with a triangle plot. The triangle plot will take up less unnecessary space while portraying two different pieces

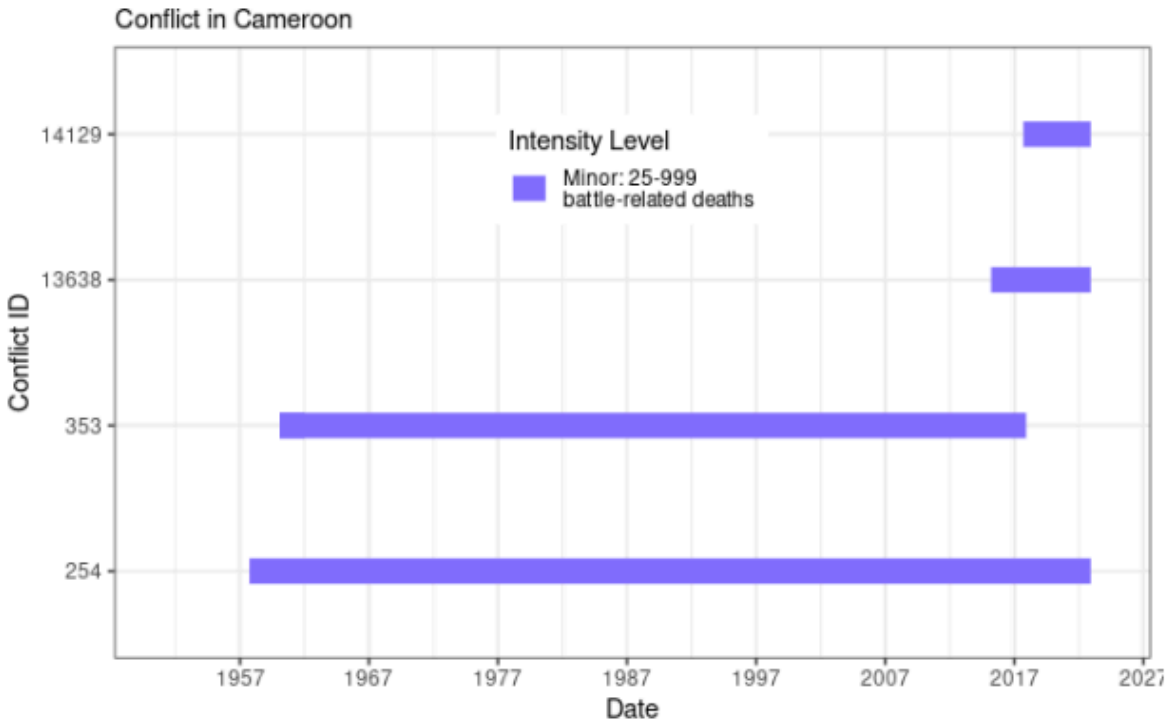
of information. The economic impact will be represented by the height of the bar chart, and the recovery time of each natural disaster will be represented by the width of the base of the triangle. Since we do not have robust data on recovery, the base of the triangle was created proportionately to the bar chart, which represents the rate of people impacted by the disasters Moreover, we created area charts of natural disasters within each country. The natural disasters examined include drought, flood, landslides, wildfire, extreme temperatures, and storms. We also created bar charts with timelines of conflicts color coded by intensity level. For our conflict charts, we used geom_segment to illustrate the beginning and end of each conflict. The conflict ID represents the corresponding conflict. For those conflicts that did not have an end date, the end date was inputted as 12-26-2022 for the purposes of our visualizations. The intent of arranging the area chart of climate disasters and the triangle plots with conflict is to facilitate visual inspection of a possible relationships.

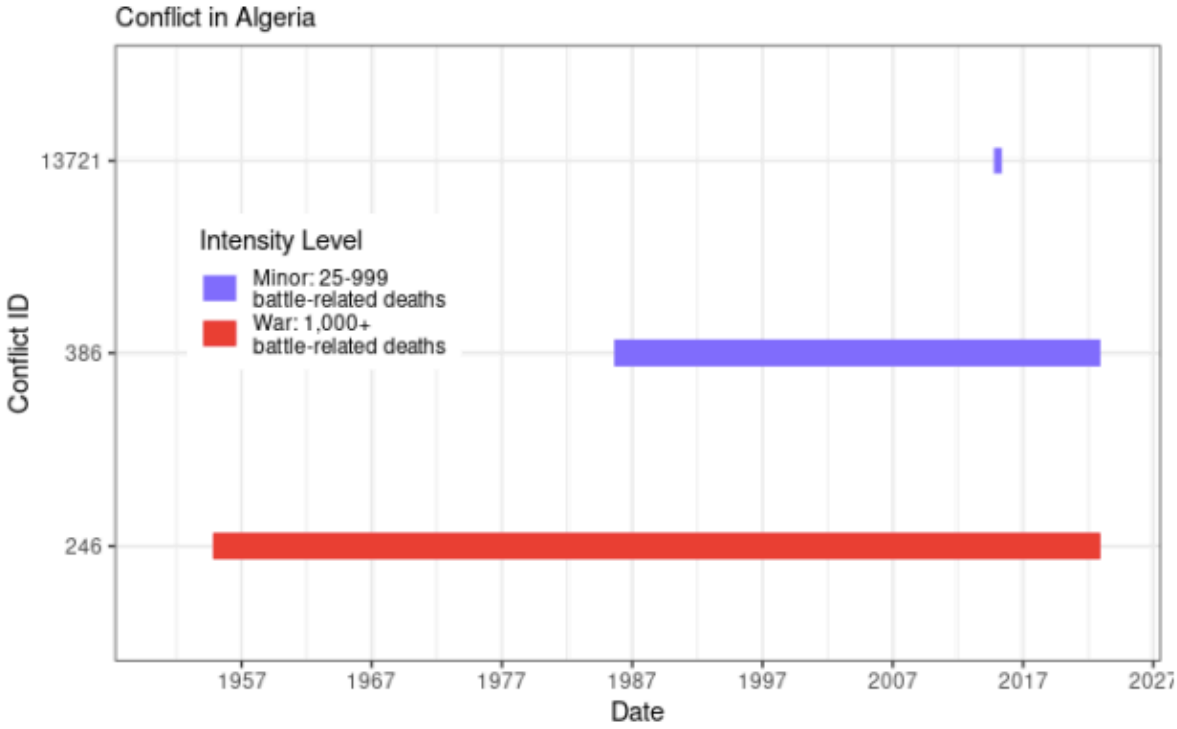
Findings and Analysis

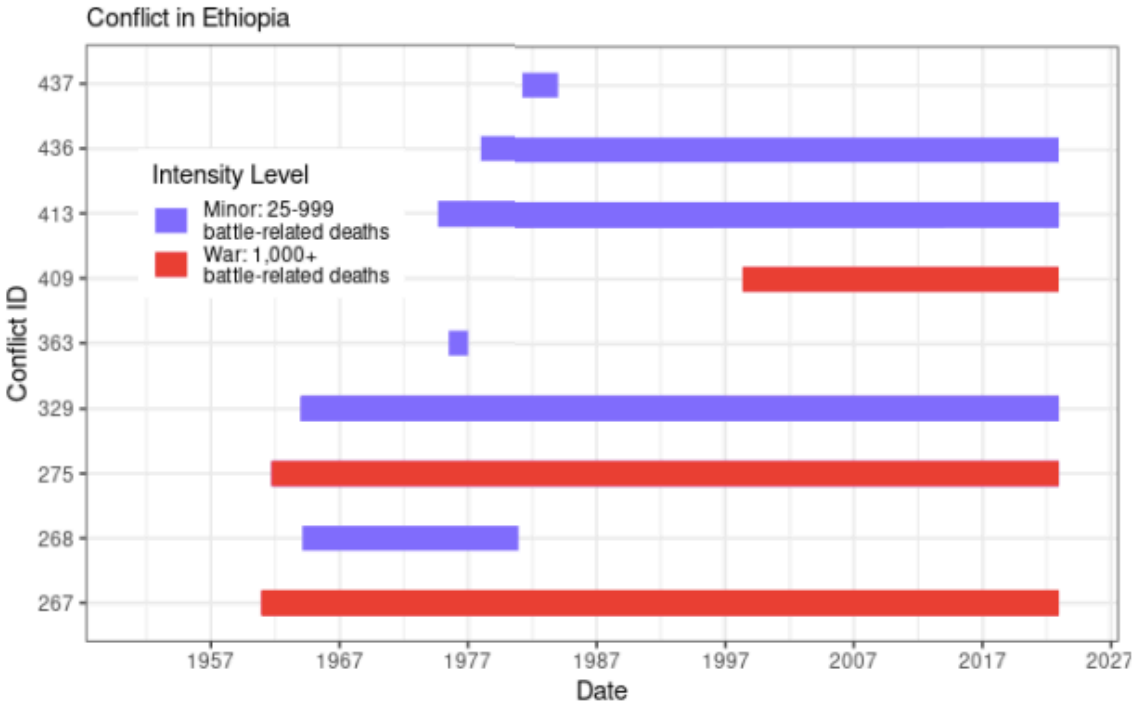
Firstly, we examine an aggregate bar chart of conflicts. The conflicts are color coded by intensity. There are two intensity levels: (1) the first level is characterized as minor, with 25-999 battle related deaths (2) the second level is characterized as war, with 1000+ battle related deaths. In this chart, you can see there is an overall decrease in conflict intensity levels over time. In the subsequent visualizations, you can see the conflict charts for each country. Overall, it is evident that the frequency of conflicts has increased over time. In South Sudan, there are two conflicts which began shortly after the country was founded. In a Cameroon, there is a total of four conflicts. Algeria has a total of two conflicts. Ethiopia shows a total of nine conflicts.


Duration of conflicts
and their intensity
Intensity Level
Minor: 25-999 battle-related deaths
War: 1,000+ battle-related deaths
South Sudan
Ethiopia
Cameroon
Algeria
Country
1961
1971
1981
1991
2001
2011
2021
Year

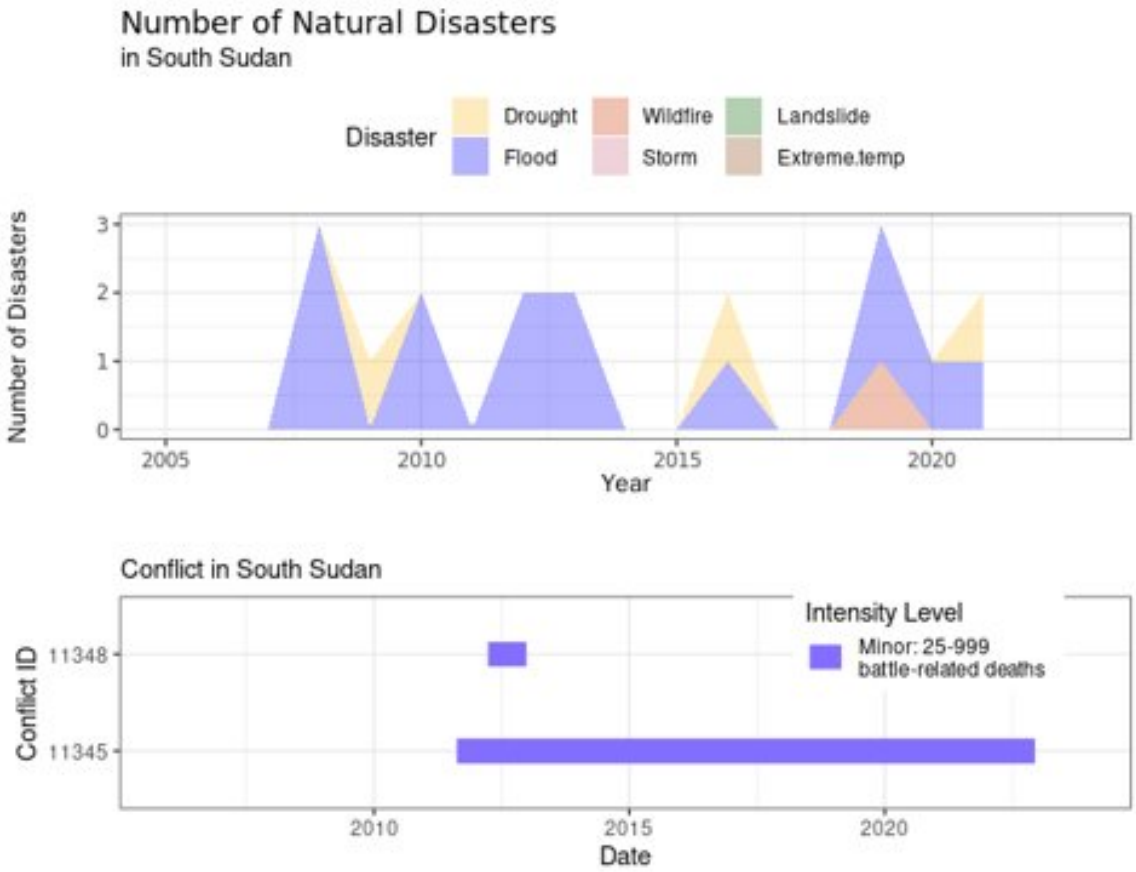

Conflict in South Sudan
Intensity Level
Minor: 25-999 battle-related deaths
11348
11345
Conflict ID
2010
2015
2020
Date


Conflict in Cameroon
Intensity Level
Minor: 25-999
battle-related deaths
Conflict ID
14129
13638
353
254
1957
1967
1977
1987
1997
2007
2017
2027
Date

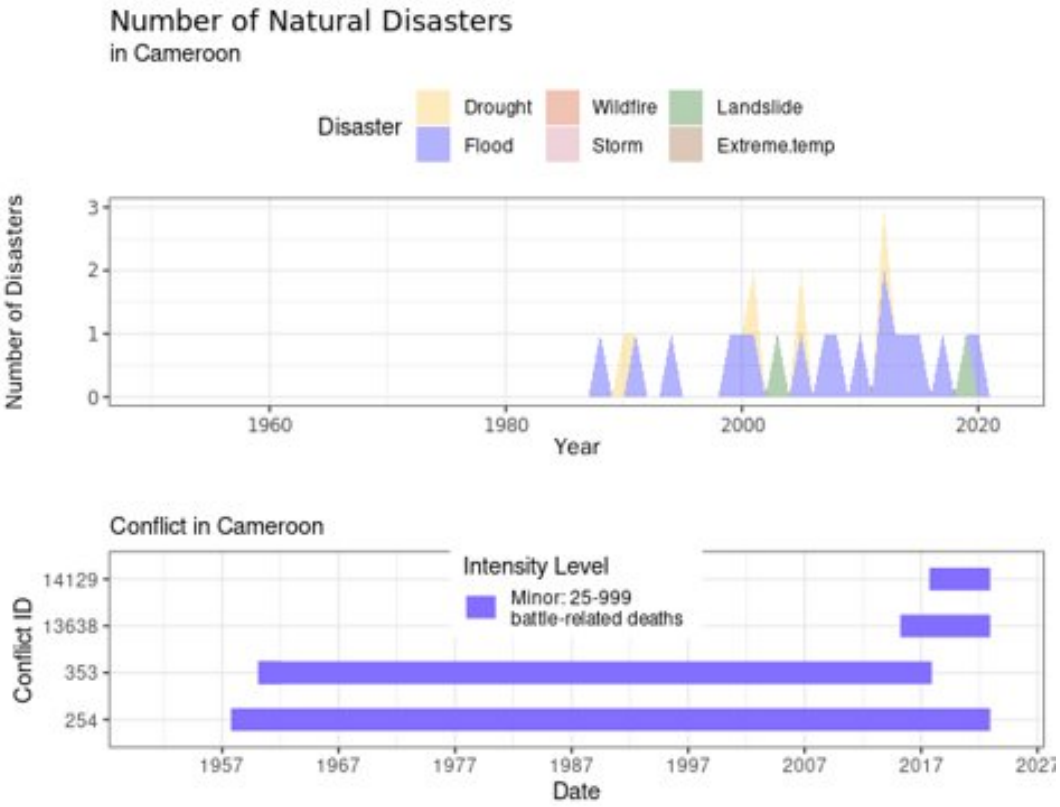

Conflict in Algeria
Intensity Level
Minor: 25-999
battle-related deaths
War: 1,000+
battle-related deaths
Conflict ID
13721
386
246
1957
1967
1977
1987
1997
2007
2017
2027
Date



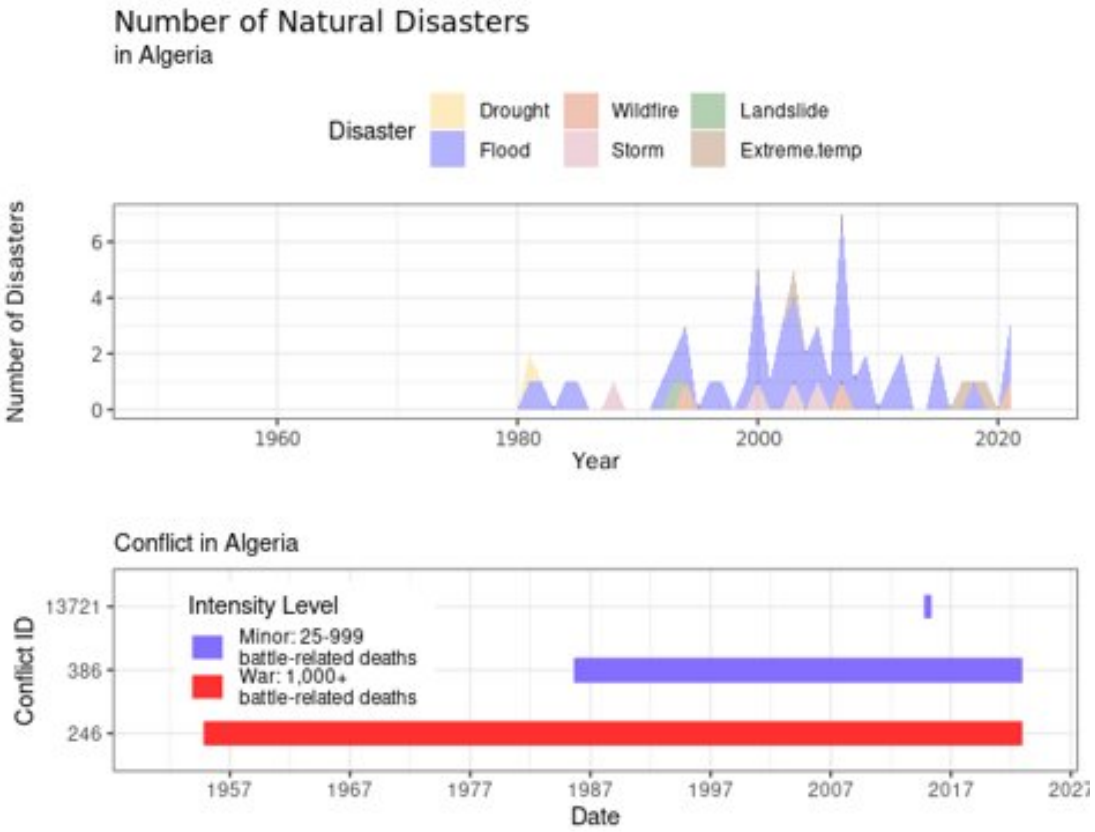
For our next set of visualizations, we have area charts showing the number of natural disasters in each country, aligned with the conflict charts. For South Sudan, the most frequent natural disaster is flooding and drought. There is severe flooding beginning in 2018. There are years where up to three floods occur. While the number of floods has not increased dramatically, the severity has. In the corresponding conflict chart, 2011 is when both conflicts begin, subsequently after bouts of severe flooding that are still ongoing. Both of these conflicts are both are characterized as minor.



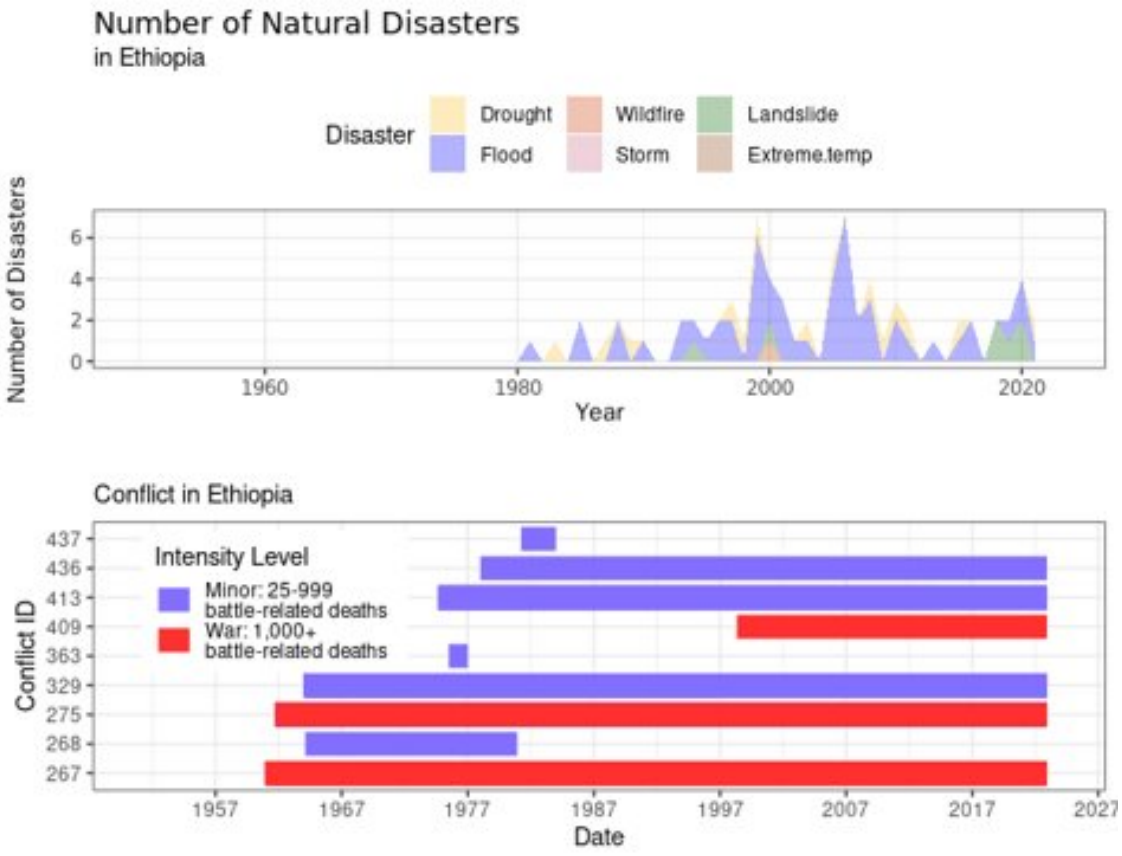
In Cameroon, the most frequent natural disasters are flood and drought, which become annual occurrences after 1998. Drought appears to occur less regularly over time relative to floods, but can reach up to three droughts annually when they do occur. You can see the frequency of conflict increase after 2016, following a spike in floods and drought. In 2016, Cameroon experiences a total of three droughts and two floods, followed by two minor conflicts.



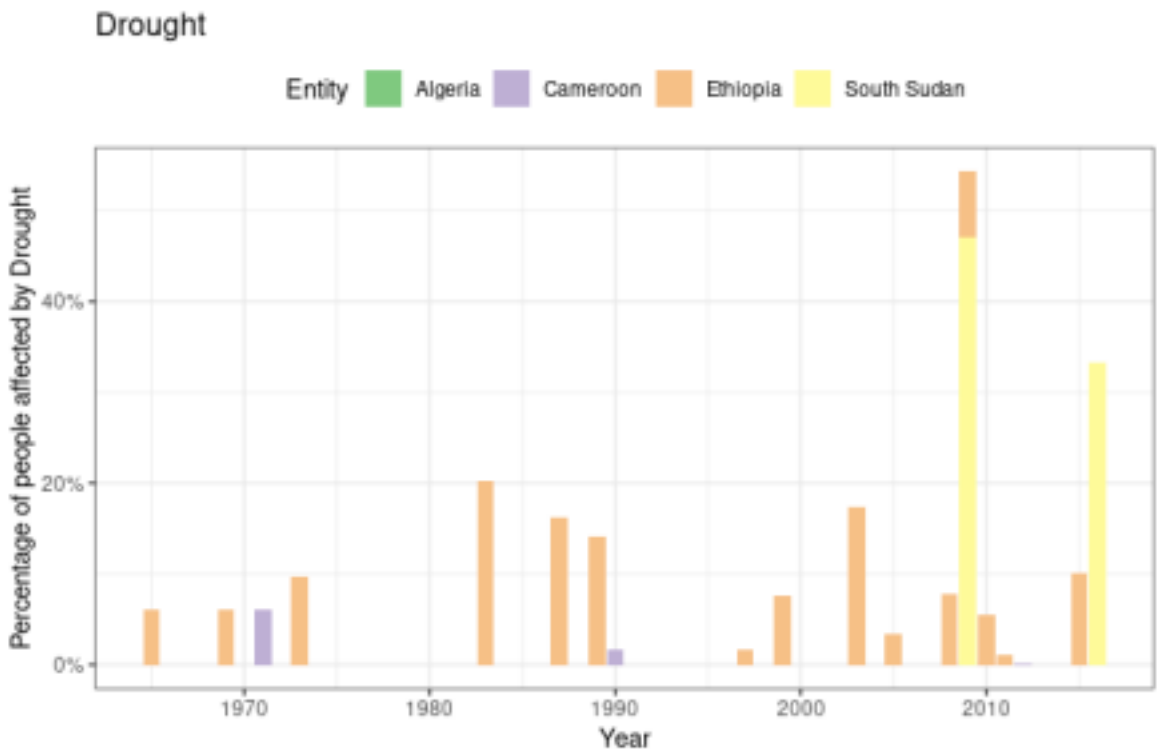
In Algeria, the most common natural disaster is also flood. There is a sustained spike in floods from the early to mid 2000s. During this period, the frequency of floods ranges from two to six annually. Floods also spikes to three during 2020.You can also see that bouts of extreme temperatures occur frequently, especially closer to 2020. During this period, Algeria reaches record breaking temperatures which results in numerous deaths. Moreover, Algeria ranks second in Africa in terms of water scarcity. When looking at the conflict chart, you can see that the frequency of conflicts increases over time.

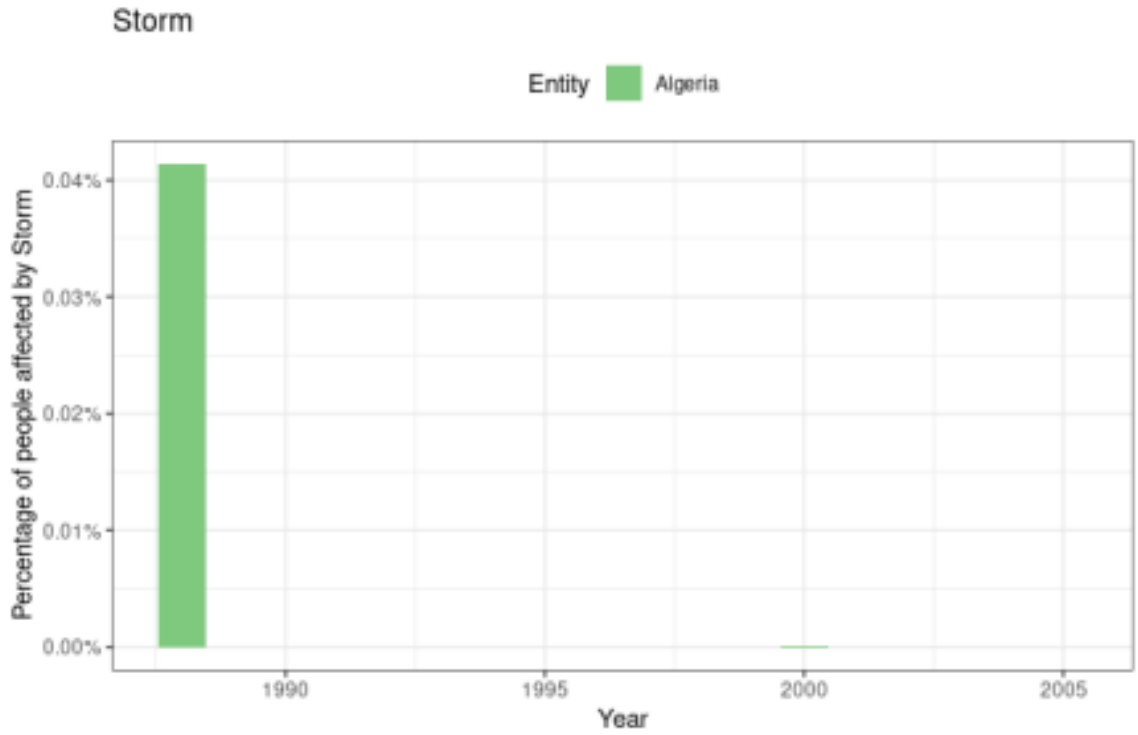


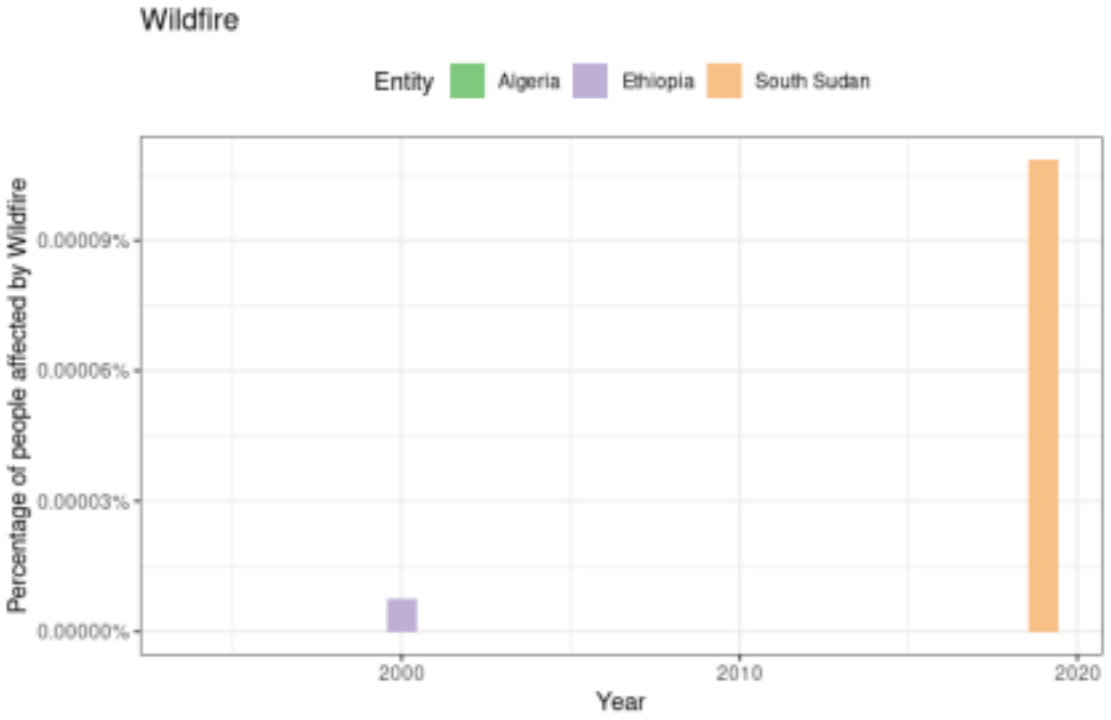
For Ethiopia, the most frequent natural disaster is floods and drought. In the late 1990s and early 2000s, floods occur up to six times annually. It is after 1990 that floods and drought begin occurring in a sustained and increased frequency. For conflicts, you can see the frequency of conflict increases around the late 1970s and early 1980s. In 2001 you can see a conflict of intensity 2 as well, which coincides with the Ethiopian government forcibly relocating communities due to local and international climate disasters (Ruettinger et al. 2015).

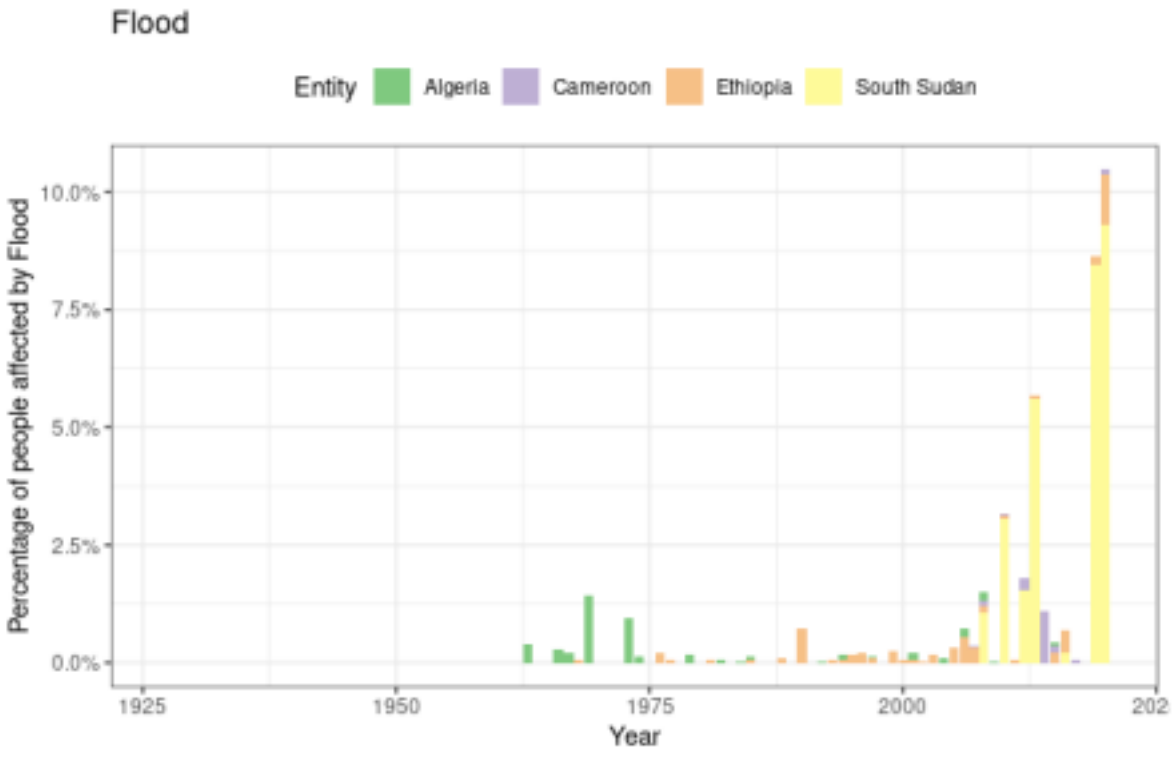


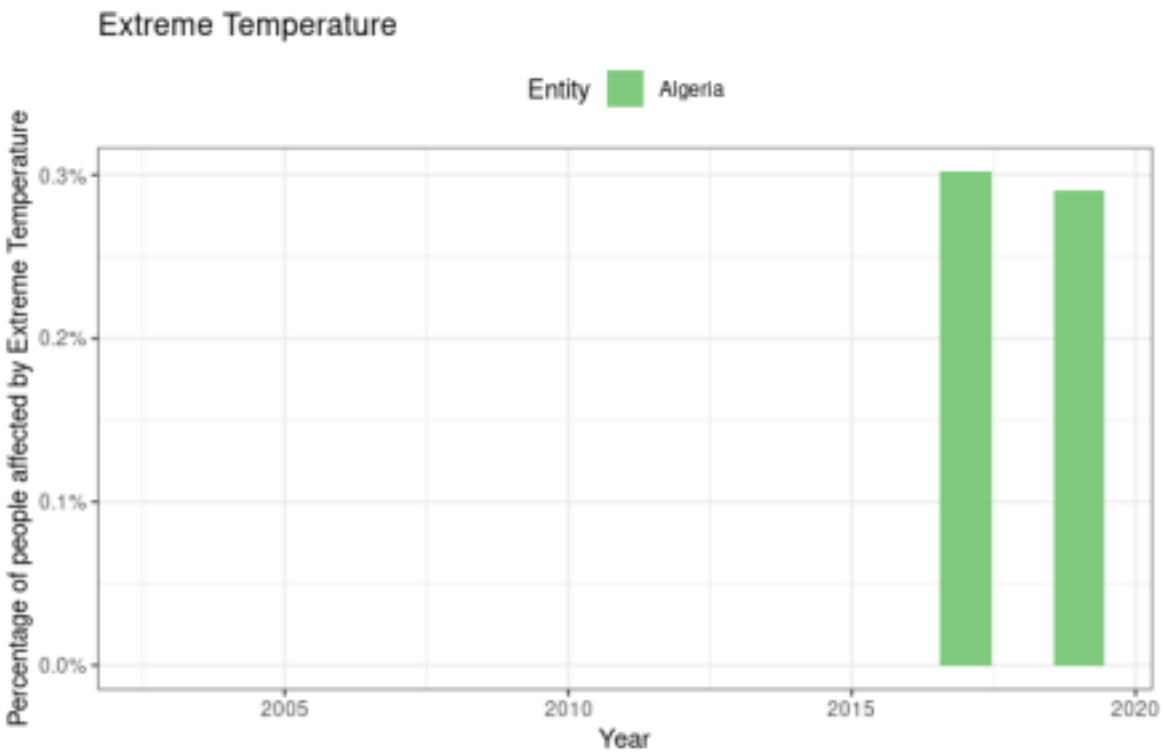
In the following bar charts we examine the percentage of people affected for each natural disaster type within each country. Landslides occur infrequently and affect 0.025% of people in Algeria, and even less so in all other countries. For floods, the percentage of people affected has increased sharply over time especially after 2000. It has affected up to 10% of populations, particularly in South Sudan and Ethiopia. Drought has also increased significantly after 2000, occurring most frequently in South Sudan and Ethiopia. It has affected nearly 60% of people, as seen in Ethiopia during 2010, and 33% of people in South Sudan during 2016. Extreme temperatures affect the most people in Algeria relative to the other countries, at a maximum 0.3% in the late 2000s. Wildfires and storms do not occur frequently or affect many people.

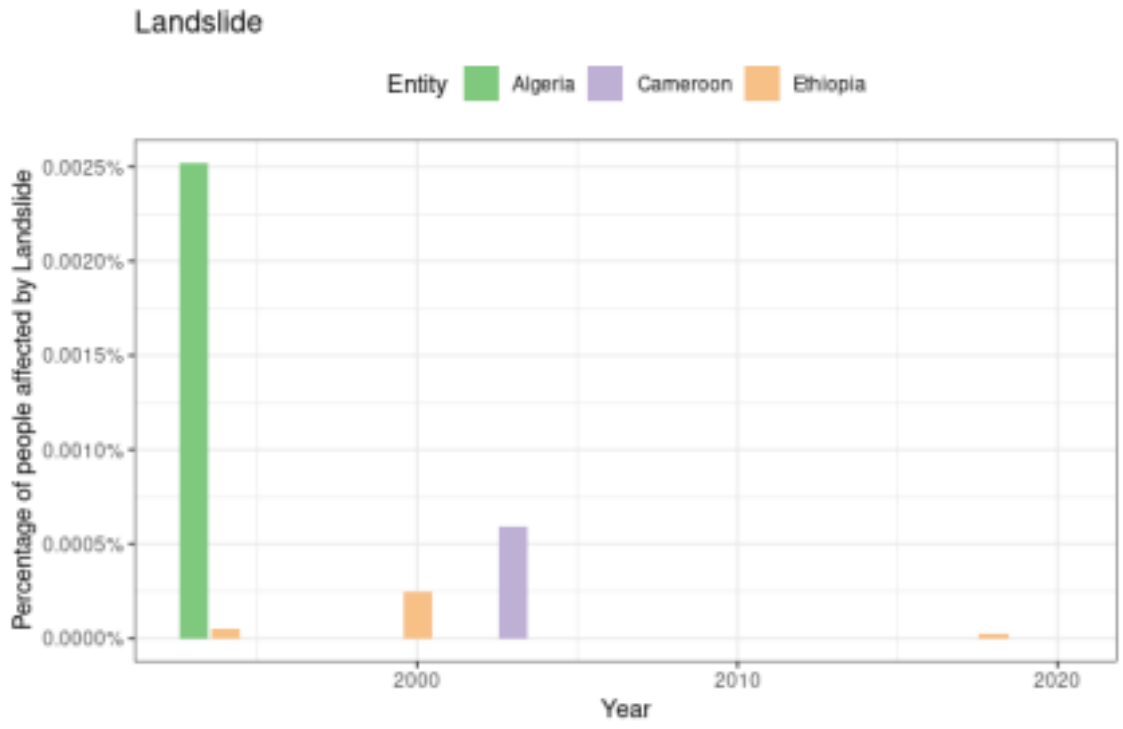

Drought
Entity
Algeria
Cameroon
Ethiopia
South Sudan
Percentage of people affected by Drought
40%
20%
0%
1970
1980
1990
2000
2010
Year


Storm
Entity
Algeria
Percentage of people affected by Storm
0.04%
0.03%
0.02%
0.01%
0.00%
1990
1995
2000
2005
Year

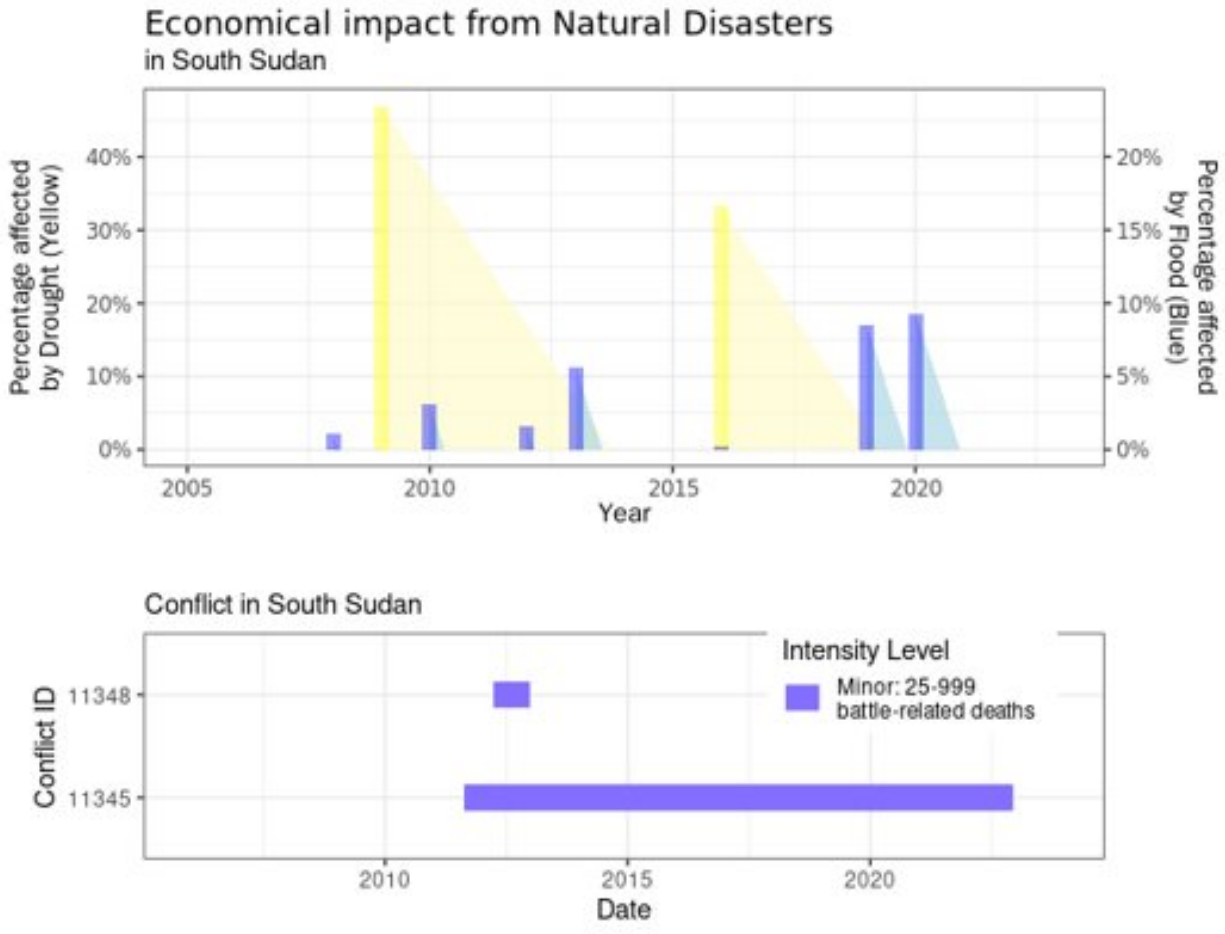

Wildfire
Entity
Algeria
Ethiopia
South Sudan
Percentage of people affected by Wildfire
0.00009%
0.00006%
0.00003%
0.00000%
2000
2010
2020
Year


Flood
Entity
Algeria
Cameroon
Ethiopia
South Sudan
Percentage of people affected by Flood
10.0%
7.5%
5.0%
2.5%
0.0%
1925
1950
1975
2000
202
Year

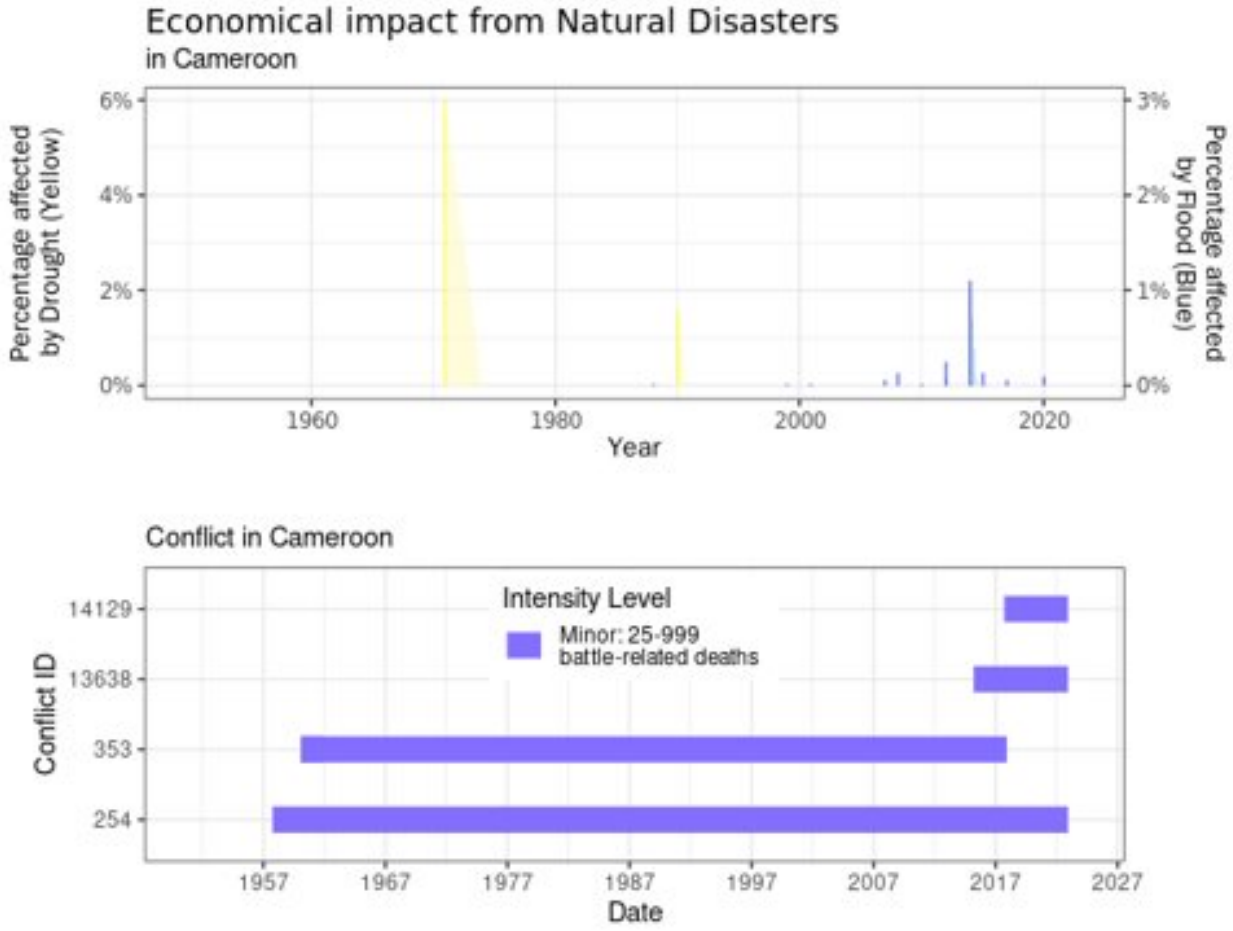

Extreme Temperature
Entity
Algeria
Percentage of people affected by Extreme Temperature
0.3%
0.2%
0.1%
0.0%
2005
2010
2015
2020
Year


Landslide
Entity
Algeria
Cameroon
Ethiopia
Percentage of people affected by Landslide
0.0025%
0.0020%
0.0015%
0.0010%
0.0005%
0.0000%
2000
2010
2020
Year

For our triangle plots, we focused on the economic impact of drought and floods, measured by the percentage of total people affected. The economic impact of drought is much higher relative to flood, so we created two y-axis and rescaled floods for the purpose of these visualizations. For South Sudan, the economic impact of drought exceeds 40% in 2008. The stickiness of that disaster is represented by the base of the triangle chart, which extends through 2012. Both conflicts begin in this period. In 2015, the base of the triangle extends through 2019, where years of consecutive flooding begin.

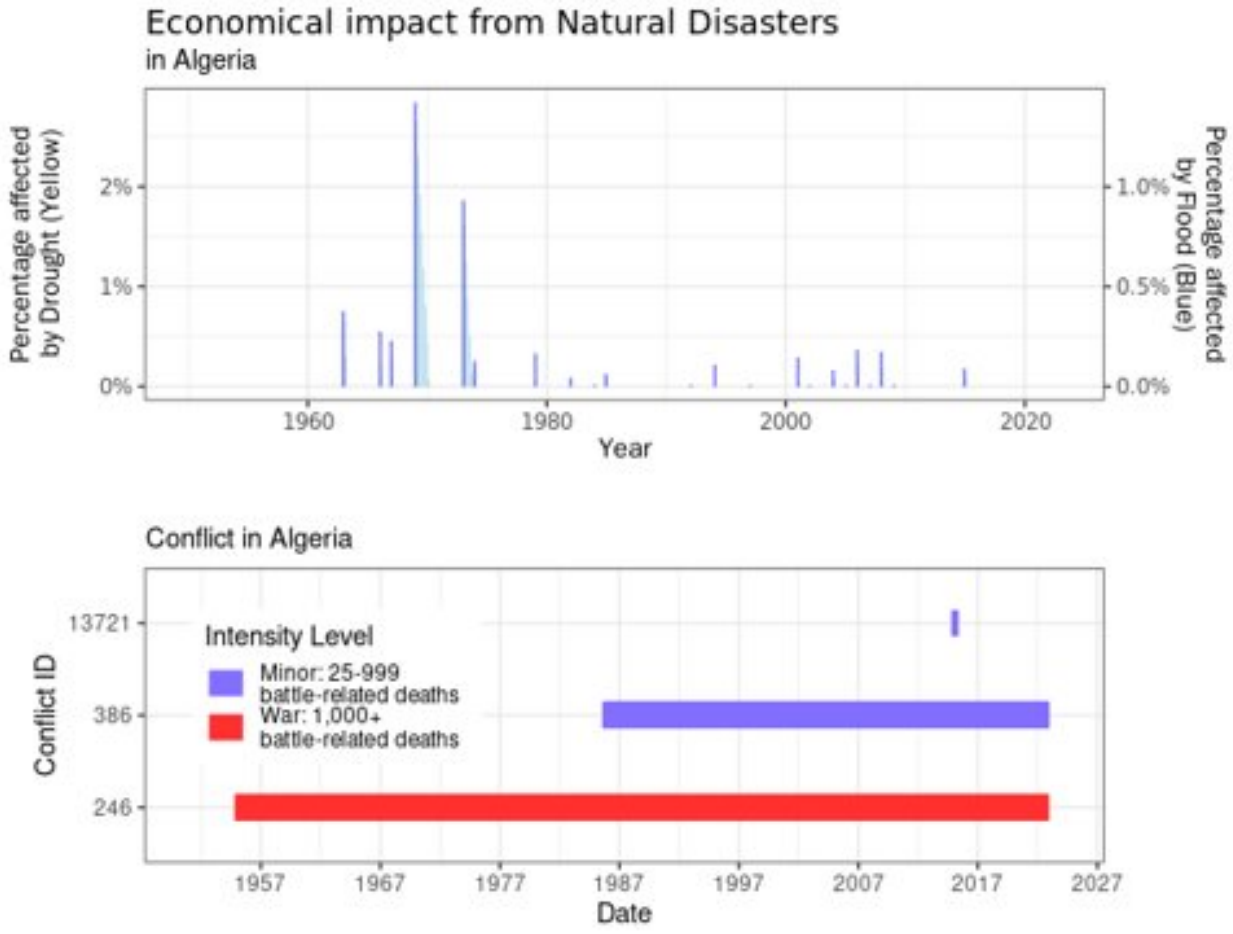


For Cameroon, the economic impact of floods is highest for drought in the early 1970s, where it reaches 6% of total people affected. The recovery period represented by the base of the triangle extents through 1975. There is a sustained economic impact from floods after 2010, which is when two new conflicts begin.

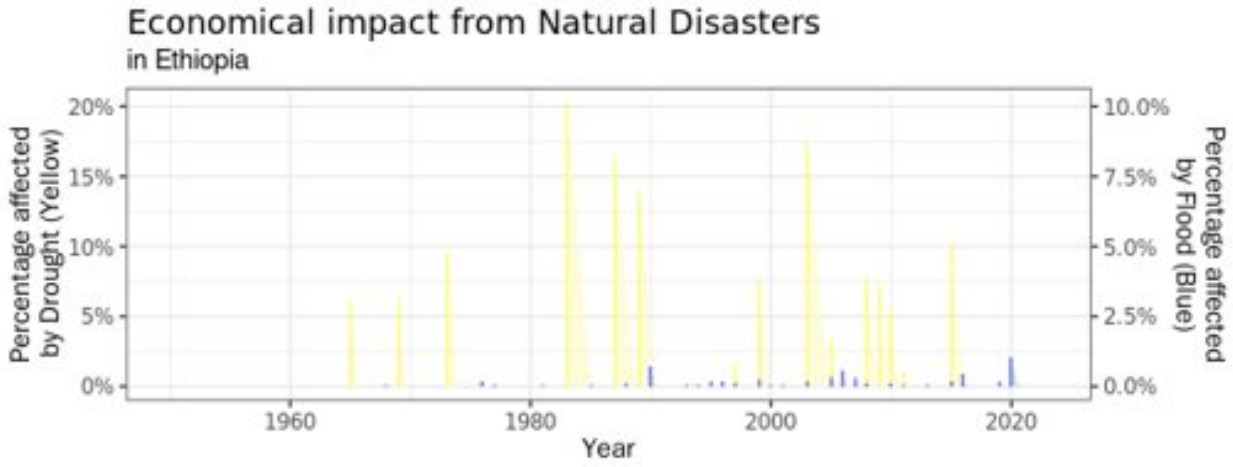


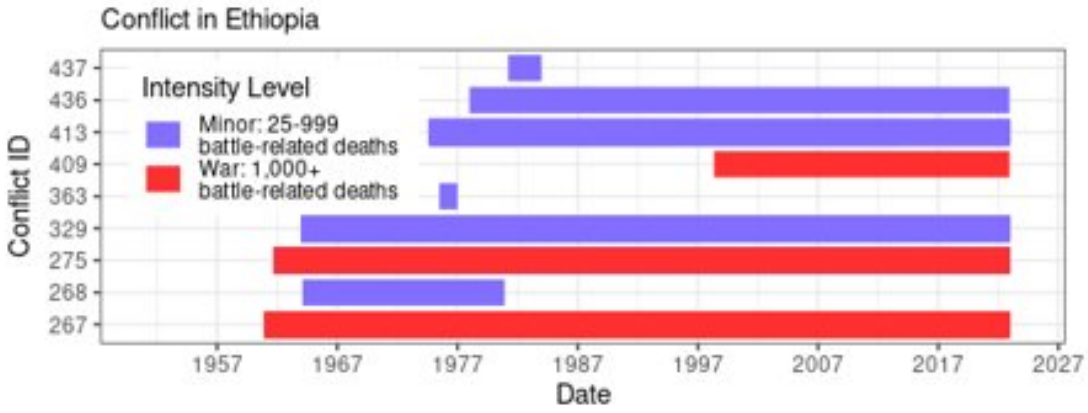
For Algeria, floods have had the most economic impact. This is most apparent from 1960 through 1980. Drought does not appear to have had a severe economic impact, according to this

visualization. The frequency of conflicts increases as the frequency of floods increases as well, although the economic impact is not as severe.



In Ethiopia, the economic impact of drought is most evident. It reaches approximately 20% in the mid 1990s, and 18% in the early 2000s. It appears to have a cyclical pattern. Repeated natural disasters of this magnitude have severely hampered the resilience of the disaster response system. There is a significant increase in conflicts over time linked to the impacts of drought and floods.





Conclusion

In conclusion, we examined the relationship between climate disasters and civil conflict in four global fragility hotspots: Algeria, Cameroon, Ethiopia, and South Sudan. Through our visualizations, we demonstrated the economic impact of these climate disasters, in addition to the frequency of their occurrence. The most common climate disasters were floods and drought, affecting up to 10% and 60% of people respectively, according to our data. Moreover, while we cannot generalize our findings for the intensity of conflicts, our visualizations show an

association between an increase of natural disasters and an increase in the frequency of conflicts. Findings are in line with overall trends in the region, supported by the broader body of literature. However our paper approaches this research question in a unique manner that contextually adds more nuance in the conflict-climate relationship within these particular countries. Our visualizations, particularly the triangle plots, demonstrate a new way of visualizing natural disasters, which have previously been modeled frequently by circular charts. Our triangle plots convey the economic damage of these natural disasters, in addition to the corresponding recovery time. When shown jointly with the conflict charts, patterns between conflict and climate become apparent, particularly in terms of frequency. Thus, the implications of this paper in addition to existing literature, show that incorporating climate change resilience measures within peace building programs could help mitigate conflict risk. For future considerations, more granular data could improve the recovery element measured by our triangle plots. Moreover, a time series analysis and causal multilevel models could be conducted in order to better investigate the causal mechanism of climate change on conflict.

Synergy report:

Bel was the lead for visualizations, particularly with the triangle plots. All group members provided technical support. Kaitlyn collected and formatted the conflict data. Prattasha collected and formatted the climate data. Leonardo acted as the coordinator and was the lead on the paper. All members supported the writing. Kaitlyn and Prattasha worked on the literature review and data sections, Bel worked on the methods section, and Leonardo worked on the other sections

and with overall editing to ensure cohesiveness. The team collaboratively worked to produce the final presentation, and practiced heavily for delivery.

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