SURV727 Final Project
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12/10/25

Abstract

This project aims to provide an analysis of fatalities and conflict events that have occurred in Sudan during the first half of 2024, particularly in relation to the country's mineral facilities. Through a cluster analysis of the Armed Conflict Location Event Data Project (ACLED), I was able to cluster groups and map them based on fatalities and distance from mineral facilities to gain an understanding of Sudan's high fatality zones and if these zones have any computational relationship to resource-rich areas. Through both quantitative analyses and a visual mapping tool, this project will provide valuable insight into Sudan's ongoing war so that relevant experts and stakeholders can continue their efforts for peace and security within the region.

Introduction

While Sudan has been trapped in a vicious cycle of conflict and genocide for decades, the most recent iteration of this war began in April of 2023. Since then, there has been an ongoing dispute between the Rapid Support Forces (RSF), a rebel militia group with historical roots in the genocidal Janjaweed militias of the early 2000s, and the Sudanese Armed Forces (SAF), the government operated military. The brutality of this war has been shocking to witness, particularly amongst the RSF who are now committing, and even continuing, a genocide in Darfur against the Indigenous African inhabitants that originally began over two decades ago. This past October, the RSF took control of El-Fasher, a city in Darfur that had been besieged for over a year. This event was amongst the most horrifying committed during this war with hundreds of civilians being massacred, tortured, and systematically raped by the RSF. While the RSF seems to be an especially brutal actor in this war, the SAF have also committed their fair share of war crimes including deadly air strikes that have killed thousands of civilians over the course of the past two and a half years.

Arguably one of the most horrific conflicts and scenes of destruction in the world right now, it is vital to understand more about the situation and the nature of each conflict actor and their particular strategies. A key aspect of this war, and what keeps funding it, are the country's rich mineral resources. The RSF are particularly known for their interest in gold, especially for their biggest buyer, the United Arab Emirates. However, gold is not the only resource of value in Sudan. The country has deposits of iron, copper, ore, and a whole host of other minerals that may prove interesting to the actors wrestling for control of the country. In order to understand this relationship, I aim to look at the clusters of events by how many fatalities were committed and

by how close each event was to a mineral facility. This analysis will be divided into two parts, the first one where I will analyze the actions of the RSF and the second one where I will analyze the actions of the SAF. This analysis will hopefully paint a picture where conflict is most dangerous and if that has any relation to Sudan's mineral facilities.

Methodology

Step 1: Data Collection

I collected my conflict information using an API to access ACLED's data on Sudan. It is fairly easy to use and includes variables on the event, when it happened, who did it, the fatalities, the geographic coordinates and more. It was a little bit trickier to find geographic data on Sudan's mineral facilities. Luckily, I stumbled upon a US Geographical Survey study that was done on all mineral industries and related infrastructure in Africa and was easily able to download the necessary shapefiles (converted to xlsx files) onto my computer.

Step 2: Data Cleaning

I filtered the Sudan data so that it was only from the first six months of 2024 (in order to limit my sample to a reasonable number and ACLED's 2025 data isn't publicly available for API usage yet) and again filtered so that only my actors of interest, the RSF and the SAF, were included. Then, I separated the data into two datasets by actor, one for the RSF and one for the SAF, in order to separately analyze them. Additionally, I had to convert the coordinates of the ACLED data into a numeric format so that they could be properly read. Finally, I used a package called "geosphere" to calculate the distance of each event from the closest mineral facility in kilometers.

Step 3: Clustering
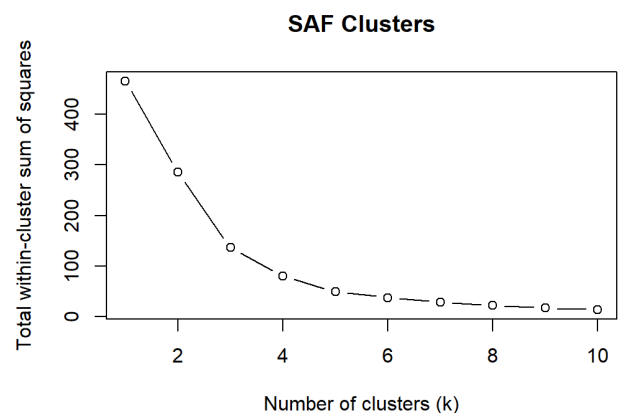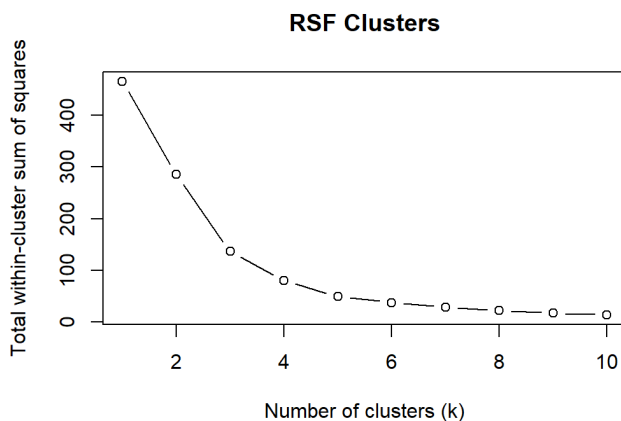
After looking at these elbow plots and analyzing the geographic spread of events, I decided to use k=4 for my cluster analysis of the RSF and k=3 for my cluster analysis of the SAF. The SAF dataset is much smaller and requires less clusters.

Step 5: Mapping Clusters
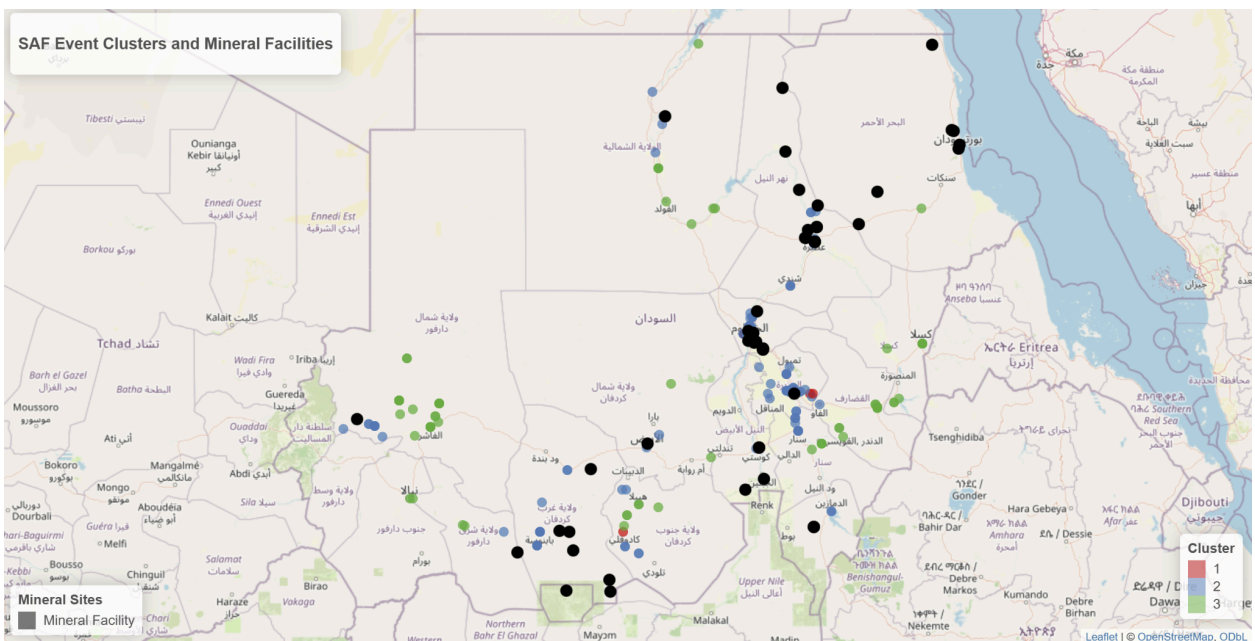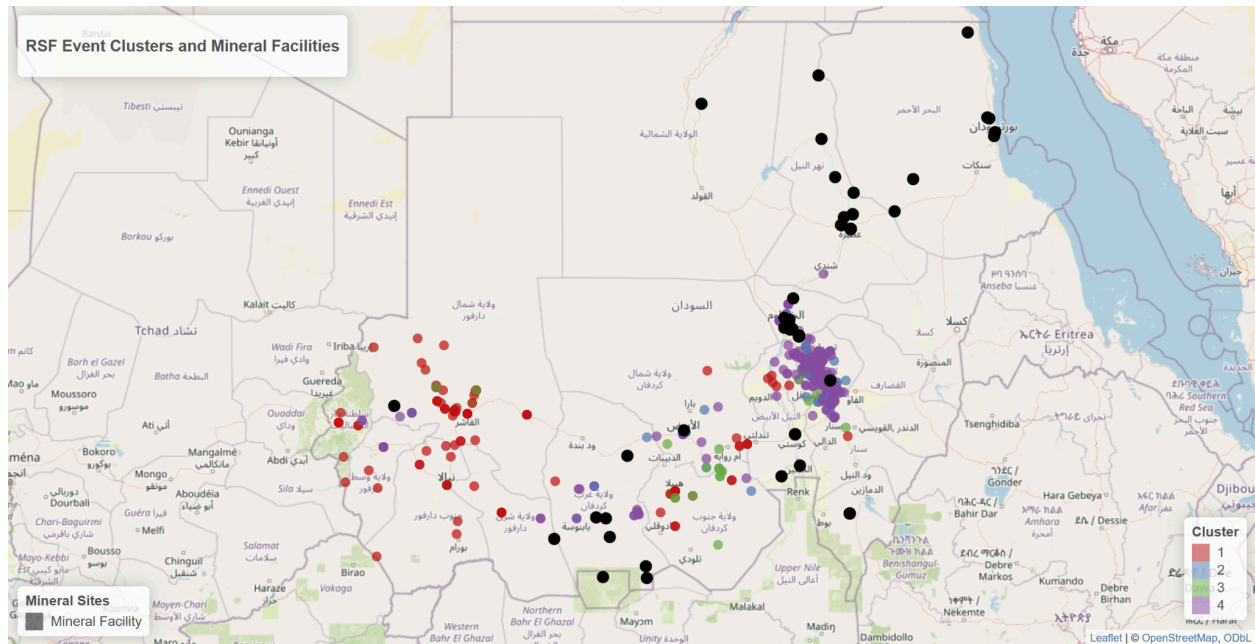
I used the Leaflet package in order to create high-quality, interactive maps of conflict events occurring in Sudan. These maps show distinctive geographical patterns in the clusters. The RSF map shows that events belonging to Clusters 2 and 4 are mainly gathered around the Khartoum area while Cluster 1 events are mainly located in the Darfur area. Cluster 3 events are scattered mostly in South Kordofan and Khartoum. Interestingly, there are no events near the mineral facilities in the North East region. Interestingly, the SAF map shows less of a geographic pattern. Events from all three clusters seem to be randomly scattered around the country without any particular gathering points near major cities or points of interest. It is possible that Cluster 2 events are mostly happening in the Khartoum area and Cluster 3 events in Darfur but enough are scattered around that it is difficult to really tell. In contrast to the RSF, there are events that have occurred around the North East where there is a cluster of mines.

Step 6: Cluster Summaries

After mapping, it was important to find a way to define each of the clusters in relation to the number of fatalities that occurred and distance from mineral facilities.

RSF Summary (average fatalities and distances from mineral facilities)
Cluster 1: lowest fatalities and farthest from mineral facilities
Cluster 2: medium fatalities and close to mineral facilities
Cluster 3: high fatalities and far from mineral facilities
Cluster 4: low fatalities and closest to mineral facilities

RSF Event Summaries (top 3 most common event for each cluster)
Cluster 1: Attack, Change to group activity, Forced disappearance & Armed clash (tied for third)
Cluster 2: Attack, Shelling/artillery/missile attack, Armed clash
Cluster 3: Armed clash, Attack, Shelling/artillery/missile attack
Cluster 4: Attack, Looting/property destruction, Shelling/artillery/missile attack

SAF Summary (average fatalities and distances from mineral facilities)
Cluster 1: high fatalities and medium distance from mineral facilities
Cluster 2: low fatalities and closest to mineral facilities
Cluster 3: low fatalities and farthest from mineral facilities

SAF Event Summaries (top 3 most common event for each cluster)
Cluster 1: Air/drone strike, Armed clash, Attack
Cluster 2: Air/drone strike, Change to group activity, Attack
Cluster 3: Air/drone strike, Change to group activity, Disrupted weapons use

The RSF cluster summaries show that the events occurring near mineral facilities are often the ones with the lowest fatalities which may suggest that RSF activity near the mineral facilities is for the purpose of maintaining control and asserting dominance rather than any major fighting. The clusters with higher fatalities are further from mineral facilities which would indicate that major battles are fought on specific territorial frontlines in key areas such as North and South Kordofan which can be seen on the map.

The SAF cluster summaries show that the high fatality events are not necessarily very close to the mineral facilities but mostly involve drone/air strikes, armed clashes, and attacks. Events featuring low fatalities more frequently involve changes to group activity, regardless of distance to mineral facilities. There is less of a pattern in the SAF's conflict activity that would connect the mineral facilities to conflict tactics and fatalities.

Step 7: Scatter Plots
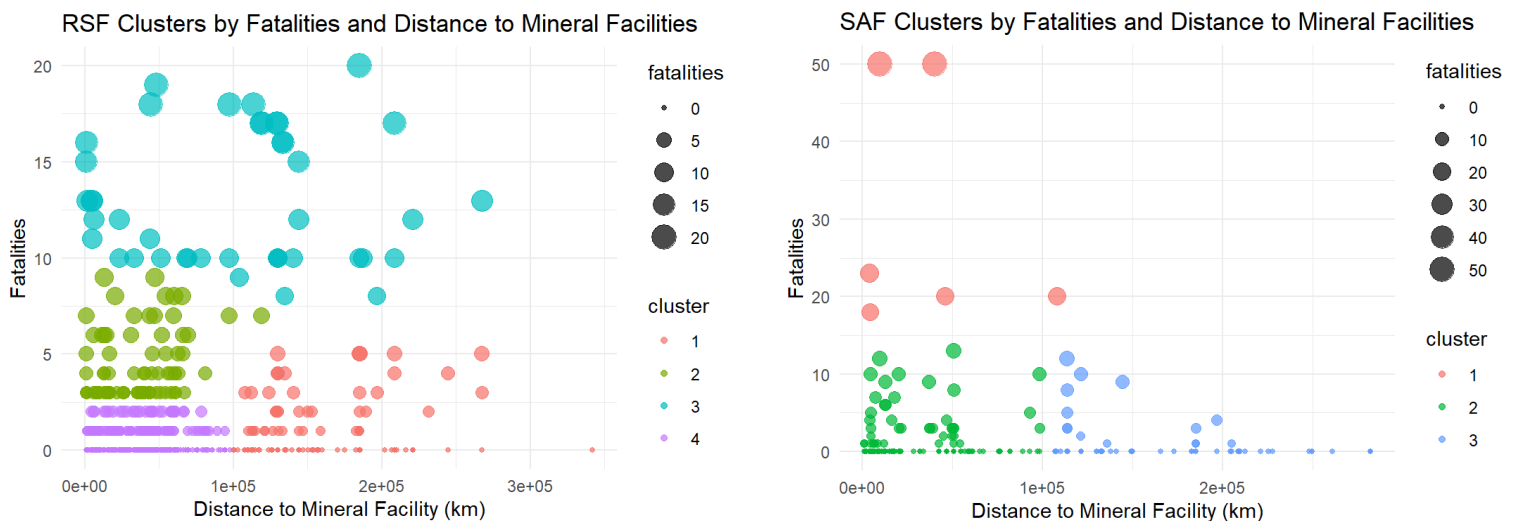
While the averages from the previous analysis remain true, these scatter plots add another dimension to our understanding of the conflict. This shows us that the SAF events with the highest number of fatalities are ones that have occurred closest to a mineral facility. While low fatality events occur regardless of proximity to a mineral facility, more fatalities seems to occur the closer the event is to such a facility. The RSF scatter plot is not quite as simple to parse through but at the very least it seems as if more events happen closer to mineral facilities, regardless of the number of fatalities.

Conclusion and Discussion

Of course, we are unable to definitively say that the RSF or the SAF act in any particular way because of proximity to mines. The cluster summary data reveals that the most violent and high fatality areas in Sudan are related to conflict frontlines, particularly in places like Khartoum and Kordofan where there is much fighting over territory. While the scatter plots reveal some sort of pattern relating to mineral facilities, it is also possible that these facilities happen to be in areas of key interest for the conflict actors and have nothing to do with the fight for natural resources at all. For example, there are several facilities in Khartoum but that region has been fought over for months with a constant back and forth between the RSF and SAF regarding control over the city. In the future, I would use a different approach to test this question because a cluster analysis is not robust against other major factors impacting conflict actors and their behaviors.

References

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