Homicides and Climate Change in the United States

Ishani Paul
Dougherty Valley High School
San Ramon, CA 94582
ishanipaul606@gmail.com

Abstract

Homicide rates have sharply increased in the USA since 2014. The reasons for this are still inconclusive. This paper examines the correlation of homicide rates in each state with extreme weather events and concludes that massive climate change could be triggering high human stress leading to increased homicides. ChatGPT 4o is used extensively and its use is documented.

1 Introduction

Homicide rates, as defined by the Center for Disease Controls (CDC), is the number of homicides per 100,000 population. In the United States, homicide rates have increased sharply since 2014 [1][2] as shown in Figure 1. Analyzing the data at a finer granularity by each state [3] reveals that 45 out of 50 states and Washington D.C. witnessed increased homicide rates during 2014-2022 indicating that it is a systemic problem throughout the United States and not just confined to a few states. The states witnessing a rise in homicide rates are shown in Figure 2. Researchers have attempted to attribute the cause to a wide range of factors ranging from COVID restrictions and gun ownership[4],to less aggressive policing [5] and socio-economics [6] but no definitive cause has been proven yet. On the other hand, prior research [7] has correlated crime with hot weather. But hot weather is just one out of the many types of extreme weather events caused by climate change. For example, the extremely cold polar vortex impacting the midwest or the increasing number of tornadoes impacting the southeast are also caused by climate change. They are equally destructive in the suffering they unleash on impacted populations. Could the unprecedented weather changes, in its various forms, that the US is witnessing in recent years be stressing Americans enough to increase the homicide rate ? Analyzing correlations between extreme weather events in 43 out of 45 states (except Alaska and Washington D.C. due to lack of weather data) , with their homicide rates reveals important insights.

1.1 Use of ChatGPT 4o

Chat GPT 4o is used extensively in this paper from sourcing reference materials, to drawing plots, to cleaning and preparing data and to calculating correlations. ChatGPT helped ideate on research topics, enabled quick experiments with data and quickly summarized prior research papers thus saving hours of time. ChatGPT retains context of past interactions. When prompted to calculate correlation between homicide rates of a state and 7 extreme weather events, Chat GPT automatically parses the uploaded files and creates tables of correlations. It correctly anticipates that the user would upload the next batch of state and weather data after a batch is complete. Minimum extra prompting is required. At every step Chat GPT offered several visualization options from bar charts to choropleth maps and heatmaps. While Chat GPT was very useful, it was not perfect. ChatGPT was not aware of either the homicide rate data nor the weather events data even though they are freely available on the internet. Both had to be manually uploaded to Chat GPT. This was very tedious. In addition there were several errors encountered with Chat GPT. For example, in many instances Chat GPT would hallucinate incorrect correlations which required additional prompting to fix the error. This required constant vigilance. When prompted to create the plot in Figure 2, Chat GPT would
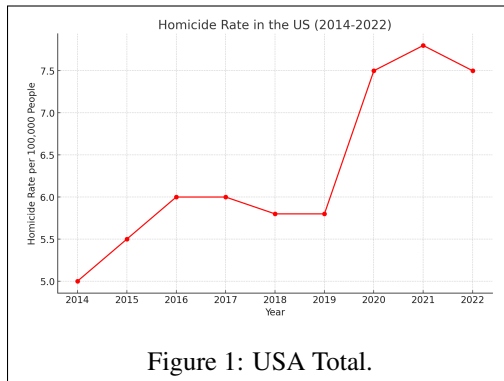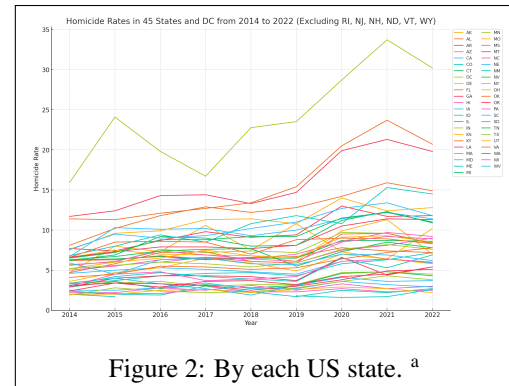
Figure 1: USA Total.

Figure 2: By each US state. [a]

Figure 3: Homicide rates 2014-2022.
[a]6 states RI, NJ, NH, ND, VT and WY are excluded from the state plot because homicide rates dropped in these states during this period.

only label half the states. Another limitation was the maximum of 10 files that can be uploaded at one time which made it very cumbersome to upload weather and homicide data only one state at a time for a total of 43 times. Throttling was an additional pain point as Chat GPT would often disable uploading files for hours without warning. Despite its limitations, Chat GPT was incredibly useful for refining ideas and driving towards conclusions.

1.2 Crime and Climate

The impact of climate change on human beings is complex and can take on many forms. Catastrophic weather events such as tornadoes and wildfires can force evacuations and burn or tear down homes and workplaces causing unemployment, homelessness and economic hardship. Rising sea levels can force evacuations of residents from coastal lowlands or islands. Prolonged droughts can cause cities to pass mandates to ration water and ban watering cherished lawns and gardens. Without appropriate air conditioning, heat waves cause physical discomfort and heat strokes. Storms can cause power outages. In each of these cases, climate change has the potential to disrupt our lives, our families and our livelihoods. This increases stress and uncertainty. And with stress comes hopelessness, loss of self control, breakdown of social order and increasing propensity for violence.

1.3 Data and Methodology

Homicide rate data is sourced from the Center for Disease Control (CDC). Homicide rate i.e. the number of homicides per 100,000 population is chosen as the key metric in this report instead of the total number of homicide deaths each year because homicide rate is normalized with respect to its underlying population and hence a better metric to compare over time periods. This is an important consideration because the population of most US states increase over time. Therefore, though the total number of homicide deaths might be expected to increase each year in proportion to the increase in the population, the homicide rate ideally should remain constant absent of an underlying cause that compels it to increase. The analysis is limited between 2014-2022 because of the unavailability of reliable homicide rate data from CDC before 2014 and beyond 2022. Weather data is sourced from the records of the United States National Weather Service (NWS) archived at the Iowa Environmental Mesonet (IEM) [8]. For extreme weather events, the "warnings" (the highest level of alert) issued by NWS and their duration in each state during each year 2014-2022 is used for analysis. In this report 7 types of the most commonly issued warnings are used as a proxy for extreme weather events. These warnings are for 1) extreme heat 2) flash flood 3) tornado 4) severe thunderstorm 5) freeze 6) flood and 7) red flag warning. With climate change, these warnings are being issued more frequently and for longer durations. Next, for each of the seven categories of weather warnings, their duration in days is calculated because often a single weather event may span over a number of consecutive days. This is calculated as the difference between the date the warning is issued and the day the warning expires. Both dates are available from the NWS records for each warning. This is an important consideration because not only are extreme weather events occurring more frequently, but they linger on for longer durations. Therefore the total number of

days of each type of event, and not just a count of their occurrences, is used to correlate with homicide rates. Finally for each state and for each category of weather warning, the correlation between the total number of days of that type of weather warning that year and the corresponding homicide rate that year is calculated. Out of 45 states that experienced an increase in homicide rates, correlations calculated for 43 states X 7 categories for a total of 301 correlations. For each state, the highest correlation between the homicide rate among the 7 weather events is selected and is listed in Table 1. Results, data, plots, prompts and Google colab notebooks are available at (https://github.com/IshaniP456/CLIMATE/).

1.4   Results and Analysis

Out of 43 states, 31 states exhibit correlations > 0.5, 24 states > 0.6 and 13 states > 0.7. Thus (31/43) = 72.09% of the states exhibit moderate or higher correlation with extreme weather events. Of the states where homicides are correlated with extreme weather, Excessive heat events i.e. Extreme Heat warnings or Red Flag warnings have the highest correlation with homicide rates in the highest number of states =12 representing (12/31=) 38.7% of the states. Excessive precipitation events i.e. Severe thunderstorms, Floods or Flash Floods comes a distant second in 7 states representing (7/31) = 22.5% of the states. This is followed by Wind events such as Tornadoes and Freeze warnings in 6 states (i.e. 19.35%) each. Consistent with prior research, excessive heat demonstrates some of the strongest correlations with homicide rates in the most number of states such as California (corel=0.838 with Extreme Heat warnings) and Colorado (corel= 0.795 with Red Flag warnings). In coastal states such as Hawaii (corel = 0.875 with Severe Thunderstorm warnings) or those in the southeastern United States e.g. Arkansas (corel = 0.774 with Tornado warnings), Alabama (corel = 0.656 with Tornado warnings) etc., wind or precipitation events tend to dominate rather than heat. Intuitively this makes sense for example in Florida (corel = 0.59 with Flash Flood warnings) with its coastal humid climate, where its proximity to incoming sea breezes from the Gulf of Mexico and the Atlantic Ocean moderates temperatures inland (semi tropical weather) even though climate change manifests itself as increasing number and intensity of flash floods. For populations used to extreme weather already, new and unexpected types of extreme weather events show strong correlation with homicide rates. For example, Arizona (corel = 0.862 with Flood warnings) is accustomed to scorching summers and the penetration ratio of air conditioners in the population is greater than 90% [9]. Therefore even though the summers are getting hotter and longer in Arizona, the residents of Arizona have developed strategies to prepare for it. On the other hand the increasing frequency and magnitude of flash floods is unexpected in Arizona. Therefore it is likely that flash floods stress Arizona residents more than heat waves, which in turn impacts the homicide rate.
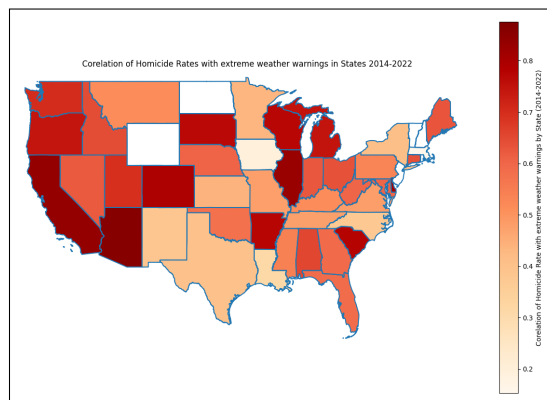

Figure 4: Correlation of homicide rates with extreme weather warnings in the USA 2014-2022

Similarly tornadoes are a rarity in Delaware. But Delaware (corel = 0.808 with Tornado warnings) experienced 6 tornado events in 2020 [10] which was unexpected and shows strong correlation with homicide rates. A third example is wildfires. Red Flag warnings from the NWS have become synonymous with wildfires in recent years. Most states and their residents were unprepared for the explosion of massive wildfires across the country in recent years and its side effects such as unhealthy smoke , power outages, evacuations and loss of habitat and life. As a result redflag warnings exhibit high correlation with homicide rates in many states such as South Dakota (corel = 0.768 with Red

Table 1: Correlation of Homicide Rates with extreme weather in the United States 2014-2022. Ranked by correlation from the highest to the lowest. Only correlations > 0.5 are shown.

Rank	State	Warning	Correlation	Rank	State	Warning	Correlation
1	Hawaii	Thunderstorm	0.875	17	Connecticut	Red Flag	0.639
2	Arizona	Flood	0.862	18	Ohio	Freeze	0.635
3	California	Heat	0.838	19	Maine	Flood	0.631
4	Illinois	Freeze	0.829	20	Indiana	Red Flag	0.625
5	Delaware	Tornado	0.808	21	Nevada	Heat	0.623
6	Colorado	Red Flag	0.795	22	Nebraska	Red Flag	0.605
7	South Carolina	Tornado	0.779	23	Maryland	Tornado	0.603
8	Arkansas	Tornado	0.774	24	West Virginia	Freeze	0.602
9	Wisconsin	Freeze	0.772	25	Georgia	Flood	0.590
10	South Dakota	Red Flag	0.768	26	Florida	Flood	0.590
11	Michigan	Thunderstorm	0.748	27	Oklahoma	Tornado	0.578
12	Oregon	Heat	0.732	28	Mississippi	Heat	0.540
13	Washington	Heat	0.701	29	Pennsylvania	Freeze	0.535
14	Utah	Red Flag	0.695	30	Kentucky	Freeze	0.515
15	Alabama	Tornado	0.656	31	Montana	Red Flag	0.515
16	Idaho	Flood	0.646				

Flag warnings), Utah (corel = 0.695 with Red Flag warnings). Finally, cold weather is not often correlated with crime. But residents of midwestern states such as Illinois (corel = 0.829 with Freeze Warnings) and Wisconsin (corel = 0.772 with Freeze warnings) states were not prepared for the unprecedented extremely cold polar vortex in 2019 and the freezes of the recent years. Such events force residents to be isolated indoors for prolonged periods of time. Schools,workplaces,shopping centers shutdown severely disrupting life causing a high correlation between Freeze warnings and homicide rates in midwestern states.

1.5 Limitations

Correlation does not necessarily mean causation. Though homicide rates have high correlation with extreme weather events in the US, there could be other unknown factors that could be partially or wholly causing the increase in homicide rates. Further research with control groups is required to isolate factors and identify better causality. Furthermore, this paper analyzes data over only nine years. Studies over longer durations are required to prove that the correlation between homicide rates and extreme weather events is not just a transient phenomena. Finally, this analysis is only based on US data. As such, these correlations may turn out to be very different in other parts of the world with different climates than the US. Similar analysis needs to be done based on global data from outside the US and the results compared and contrasted with the findings of this report.

1.6 Conclusion and Next Steps

Homicide rates demonstrate strong correlation with extreme weather in a majority of states. However, homicides are just one indicator of a society's health. Since climate change impacts every aspect of our lives, further research is required to analyze the effect of climate change on other important societal issues such as homelessness, food security, population health etc. While these are areas of active research and there are many unknowns, it is clear that due to its vast scale of impact, extreme weather events require concerted efforts from government and administrations to educate, prepare and protect their populations from the effects of climate change. Artificial Intelligence(AI) can help governments analyze huge quantities of data, that would otherwise take years, and come up with actionable insights quickly. AI can also help governments design quick experiments to measure the efficacy of solutions. Climate models are yet another area where AI can help, as new climate models are required to predict our changing climate. With ever more powerful AI models being invented every month , it is the perfect technology to tackle the ever increasing threat of climate change. The timing could not be more right.

Acknowledgments and Disclosure of Funding

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