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Climate and Crime

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Abstract- Few issues provoke as much public concern as violence. Persistent variations in the homicide rates of different countries have led sociologists, criminologists and geographers to question why violence, and lethal violence as an extreme example, is more common in some societies than in others. This paper focuses on one possible explanation: climate, and especially temperature. The analysis is based on monthly crime, temperature, relative humidity and precipitation data of 62-year period (1952 to 2013) of Allahabad city, India. Results show that temperature has a significant positive impact on criminal behavior, and murder incidences in Allahabad city were high in hot months. Relative humidity too seems having significant and positive influence on crime rate, while rainfall showed a negative correlation with crime pattern. Results reveal that climate-crime association follow a linear relationship and crime rate increases with rise in temperature.

Keywords: *violent offenses, social interaction theory, ambient temperature, geographic resolution.*

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Climate and Crime

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I. Introduction

Scientists have long been wrestling on the effects of climate on human behaviour, including crime (Sorokin, 1928; Parker, 2000). There is considerable evidence that weather does affect criminal behavior (Brunsdon et al, 2009; Bushman, Wang, and Anderson, 2005; Cohn and Rotton, 2000; Cohn, 1990). Simister and Cooper (2005) observe a strong linear relationship between severe crime and temperature. In a study, Jacob, Lefgren, and Moretti (2007) find that rates of violent crime are elevated during weeks with hot weather.

Although studies suggest a plausible relationship between climate and criminal offences, there is disagreement between researchers on the effects of temperature on violence whether it is linear or curvilinear (Anderson et al., 2000; Rotton & Cohn, 2002; Rotton, 1986, 1993). Some writers, such as Van de Vliert et al. (1999), report evidence to support a 'curvilinear hypothesis': violence tends to increase with higher temperatures, up to a daytime temperature about 24°C, but then declines with further increases in temperature. Simister & Cooper (2005) reach an opposite conclusion: that there is more violence at very hot temperatures. Although these two claims are not as different as they appear – over a range of roughly 8 to 24°C, both groups of researchers claim violence tends to increase at higher temperatures.

Present paper focuses on the controversy of high temperatures: does violence fall above 24°C, or does violence continue to increase at higher temperatures? The study uses month-wise time series data of 62 years period (1952 to 2013). Murder is the most violent crime in all criminal offences hence the study deals with incidence of murders/attempted murders only for analyzing climate-crime association. The explanatory variables are temperature, humidity and rainfall. Annual crime data has been derived from National Crime Record Bureau (NCRB) while monthly crime data was collected by the various police stations of Allahabad city and from crime record bureau of Uttar Pradesh. Temperature and rainfall data was obtained from the local weather station, and from India Meteorological Department (IMD). The study uses simple correlation and regression techniques to understand climate-crime correlates.

II. Results

Results suggest that incidence of violent crime has significant association with climatic elements i.e. temperature, relative humidity and rainfall. Figure 1(a) shows very striking connection between temperature and crime (r = 0.75), and the rate of murder/attempted murder tends to increase with rise in temperature. It is evident from Figure 1 (b) that the relation between relative humidity and crime is strong (r = 0.68), while Figure 1(c) shows that rain has a negative impact on crime (r = 0.14), and violence decreases with increasing rainfall.

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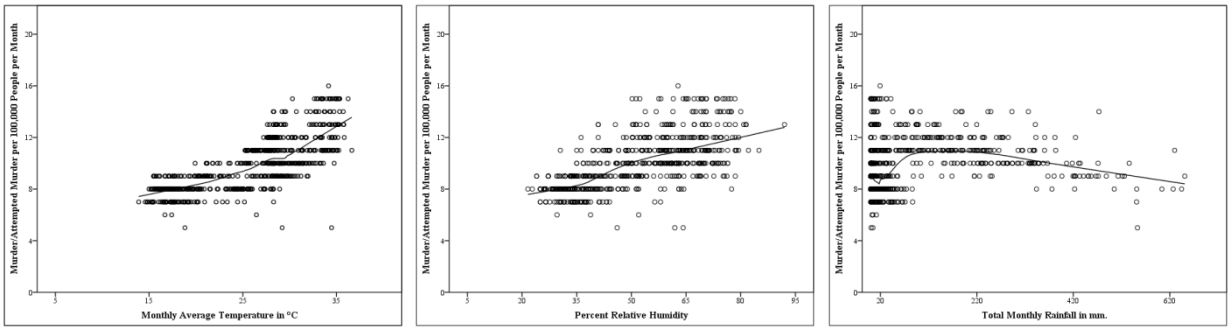

(a) (b) (c)

Figure 1 : Incidence of murder/attempted murder versus Temperature, Relative Humidity and Rainfall

Figure 2 presents the combined impact of all these factors on crime rate. It is evident that hot and humid months have recorded more criminal offences, while wet months, even having high temperatures, have registered less crime incidences comparatively.

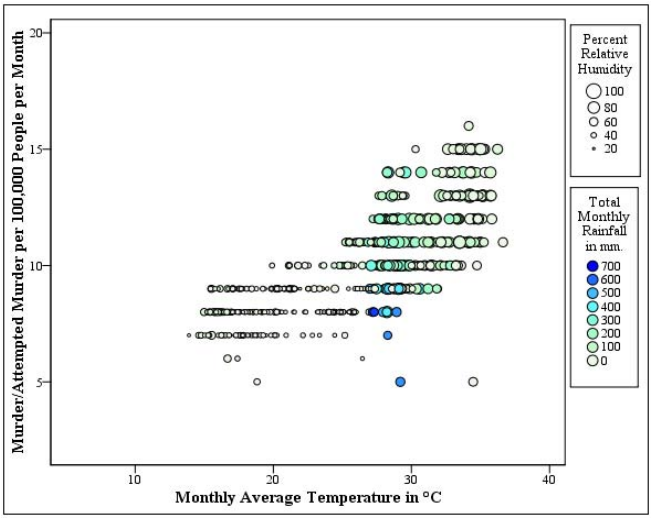

Figure 2 : Association of severe criminal offences with climatic elements

Month-wise correlates of climate and criminal offences support the linear hypothesis that rate of crime increases with rise in temperature, for such situations where average temperature varies between 16 to 35°C (Table 1). Relative humidity although has a significant and positive association with crime, yet, temperature is the most influencing variable among all climatic factors.

Table 1 : Crime statistics of Allahabad city (1995-2012)

Month	Average Temperature in °C	Average Rainfall in mm.	Average Relative Humidity in per cent	Correlations		
				Murder versus temperature	Murder versus Rain	Murder versus Humidity
January	16.3	26.3	38.8	0.19	-0.07	0.06
February	19.0	16.4	33.5	0.21	-0.05	0.19
March	24.8	13.1	32.8	0.24	-0.03	0.11
April	30.1	4.5	54.1	0.32**	-0.03	0.10
May	34.0	8.8	66	0.35**	-0.16	0.21
June	33.4	107.5	68.9	0.34**	-0.17	0.28*
July	29.4	288.2	70.6	0.29*	-0.28*	0.26*

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August	28.2	336.9	63.1	0.27*	-0.32*	0.19
September	28.0	178.1	53.6	0.26*	-0.26*	0.02
October	26.0	29.7	47	0.26*	-0.25*	0.12
November	21.1	10.8	37.4	0.20	-0.01	0.13
December	17	6	31.9	0.18	-0.18	0.12

**: $p < 0.05$; **: $p < 0.01$.*

Source: NCRB, IMD

Regression analysis is a more convincing approach to test the hypothesis that the three variables-temperature, humidity and rainfall have determining influence on the crime rate of a region. Stepwise regression results are shown in table 2.

Table 2 : Step-wise regression result showing climate-crime co-variance

Model	R	R Square	F
1	0.75[a]	0.56	937.76***
2	0.76[b]	0.58	514.41***
3	0.78[c]	0.61	380.37***

***: $p < 0.001$

a. *Predictors:* Monthly Average Temperature in °C
b. *Predictors:* Monthly Average Temperature in °C, Percent Relative Humidity
c. *Predictors:* Monthly Average Temperature in °C, Percent Relative Humidity, Total Monthly Rainfall in mm.
d. *Dependent Variable:* Murder/Attempted Murder per 100,000 People per month

Regression result shows that coefficient of determination for the first model which considered only temperature as a predictor, was 0.56. This reveals the temperature alone explained 56 per cent of the variance of crime pattern. After including relative humidity and rainfall, the third model attained R^2 value 0.61. This affirms that among all the climate elements temperature has most significant impact on crime incidences. Figure 2 which shows approximately an upside V shape, portrays this claim more evidently: as temperatures rise above some threshold (which is about 25°C in case of Allahabad), violence tends to increase. Very high temperatures are associated with high rainfall, and rainfall tends to reduce thermal stress. But if rainfall (and humidity) were unchanged, very high temperatures would not cause a reduction in violence. Regression result seem inconsistent with the curvilinear hypothesis and does not support the claim that violence declines at very high temperatures.

Table-1 suggests that, if temperatures are high, rainfall has a significant tendency to reduce violence. The significantly positive coefficients for humidity may explain the discrepancy between the results. Rainfall and humidity tend to have opposite effects on violence: humidity appears to increase violence, but rainfall tends to reduce it.

III. Conclusion

It is evident that climate and especially temperature, has determining influence on human behavior. In case of Allahabad city, 25°C temperature seems tipping point for criminal offences and crime rate increases with increase in temperature. Thus, present study rejects the curvilinear hypothesis that after some point crime rate decreases with further increase in temperature. Result shows that rainfall tends to reduce violence, whereas temperature and humidity tends to increase it. But all climatic factors are inter-linked and, thus, carry some auto-correlation errors. Actually any climatic element viz. temperature, rainfall or humidity, is the production function of rest of the climatic variables. Hence regression analysis sometimes produces misleading results. Therefore, more variables like wind speed, human perception etc. should also be taken into account for such analysis to increase the accuracy.

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