IS THERE MORE VIOLENCE IN VERY HOT WEATHER? TESTS OVER TIME IN PAKISTAN, AND ACROSS COUNTRIES WORLDWIDE

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Abstract:

Several writers have claimed that temperature appears to influence violent behaviour. We consider two papers which studied this issue, but which arrived at different conclusions. Van de Vliert et al (1999) claim the highest rates of violence are associated with temperatures about 24°C; whereas Simister and Cooper (2005) consider violence to be more common if temperatures are more than 24°C. We report evidence to support each viewpoint. We claim that other aspects of climate (in addition to temperature) are also relevant to violence, including rainfall and humidity. It appears that more climate and crime data are needed, before we can fully understand this issue; the Pakistan government (and it agencies) are well-placed to help researchers. This is an important topic: governments may be able to reduce violence, if the causes are understood better.

Introduction:

Few issues provoke as much public concern as violence. No wonder: in the year 2000, for example, an estimated 0.8 million people worldwide lost their lives to intentional injury; over three-fifth of these deaths were homicides (murders) (Krug et al., 2002: 9-10). Persistent variations in the homicide rates of different countries have led sociologists and criminologists 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, which has been supported by several researchers: climate, and especially temperature.

There is disagreement between researchers on the effects of temperature on violence. 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. 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. There is little evidence in either paper on the effects of cold temperatures (Simister & Cooper, 2005), are cautious about claiming violence increases at very cold

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temperatures; cold temperatures are hardly mentioned in Van de Vliert et al, 1999). This paper focuses on the controversy of high temperatures: does violence fall above 24°C, as Van de Vliert et al, 1999, claim – or does violence continue to increase at higher temperatures, as claimed by Simister & Cooper (2005)? We use the phrase 'curvilinear hypothesis' to refer to Van de Vliert et al's claim that violence declines as temperatures exceed about 24°C; the alternative hypothesis is that violence continues to increase at very hot temperatures.

This paper uses two types of evidence: time-series data from Pakistan and cross-section data from different countries. We study murder and attempted murder in Pakistan; and political violence in our cross-section data. The explanatory variables are temperature, rainfall, and humidity.

Literature Review

There are many possible influences on violence; we do not have sufficient space to examine them all. Scientists have long been wrestling with the effects of climate on human behaviour, including crime (for overviews, see Sorokin, 1928; Parker, 2000). Some of this previous research focused on whether the relationship between temperature and violence is linear or curvilinear (for overviews, see Anderson et al., 2000; Rotton & Cohn, 2002; Rotton, 1986, 1993). The exact mechanism is unclear – Van de Vliert et al (1999) suggest a cultural explanation which connects climate to behaviour; whereas Simister & Cooper (2005) suggest a medical explanation, considering violence to be a side-effects of adrenaline (which is secreted into the blood at high temperatures, as part of a thermal control mechanism in humans).

There are many complications in this field – not least, identifying cause and effect. For example, violence may be a response to poverty. On the other hand, income or capital resources can be exchanged for a wide variety of goods to overcome or mitigate the hardships of harsh climates (Parker, 2000: 132-135). Extreme climates may be a cause of income levels: "poverty is ... approximately a tropical problem" (Theil & Finke, cited in Ram, 1997; see also Van de Vliert, Kluwer & Lynn, 2000) – for example, farm output may be reduced by extreme weather. According to resource mobilization models (e.g. Boswell & Dickson, 1993; Cooney, 1997; Muller & Weede, 1990; Tilly, 1978), the political system mobilizes resources for collective goal attainment, distributes power, and provides access to dispute resolution structures. Democracy may be related to violent behaviour: highly repressive regimes suppress violence; highly democratic regimes provide non-violent channels for expression; and regimes between these extremes may experience most violence. Another viewpoint is 'cultural masculinity', in which gender roles are clearly distinct: men are supposed to be assertive, tough, whereas women are supposed to be more tender (Hofstede, 2001: 297); cultural masculinity may be related to climate (Van de Vliert et al., 1999).

Data and Methods:

For this paper, we use the term 'climate' to represent several variables – including temperature, rainfall, and humidity. Climate varies from harsh at latitudes closer to the icecaps (e.g. Canada), in countries with land climates (e.g. China), and in desert areas (e.g. Sudan), to temperate in countries with sea climates at latitudes closer to the equator (e.g. Costa Rica). Van de Vliert & Smith (2004) claim that the more the local temperature deviates below or above 20°C, the more hostile the temperature seems to humans; others (such as Brück, 1989: p. 631) also discuss other variables, such as humidity and wind speed, as being relevant to how 'cold' or 'hot' a human is likely to feel.

We use both time-series and cross-section data. Our time-series data is for Pakistan: our methods are similar to those of Simister & Cooper (2005), but using entirely different data, because we could not find sufficient humidity data for USA. We suspect Pakistan is one of the best countries to study for this topic, regarding availability of published data. There are other advantages in studying Pakistan: it has large month-to-month variations in rainfall, receiving a mild monsoon around July to August. Our cross-section research uses data provided in Van de Vliert et al (1999), with additional climate data explained below.

Our regression specifications are simpler than the two papers we are assessing. The issue of which variables to include in regression is controversial: there are risks in using too few variables (omitted variables bias) or too many variables (collinearity). A simple regression specification has advantages here, because we are not sure which variables are causes and which are effects. To illustrate this, consider six of the variables in Van de Vliert et al (1999): income and income squared; democracy index, and democracy squared; masculinity index and masculinity squared. None of these six variables were statistically significant in either regression (by the final step), which suggests they are irrelevant to political violence. But even if they are relevant, any of them could be effects, rather than causes, of violence. Political violence could end or begin a period of democracy. Income may be affected by violence, because investors are less likely to invest in a violent country. Simister & Cooper (2005) suggest a culture of 'masculinity' may be caused by aggression as a side effect of adrenaline in hot climates. Note, however, that there is a case for including variables which are not statistically significant, if only to prove their insignificance. We exclude some variables used by Simister & Cooper (2005), such as day length (which they found statistically insignificant).

This paper is unusual in considering the influences of 'rainfall' (which we use as a shorthand for precipitation – including snow, hail, etc), and humidity, on violence. We think most (or all) temperature-related violence occurs in hot weather, i.e. in the summer months. So we only consider effects of rain in summer, and ignore effects of rain in other months. To do this, we consider only rainfall in June &

July in northern hemisphere countries (including Pakistan), or in December & January in southern hemisphere countries. Our 'summer rain' variable is equal to rainfall in June and July, or is equal to zero for other months. For cross-section data, we then calculate the average of this 'summer' rainfall for all 12 months. We then do the same for humidity (on the assumption that only humidity in June or July is relevant to crime). Other researchers might consider different definitions of "summer", such as June to August for northern hemisphere countries.

In this paper, all temperatures are "dry-bulb" temperatures, in degrees Centigrade; all rainfall data is in millimetres per month; and all humidity data is 'relative humidity' at noon, expressed as a percentage. All crime rates in this paper are numbers of crimes per year, per 100,000 people. To calculate 'temperature squared' for regression, we follow Van de Vliert et al (1999), and subtract the mean temperature from each individual temperature before squaring. This is vital, because without it the correlation between temperature and temperature squared is extremely high (about .965 in our cross-section data, or .997 in our time-series data) – so collinearity would be a major problem if we did not subtract the mean before squaring.

Evidence from Pakistan:

Crime data in each province of Pakistan (and Karachi city) is available, but we found too few observations to produce reliable results; so we study crime in Pakistan as a whole. We measure violence by number of murders plus attempted murders, reported in Monthly Bulletin of Statistics (Federal Bureau of Statistics, multiple editions). We divide the number of these crimes by our estimate of population each month (based on census data), to give a crime rate per 100,000 people; we divide this by the number of days per month, and multiply by 365 to get annual equivalents (for comparability with cross-section data below). Monthly data is available from July 1977 to December 2001; we sought climate data (temperature, rainfall, and humidity) for the same period.

The Monthly Bulletin of Statistics (Federal Bureau of Statistics, multiple editions) has monthly data on temperature at about a dozen weather stations; but there are missing values for some weather stations, which can distort results (for example, if data were missing from a hot area, the Pakistan average might appear colder that month). We use data from 4 weather stations, which have few missing observations: Karachi Airport (Sindh); Lahore (Punjab); Peshawar (North West Frontier Province); and Quetta (Baluchistan). For temperature, rainfall, and humidity, we calculate unweighted averages of these 4.

From October 1988, we use temperatures from The Monthly Bulletin of Statistics (Federal Bureau of Statistics, multiple editions), calculating the average of 'maximum' and 'minimum' temperature at each of the 4 weather stations. Before October 1988, we use data from CRU (2001, 2004) for the same 4 weather stations (sadly, this type of data is no longer available on the CRU website: CRU now only make gridded data available). For several years, we have temperature data from both sources, and we find they report identical data in most cases we examined; hence we are confident that CRU (2001 and 2004) temperature data can safely be combined with data from Federal Bureau of Statistics. Temperature data at these 4 weather stations are fairly complete; but there are a few missing temperature observations, which we estimate (for example, there is missing data for December 1984 in Quetta; we use the average December temperature in Quetta for all available years, as our estimate of Quetta's December 1984 temperature).

The rainfall data we found is less reliable than temperature data. We use rainfall data from The Monthly Bulletin of Statistics (Federal Bureau of Statistics, multiple editions), at the 4 weather stations we chose, for November 1988 to November 2001, and calculate the average of these 4. To use earlier crime data, we combine this with gridded data from CRU (Mitchell et al, 2003). These two sources are not directly comparable – we encourage CRU to make data on individual weather stations available, as they used to do for temperatures. Our approach is to estimate rainfall in Pakistan as a whole, from each source. For each month from November 1988, we calculate the average of 4 chosen weather stations. For earlier months, we use data from the 4 grid 'squares' labelled "Pakistan" in Mitchell et al (2003): 25 to 30 degrees north, 60 to 65 degrees east; 25 to 30 degrees north, 65 to 70 degrees east; 30 to 35 degrees north, 65 to 70 degrees east; and 35 to 40 degrees north, 70 to 75 degrees east. A grid square typically includes data from several weather stations. Grid squares do not always follow national boundaries: some weather stations in these 4 squares may be outside Pakistan, and some Pakistan weather stations may be in grid squares other than these 4. We have data from both sources (Federal Bureau of Statistics, and Mitchell et al 2003) for several years; in the overlap period (November 1988 to December 1994), average rainfall from CRU is only 59.5% of that in the 4 chosen weather stations, so we multiply Federal Bureau of Statistics data by 0.595, to make average rainfall from the 4 weather stations comparable to CRU.

Humidity data is harder to obtain than temperature or rainfall data. Federal Bureau of Statistics (1998) reports climate 'normals' for our 4 chosen weather stations, including 'vapour pressure' for each month (at different times: we chose noon). We multiply this by the ratio of (average vapour pressure for each year) to (average vapour pressure for all years), using the same publication. This gave estimates of vapour pressure each month & year, at all 4 weather stations; we calculate relative humidity, and the unweighted average of relative humidity at the 4 weather stations. The end result is far from ideal, but is the best source of humidity data we have. As a check, Karachi's monthly humidity from 1997 to 2000 is available from sbos.sdnpk.org for 8am and 5pm; the average of these two humidity values is close to our estimate of Karachi's humidity of noon.

We now turn to our Figure 1, which uses (as an indicator of violence) murders & attempted murders (combined), as a monthly rate of murders or attempted murders per 100,000 people. This chart uses data from July 1977 to December 2001. The

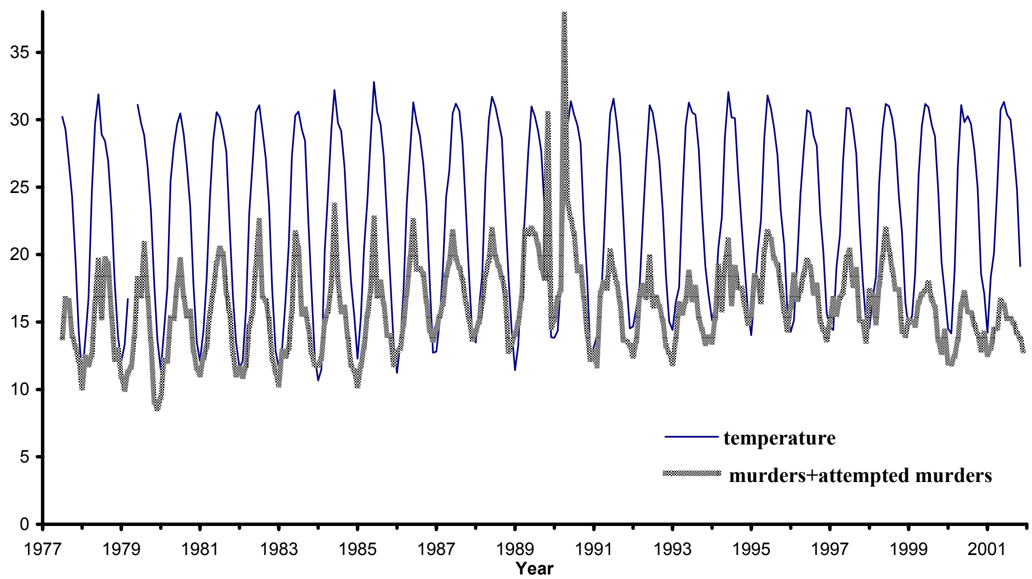

Figure 1: Murder/attempted murder per 100,000 people per year, & temperature, versus time: Pakistan

crime rate in Figure 1 has two outliers (November 1989, and April - May 1990). To avoid distorting regression results, we replace these values with average crime rates (for November, April, and May respectively).

Figure 1 shows a very striking connection between temperature and violent crime: the rate of murder/attempted murder tends to be higher in hot months, as indicated by the vertical spikes about the middle of each year. These confirm the association between crime and extreme temperatures –

murders & attempted murders tend to increase in summer months, when temperatures are high. Figure 1 also offers our first evidence against some ideas in Van de Vliert et al (1999): they claim crime tends to reduce above 24oC, yet Pakistan temperatures rise to over 30oC each summer – and crime appears to peak

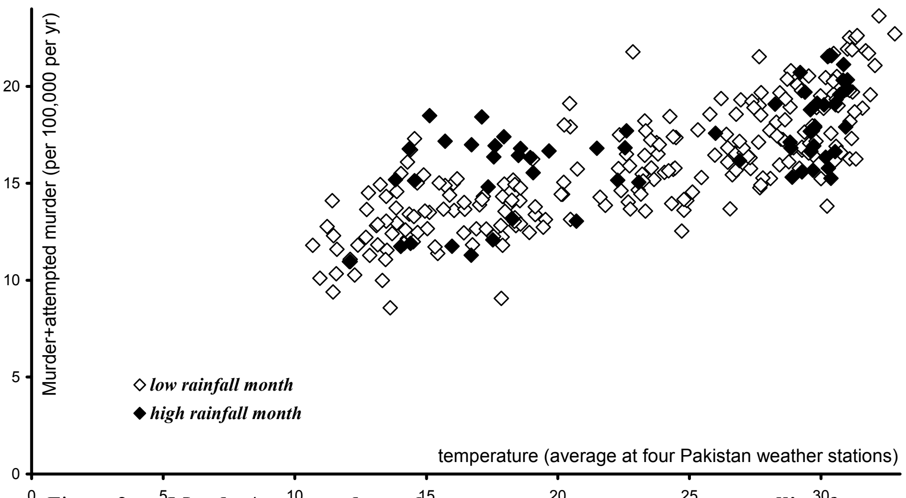

Figure 2: **Murder/attempted murder rate versus temperature, controlling for rainfall, Pakistan**

at the hottest month. Clearer evidence on this is shown in Figure 2, which represents the same crime rate and temperature data as Figure 1, but as a 'XY' (scatter) graph.

Figure 2 can be used to assess the claim of Van de Vliert et al (1999), that violence tends to be less prevalent if temperatures rise above about 24oC: the 'curvilinear hypothesis' predicts an inverted V-shape. But Figure 2 suggests an approximately linear pattern, which casts doubt on the claims of Van de Vliert et al. We return to this issue in our regression findings below.

In Figure 2, we add a third dimension: months in which rainfall is over 40mm (wet months are shown as black, others as white). Rain seems to have complicated effects on violence. On the right-hand-side of Figure 2, there is less violence in rainy months than in dry months; whereas the opposite effect is seen on the left-hand-side of Figure 2, where there tends to be more violence in months with high rainfall (although some cold & rainy months have low crime rates). Both effects of rainfall seem plausible to us: in hot weather, rain falling on skin or clothes will cool the body as it evaporates. But in cold weather, this cooling effects of rain can make people too cold, increasing thermal stress. This complexity causes us problems, however, when comparing rainfall in different countries (to test the curvilinear hypothesis). In this paper, we focus on rainfall in summer months (which we assume to be June & July, in Pakistan).

Many wet months are on the right-hand-side of Figure 2, suggesting that wet summers tend to be associated with high temperatures. And we can also observe in Figure 2 that wet summer months tend to have lower crime rates than would be expected, given their high temperature. Taken together, these suggest that wet summers are likely to be correlated with large values of (temperature2). This could explain Van de Vliert et al's (1999) regression finding, that (temperature2) tends to be negatively associated with crime – which they interpreted as evidence that violence tends to decline at high temperatures. Their interpretation may be incorrect: we suspect crime rates may continue increasing if temperatures rise above 24oC, and their regression results are an artefact of the data (a result of the fact that the hottest climates tend to have high rainfall). This explanation is not entirely persuasive, however. If rainfall reduces violence, we would expect all 'wet summer' months to have less violence than other months at the same temperature; but these wet summer months form approximately a vertical line – some wet summer months (near the top of the vertical line) have high crime rates. This led us to investigate another issue: humidity.

Previous researchers (such as Brück, 1989: p. 631) discuss many influences on how hot humans feel – including humidity. Perspiration is one way humans keep cool, if the temperature is high; but sweating tends to be less effective if the air is very humid. This paper is mainly concerned with hot weather, because (as Figure 1 indicates), more crime occurs in hot weather. So for our regressions (in Table 1), we focus on what we call 'summer', and calculate average humidity in June & July for Pakistan as a whole, using humidity at 4 weather stations (see 'data and methods' section above).

International Data:

For this section, we use political violence data (riot & armed attacks), reported in Van de Vliert et al (1999). Like Van de Vliert et al (1999), we use logs to minimise the distorting effects of very high rates of violence in some countries: Log(1+political crime rate per 100,000) adding 1 because no political crime is reported in some countries (this is the vertical axis in Figures 3 and 4, and is the dependent variable in regressions C and D in Table 1). For cross-country analysis, we use monthly data from Mitchell et al (2003) on temperature, rainfall, and humidity: we calculate the average for all weather stations in each country (whereas Van de Vliert et al, 1999, use temperature in the capital city). Temperatures on the horizontal axis of Figures 3 and 4, and in our regressions, are average of 12 months (January to December).

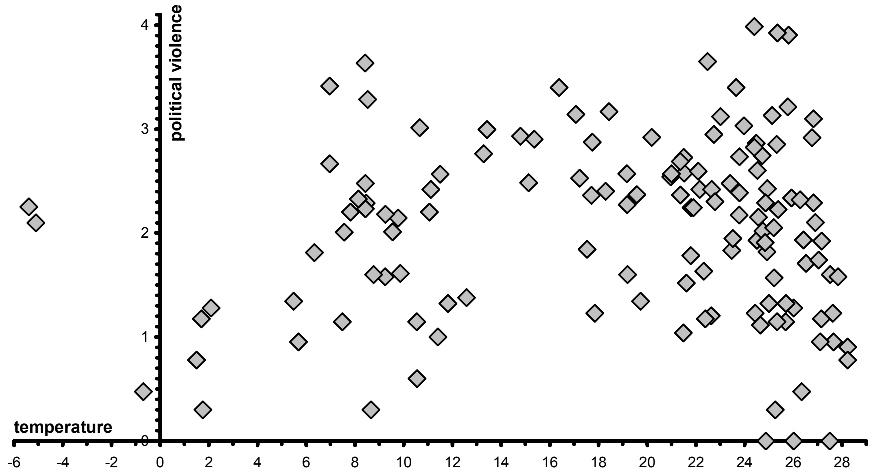

Figure 3: **Political violence rate versus temperature**

Figure 3 broadly reflects the methods used by Van de Vliert et al (1999). We calculate the rate of violent crimes per 100,000 people; each symbol in Figure 3 represents a country. As a whole, the distribution of these countries in Figure 3 suggests an inverted-V shape, in which violent political crimes tend to be less frequent at high temperatures; hence, Figure 3 appears to support the 'curvilinear hypothesis' promoted by Van de Vliert et al (1999). But why is Figure 3 such a different shape to Figure 2? Our first attempt to answer this question is to consider possible impacts of rainfall and humidity, in Figure 4. We use lighter shading for those countries which have, in their summer months, less than 90mm of rain per month and more than 90% relative humidity. Our reasoning is that if rain tends to reduce thermal stress but humidity tends to increase it (as our regression results in Table 1 suggests), then the least stressful countries are those with low rainfall and high humidity in summer (if other factors, such as temperature, are held constant). Both of these cut-off points (90mm and 90%) are arbitrary; we tried various combinations, and chose these because they produce a fairly clear graph.

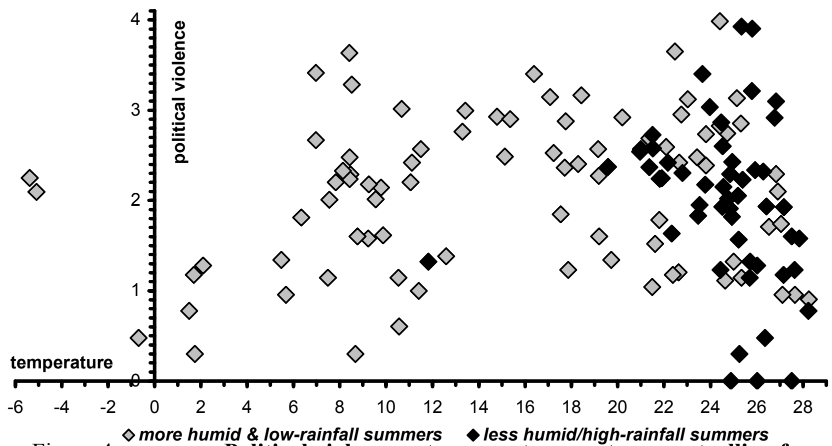

Figure 4: **Political violence rate versus temperature, controlling for rain & humidity**

In Figure 4, the darker-shaded symbols represent countries which have high rainfall, or low humidity, or both. We would expect the darker-shaded countries to have less thermal stress than other countries at the same temperature. Figure 4 is not entirely clear; but there seems to be a tendency for the low humidity & high rainfall countries to be concentrated in the lower-right corner of Figure 4 (perhaps this relationship is partly obscured by other unmeasured variables, such as wind speed). Hence, it is possible that the true relationship between temperature and violence is approximately a straight line from bottom-left to top-right: in other words, the pattern observed in Figure 2. It is possible that Figure 3 only approximates to an upside-down-V shape due to an artefact of the data (because rainfall & humidity are left out of Figure 3). Hence, Figure 4 shows less support (than does Figure 3) for the 'curvilinear hypothesis'. However, even if the darker-shaded countries in Figure 4 are ignored, Figure 4 does not look much like Figure 2, and hence we do not see clear support for the simple hormone-based explanation for violence argued for by Simister & Cooper (2005).

Regression Analysis:

We now turn to regression analysis, which we think is a more persuasive approach (than graphs) to testing the competing claims of the two sets of authors. We carry out regression on both datasets used above: Pakistan time-series data, and cross-country data. We combine results from both datasets in Table 1, to make comparisons easier.

Because we use time-series data in Pakistan, OLS regression would not be appropriate: it would lead to a high risk of inaccurate results, because of autocorrelation and seasonality. Autocorrelation is where each observation is similar to the previous observation and seasonality where a pattern is repeated each year. We deal with these problems by using ARIMA (AutoRegressive Integrated Moving Average) regression – we use the ARIMA(1,0,0)(1,0,0) specification. Our results are reported as regressions A and B, in Table 1. The need for ARIMA is confirmed by the fact that AR1 (autoregressive) and SAR1 (seasonal correlation) terms are both statistically significant in regressions A and B (our investigations, not all reported here, suggest that first-differencing or seasonal first-differencing are not required, and could cause problems due to over-differencing). Autocorrelation is not a problem in regressions C and D (which use cross-section data), so we use OLS regression.

Our regression specification is one of the simplest we could use, to test whether rainfall and/or humidity in hot weather can explain the apparent difference between the two papers we compare. Our regression specification has the advantage that our variables can be used in both cross-section and time-series analyses. Other researchers could add other variables, such as wind speed.

Table 1: Regression Results

	Pakistan (time-series)		***All available countries (cross-section)***	
	Regression A	**Regression B**	**Regression C**	**Regression D**
AR1	.6096 **	.6246 **		
SAR1	.4750 **	.4476 **		
Constant	1.0028	1.0194 **	.521 **	-.882
Log(summer rainfall)		-.0349 **		-.479 **
Log(summer humidity)		.0324 **		1.635 **
Temperature	.0092 **	.0085 **	.008	.017 *
Temperature^2	.0002	.0001	-.001 *	-.001
Sample size	*294*	*294*	*135*	*135*
R^2			*.12*	*.19*

** indicates significant at 5%; ** indicates significant at 1%.*

In our view, the key part of Table 1 is the (Temperature2) row. In regression C, this coefficient is negative and statistically significant, apparently confirming the claims of Van de Vliert et al (1999). This is consistent with the overall shape of Figure 3, which shows approximately an upside-down V shape: as temperatures rise above some threshold (which Van de Vliert at al suggest is about 24oC), violence tends to reduce. However, column D of Table 1 does not support their hypothesis: when we control for summer rainfall and humidity, the (Temperature2) term is no longer statistically significant, which suggests that the apparent negative effect of very high temperature on violence is an artefact of the data. Figures 2 and 4 in this paper may help explain why (Temperature2) is misleading in regression C: 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. Regressions A and B also seem inconsistent with the curvilinear hypothesis, because the (Temperature2) coefficients are both positive (which is consistent with the tendency of Figures 1 and 2 to become, if anything, more steep at very high temperatures). In summary, Table 1 (as a whole) does not support the central claim of Van de Vliert et al (1999), that violence declines at very high temperatures.

Table 1 also appears to reject some claims by Simister & Cooper (2005, p. 13). They found that rainfall appeared not to have a significant effect on violence; but our Regressions B and D suggest that, if temperatures are high, rainfall has a highly significant tendency to reduce violence. We think the significantly positive coefficients for humidity (in Regressions B and D) may explain the discrepancy between our results and those of Simister & Cooper, because they did not include humidity in their regression. We think rainfall and humidity tend to have opposite effects on violence: humidity appears to increase violence, but rainfall tends to reduce it, if other factors (such as temperature) are held constant. However, if only rainfall is considered, the regression coefficient for rainfall may be insignificant because of a tendency for humidity to be higher when rainfall is high. There are other complications: our research (not all reported here) indicates that in Pakistan (at least), heat and rainfall both tend to be high in summer months. This gives a positive association between rainfall and temperature; hence, collinearity makes it more difficult to test the competing claims by Van de Vliert et al (1999) and Simister & Cooper (2005).

Our regression results generally support the view (in Van de Vliert et al 1999, and Simister & Cooper 2005, and others) that violence tends to increase if temperature rises, using the ‘Temperature’ row of coefficients in Table 1. This coefficient is always positive, and is statistically significant in regressions A, B, and D.

Discussion:

Simister & Cooper (2005: pp. 7-8) discuss cities in Puerto Rico, which appear to be 'outliers' in having low crime rates relative to other USA cities. Their explanation is acclimatisation, arguing that Puerto Ricans can acclimatise to the high temperatures they face because there is little annual temperature variation in Puerto Rico. This paper suggests another explanation: rainfall. There is more rain in Puerto Rico than in most of USA (for example, June rainfall in Puerto Rico is 184 mm, compared to 69mm in USA: calculated from Mitchell et al, 2003). However, we cannot be confident from data we currently have, whether acclimatisation or rainfall (or something else) is the correct explanation for the anomaly of Puerto Rico.

Much research on the effects of climate on violence has focused on temperature. This paper has considered two other variables: rainfall, and humidity. We think rainfall tends to reduce violence, whereas humidity tends to increase it (holding temperature constant). But temperature is related to rainfall and humidity (and other aspects of climate), hence regression and other types of analysis could produce misleading results – larger samples help to reduce this risk. Apart from rainfall and humidity, there are numerous other influences on how "hot" a person feels, including wind speed; clothing; and how active s/he is (Brück, 1989). We cannot yet give a complete explanation of the effects of climate on violence; for a fuller understanding, researchers need more data for each month, on factors such as humidity and wind speed. A larger number of monthly observations would also help.

The Pakistan government and its employees deserve credit for making available so much monthly data on crime, temperature, and rainfall. The Pakistan 'Monthly Bulletin of Statistics' (Federal Bureau of Statistics, multiple editions) is very useful (although we think this publication does not report monthly crime data before July 1977; or monthly temperatures before April 1986; or monthly rainfall before November 1988). We ask government agencies in all countries to follow Pakistan's example, and make more monthly data available – preferably on web sites.

Researchers might take note of the impressive range of climate data at CRU at the University of East Anglia (UK). In addition to the variables used in this paper, they provide information on factors such as cloud cover; wet days per month; and wind speed. Unfortunately, many variables are only available in the form of climate 'normals'. An additional problem is that much of their data is 'gridded', and it is hard work for a researcher to identify which latitude and longitude values correspond to each country. In view of the many uses of climate data, we hope that staff at CRU will continue to maintain and extend their work.

Conclusion:

This paper has considered two papers, which make opposite claims about the effects of very high temperatures on violence: Van de Vliert et al (1999), and Simister & Cooper (2005). The key question is: were Van de Vliert et al correct, or were Simister & Cooper correct? The answer is no. Both papers make claims which, in our view, are rejected by this paper: Van de Vliert et al (1999) claim crime is less common above about 24oC, a hypothesis we reject – it seems likely that their mistake was not controlling for rainfall and humidity. Simister & Cooper (2005: p. 13) include rainfall in their regression, but find it insignificant: their mistake was not to consider the effects of humidity. Simister & Cooper (2005: p. 8) attribute the low crime rate in Puerto Rico (compared the rest of USA) to acclimatisation, but our evidence suggests a more plausible explanation is high rainfall in Puerto Rico.

This paper analyses two types of data on violence: murder & attempted murder, in Pakistan; and data on political violence in many countries. Our analysis, not all reported here, suggests that these different types of violence respond in broadly similar ways to temperature variations (future researchers may wish to test this assumption). Simister & Cooper (2005) interpret the apparent effects of climate on violence as indirect evidence of the effects of stress hormones, such as adrenaline; evidence in this paper is generally consistent with that interpretation, but we cannot rule out alternative explanations, such as the culture-based model of Van de Vliert et al (1999). Perhaps more medical research is the only way to settle this debate; methods such as inflicting different temperatures on humans (to measure the level of adrenaline in their blood) is made difficult, but not impossible, by ethical concerns. Future research may tell us whether (for example) we are more likely to reduce violence by education such as anger management, or by air conditioning.

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