Climate of Discontent:
Weather, Typhoons, and Crime in the Philippines, 1990-2008

JESSE K. ANTTILA-HUGHES* AND EMILY WETHERLEY†

DECEMBER 2015

We combine nineteen years of regional Filipino crime data with climate data to test three distinct hypotheses regarding climate variability's influence on crime. Mirroring recent results in the climate and conflict literature, we find that high temperatures are nonlinearly associated with increases in the murder rate. Consistent with the literature suggesting a causal link between poverty and crime, we find that climate conditions associated with low crop yields increase rates of property crimes. Lastly, we find that tropical cyclones increase property crime rates the year following impact, consistent with prior evidence suggesting that cyclones' poverty effects are substantial but take time to emerge. Our findings demonstrate that climate variability can influence crime rates through multiple distinct economic and noneconomic channels in a middle-income country, and in particular support both the growing consensus that high temperatures increase rates of interpersonal violence as well as a causal interpretation of poverty's association with property crime.

* Anttila-Hughes: University of San Francisco Department of Economics, 2130 Fulton St., San Francisco, CA94110 (e-mail: jkanttilahughes@usfca.edu, emily.wetherley@gmail.com). †Wetherley: State of Utah Juvenile Courts. The authors would like to thank Ram Fishman, Solomon Hsiang, Amir Jina, Gordon McCord, Bruce Wydick, and seminar participants at the University of San Francisco for useful feedback, as well as Mary Recelis, Luz Malibaran, and the Philippine National Police for their help in gaining access to the necessary data for this study The authors note that versions of these results appear first in Wetherley's 2014 Masters' Thesis "Typhoons and Temperature Impact Crime Rates: Evidence from the Philippines".

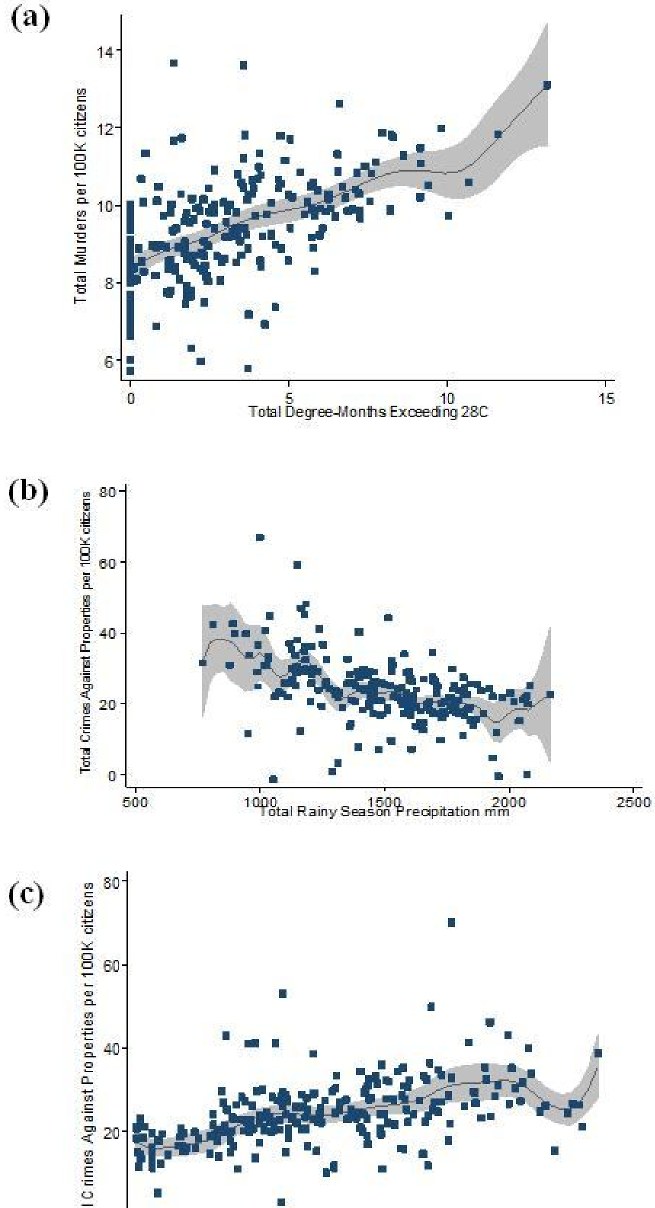
A large body of work in economics and the applied social sciences has established that the climate can influence antisocial behavior through a variety of channels. Variability in rainfall, increases in temperature, and large scale climate variability such as El-Niño have been associated with increased intergroup violence (Miguel, Satyanath, and Sergenti 2004; Miguel and Satyanath 2011; Hsiang, Meng, and Cane 2011; Hsiang, Burke and Miguel 2013; Burke, Hsiang, and Miguel 2014), and temperature has been directly implicated as a driver of interpersonal violence in a variety of studies both within and outside economics (Cohn 1990; Ranson 2014; Burke, Hsiang, and Miguel 2014). Recent work has established that rainfall variability can also influence property crime rates in agrarian societies where rainfall is linked to livelihood outcomes (Iyer and Topalova 2014; Blakeslee and Fishman 2014), consistent with the larger literature in urban economics linking property crime rates to poverty and unemployment (Becker 1968; Raphael and Winter-Ebmer 2001; Gillado and Ta-Cruz 2004; Foley 2011; Corman, Dave, and Reichman 2014).

In this paper we use nineteen years of Filipino regional crime statistics to explore how both interpersonal crime and property crime responds to climate variability. We first test whether unusually high temperatures are associated with violent crime, using a simple-to-construct proxy for nonlinear heating, degree-months, to show that excess heating is associated with an increase in regional murder rates. We estimate that a one-standard deviation increase in the number of degree months increases the murder rate by approximately 0.88 murders per 100,000, or 8% of the regional average murder rate during this period. We find no association between high temperatures and rape, perhaps due to the Philippines' unusually low reported rape rate (3.6 per 100,000 compared to the United States' 26.6/100,000), nor do we find an association with "homicides," the Filipino designation for deaths where intent to kill was not present, i.e.., manslaughter or "negligent homicide" in the United States. Figure 1 provides a visual representation of this and our other core results.

We next test to see whether conditions associated with low agricultural yields are associated with increased property crimes, and find evidence to suggest that rainy season precipitation and average temperature are negatively associated with property crime rates, while degree months, our nonlinear measure of heating, is positively associated with crime rates. We estimate that a one standard deviation decrease in rainy season precipitation leads to approximately 5.4 extra property crimes per 100,000, or 20% of the regional average property crime rate during this period. We find ample evidence to suggest that poor growing conditions also increase the likelihood of property crimes the following year, albeit to a lesser extent, suggesting that rainfall-induced poverty is at least mildly persistent. T

Lastly, we test whether tropical cyclones, or typhoons as they are locally known, influence property crime rates. Prior work has indicated that tropical cyclones have lagged negative effects on income, particularly in the Philippines (Anttila-Hughes and Hsiang 2011; Hsiang and Jina 2014). We test to see whether property crime rates increase as a function of tropical cyclones using LICRICE, a cyclone treatment variable first developed in Hsiang (2010), and find no contemporaneous impacts but a significant relationship between cyclone exposure and property crimes in the following year. We estimate that a one standard deviation increase in our cyclone exposure measure corresponds to an increase in the total property crime rate of 2.7 per 100,000, or 10% of the regional average property crime rate during this period.

Figure 1: Climatic Influences on Crime



Notes: Figures show double residual semiparametric Robinson (1988) estimates of the partial relationship between shown climate factors and crime outcomes conditional on region and year fixed effects. Shaded area shows 95% confidence interval of estimates calculated using Newey-West (1987) standard errors.

The main contribution of this paper is in demonstrating that a major class of hydrometeorological disaster, tropical cyclones, lead to increases in property crimes, suggesting that the relationship between crime and climate need not only operate through the standard mechanisms of temperature and precipitation. Our finding dovetails with the rapidly growing consensus that poverty can increase property crime rates, a conclusion only further bolstered by our findings relating bad growing season climate conditions to property crime rates. An additional contribution of this paper is the novelty of data analyzed; to our knowledge this is the second applied economic paper analyzing Filipino crime at the regional level, the previous being Gillado and Ta-Cruz (2004). A third contribution of this paper consists of demonstrating that nonlinear effects of heat on violence can be recovered using a relatively computationally cheap approach, degree-months, which can be easily derived from a much wider array of climate data sets than the current limited set of daily datasets. Our paper more broadly contributes to the interdisciplinary literature on climate variability and social welfare in developing and middle-income economics (Dell, Jones, and Olken 2014).

I. Background

Philippines' typhoon climate Typhoons, or tropical cyclones generated in the West Pacific Ocean, are large, powerful tropical storms characterized by extremely strong winds, heavy rain, and large storm surge (wind-driven coastal flooding). They are among of the most destructive hydrometeorological hazards, resulting in lower-bound global damage estimates on the order of billions of dollars per year that are only expected to increase under climate change (Mendelsohn et al. 2012; Hsiang and Jina 2014). The Philippines is notable for being situated in one of the world's most active tropical cyclone climates, with a typical year seeing in excess of 10 tropical cyclones affecting at least some part of the island chain[1].

Typhoons have a long history of being particularly destructive to human settlements in the Philippines, with extensive documentation of their negative impacts existing all the way through to the early colonial Spanish period (Garcia-Herrera et al 2007). A growing number of studies in economics and related fields have demonstrated that cyclones' impacts on Filipino livelihoods are severe. Particularly relevant are several papers in applied economics documenting the economic impacts of cyclones exploiting quasi-experimental approaches more typified in the climate impact literature (Kousky 2013; Dell Jones Olken 2014). Particularly relevant to this paper, Anttila-Hughes and Hsiang (2011) demonstrate that typhoon-driven poverty takes time to emerge, with storm damages to income at their maximum one year following storm incidence, consistent with more recent work by Hsiang and Jina (2014) demonstrating that the negative growth effects of storms can take several years to emerge.

Climate and crime While theories positing climatic effects on crime can be found throughout human history, the past decade has seen an explosion of research linking climate variability to crime using the quasi-experimental techniques from the climate impacts literature (Dell Jones Olken 2014), with ample evidence now suggesting several plausible mechanisms through which climate variability appears to affect crime rates. Hsiang, Burke, and Miguel (2013) and (2014) provide relevant overviews of the growing evidence linking high temperatures with violent crime. Violent "intragroup" crimes, such as homicides and rapes, are generally positively associated with increased temperatures due to a range of hypothesized factors including increased time

[1] For further background on the Philippines' cyclone climate see Anttila-Hughes and Hsiang (2011) and Hsiang and Jina (2014).

spent outside as well as growing evidence that human aggression and impulse control weaken with high temperatures.

Links between property crime and the climate are much older than the modern climate impacts literature, drawing largely from the now ample literature linking poverty to crime, especially property crime (Kelly 2000; Bignon, Caroli, and Galbiati 2015). Climatic effects on agricultural livelihoods result in exactly the sort of income fluctuations that should reduce the opportunity cost of property crime, and several studies now exist demonstrating that poor climatic conditions can result in increased crime rates in agricultural areas. Particularly relevant are Iyer and Topalova (2014) who exploit plausibly exogenous rainfall and trade shocks in India to show that both shocks to income result in increases to property crime rates. Blakeslee and Fishman (2014) conduct a similar analysis focusing on excess heating, finding that excess heating's well-documented sharply negative influence on yields (Schlenker and Roberts 2009) translates into property crimes as well. Relevant, though not explicitly linked to the climate literature, is Gillado and Ta-Cruz (2004)'s analysis of regional Filipino crime data demonstrating that poverty and income inequality are positively associated with property crimes within the Philippines in a panel data settting.

The literature exploring links between disasters (other than drought) and crime is comparatively underdeveloped. Some case study and similar evidence, largely from outside of economics, suggests that prosocial behaviors are particularly likely to emerge in the wake of extreme disasters (Solnit 2010). Evidence that typhoons increase poverty, coupled with the growing body of evidence linking poverty to property crimes, would suggest that the opposite is more likely.

II. Data

Weather data are taken from multiple sources[2]. Temperature data are extracted from the gridded reanalysis of the Climate Data Assimilation System I (CDAS1) produced by the National Center for Environmental Prediction (NCEP) and the National Center for Atmospheric Research (NCAR) (Kalnay et al. (1996)). Rainfall estimates are obtained from the Climate Prediction Center (CPC) Merged Analysis of Precipitation (CMAP). Both temperature and precipitation data are spatially averaged over each region in the Philippines using GMAP boundary data. Over the period of this analysis several regions changed boundaries, motivating us to aggregate up several regions so as to provide continuously observed units of analysis. Summary statistics are provided in Table 1.

Table 1. Climate Summary Statistics

	Mean	*Std. Dev.*	*Min*	*Max*
Mean maximum typhoon wind speed (m/s)	16.9	9.8	0.0	41.4
Total Annual Precipitation (mm)	2162.3	408.5	1254.4	3117.8
Total growing season precipitation (mm)	1489.8	302.1	769.7	2164.9
Mean annual temperature (°C)	27.4	0.7	25.2	28.8
Degree months exceeding 28°C	3.0	2.7	0.0	13.1

Note: Summary stats shown for 13 regions between 1990 and 2008.

Typhoon data are taken from the LICRICE dataset reconstructing historical typhoon windfields, documented in detail n Hsiang (2010) and Hsiang and Jina (2014). Wind fields for historically tracked storms from the IBTrACS database are modeled using recorded or estimated wind speed observed at storm's center over 6 hour intervals. We note that our window of analysis, from 1990 through 2008, comes well after the remote-sensing revolution in satellite and

[2] See Aufhammer, Hsiang, and Schlenker (2013) as well as reanlyses.org for background on reanalysis and other climate data.

similar data that took place in the late 1970s and early 1980s, attenuating any potential data concerns regarding endogenous monitoring.

Filipino crime data are taken from the Philippine National Police Archives from 1990-2008; summary statistics are provided in Table 2. Records are kept on standard crimes as reported to the Philippine National Police, notably including "murders" (corresponding to 1st or 2nd degree homicide in the US legal system), "homicides" (corresponding to manslaughter and accidental deaths), rapes, robbery (i.e., violent property crime) and theft (nonviolent property crime). We convert all raw crime rates to per capita figure using data from the Filipino census for each region from the National Statistical Office of the Philippines[3], interpolating between population data points by fitting constant exponential growth curves between each period.

Table 2. Crime Rate Summary Statistics

	Mean	*Std. Dev.*	*Min*	*Max*
Violent crimes				
Murder Rate	9.7	5.0	3.0	37.5
Rape Rate	3.6	1.1	0.8	7.3
Homicide Rate	7.3	4.2	1.9	21.5
Property crimes				
Robbery Rate	10.7	9.6	2.4	57.7
Theft Rate	15.9	17.0	1.9	102.4
Total Crimes Against Property Rate	26.6	25.9	5.2	160.1

Note: Crime rates shown per 100,000 Filipino citizens for 13 regions between 1990 and 2008.

[3] See https://psa.gov.ph/statistics/census/population-and-housing

III. Methods

We follow a standard quasi-experimental approach to infer the causal relationship between climate and crime, exploiting the plausibly exogenous realization of climate outcomes in a panel setting to identify our coefficients (Holland 1986; Angrist and Pischke 2008; Dell Jones and Olken 2014). We note that variation in all our climatic measures, including typhoon incidence, is fairly rich, allowing us to employ nonparametric spatial and temporal controls (e.g., region fixed effects and year fixed effects of regional trends). We are thus able to estimating the relationship between climate variability and crime *within* a specific region, comparing a certain time period against other counterfactual observations of both that and other regions at different points in time.

We paramaterize the relationship our climate data based on several distinct methodological consideration. We examine precipitation both at the total annual level, as well as disaggregated into growing season, which we designate for simplicity as May-November (i.e., rainy season), and non-growing season totals. We capture the effect of temperature through two measures: mean monthly temperature and a novel measure we call degree-months, the monthly analog to degree-days[4]. We include both measures to firstly control for the well documented divergent relationship between average temperatures below critical threshold values, which on net should increase yields, and extreme temperatures above threshold values centered in the 27-30°C range that are well-known to reduce plant yields (Schlenker and Roberts 2009); we choose a 28°C threshold and demonstrate that our results are only mildly sensitive to local threshold choice. We secondly note that the majority of literature linking temperature to violent crime has demonstrated similar threshold effects at similar temperature ranges

[4] . We choose degree months as a computationally-light but still meaningful measure capturing the nonlinear effect of heating. Calculation of degree-days requires both access to daily estimated reanlaysis or similar temperature data, as well as analysis of models fitting daily data which are computationally and memory intensiv. We provide an overview of this measure in the appendix.

(Hsiang, Burke, and Miguel 2013), further supporting our use of both measures. Lastly, we compute average monthly spatially-averaged maximum typhoon wind speed for each region as outlined in Anttila-Hughes and Hsiang (2011).

Our basic specification thus explores several variants of the model

$$(1) \quad Y_{rt} = \alpha_r + \gamma_t + \lambda_r \, year_t + \beta_1 \, Mean\ temp_{rt} + \beta_2 \, Precip_{rt} + \beta_3 \, Degree\ months_{rt} + \psi_1 \, TC_{rt} + \psi_2 \, TC_{r(t-1)} + \varepsilon_{rt}$$

where Y_{rt} is a per capita crime rate of interest, α_r are region fixed effects, γ_t are optional year fixed effects and λ_r are optional regional trends in year, $Mean\ temp_{rt}$, $Precip_{rt}$, $Degree\ months_{rt}$ and TC_{rt} designate climate outcomes in region r during year t or t-1 (i.e., a one-period distributed lag).We calculate Newey-West (1987) standard errors ε_{rt} to control for potential heteroscedasticity in our error structure across observations, noting that our results are substantively similar using Huber-White standard errors clustered at the region level. To generate Figures 1a-1c, we estimate double residual semiparametric Robinson (1988) estimates of the partial relationship between shown climate factors and crime outcomes conditional on region and year fixed effects, calculating Newey-West (1987) standard errors.

IV. Results

Violent crimes and the climate

Table 3 provides an overview of our results documenting the relationship between extreme temperatures and violent crime.

Table 3. Relationship between temperature and regional murder rates

	Murder Rate	Murder Rate	Murder Rate	Murder Rate	Homicide Rate	Rape Rate
Avg Annual Temp C	5.428***	0.845	-0.455	0.005	-0.148	-0.077
	(1.858)	(1.053)	(1.19)	(1.114)	(1.013)	(0.541)
Total Degree-Months Exceeding 28C			0.329***	0.286***	0.071	0.022
			(0.103)	(0.102)	(0.106)	(0.065)
Total Annual Precip mm				-0.014	-0.018	-0.010
				(0.021)		
Typhoon Wind Measure (m/s)				0.006		
				(0.019)		
Typhoon Wind Measure, 1 Year lag (m/s)				0.024		
				(0.017)		
Region Fixed Effects	Y	Y	Y	Y	Y	Y
Year Fixed Effects	Y					
Region X Year Trends		Y	Y	Y	Y	Y
R-squared	80.6%	94.6%	94.8%	94.2%	88.9%	67.3%

Note: Crime rates shown per 100,000. Coefficients shown for an OLS regression. Robust standard errors reported in parantheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

We note first that conditional on year and region fixed effects there exists a positive correlation between the per-capita murder rate and gross average annual temperature (column 1). This relationship becomes sharply attenuated by the substitution of regional trends for annual fixed effects (2) but reveals the a strong association between murder and degree months corresponding to a statistically significant 0.329 increase in murders per 100,000 for every degree month in excess of 28C, or an increase of 88 murders per 100,000 for a 1 standard deviation increase in 28°C degree months for a representative region in a representative year. This relationship is robust to the inclusion of precipitation and typhoon measures (column 4). We test for and do not find relationships between any of our climate measures and homicides (accidental deaths and manslaughter) or rapes (columns 5 and 6).

Property crimes and the climate

Table 4 provides an overview of our results linking weather to property crime.

Table 4. Impact of Climate Variability on Property Crime

	Property Crime Rate	Property Crime Rate	Property Crime Rate	Property Crime	Robbery Rate	Theft Rate
Avg Annual Temp, °C	-28.68**					
	(11.72)					
Total Annual Precip, mm	-0.307**					
	(0.145)					
Total 28°C Degree Months	0.728					
	(0.805)					
Total Rainy Season Precip, mm		-0.017**	-0.018***	-0.018***	-0.003	-0.015***
		(0.007)	(0.007)	(0.006)	(0.002)	(0.004)
Total Dry Season Precip mm		-0.005	-0.004			
		(0.006)	(0.006)			
Total Rainy Season 28°C Degree Months		2.312				
		(1.84)				
Total Dry Season 28°C Degree Months		-0.554				
		(3.033)				
Avg Rainy Season Temp °C		-5.413**	-4.473**	-4.699***	-1.119	-3.581***
		(2.696)	(1.78)	(1.68)	(0.691)	(1.079)
Avg Dry Season Temp °C		-0.644	-0.810			
		(1.26)	(1.064)			
Total Rainy Season 29°C Degree Months			4.329*	4.842**	2.141***	2.701*
			(2.225)	(2.029)	(0.724)	(1.388)
Total Dry Season 29°C Degree Months			4.214			
			(5.84)			
Total Rainy Season Precip mm, 1 Year lag				-0.008	-0.001	-0.007*
				(0.006)	(0.002)	(0.004)
Total Rainy Season 29°C Degree Months , 1 Year lag				4.509***	1.945***	2.564**
				(1.6)	(0.577)	(1.11)
Avg Rainy Season Temp °C, 1 Year Lag				-2.741**	-1.095**	-1.646**
				(1.124)	(0.476)	(0.712)
Region Fixed Effects	Y	Y	Y	Y	Y	Y
Year Fixed Effects	Y	Y	Y	Y	Y	Y
Region X Year Trends	Y	Y	Y	Y	Y	Y
R-squared	87.9%	88.4%	88.6%	89.2%	89.9%	87.7%

Note: Crime rates shown per 100,000. Coefficients shown for an OLS regression. Robust standard errors reported in parantheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

We find a wealth of evidence demonstrating that climate conditions associated with worse agricultural outcomes are also associated with worse property crime rates. Poor growing conditions (i.e., low rains, low average temperature, or degree months in excess of our threshold) are associated with increased total property crime (i.e., theft plus robbery) rates at the annual level (column 1), as well as when broken out by season, and while varying degree month thresholds (cols 2-4). Disaggregating by type, we find that comparatively violent robberies are less elastic to precipitation and average temperature than thefts, but more responsive to our nonlinear measure of intensity, perhaps suggesting the explicit role of an aggression or violence mechanism.

Table 5. Impact of Tropical Cyclones on Property Crime

	Property Crime Rate	Property Crime Rate	Robbery Rate	Theft Rate
Avg Annual Temp, °C	-10.190			
	(7.624)			
Total Annual Precip, mm	-0.314**			
	(0.121)			
Total 29°C Degree Months	2.798**			
	(1.26)			
Typhoon Wind Measure (m/s)	0.087	0.081	0.028	0.054
	(0.114)	(0.116)	(0.041)	(0.082)
Typhoon Wind Measure, 1 Year lag (m/s)	0.332**	0.276**	0.070	0.206**
	(0.14)	(0.117)	(0.044)	(0.079)
Total Rainy Season Precip, mm		-0.014***	-0.002	-0.012***
		(0.005)	(0.002)	(0.004)
Total Rainy Season Precip, mm, 1 Year lag		-0.008	-0.001	-0.007*
		(0.006)	(0.002)	(0.004)
Total Rainy Season 29°C Degree Months		3.454**	1.666***	1.788*
		(1.438)	(0.503)	(0.981)
Total Rainy Season 29°C Degree Months , 1 Year lag		4.29***	1.78***	2.51**
		(1.486)	(0.56)	(1.004)
Avg Rainy Season Temp °C		-1.278	-0.506*	-0.772
		(0.884)	(0.295)	(0.645)
Avg Rainy Season Temp °C, 1 Year Lag		-3.208***	-1.205**	-2.003***
		(1.213)	(0.533)	(0.745)
Region Fixed Effects	Y	Y	Y	Y
Region X Year Trends		Y	Y	Y
R-squared	89.0%	90.1%	91.3%	88.3%

Note: Crime rates shown per 100,000. Coefficients shown for an OLS regression. Robust standard errors reported in parantheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Property crimes and typhoons

Table 5 details our results linking tropical cyclones to property crime. We find a strong positive effect of last year's tropical cyclone on property damage, consistent with prior evidence demonstrating lagged poverty effects of tropical cyclones (column 1). This result is robust to the inclusion of additional climatic controls, and further seems driven largely by thefts as opposed to robberies.

IV Discussion

Together, our results provide further evidence of a causal link between climate variability and crime. Adding to the climate and conflict literature, we find robust evidence in both murder and robbery rates that excessively high temperatures can result in increased violence. We further add to the growing literature on the poverty impacts of the climate, in particular demonstrating that the relationship between climatically-induced poverty and property crimes can be found in lower middle-income countries and not just areas with large agricultural subsistence populations such as modern India.

The finding that typhoons increase poverty rates a year after impacts further bolsters growing evidence that the welfare effects of disasters can take time to emerge, as well as contribute to the literature on the causal effect of poverty on crime. We note that in this area in particular the frequent typhoon climate of the Philippines, while an aid to internal validity, may somewhat hamper our ability to opine on the external validity of results. Much of the sociological and similar literature on the pro- vs. anti-social response to disaster is predicated on disasters being unusual, whereas typhoons in the Philippines are remarkably common. As such. it may be natural to suppose that the poverty effects of disasters would outweigh any possible "good-will" effects resulting from increased altruism during times of duress.

References:

Anderson, Craig. (1989). Temperature and Aggression: Ubiquitous Effects of Heat on Occurance of Human Violence. *Psychological Bulletin.* 106(1). 74-96.

Anderson C, Bushman B, Groom R (1997). Hot Years and Serious and Deadly Assault: Empirical Tests of the Heat Hypothesis. *Journal of Perspective of Social Psychology*. 73(6). 1213.

Anttila-Hughes, Jesse K. and Solomon M Hsiang. (2011). Destruction, Disinvestment, and Death: Economic and Human Losses Following Environmental Disaster *Working Paper*.

Auffhammer, Maximilian, et al. "Using weather data and climate model output in economic analyses of climate change." *Review of Environmental Economics and Policy* (2013): ret016.

Bass, Leslie James. (2008). A Pooled Time Series Analysis of Hurricane Katrina Evacuees and their Effect on Crime Rates. Paper Presented at Mid-Western Political Science Association: 2008 Annual Meeting. University of Missouri- Columbia.

Baysan, Ceren, Marshall Burke, Felipe Gonzalez, Solomon Hsiang, and Edward Miguel. (2015). Economic and Non-Economic Factors in Violence: Evidence from Organized Crime, Suicides and Climate in Mexico. *Working paper.*

Becker, Gary S. (1968). “Crime and Punishment: An Economic Approach.” *Journal of Political Economy* 76: 169–217.

Bignon, Vincent, Eve Caroli, and Roberto Galbiati. "Stealing to Survive? Crime and Income Shocks in 19th Century France." *The Economic Journal* (2015).

Blakeslee, David, and Ram Fishman. (2014) "Weather Shocks, Crime and Agriculture: Evidence from India."*SSRN Working Paper 2428249*.

Burke, Marshall, Solomon M. Hsiang, and Edward Miguel. (2014) Climate and Conflict.*National Bureau of Economic ResearchWorking Paper 20598*.

Cane, M.A., E. Miguel, M. Burke, S.M. Hsiang, D.B. Lobell, K.C. Meng, S. Satyanath. (2014). Temperature and Violence. *Nature Climate Change, 4*. 234-235.

Cohen, Lawrence E. and Marcus Felson. (1979). Social Change and Crime Rate Trends: A Routine Activity Approach. *American Sociological Review, 44* (3). 588-608.

Cohn, Ellen G. (1990). "Weather and crime." *British Journal of Criminology* 30.1: 51-64.

Chamlee-Wright, Emily and Virgil Henry Storr. (2011). Social Capital as Collective Narratives and Post-Disaster Community Recovery. *The Sociological Review, 59* (2). 266-282.

Field, Simon. (1992). The Effect of Temperature on Crime. *British Journal of Criminology. 32(3).* 340-351.

Foley, C. Fritz. (2011). "Welfare payments and crime." *The Review of Economics and Statistics* 93.1: 97-112.

Fritz, Charles E. (1961) Disaster. Pages 651–694 in Robert K. Merton and Robert A. Nisbet (editors), *Contemporary Social Problems.* New York: Harcourt.

García-Herrera, Ricardo, et al. "Northwest Pacific typhoons documented by the Philippine Jesuits, 1566–1900." *Journal of Geophysical Research: Atmospheres* (1984–2012) 112.D6 (2007).

Gillado, Miguel, and Tina Tan-Cruz. "Panel Data Estimation of Crime Rates in the Philippines." *9th National Convention on Statistics (NCS) Paper*. 2004.

Hilfinger, Messias, DeAnne, Clare Barrington, and Elaine Lacy. (2012). Latino Social Network Dynamics and the Hurricane Katrina Disaster. *Disasters,36* (1) 101-21.

Haertzen, Charles, Karen Buxton, LinoCovi, and Henry Richards. (1993). Seasonal Changes in Rule Infractions Among Prisoners: A Preliminary Test of the Temperature – Aggression Hypothesis. *Psychological Reports. 72*. 195-200.

Hsiang, S.M. (2010) Temperatures and cyclones strongly associated with economic production in the Caribbean and Central America. *Proceedings of the National Academy of Sciences.* 107(35) 15367-15372.

Hsiang, S.M., M. Burke, E. Miguel. (2013). Quantifying the Influence on Human Conflict. *Science.*

Hsiang, S.M., Meng, K.C., Cane, M.A. (2011). Civil conflicts are associated with the global climate. *Nature*, 476(7361) 438-441.

Hsiang, S.M. and K.C. Meng. (2014). Reconciling Disagreement Over Climate – Conflict Results in Africa. *Proceedings of the National Academy of Sciences.*

Iyer, Lakshmi, and Petia B. Topalova.(2014). "Poverty and Crime: Evidence from Rainfall and Trade Shocks in India." *Harvard Business School BGIE Unit Working Paper 14-067*.

Kelly, Morgan. "Inequality and crime." *Review of Economics and Statistics* 82.4 (2000): 530-539.

Larrick, Richard P., Thomas Timmerman, Andrew M. Carton, Jason Abrevaya. (2011). Temper, Temperature, and Temptation. *Psychological Science. 22(4).* 423-428.

Leitner, Michael, Michelle Barnett, Joshua Kent and Tom Barnett. (2011). The Impact of Hurricane Katrina on Reported Crimes in Louisiana: A Spatial and Temporal Analysis. *The Professional Geographer, 63* (2) 244-261.

Mendelsohn, Robert, et al. "The impact of climate change on global tropical cyclone damage." *Nature Climate Change* 2.3 (2012): 205-209.

Merton, Robert K. (1938). Social Structure and Anomie. *American Sociological Review, 3* (5). 672-682.

Miguel, Edward, ShankerSatyanath, and Ernest Sergenti. (2004). "Economic shocks and civil conflict: An instrumental variables approach." *Journal of Political Economy* 112.4: 725-753.

Miguel, Edward, and ShankerSatyanath. (2011). "Re-examining economic shocks and civil conflict." *American Economic Journal: Applied Economics* 3.4: 228-232.

Quetelet, Adolphe. (1842). A Treatise on Man and the Development of His Faculties. Edinburgh: W. and R. Chambers.

Ranson, Matthew. (2014). Crime, weather, and climate change. *Journal of Environmental Economics and Management*, 67(3), 274-302.

Raphael, Steven, and Rudolf Winter-Ebmer. (2001). "Identifying the effect of unemployment on crime*." *Journal of Law and Economics* 44.1: 259-283.

Robinson, Peter M. "Root-N-consistent semiparametric regression." *Econometrica* (1988): 931-954.

Rodriguez, Havidan, Joseph Trainor, and Enrico Quarantelli. (2006). Rising to the Challenges of a Catastrophe: The Emergent and Prosocial Behavior following Hurricane Katrina. *The ANNALS of the American Academy of Political and Social Science,604*(1) 82-101.

Roy, Susmita. (2010). The Impact of Natural Disasters on Violent Crime (Working Paper). Retrieved from the New Zealand Association of Economists (NZAE)

Schlenker, Wolfram, and Michael J. Roberts. "Nonlinear temperature effects indicate severe damages to US crop yields under climate change." *Proceedings of the National Academy of Sciences* 106.37 (2009): 15594-15598.

Solnit, Rebecca. A paradise built in hell: The extraordinary communities that arise in disaster. *Penguin*, 2010.

Xiao, Yu. (2011). Local Economic Impacts of Natural Disasters. *Journal of Regional Science, 51* (4). 804-820.

Zahran, Sammy, Tara O'Connor Shelley, Lori Peek, and Samuel D. Brody. (2009) Natural Disasters and Social Order: Modeling Crime Outcomes in Florida. *Natural Disasters and Social Order: Modeling Crime Outcomes in Florida 27* (1). 26-52.