Tropical Cyclone Bibliography

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February 7, 2020

(Kinney et al. 2008)

Spatial Scale:

- “National Weather Service maps of storm tracks were used to identify the parishes that were hit by the centers of each storm, and thus were likely to have experienced the most intense effects of the storm” (Kinney et al. 2008)

Exposure:

- Severity of prenatal storm exposure assessed two ways: intensity of storm’s impact on parish, and how vulnerable residents would be if storm hit their parish. (Intensity and Vulnerability).
- Using data from NCHS, 40 week gestations were assumed to estimate the gestional age of babies during the storm.

Results/Outcomes:

- AD(Autistic Disorder) had significantly higher prevalence in those with higher prenatal storm exposure. AD Prevalence also depended on Prenatal Period of Storm Exposure (what gestational period the baby was in when the storm exposure occured)

(Bayleyegn et al. 2006)

Spatial Scale:

- Escambia and Santa Rosa counties were identified as those most impacted by Hurricane Ivan by Florida Department of Health. Probability Proportional to Size Sampling (modified from the WHO), was used to obtain a sample of 30 clusters within these counties, which were put on maps given to interview teams.
- 7 households interviewed per cluster, for a total of 420 households interviewed.
- Interviews administered asking for demographic info, housing info, damage info, etc.

Temporal scale

- Survey instruments administered over 3 days, 6 days after Hurricane Ivan made landfall.

Results/Outcomes

- Most commonly reported “Greatest needs” were garbage pickup and restoration of electricity, after that it was access to medical care, medications, home repair, and ice. -Interviews and surveys were intended to look at what the health and safety impacts were after the hurricane, it turned out to be a wide variety of factors including poor environmental hygiene, living in damaged homes, sleep disturbance, respiratory problems, and the aformentioned “Greatest Needs.”

(Hagy, Lehrter, and Murrell 2006)

Temporal/Spatial Scale:

- Water quality surveys conducted monthly from 2000 to 2004 at up to 15 sites located on two transects within the Pensacola Bay system. Post Hurricane Ivan surveys were taken October 6 and November 5, or 20 and 50 days after the storm.

- Extent of inundated land and maximum height of tidal surge were estimated by directly observing locations and heights of high water marks around perimeter of Pensacola Bay. -Total Prism Model used to estimate the magnitude of exchane associated with storm surge.

Outcome/Results:

- Hurricane Ivan caused water to rise continuously for 31 hours.
- Storm surge inundated 165 km^2 of land, which increased the Bay's surface area by 50% and it's volume by 230%.
- Based on Total Prism Model, storm surge flushed a maximum of 60% of the Bay's water out to sea as it retreated - this must have increased salinity of the Bay substantially.
- Using Navy's model estimate of offshore salinity in the Tidal Prism Model, Ivan's surge was computed to have increased the mean salinity of the Bay from 23.4 to as high as 30.0.
- Tidal surge replaced Bay waters with low-nutrient, well-oxygenated, oligotrophic Gulf waters
- Post-storm freshwater input stimulated an increase in phytoplankton biomass, which persisted for several weeks.
- Hypoxia was intensified relative to the seasonal norm.

(Lieberman-Cribbin et al. 2017)

Spatial Scale:

- Self reported flood data
- "Public macro-level flood data was obtained from the FEMA Modeling Task Force (MOTF) Hurricane Sandy Impact Analysis" (Lieberman-Cribbin et al. 2017)
- New York State 3 meter spatial resolution storm surge product downloaded and imported into licensed version of ArcGIS to provide water depth above ground in New York City and Long Island
- Street level geo-coding in SAS using datasets generated from U.S. Census Bureau TIGER/Line shapefiles. Process matches street, city, and zip-code from survey dataset with lookup dataset to produce a coordinate

Results/Outcomes:

- Mental health variables considered based on scores of a questionaire were anxiety score, depression score, and PTSD score
- Self reported flood exposure and FEMA flood exposure data showed significant discrepencies in the associations between flooding and mental health outcomes.
- Self reported dichotomous flooding showed significant associations with all mental health outcomes, whereas dichotomous FEMA flooding only showed significant associations with PTSD.
- Macro-level flooding data is less expensive and faster, but potentially underestimates mental health outcomes.

(S. C. Grabich et al. 2016)

Spatial Scale:

- Births to (only) Florida residents linked to address to link to hurricane exposure
- Hurricane risk assessed at county level
- Florida Department of Health, Vital Statistics Department was the source of data on births from 2003 to 2005.
- Hurricane exposure classified as maximum wind speed in specific Florida county extracted from NOAA's Hurricane Research Division public database.
- Exposure defined as >= 39 mph and >= 74 mph

Temporal Scale:

- Risk period begins at 20 weeks of gestation
- Pregnancy divided into exposed time and unexposed time after 20 weeks
- Study population included births with estimated date of conception between October 24, 2003 and September 26, 2004.

Results/Outcomes

- Outcome of interest was to see if there was an association between hurricane exposure and the risk of a preterm birth.
- Two outcome standards: extremely preterm delivery $<$ 32 weeks gestation, and overall preterm delivery $<$ 37 weeks gestation.
- Overall positive association observed between exposure to Hurricane Harvey and hazard of extreme preterm delivery (not overall preterm delivery however)
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(Scaramutti et al. 2019)

Spatial Scale:

- Major cities in Florida and Puerto Rico were coded as urban with 0, and all other areas were coded as rural/suburban with a 1.
- Word of mouth and outreach to community leaders and community centers in Central and South Florida and Puerto Rico
- Online surveys available through Qualtrics, respondants asked to refer 3 additional respondants
- Linear regression models used with site and urbanacity as predictors for depressive symptoms, anxiety symptoms, and PTSD symptoms
- Binary logistic regression analysis for clinical vs non-clinical anxiety, depression, and PTSD as criterion variables, and site or urbanacity as predictors

Temporal Scale:

- Assessing mental health of Puerto Ricans in Florida and Puerto Rico 6 months after Hurricane Maria.

Results/Outcomes:

- Mental health outcomes of interest were anxiety, depression, and PTSD

- Results showed significant associations between urbanacity and anxiety, approaching statistical significance for association between urbanacity and depressive symptoms, and significant association between urbanacity and PTSD intrusive reexperiencing and PTSD hypervigilance.
- Overall, rates of depression and PTSD were higher in Puerto Ricans who migrated to Florida after Hurricane Maria.
- Puerto Ricans outside major cities were more likely to meet criteria for depression and PTSD
- Puerto Ricans in Puerto Rico had significantly fewere clinical symptoms than those in Florida, but rates were high overall for both Florida and Puerto Rico.

(Bianchette et al. 2009)

Temporal/Spatial Scale:

- Study area was three coastal lakes known as the Shelby Lakes in Gulf State Park, Alabama.
- Hurrican Ivan brought 120 mph winds and a storm surge of 10-12 feet, which inundated all of the coastal plane around the Shelby Lakes.
- Post hurricane images of vegetation take 9.5 months after hurricane to ensure that vegetation damage observed was permanent.
- Remote sensing using Landsat 5 images coupled with ground surveys of tree mortality were used.

Results/Outcomes:

- Ecological impacts were the main concern of this study, primarily measured by tree mortality.
- Trees at lower elevation showed greater mortality than those at higher elevations.
- Results suggested that saltwater intrusion and storm surge flooding were the main reasons for tree mortality in forests around Shelby Lakes, rather than wind damage.

(S. Grabich et al. 2016)

Spatial/Temporal Scale:

- Hurricane disaster exposure 3 methods, FEMA Presidential disaster declarations, spatial data on specific storm trajectory (storm tracks with a symmmetrical buffer around them), novel meteorological measure based on Saffir-Simpson hurricane intensity scale.
- Preterm birth and low birth weight rates collected from the county level of exposed areas

(Bevilacqua et al. 2020)

Spatial Scale

- ggmaps package in R was used to generate distribution of zip codes of the participants

Temporal Scale

(Lane et al. 2013)

Spatial Scale

- “Based on vulnerable subgroups identified in the literature, potential indicators of population vulnerability for which data are available were identified and mapped within the 42 NYC United Hospital Fund (UHF) neighborhoods located within any NYC hurricane evacuation zone. UHF neighborhoods are zip code-aggregated areas within all five boroughs. For each indicator, prevalences were categorized intoquartilesbyneighborhood.”

(Lane et al. 2013)

(Schwartz et al. 2018)

Spatial

- Convenience sampling from the Greater Houston area

Temporal

- Research team arrived in Houston less than 3 weeks after Hurricane Harvey made landfall

(Pugatch 2019)

- "I use windspeed data on tropical storms originating in the Atlantic and eastern North Pacific oceans (the regions relevant to Mexico), available from the National Oceanic and Atmospheric Administration (NOAA) Tropical Prediction Center, a U.S. government agency. NOAA analyzes data from reconnaissance aircraft, ships, and satellites to create "best tracks" of individual storms: positions (latitude and longitude) of storm centers at 6-hourly intervals, combined with intensity information (windspeed and barometric pressure; Jarvinen, Neumann, & Davis, 1993; Davis, Brown, & Preston, 1984; Chu, Sampson, Levine, & Fukada, 2002). Complete records for both ocean regions are available since 1949. Fig. 1 maps storm best tracks making landfall in Mexico" (Pugatch 2019)
- "I use data on tropical storm exposure and mortality in all 31 Mexican states, plus Mexico City, for each month during 1990– 2011 (I chose the starting period based on the availability of microdata on mortality). I create an index to measure storm severity by incorporating two elements, windspeed and population density" (Pugatch 2019)

(Jaycox et al. 2010)

New Orleans schoolchildren were participated in a trial and assessment of an intervention after Hurricane Katrina. Group intervention at school and individual intervention at a clinic were the two options. Both treatments led to a reduction in symptoms of PTSD, but there were still elevated levels of PTSD even post treatment.

Spatial Scale

- Three schools in New Orleans participating in Project Fleur-de-Lis.

Temporal Scale

- Interventions began 15 months after Hurricane Katrina.
- "Students were assessed at baseline (December 2006–January 2007), at 5 months (April–May 2007) and at 10 months (September–October 2007). The CBITS groups ran March to May 2007 and TF-CBT was implemented February to September,

2007. This study only reports on the 10-month follow-up assessment results."(Jaycox et al. 2010)

Exposure

- Exposure measured via self report by students using the Disaster Experience Questionnaire.
- "For an overall exposure to hurricane experiences measure, we tallied experiences listed in the top panel of Table 2, for a total number of experiences per student." (Jaycox et al. 2010)
- PTSD symptoms assessed using the Child PTSD Symptom Scale (a score greater than 11 is considered elevated symptoms).

Results/Outcomes

- More girls than boys were at risk for PTSD symptoms (63% for girls, and 37% for boys).
- PTSD scores at 10 months were generally improved from scores at baseline assessment in students who participated in the intervention.
- “More than 60% of students screened positive for elevated PTSD symptoms and were included in the intervention field trial.” (Jaycox et al. 2010)

(Bourque et al. 2006)

Temporal Scale

Spatial Scale

Exposure

Results/Outcomes

- NOAA’s Tropical Prediction Center estimates that between 1970 and 1999, 1% of deaths in hurricanes were caused by storm surges, 59% by freshwater (inland) flooding, and 12% by wind.

(Harville et al. 2010)

- Low birth rates and preterm births were studied in Louisiana at three spatial levels: Orleans Parish (New Orleans), Region 1 (this includes Orleans Parish, and several others), and Louisiana as a whole.

Temporal Scale

- Data used in analysis came from Louisiana birth records 2003-2007, in Medicaid-linked data.
- Birth outcomes among state residents were examined for the 2 years before and after Hurricane Katrina.

Spatial Scale

- The Regional Level is the scale that was used to study birth outcomes, and Louisiana is divided into 9 health regions.
- The Region of mother’s residence was used to study rather than the region that the mother gave birth in.
- Region 1 was the Louisiana region hit most strongly by Hurricane Katrina and consists of Orleans,Jefferson,Plaquemines,and St Bernard parishes. The study looked at Orleans parish (city of New Orleans), Region 1, and Louisiana all together.

Exposure

- Exposure defined as giving birth in the two years after Hurricane Katrina

Results/Outcome

- Outcomes of interest were Low Birth Weight, and Preterm Birth.
- In Louisiana as a whole, rates of LBW rose in the two years after Hurricane Katrina, but rates of Preterm births did not.
- Overall, Hurricane Katrina was not associated with an increase in the rates of LBW and preterm births, in some areas there was a reduction of these. This may be due to population changes though because the population at risk after the hurricane had a higher risk profile.

(Ferdinand 2005)

- Hurricane Katrina led to a large number of people with uncontrolled hypertension and cardiovascular disease. Higher rates of high blood pressure are seen in African Americans than in whites, and the rates of controlled blood pressure in disadvantaged communities in Louisiana is very low.

Spatial Scale

- 680 adults staying in Hurricane Katrina shelters in Houston Texas were given a survey
- 98% of these survey subjects were from New Orleans.
- Population in areas of flooding was 76% black, and 29% below the poverty line.

Temporal Scale

- Surveys were administered from September 10 - 12, 2005.

Exposure

- Exposure to flooding leads to evacuation and unexpected displacement, which increases the odds of losing medical records and information that include hypertensive patient's medication regimen, including frequency, dosage, and indications.

Results/Outcome

- Outcomes of concern in this paper are hypertension and cardiovascular disease.
- "There is a 1.8x greater rate of fatal stroke, 1.5x greater rate of coronary heart disease and mortality, and a 4.2x greater rate of end-stage renal disease in this population." (Ferdinand 2005)
- "Only 52% of evacuees had health insurance at the time of the hurricane, and chronic conditions such as heart disease, hypertension, diabetes, and asthma were reported by 41% of the adults surveyed. Furthermore, 29% of evacuees reported having problems in obtaining their necessary prescription drugs." (Ferdinand 2005)

(Christopher 2017)

Temporal Scale

- July 1, 2004 to August 31, 2006 for Hurricane Katrina.
- March 1, 2010 to April 31, 2012 for April 2011 Alabama tornado disaster.
- "The gestation period for mothers in the sample ranged from 18 to 47 weeks, with a mean gestation period of 37.97 weeks (SD = 2.84 weeks"[christopher2017effects]

Spatial Scale

- "For Hurricane Katrina, the population was delimited to pregnant women residing in the counties of Hancock, Harrison, Jackson, and Jones, Mississippi, who experienced a live singleton birth which survived or was born and died between the periods of July 1, 2004 to August 31, 2006." (Christopher 2017)
- "For the April 2011 Alabama tornado disaster, the population was delimited to pregnant women residing in the counties of Calhoun, DeKalb, Franklin, Jefferson, Lawrence, Limestone, Madison, Marion, St. Clair, and Tuscaloosa, Alabama who were most likely affected by the April 2011 tornado disaster, and experienced a live singleton birth which survived or was born and died between the periods of March 1, 2010 to April 31, 2012." (Christopher 2017)

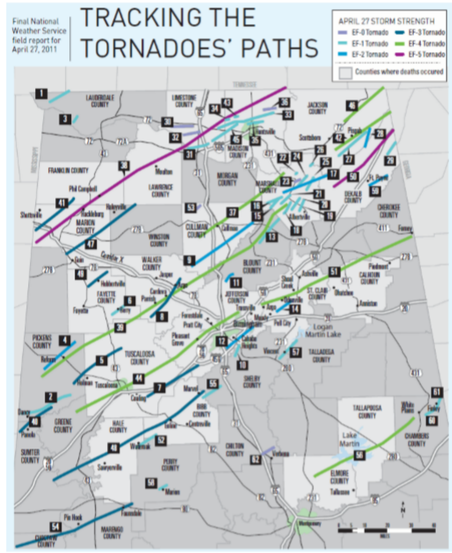

Figure 3. Illustration of the paths and types of tornadoes impacting Alabama on 27 April 2011. Adapted from "Cultivating a State of Readiness: Our Response to April 27, *2011*,"by Tornado Recovery Action Council of Alabama, 2012, p. 17. Retrieved from ema.alabama.gov/filelibrary/TRAC_Report.pdf

Figure 1: Example of how exposure to tornadoes was assesses in Christopher (2017) for counties.

Exposure

- Maternal prenatal exposure to Hurricane Katrina in Mississippi
- Maternal prenatal exposure to April 2011 Tornado disaster in Alabama.
- "The data consisted of customized delimited county-level linked birth and infant death data drawn from Alabama and Mississippi Linked Infant Births and Deaths Record Files for the period 1997-2013." (Christopher 2017)

Results/Outcome

- Response variables of interest included birth weight, preterm birth, infant mortality, and mode of delivery.
- Exposure to hurricanes increased odds of low birth weight and also increased risk for preterm birth, however it wasn't shown to have a significant association with increased infant mortality.

(Zahran et al. 2011)

Temporal Scale

- "Mental health condition is measured as the reported count of poor mental health days experienced by a respondent in the previous 30 days. Data on mental health days are from the CDC's BRFSS, 2005–2006." (Zahran et al. 2011)

Spatial Scale

- Intensity of hurricane's path measured using data on property damage and crop loss from the Spatial Hazard Losses and Events Database.

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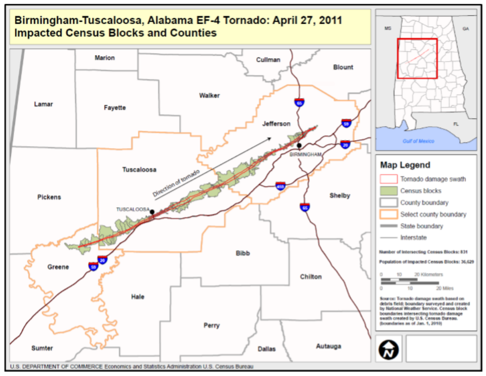

Figure 4. 2011 Alabama EF-4 Tornado track. From U.S. Department of Commerce, U.S. Census Bureau, Census Data & Emergency Preparedness, 2011 Tornadoes, Birmingham-Tuscaloosa Alabama EF-4 Tornado, 2014b. Retrieved from https://www.census.gov/newsroom/emergencies/2011_tornadoes.html

Figure 2: Second Figure.

Exposure

- "Individual exposure to Hurricane Katrina and/or Rita was determined by information on the temporal and spatial coordinates of each hurricane event, the date a respondent was interviewed by the CDC, and the respondent's place of county residence, as reported in the CDC's Behavioral Risk Factor Surveillance System (BRFSS) database" (Zahran et al. 2011)
- Number of poor mental healthd days expected to have spikes corresponding to hurricane events in affected but not unaffected areas with respect to hurricane exposure.

Results/Outcomes

- Outcome of interest was mental health resilience of Hurricane Katrina and Rita survivors, stratified by vulnerability status. Number of poor mental health days used as metric for this.
- Vulnerability status measured by poor physical health, social support, education level, income, and being a single mother.
- Single mothers were identified as a particular vulnerability category of interest
- "Resistance refers to the capacity to limit displacement from equilibrium following a traumatic event. Resilience, by contrast, points to the ability to return to an equilibrium state—the more rapid the return to preevent functioning, the greater the resilience." (Zahran et al. 2011)
- Average number of poor mental health days in 30 was 3.37 for the population as a whole, and 5.95 for single mothers.
- Overall, hurricane exposed single mothers and exposed "others" all experienced an increased number of days of poor mental health.
- "We estimate that single mothers, as a group, suffered over $130 million in productivity loss from added postdisaster stress and disability." (Zahran et al. 2011)

(Zahran, Tavani, and Weiler 2013)

Temporal Scale

Spatial Scale

- Casualty counts are recorded at the county level in counties affected by either hurricanes or tornados.
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Exposure

- "In the event of a natural disaster,people living in affected areas suffer both income and wealth losses. Wealth losses typically involve damage to residential or commercial property, whereas income losses involve lost wages, profits, dividends, and rents in consequence of the disaster." (Zahran, Tavani, and Weiler 2013)

Results/Outcomes

- Dependent variables analyzed are hurricane casualties and tornado casualties.
- Predictor variables are disaster damage, recency bias, and day of the week.

(Nordhaus 2010)

Temporal Scale

- Annual number of tropical cyclones from 1970 to 2004 averaged at 85.
- Reliable data on the number of tropical cyclones has only been collected since 1960, so it is hard to accurately gage if the average number of tropical cyclones per year is increasing.
- "Using "best track" or HURDAT data for North Atlantic storms, there has been a clear increase in the frequency of storms over the 1851–2005 period, particularly since 1980."

Spatial Scale

- Study focues on tropical cyclones in the North Atlantic, focusing on the East Coast of the United States

Exposure

- Storm intensity is measured by something called "Hurricane Power" which is defined as a function of maximum wind speed squared or cubed
- "NOAA has constructed a power index called the accumulated cyclone energy (ACE) index, which is a function of maximum wind speed squared." [nordhaus2010economics]
- This study analyzes economics impacts by looking at three primary factors: number of storms, maximum wind speed at landfall, and GDP.

Results/Outcomes

- Southern Atlantic coast is most vulnerable to hurricanes in the context of climate echange
- Damages appear to increase to the ninth degree of wind speed.
- It is estimated that climate change will increase the intensity of hurricanes and tropical cyclones, but it isn't clear if it will also increase the frequency. - Based on 2005 incomes, it is estimated that average annual US hurricane damages will increase by $10 billion.

(Gaddis et al. 2007)

Temporal Scale

- Built capital recovery is typically measured in the short term because it is limited by available human labor and construction materials, whereas natural capital recovery may take much longer because it is often limited by natural processes.
- Standard discount rate may be appropriate for built capital stocks but it is inappropriate to apply it to social, human, and natural capital stocks.

Spatial Scale

- Full cost accounting of damages after hurricanes must look at regional, national and international scales since communities and areas not affected by the direct results of the tropical cyclone or hurricane may still be impacted economically.
- It was noted that some regions benefit economically from storms, for example areas surrounding New Orleans saw their property values go up because of people trying to leave the New Orleans area.

Exposure

- Economic damage in the form of built capital, human capital, natural capital, and social capital.

Results/Outcomes

- Current policies that incentivize settling in vulnerable coastal areas should be replaced with policies that encourage populating the interior of the country which is experiencing negative population growth.
-

(Narita, Tol, and Anthoff 2009)

Temporal Scale

- Model runs from the years 1950 (1950 to 2000 used for model calibration) to 3000

Spatial Scale

- Globe divided into 16 regions to test scenarios.

Exposure

- FUND version 3.4 used to analyze climate change impacts attributable to enhancement of tropical cyclone activity
- "Essentially, FUND is a model that calculates damage caused by climate change for 16 regions of the world listed in Table 1 by making use of exogenous scenarios of socioeconomic variables. The scenarios comprise projected temporal profiles of population growth, economic growth, autonomous energy efficiency improvements and carbon efficiency improvements (decarbonization), emissions of carbon dioxide from land use change, and emissions of methane and of nitrous oxide. Carbon dioxide emissions from fossil fuel combustion are computed endogenously on the basis of the Kaya identity. The calculated impacts of climate change perturb the default paths of population and economic outputs corresponding to the exogenous scenarios. The model runs from the years 1950 to 3000 in time steps of a year, though the outputs for the 1950 to 2000 period is only used for calibration, and the years beyond 2100 are used for approximating the social cost of carbon under low discount rates, a matter that does not concern us in this paper."(Narita, Tol, and Anthoff 2009)

Results/Outcomes

- Direct economic damages to the USA calculated to almost USD $19 billion.

(Pistrika and Jonkman 2010)

Temporal Scale

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Spatial Scale

- Greater New Orleans metropolitan area was studied. The area was divided into three sections based on “bowls” aka polders.
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Exposure

- Hydrodynamic flood simulations used to analyze relationship between flood characteristics and damage to buildings.
- Momentum = mass x velocity = density x volume x velocity => Momentum = density x flooded horizontal area x (depth x velocity)
- Characteristics of the flood (load/flood action) and building resistance and are used to predict the structural damage. This then is used to analyze and predict the economic damage by looking at the total replacement cost and the building’s market cost prior to the disaster.

Results/Outcome

- Outcome of interest is direct damage to residential buildings in New Orleans caused by flooding after Hurricane Katrina
- “The spatial level of detail of the analysis is a determining factor for the correlation between predictions and observations. The smaller the spatial unit of the analysis the poorer the relationship between flood characteristics and damage.” (Pistrika and Jonkman 2010)
- “The highest damage percentages and structural damage mainly occurred in areas where higher flow velocities occurred, especially near the breaches in the Lower 9th Ward neighborhood. Due to the approach that was used for damage quantification, buildings that sustained structural damage, had damage levels higher than 50% of their market value.” (Pistrika and Jonkman 2010)
- “An alternative approach has been proposed that could be used to distinguish three different damage zones based on the combination of water depth and flow velocity. There appeared to be clear differences between the average, observed damage values in the three zones. This approach could be useful to determine the extent of flood damage and distinguish the main damage zones for an area affected by flooding due to breaching of flood defenses.” (Pistrika and Jonkman 2010)

(Xian, Lin, and Hatzikyriakou 2015)

FEMA’s flood risk mapping techniques are tested against a survey quantitatively assessing the damage to 380 structures in Ortley Beach, New Jersey, after Hurricane Sandy in 2012.

Temporal Scale

- Damage was surveyed in the aftermath of Hurricane Sandy

Spatial Scale

- 380 structures in a heavily affected area of Ortley Beach

Exposure

- “we quantitatively measure the damage percentage for each of the significant building components (foundation, exterior walls, wall siding, windows, doors, roof, and roof cover). Moreover, we assess the damage percentage to each component at each story and each side of a structure. The survey indicates that different sides and stories of a structure suffered different levels of damage due to the different surge/wave effects.” (Xian, Lin, and Hatzikyriakou 2015)

- Different factors were put in a database: Distance from the coast, ground elevation, elevation above ground, and year building was built.

Results/Outcome

- Overall, the side facing the ocean, and the first floor of a building were typically at a greater risk for damage than the other three sides and other floors.
- Buildings built after 1979 tended to withstand damage from the hurricanes greater than buildings built before this year.

(Willison et al. 2019)

Quantifying the US federal response and resulting inequality in Texas and Florida versus Puerto Rico. Hurricanes Irma, Harvey, and Maria are all analyzed.

Temporal Scale

- Analysis spans landfall to six months after each hurricane, in this case Harvey, Irma, and Maria.

Spatial Scale

- Florida, Texas, and Puerto Rico were all analyzed at the state/territory level.

Exposure

- "To examine differences in disaster responses across the three hurricanes, we focus on measures of federal spending, federal resources distributed and direct and indirect storm-mortality counts. Federal spending estimates come from congressional appropriations and FEMA records. Resource estimates come from FEMA documents and news releases. Mortality counts come from National Oceanographic and Atmospheric Administration (NOAA) reports, respective vital statistics offices and news reports. Damage estimates came from NOAA reports. In each case, we compare the responses and the severity at critical time points after the storm." (Willison et al. 2019)

Results/Outcome

- "Our results show that the federal response was faster and more generous across measures of money and staffing to Hurricanes Harvey and Irma in Texas and Florida, compared with Hurricane Maria in Puerto Rico. This result would be unsurprising if Hurricane Maria was less damaging than Irma and Harvey. However, Hurricanes Harvey and Irma made landfall as category four hurricanes,1 5 and Maria hit Puerto Rico as a 'high-end' category 4, or just below the threshold of a category 5 hurricane.6 Maria caused more damage in Puerto Rico than Irma in Florida or Harvey in Texas in terms of loss of electricity and housing destruction,1 5 6 with overall damage estimates comparable to Harvey, and greater than estimates for Irma.1 Assuming that infrastructure costs are higher in Texas and Florida, and therefore more expensive to repair, compared with Puerto Rico, the high damage estimates in Puerto Rico emphasise the severity of storm damage." (Willison et al. 2019)

(Xian et al. 2018)

Hydrodynamic storm surge and wave modeling was coupled with rapid damage surveying in the Florida Keys to assess physical damage.

Temporal Scale

- Field surveys were carried out September 21-24 soon after Hurricane Irma (September 10 is when it made landfall).
- Rapid survey method involved driving at a speed of 10 mph throughout affected areas and taking GPS informed pictures from the rear side windows.

Spatial Scale

- Big Pine Key and Marathon are the two survey locations in the Florida Keys, they were the two areas that were most affected by the hurricane.
- Over 1600 residential buildings were surveyed using the rapid survey method.

Exposure

- After conducting a damage and assessment survey after Hurricane Irma, a statistical regression approach is used to quantify the contribution of various hazard and vulnerability factors.
- "To understand the hazard and inform the field survey, we first use the coupled hydrodynamic and 41 wave model ADCIRC+SWAN (Dietrich et al. 2012, Marsooli and Lin 2017) to simulate the 42 storm tide (i.e., water level) and wave height for Hurricane Irma. To simulate Irma's storm tide 43 and wave (Figure 1), we apply the surface wind (at 10-m) and sea-level pressure fields from 44 National Center for Environmental Prediction Final (NCEP FNL) operational global analysis data (0.25o x 0.25o 45 x 6 hours)." (Xian et al. 2018)
- The collected photos and satellite images are used to categorize damage state for each residential building surveyed.
- FEMA's damage state criteria that were used in Hurricane Sandy are used to categorize and assess the damage in Big Pine Key and Marathon, and include the categories No/very limited damage; Minor damage; Minor damage; and Destroyed.

Results/Outcome

- Hydrodynamic forces induced by storm surges and waves were the primary cause of destroyed and heaviliy damaged buildings.
- Observed storm surge damage is consistent with the hydrodynamic models.
- Analysis on Big Pine Key revealed that distance from the coastline was the most significant predictor for damage state
- On Marathon, building type and size were the two main predictors.

(Shao et al. 2017)

This study focuses on the effects of external influences and perceptions of flood risk on individual's behavior relating to purchasing flooding insurance. Flood insurance ownership rates are relatively low and despite the fact that home owners in Special Flood Hazard Areas are required to buy flood insurance if they are receiving a mortgage from a federally backed or regulated lender, the law is not heavily enforced.

Temporal Scale

- Individual levels variables constructed from data collected in 2012 Gulf Coast Climate Change Study
- Data collected by phone interviews from January 3rd through April 4, 2012.

Spatial Scale

- State level
- Stratified random sampling strategy drew independent samples in Texas, Louisiana, Mississippi, Alabama, and Florida.

- Contextual variables pertaining to flooding risk taken at the county level in these states.

Exposure

- 3856 respondants, response rate was 17.6%

Dependent Variables

- "The two dependent variables are based on responses to two survey questions. The two questions are"do you haveflood insur-ance?"and"do you have flood insurance to feel safer or because it is required?" " (Shao et al. 2017)

Independent Variables

- "The individual-level independent variables, including socio-demographic features, home ownership, distance from the coast(self-reported), trust in the local government and flood-related risk perceptions, are all constructed based on survey items." (Shao et al. 2017)
- "The contextual variables include spatial information about flood hazards estimated by FEMA, peak height of storm surge from the most recent hurricane landfall, and economic damages from the most recent and most impacted flooding events, respectively. They are all at county-level"

Results/Outcome

- People from racial minorities were more likely to buy flood insurance voluntarily than whites when controlling for other variables, perhaps reflecting that whites perceive less risk than minorities.
- People of higher socioeconomic status (both higher levels of education and income) were more likely to buy flood insurance.
- A perception that flooding and storm intensity is increasing also made coastal residents more likely to buy flood insurance.
- The other major factors in predicting whether or not a resident would buy flood insurance were self reported distance from the coast, and belief in local government's preparedness to address climate change.

(Xian, Lin, and Kunreuther 2017)

This paper is about creating an economically optimal elevation level (OEL), because it is more economical to use this rather than 1 foot above base flood elevation (BSE). "Under the regulations of both ASCE 242 and NFIP, FEMA requires coastal houses with repetitive losses and/or substantial damage from flood events to be elevated to at least 1 foot above the BFE and recommends all houses in SFHA to be elevated to this level (FEMA, 2011). However,this requirement/recommendation does not provide guidance for home owners about how many feet exactly their houses should be raised to."(Xian, Lin, and Kunreuther 2017)

Temporal Scale

- "The house information data used in this study, including location, ground elevation, house size, and house value, were collected by a team of students and faculty from University of Notre Dame and Princeton University in an onsite survey three weeks after Sandy." (Xian, Lin, and Kunreuther 2017)

Spatial Scale

- Three actual houses in Ortley Beach, New Jersey were used to test the OEL model.

Exposure

- "We propose that an economically optimal elevation level (OEL)for coastal houses can be estimated through a cost-benefit analysis(CBA). Specifically, the OEL can be calculated as the level that minimizes the sum of the upfront elevation cost and present value of cumulative annual expected losses over the lifespan of a house."(Xian, Lin, and Kunreuther 2017)

Results/Outcome

- About half of the houses at Ortley Beach would save 10,000 dollars per structure if elevated to OELs instead of 1-foot freeboard, and about 5% of the houses could save up to 100,000 dollars.

(Deryugina, Kawano, and Levitt 2018)

Temporal Scale

- Data taken from individual Federal tax returns and third party information returns filed between 1999 and 2013.

Spatial Scale

- City of New Orleans, Louisiana is the focus of the study and New Orleans residents were identified as those with a New Orleans zip code on their tax return or on their W2 form.
- Cities with similar characteristics to Louisiana are compared, with three pre-Katrina dimensions: median earnings, population growth rate, and percentage of the population that is black. These cities were Baltimore, MD, Birmingham, AL, Detroit, MI, Gary, IN, Jackson, MS, Memphis, TN, Newark, NJ, Portsmouth, VA, Richmond, VA, and St. Louis, MO.

Exposure

- "We explore five key dimensions across which one might expect the economic impact of the hurricane to be heterogeneous: whether a household's own home was severely affected by the storm, pre-Katrina income, age, homeownership, and whether the household left New Orleans." (Deryugina, Kawano, and Levitt 2018)

Results/Outcomes

- After a few years, the income of New Orleans residents affected by Hurricane Katrina actually recovered and surpassed that of controls in other cities.

(Shao et al. 2017)

This is a different article than the other one with the name shao2017understanding. This one is about perception of increasing hurricane strengths in the Gulf States.

Temporal Scale

- Individual levels variables constructed from data collected in 2012 Gulf Coast Climate Change Study
- Data collected by phone interviews from January 3rd through April 4, 2012.
- Previous hurricanes that made landfall were used from the past 20 year period of 1992 to 2011.

Spatial Scale

- State level

- Stratified random sampling strategy drew independent samples in Texas, Louisiana, Mississippi, Alabama, and Florida.
- Respondants had to have lived in coastal counties with at least one hurricane landfall between 1992 and 2011. (The reasoning is that hurricanes don't often occur at a single location, and human memory is short so anything past 20 years wouldn't be accurate).

Exposure

- Spatial pattern of perception of increasing hurricane strength is mapped and used as the dependent variable.
- Hurricane strength is measured by maximum windspeed at landfall, storm surge, and economic damage.

Results/Outcomes

- Outcome of interest is coastal residents' perceptions of increased hurricane strength. Intensity of past hurricanes, physical characteristics like wind speed, consequences such as economic damage, and people's opinions of climate change are the four factors that are framed as research questions to see how they affect this perception of increased hurricane strength.
- Perceptions of increasing hurricane strength are stronger in Louisiana and Mississippi, likely because of memory of Hurricane Katrina, and less strong moving away from this epicenter into the Gulf Coasts of Texas and Florida.
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