

Tropical Storm Paper

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When studying the economic, social, and health impacts that tropical storms and hurricanes have in places such as the Gulf Coast of the United States, it is important to select an appropriate spatial and temporal scale in order to adequately classify exposure. Failure to classify exposure accurately allows misclassification bias to move the results of the study further from the true parameter. Of particular concern in environmental epidemiology is non-differential misclassification which will in all cases bias the results towards the null (Armstrong 1998). In effect, this will weaken or obscure any associations that are present that the researcher may hope to observe in the data (Armstrong 1998).

A literature review was conducted to investigate the different spatial and temporal scales that were most commonly used by researchers studying tropical storm and hurricane impacts on health, ecology, and economic systems in affected areas. Spatially, the most common units tended to be the county and state level, while the temporal scale ranged from days to weeks to cumulative measures across storm events.

Spatial Scales

Point Location

Point locations are the smallest resolution of spatial data used to assess the exposure to tropical storms and hurricanes. The obvious advantage of a point location is that when mapped it can be overlaid with data on storm patterns to gage a very accurate picture of exposure. Since storm tracks are often spatially represented by the path of storm's center, having point locations for the exposed units of interest means that you can more accurately measure how close they were to the center of the storm, and then further make conclusions based on this.

In many cases the point location was assessed by collecting information on the study subject's residential address through some sort of a survey (Lieberman-Cribbin et al. 2017), (Jaycox et al. 2010), (Bayleyegn et al. 2006). These surveys were often designed to assess psychological needs of hurricane survivors, as well as medical, financial, and nutritional needs. In other cases, point locations were recorded using a GPS device that recorded actual coordinates (Hagy, Lehrter, and Murrell 2006). This is a pretty common practice in ecological research.

Zip Code/County/Parish

While Point locations are very useful, many of the papers cited used larger geographic areas to denote spatial exposure to storms. Zip codes (Bevilacqua et al. 2020), (Lane et al. 2013), are often used to aggregate groups of people living in a given area, as are counties (Kinney et al. 2008), (S. C. Grabich et al. 2016), (S. Grabich et al. 2016), (Schwartz et al. 2018), (Harville et al. 2010). There are several disadvantages and pitfalls to using this spatial level. One is that not all counties and zip codes (which are called parishes in Louisiana) are the same size or have the same population, so they may not be immediately comparable. Using the county/parish or zip code also lends itself to the possibility of exposure misclassification. There are many ways that this can occur in a study on tropical storms; one common example is that counties selected as exposed are those that had the center of the storm pass through their county's physical boundaries. However it is very possible that some individuals lived in a county that was classified as exposed based on

this criteria but were in a region of the county far enough away from the storm center that they were not severely impacted. That means these individuals would be classified as exposed when they really were not and it could bias the association towards the null if one existed. Alternatively, individuals who lived in a county that wasn't classified as exposed but were near the border of a county that was could be incorrectly categorized as being unexposed even if they actually experienced many of the effects of the storm.

State/Metropolitan Region

Many studies used the spatial level of entire states or specific metropolitan areas to gather information on those who were exposed. This is the spatial level of an ecological study and can be useful to compare the emergency preparedness and policies of different states. The potential for the ecological bias is of course present when looking at this spatial scale however, which occurs when the outcomes on the population level (typically an average), do not represent the individual outcomes very well.

Temporal Scales

Week

Week appears to be a very common unit of time used to ascertain exposure, particularly for studies that are concerned with birth outcomes and gestation during hurricane exposure (Kinney et al. 2008), (S. C. Grabich et al. 2016), (S. Grabich et al. 2016). When the week of gestation is known, the timing that the hurricane makes landfall, or has its storm center pass through a county can be matched up to this week of gestation to identify possible "critical periods" of exposure during development.

Cumulative Measures of Time

Many of the studies looked at didn't assess exposure at the moment of the storm, but rather after it had done damage.

References

- Armstrong, Ben G. 1998. "Effect of Measurement Error on Epidemiological Studies of Environmental and Occupational Exposures." *Occupational and Environmental Medicine* 55 (10). BMJ Publishing Group Ltd: 651–56.
- Bayleyegn, Tesfaye, Amy Wolkin, Kathleen Oberst, Stacy Young, Carlos Sanchez, Annette Phelps, Joann Schulte, Carol Rubin, and Dahna Batts. 2006. "Rapid Assessment of the Needs and Health Status in Santa Rosa and Escambia Counties, Florida, After Hurricane Ivan, September 2004." *Disaster Management & Response* 4 (1). Elsevier: 12–18.
- Bevilacqua, Kristin, Rehana Rasul, Samantha Schneider, Maria Guzman, Vishnu Nepal, Deborah Banerjee, Joann Schulte, and Rebecca M Schwartz. 2020. "Understanding Associations Between Hurricane Harvey Exposure and Mental Health Symptoms Among Greater Houston-Area Residents." *Disaster Medicine and Public Health Preparedness*. Cambridge University Press, 1–8.
- Grabich, SC, J Horney, C Konrad, and DT Lobdell. 2016. "Measuring the Storm: Methods of Quantifying Hurricane Exposure with Pregnancy Outcomes." *Natural Hazards Review* 17 (1). American Society of Civil Engineers: 06015002.
- Grabich, Shannon C, Whitney R Robinson, Stephanie M Engel, Charles E Konrad, David B Richardson, and Jennifer A Horney. 2016. "Hurricane Charley Exposure and Hazard of Preterm Delivery, Florida 2004." *Maternal and Child Health Journal* 20 (12). Springer: 2474–82.
- Hagy, James D, John C Lehrter, and Michael C Murrell. 2006. "Effects of Hurricane Ivan on Water Quality in Pensacola Bay, Florida." *Estuaries and Coasts* 29 (6). Springer: 919–25.
- Harville, Emily W, Tri Tran, Xu Xiong, and Pierre Buekens. 2010. "Population Changes, Racial/Ethnic

Disparities, and Birth Outcomes in Louisiana After Hurricane Katrina.” *Disaster Medicine and Public Health Preparedness* 4 (S1). Cambridge University Press: S39–S45.

Jaycox, Lisa H, Judith A Cohen, Anthony P Mannarino, Douglas W Walker, Audra K Langley, Kate L Gegenheimer, Molly Scott, and Matthias Schonlau. 2010. “Children’s Mental Health Care Following Hurricane Katrina: A Field Trial of Trauma-Focused Psychotherapies.” *Journal of Traumatic Stress: Official Publication of the International Society for Traumatic Stress Studies* 23 (2). Wiley Online Library: 223–31.

Kinney, Dennis K, Andrea M Miller, David J Crowley, Emerald Huang, and Erika Gerber. 2008. “Autism Prevalence Following Prenatal Exposure to Hurricanes and Tropical Storms in Louisiana.” *Journal of Autism and Developmental Disorders* 38 (3). Springer: 481–88.

Lane, Kathryn, Kizzy Charles-Guzman, Katherine Wheeler, Zaynah Abid, Nathan Graber, and Thomas Matte. 2013. “Health Effects of Coastal Storms and Flooding in Urban Areas: A Review and Vulnerability Assessment.” *Journal of Environmental and Public Health* 2013. Hindawi.

Lieberman-Cribbin, Wil, Bian Liu, Samantha Schneider, Rebecca Schwartz, and Emanuela Taioli. 2017. “Self-Reported and Fema Flood Exposure Assessment After Hurricane Sandy: Association with Mental Health Outcomes.” *PLoS One* 12 (1). Public Library of Science: e0170965.

Schwartz, Rebecca M, Stephanie Tuminello, Samantha M Kerath, Janelle Rios, Wil Lieberman-Cribbin, and Emanuela Taioli. 2018. “Preliminary Assessment of Hurricane Harvey Exposures and Mental Health Impact.” *International Journal of Environmental Research and Public Health* 15 (5). Multidisciplinary Digital Publishing Institute: 974.