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AN OVERLOOKED SOURCE OF WEATHER-RELATED PROPERTY DAMAGE IN THE SOUTHEAST: LIGHTNING LOSSES FOR GEORGIA, 1996-2000

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I compiled weather-related property damage claims for Georgia and compared them with observational loss records in the National Oceanic and Atmospheric Administration's *Storm Data* reports for 1996-2000. Lightning comprised 53% of a total 37,093 weather-related claims for property damage observed during this interval, amounting to $22.9 million in losses. Based on tests of group differences obtained with multiresponse permutation procedures (MRPP), lightning was comparable to wind damage in total dollar losses. When adjustments are made for the market share of insurer providing these claims data, lightning losses in Georgia may approach $92 million for the five-year period. *Storm Data* greatly underestimated lightning losses, suggesting that insurance claims can provide much needed detail on the economic costs of high frequency, localized weather hazards such as lightning. For the southeastern U.S., lightning may be an underrecognized agent of weather-related property losses.

Key words: lightning, weather hazards, insurance claims, MRPP.

INTRODUCTION. Property insurance loss records are recognized as useful indicators of climate change and damaging weather events (Nutter, 1999). Their utility rests in the fact that standard weather observations record only the conditions that potentially result in property losses. For example, not all severe thunderstorms or heavy snowfalls result in property damage. Insurance claims data, however, link weather phenomena to their economic costs. More important, by accounting for shifts in the price of repairs, variations in population density, and changes in construction methods, insurance claims data capture the changing societal sensitivity to damaging weather (Skinner et al., 1999; Changnon et al., 2000).

Insurance data have been used extensively to document hurricane and tornado damage (Changnon and Changnon, 1999). However, few studies have employed insurance data to examine more frequent but less intense weather phenomena such as freezing temperatures, hail, or lightning (Skinner et al., 1999). Based on lightning property insurance losses for three western states (Colorado, Utah, and Wyoming), Holle et al. (1996) suggested that lightning may outrank thunderstorm winds, heat waves, and droughts in the dollar amount of weather-related property damage in the United States. Similar insurance-based estimates of lightning property losses have not been compiled for the southeastern U.S. despite this region's higher population density (54.6 persons/km^2 versus an average of 24.6 for Colorado, Utah, and Wyoming (U.S. Census, 2000)) and nearly twice the cloud-to-ground flash density. To

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gauge the extent to which lightning contributes to property loss, I compiled weather-related property damage claims data for Georgia and compared them with loss records recorded in the National Ocean and Atmospheric Administration's online *Storm Data* reports for the interval 1996-2000. *Storm Data* is frequently cited as a data source for the costs of weather-related property losses, including lightning (Curran et al., 2000).

DATA AND METHODS. Weather-related claims data for the years 1996-2000 were obtained from the third largest insurer in Georgia. Commercial, homeowner, and farmowner claims were combined to determine the total dollar losses and the number of claims per year for five weather categories: lightning, wind damage (inclusive of thunderstorm winds, tornadic circulation, and tropical storms), ice damage, freeze damage, and hail. Deductibles were not included in these figures; thus total dollar losses and the number of claims may be slightly higher than stated. *Storm Data* is available online and provides annual damage reports for lightning and other severe weather phenomena. While *Storm Data* is widely employed as a reference for summarizing damage-producing weather, it may underestimate property losses because reporting is compiled from newspaper articles provided to the National Weather Service by contracted clipping services (Curran et al., 2000).

Multiresponse permutation procedures (MRPP) were used to test for significant differences in annual loss measures (total dollars, claims counts, and dollar cost per claim) among insurance claims weather categories (lightning, wind damage, freezing, hail, ice). MRPP was also used to test for significant differences in lightning losses for my two data providers, *Storm Data* and the third largest property insurer in Georgia. As MRPP is a nonparametric test of group differences, it was ideal given the small number of observations in each group (n = 5). MRPP measures the extent to which two data distributions overlap based on comparisons of the observed and permutated average within-group distance among sample points (Biondini et al., 1991). MRPP employs a within-group homogeneity statistic (A) to gauge whether observed between-group differences are useful, and not the result of random variation within groups. This statistic ranges from -1 to 1, with values greater than 0 indicating group differences greater than expected by chance. All MRPP significance tests were conducted at the 0.05 significance level in PC-Ord Version 4.04 (McCune and Mefford, 1999).

RESULTS. For insurance claims, lightning property losses totaled \$22.9 million (35% of all weather-related losses). Wind claimed a higher total dollar value of 36.7 million in losses (55%). Wind damage exceeded lightning in all years (Fig. 1). However, lightning had a higher total number of claims (19,582 (53% of all weather-related losses)) than wind damage (14,578 (39%)). Lightning exceeded all weather categories in the number of claims in all but one year (1998) (Fig. 2). Average loss per insurance claim was \$1100 for lightning and \$2200 for wind. Holle et al. 1996

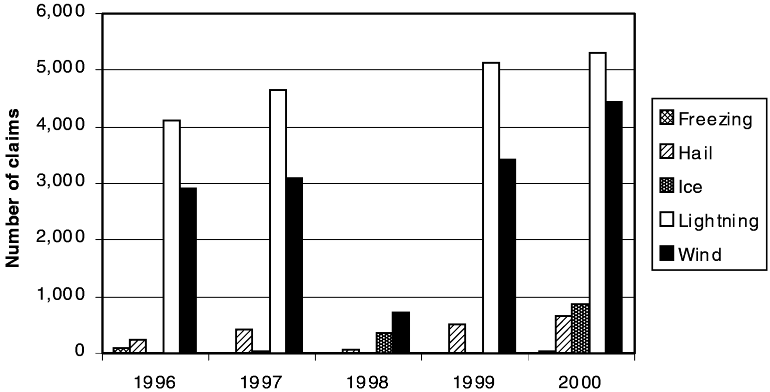

Fig. 1. Property damage losses by weather category compiled from insurance claim data.

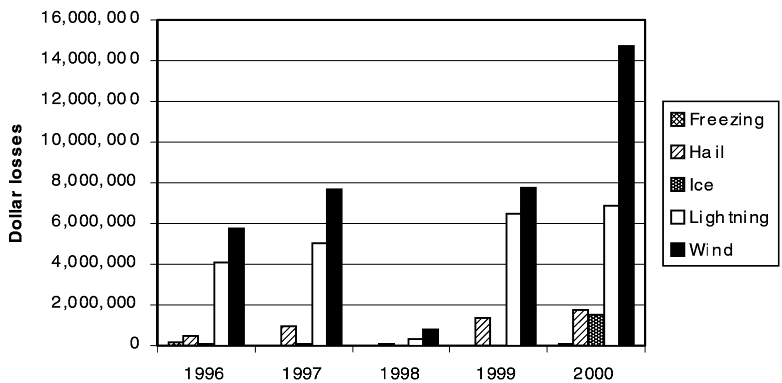

Fig. 2. Number of incidents by weather category compiled from insurance claim data.

found a similar dollar loss per claim figure of $916. *Storm Data* records for lightning were lower in dollar losses and in the number of incidents recorded. Lightning property losses between 1996 and 2000 totaled $13.5 million from a smaller total of 144 lightning incidents. In 1998 and 2000, *Storm Data* loss totals were higher than insurance claims.

MRPP indicated no significant difference in the distribution of annual dollar losses (A = -0.03. p = 0.70) and the total number of claims (A = 0.02, p = 0.39) for lighting and wind damage over the interval 1996-2000. However, the dollar amount per claim for these two weather phenomena differed significantly (A = 0.33, p = 0.01). *Storm Data* and insurance data were not significantly different in their annual dollar losses attributed to lightning (A = -0.001, p = 0.43), yet these two data providers were significantly different in the number of claims ($A = 0.39$, $p = 0.003$) and in the dollar cost per individual claim ($A = 0.77$, $p = 0.002$).

DISCUSSION. Based on insurance claims data, lightning was not statistically different from wind in the dollar amount of property damage, exceeding ice damage, freeze damage, and hail. Given that wind damage includes thunderstorm winds and tornadic circulation, lightning may be an under-acknowledged agent of weather losses in Georgia. In agreement with Holle et al., (1996), *Storm Data* was shown to underestimate weather-related property losses. In this study, insurance claims recorded 136 times more lightning strike incidents and more than double the dollar losses when compared to *Storm Data*. While MRPP muted these descriptive differences between the two data providers one must consider the market position of the company that provided the claims data. As the major insurer in Georgia holds four times the market share of the company that provided the data for this study (based on 1999 figures), estimates of lightning property losses could range as high as $91.6 million over the five-year interval, approximately seven times higher than the amounts recorded in *Storm Data*. MRPP tests, when insurance claims are scaled to market share, were significantly different from *Storm Data* in annual dollar losses ($A = 0.36$, $p = 0.02$). I do note, however, that extrapolation of these cost figures need also to consider differences among insurance companies in the distribution of policy holders relative lightning activity and the robustness of the correlation between market share and claims paid.

While *Storm Data* underestimates property losses, it is easy to access. Insurance claims data may be difficult to acquire. For this study, requests for claims data were refused from the first and second largest insurer in the state, but provided without geographic detail from the third largest insurer. *Storm Data*, by contrast, provide better locational information for lightning incidents. Such geographic specificity from insurance company data is unlikely given concerns of confidentiality and liability. Thus while *Storm Data* is biased toward large newsworthy weather events, its utility lies in its identification of individual thunderstorm events that cause high levels of lightning property damage. For example, *Storm Data* documents a lightning outbreak in Gwinnett County in September of 2000, in which fire department personnel received 97 lightning-related calls during a 3.5 hour early morning thunderstorm. In part, this outbreak may be responsible for the spike in *Storm Data* losses for 2000 (Fig. 3), as this event caused an estimated $625,000 in damage and made local headlines (NOAA, 2002). Both insurance claims and *Storm Data* exhibited a decline in lightning events in 1998, perhaps due to the occurrence of a strong La Niña, which would dampen thunderstorm activity (Goodman et al., 2000).

CONCLUSION. For the year 2000, the Georgia Emergency Management Agency estimated that 4.5 million in property damage from lightning strikes occurred in Georgia (Davis, 2000). Yet based on information provided by the insurer in this

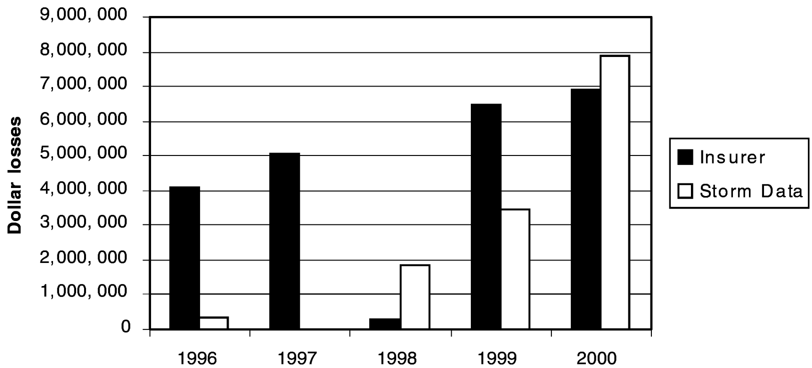

Fig. 3. Comparison of dollar losses attributed to lightning grouped by insurance claims and *Storm Data* losses (1996-2000).

study, losses for 2000 totaled at least $6.9 million. Again, revising this figure to account for market share, losses for lightning property damage in Georgia may range as high $27.6 million for this one year alone. While infrequent, catastrophic weather events may periodically overshadow lightning losses, and recognizing also that potentially damaging weather varies in its distribution throughout the Southeast, lightning may nonetheless deserve greater recognition for its influence on the economics of weather-related property loss.

The large lightning property damage losses documented in this study warrant more investigative detail, particularly on the finer-scale geographic trends of lightning and lightning property damage in the densely populated Atlanta region. Recent studies have suggested that urban growth and land-use change in Atlanta has triggered an increase in the frequency of thunderstorms due to heat island effects (Quattrochi and Luvall, 1999; Bornstein and Lin, 2000). When urban-heat island thunderstorms are initiated, enhanced lightning may develop in the surrounding suburbs (Westcott, 1995; Changnon, 2001; Orville et al., 2001). A dearth of research has been conducted on urban lightning characteristics (flash density, distribution, polarity, and multiplicity) and how these characteristics intersect with the underlying trends in housing development, density, and value. Urban weather impacts are a major research need identified by the U.S. Weather Research Program (Dabberdt, 2000). An elaboration of the more detailed distributional patterns of lightning property losses would inform insurers, utility companies, fire services, and property owners (commercial and home) of a more detailed geographic understanding of lightning risks.

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