

# The Effect of Suburbanization on Significant Tornado Impacts

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Is excessive suburbanization related to increased fatalities and injuries from tornadoes?



- At least over the short term, risk of tornadoes is relatively constant by place
- Suburban growth into areas already at risk should increase the likelihood of increased effects
- The related literature only examines this by examining density
  - Density isn't the whole story



- “Excessive Suburbanization”
  - Low density
  - Distance from city center to urban fringe is excessively large
- Implies that both density and the spatial extent of urban development are important
- The current literature doesn't examine the role of the spatial extent of urban development in tornado effects



- Time Period: 2000-2010
- 15,328 observations
- Units of Analysis: Tornado-County
- Most data from NOAA-SPC
- Economic and population data from the Bureau of Economic Analysis, National Cancer Institute, & USDA



$$C_{it} = f[\text{urban form}_{it}, \\ \text{tornado attributes}_{it}, \\ \text{demographics}_{it}]$$

- Urban form: Density & percent of county developed
- Attributes: Storm intensity, time of day, time of year
- Demographic: Income, gender/race/age attributes of a county



- Density
- Percent developed
- F-Scale
- Length
- Time of day
- Weekend
- Month of storm
- Personal income, per capita
- Percent female
- Percent nonwhite
- Percent under age 19
- Percent over age 65



- Count data
- Negative binomial or Poisson regression (depending on dispersion)
- Robust standard errors
- Year fixed effects



# Descriptive Statistics



Variable	Mean	p25	p50	p75	St. Dev.
Total casualties	0.64	0	0	0	4.57
Fatalities	0.05	0	0	0	0.40
Injuries	0.59	0	0	0	4.30
Density	4.82	2.29	3.33	4.75	9.16
Percent developed	6.71	0.98	2.73	7.53	10.93
F1	0.27	0	0	1	0.45
F2	0.09	0	0	0	0.29
F3	0.03	0	0	0	0.18
F4	0.01	0	0	0	0.09
F5	0.00	0	0	0	0.02
Length	2.67	0.23	1	3.56	3.83
Area	0.48	0.00	0.03	0.23	1.74
Morning	0.08	0	0	0	0.27
Evening	0.41	0	0	1	0.49
Overnight	0.12	0	0	0	0.32
Weekend	0.29	0	0	1	0.45
Personal income, per capita	32.20	27.71	31.30	35.72	6.72
Percent female	50.33	49.92	50.64	51.29	1.93
Percent nonwhite	13.31	2.14	6.31	18.85	16.24
Percent under 19	27.59	25.79	27.44	29.27	3.09
Percent over 65	15.40	12.41	14.91	17.94	4.36

# Results - Total Casualties



Variable	(1)	(2)
Density	0.0029 (1.10)	0.0078* (2.10)
Percent developed	0.0216** (5.44)	0.0252** (5.69)
Length	0.0655** (7.64)	–
Area	–	0.8999** (16.45)
Constant	-2.7860* (2.39)	-1.5278 (1.22)
F-Scale Dummies	Yes	No
Time of Day Dummies	Yes	Yes
Month Dummies	Yes	Yes
Demographics	Yes	Yes
Year Dummies	Yes	Yes
Estimation Method	NB	NB
Observations	15,328	15,328

# Results - Fatalities



Variable	(3)	(4)
Density	0.0026** (2.83)	0.0068** (7.59)
Percent developed	0.0124* (2.33)	0.0189** (2.95)
Length	0.0566** (5.36)	–
Area	–	0.2321** (23.80)
Constant	-6.9801** (3.46)	-6.2157* (2.53)
F-Scale Dummies	Yes	No
Time of Day Dummies	Yes	Yes
Month Dummies	Yes	Yes
Demographics	Yes	Yes
Year Dummies	Yes	Yes
Estimation Method	P	P
Observations	15,328	15,328

# Results - Injuries



Variable	(5)	(6)
Density	0.0026 (0.99)	0.0076* (2.13)
Percent developed	0.0215** (5.23)	0.0251** (5.62)
Length	0.0671** (7.65)	–
Area	–	0.8855** (16.36)
Constant	-2.6340* (2.23)	-1.2889 (1.02)
F-Scale Dummies	Yes	No
Time of Day Dummies	Yes	Yes
Month Dummies	Yes	Yes
Demographics	Yes	Yes
Year Dummies	Yes	Yes
Estimation Method	NB	NB
Observations	15,328	15,328



- Results suggest an omitted variable bias in previous research
- Particularly for injuries, increased numbers of individuals in the path of potential storms leads to more injuries on average
- Policy implications: Individuals may be moving into areas that expose them to more tornado risk
  - Welfare implications are unknown. Need to see how tornado risk is capitalized.