Public Storm Shelters: A Plan for Norman, Oklahoma
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Statement of Purpose
In recent years public storm shelters have come under a lot of scrutiny, and many have come to the conclusion they do more harm than good. However, since not all residents have access to suitable shelter, and safety should be a basic right, it is in the interest of municipalities to look into all possible sheltering options. This idea motivates this planning study to determine the cost and benefit of a public storm shelter network in the city of Norman, Oklahoma.

Background
- In 2013, Norman, Oklahoma closed down all its public shelters citing the following concerns:
  - Greater risk while travelling
  - Integrity of shelters against 200+ mph winds.
  - Overcrowding
  - Health concerns regarding pets
- Norman is located in a high risk area for tornadoes (see Figure 1) and has a vulnerable population (Cutter et al., 2003; see Figure 2)
- Community shelters may be the best way to keep the population safe.
- It is possible to answer most of the concerns regarding public shelters:
  - Shelters can be placed within 400 m of all buildings (5 min walk)
  - Shelter capacity can be matched to the surrounding population.
  - Most modern shelters are capable of withstanding 200+ mph winds

Data and Methods
- Data Sources
  - Tornado tracks for 1950 to 2015 (SPC, 2016)
  - Norman Interactive Map data (City of Norman, 2016)
  - Demographic data from the 2010 Census (MPC, 2016)
- Shelter locations
  - First guess was the center of a 800 x 800 m grid placed over Norman
  - Final location was the mean center of the surrounding buildings.
- Additional shelters were placed at each school and hospital.
- Shelter specifications
  - Capacity was based on the surrounding population
  - Cost was based on capacity using the price estimates in Table 1.
- Priority to build shelters
  - High for schools, hospitals, or mobile home parks
  - Medium for other vulnerable populations.
  - Low otherwise.
- The cost per life saved for storm shelters was assessed following the method of Simmons and Sutter (2006).

Tornado Risk in Norman, Oklahoma (1950 - 2015)

Vulnerable Areas in Norman Versus Existing Refuge Areas

Cost Per Life Saved: Permanent Versus Mobile Homes

Results
- Even in a high risk location like Oklahoma the cost of a storm shelter exceeds the value of a statistical life ($10 million).
  - Shelter locations (Figures 3 & 4) and total cost (Table 2)
  - The cost per life saved for storm shelters in Norman:
    - Permanent Home: $66.4 million
    - Mobile Home: $16.4 million

Discussion
- Stand alone storm shelters are not economical
- Best practices involve new construction.
  - FEMA can cover up to 75% of approved personal or community storm shelter projects under their Hazard Mitigation Grant Program (FEMA, 2016a).
  - It is usually cheaper to build a safe room in a new building than to retrofit an old one (FEMA, 2010).
  - Increased push for better construction should reduce costs through competition (Johnston, 2013).
- New homes can withstand winds up to 120+ mph with the addition of metal connectors costing about $0.50 per square foot (FEMA, 2016b).