When it Rains...

The Geography of Stormwater Infrastructure in San Antonio, Texas

Background:

Storm water drainage infrastructure is an essential, if unglamorous part of any city's functioning. Most modern cities originated around natural water sources in areas with some rainfall. However, as cities expand and develop, land cover becomes increasingly impermeable, adding to the safety and sanitation necessities of developing complex, comprehensive runoff management systems.

FEMA, the United States Federal Emergency Management Agency, is the entity responsible for most of the United States' floodplain map. Floodplains are areas of land subject to periodic flooding, and are classed according to the number of times section can be expected to flood at least once, on average, using assessments of topography, precipitation, and landcover data. A property at the edge of a 10-year flood plain, for example, is likely to once every ten years, but may flood more or less given normal variation in weather events.

Residents of frequently flooded areas are required to purchase insurance annually from the federal government, in order to offset the costs of probable but relatively rare flooding events. Additionally, the development of drainage infrastructure plays a vital role in mitigating personal risk: in one US study, an estimate of total benefit of infrastructure improvements to property was 2-5 percent of property value[1,2].

Variables:

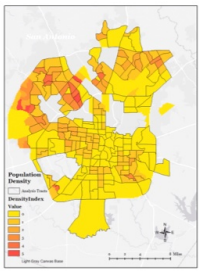
The City of San Antonio, Texas, has a remarkably comprehensive inventory of its infrastructure. Data examined in this analysis include: location of manholes (that is, individual street storm drains); a map of aboveground channels and underground drainage conduits; FEMA floodplain data; information from the US Census; and LANDSAT-derived estimates for surface permeability.

Methodology:

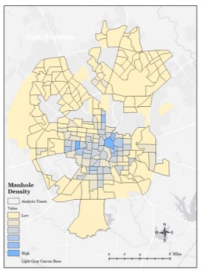
First, I organized information from various sources according to average density or median values by census tract, according to which was most applicable. For example, the file denoting locations of San Antonio manholes was converted into a density metric (manholes per square mile).

Each density dataset was then indexed from 0 to 5. The intervals were equal portions of the range of values in the city's census tracts. I then combined the channel and manhole indices into one infrastructure index, and added the flood index, surface permeability index, and

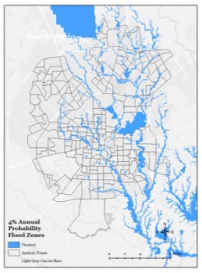
Index of Population Density by Census Tract



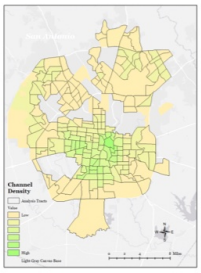
Index of Manhole Density by Census Tract



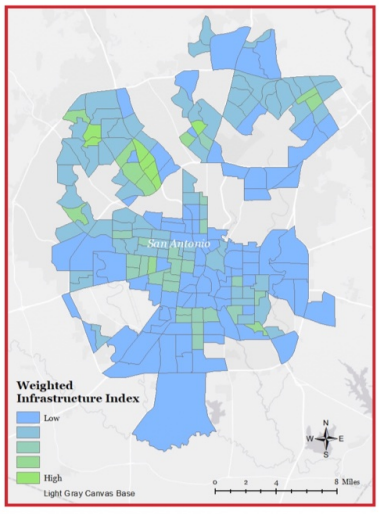
Four-Percent Annual Probability Flood Zone



Index of Aboveground Channels and Below-Ground Conduits



Weighted Stormwater Infrastructure Index



Results:

There are over 20 tracts with an index value of zero. The districts scoring disproportionately highly on the index seem to be located mostly towards the northeast.

Based on an initial examination of the data, storm drainage infrastructure does appear to be distributed unequally throughout the city. However, further investigation of possible variables associated with such inequality will be necessary.

Author:
Patrick McVee, Tufts School of Arts and Sciences, BA Economics '19.

Tufts UNIVERSITY

Sources:

Literature:

1. Braden & Johnson. Downstream Economic Benefits from Storm-Water Management. https://ascelibrary.org/doi/pdf/10.1061/%28ASCE%290733-9496%282004%29130%3A6%28498%29

2. Hellman et. Al. Estimating the Economic Impact of Stormwater Runoff in the Allen Creek Watershed. https://people.umass.edu/khellman/pdfs/Hellman-Estimating%20the%20Economic%20Impact%20of%20Runoff.pdf

Data:

-Basemap: ESri, HERE, Garmin, OpenStreetMap contributors, GIS user community

-Brown de Colstoun et.al 2017. Global Man-made Impervious Surface (GMIS) Dataset From Landsat. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). https://doi.org/10.7927/H4P55KKF.

-City of San Antonio GIS Open Data. http://opendata-cosagis.opendata.arcgis.com/datasets/5c5fc360c5ec429baa0d2a4f4c58424c_0

-TIGER US Census Database ftp://ftp2.census.gov/geo/pvs/tiger2010st/48_Texas/48029/

-CensusReporter.Org