

Section 11.02 *Excessive precipitation*

Overview

Climate change is expected to increase both the amount and frequency of extreme rain storms in the Piedmont Region of North Carolina, including Durham.ⁱ Warm air causes more evaporation of water into the atmosphere, leading to more extreme rain, snow or hail storms. The large amount of rain over a short period of time can lead to flooding, an increase in disease-carrying mosquitoes, water contamination and mental health issues due to stress.

The NC Climate Science Report defines extreme precipitation events as days on which three inches or more precipitation falls over an area.ⁱⁱ Rainfall can have a few separate extreme values including duration and intensity that are also significant. For example, flash floods can be dangerous even though the duration of the rainstorm is relatively short. At times, smaller amounts of rainfall can fall on a smaller area in very short durations and create an extreme event. At other times, rain can fall continuously over an area for a long time period. Both can accumulate water at the surface at a rate incompatible with the amount of water that the ground can absorb.ⁱⁱⁱ This vulnerability is determined by a number of factors including the severity of weather events themselves, the built environment and other social and economic determinants of health such as income level, health insurance and access to reliable transportation. Durham County is experiencing extreme precipitation events more frequently than historical averages and that trend is projected to increase in the next 30 to 80 years.^{iv,v}

Flooding causes the most adverse public health outcomes stemming from all extreme precipitation events that Durham might experience, which include fast, heavy downpours or prolonged periods of sustained rain. Human factors influence the severity of flooding including damage to or structural failures of dams and levees, altered drainage and land-use patterns. Urban areas have a lot of impervious surfaces, which are surfaces that do not allow rainwater to soak into the ground, such as roads, pavement, parking lots and buildings. This increases water runoff and sometimes overflowing storm drains. Infrastructure issues including clogged culverts, improperly graded asphalt, blocked drainage and inadequate capacity of storm water pipe systems also contribute to flooding.^{vi}

Flooding is currently ranked as the second most deadly weather-related hazard in the United States.^{vii} One hundred and fifty-four people died and 244 were injured in North Carolina due to floods between 1959 and 2005, making it the state with the ninth most flooding fatalities in the US.^{viii} The major hazards posed by flooding are the immediate threats to persons through fast-moving water and the debris carried in it. Flooding, especially flash flooding can create emergency situations with very little warning. These events can pose imminent danger to people regardless of where they are. These events are especially dangerous to people in low-lying areas or areas with a large percentage of impervious surface over the ground such as concrete.^{ix}

There are lingering health hazards posed by flooding that can be felt for hours, days or weeks after the event. These include water flooding or seeping into households, basements and crawlspaces

causing fungal or mold growth, which can make existing respiratory health problems worse. Additional issues include long-lasting power, infrastructure and communications outages which can lead to people having a lack of access to edible food and potable water or access to emergency services and relief. The creation and exacerbation of new habitat and growing areas for the water-dwelling larvae of biting insects like mosquitoes can be a disease vector for serious illness including Zika, malaria and West Nile fever.^x The release of pesticides, animal waste and hazardous chemicals into water sources can harm people and wildlife.

Flooding also impacts mental health. People who live in floodplains and fear the dangers presented by flooding or who have witnessed death or destruction during a prior flooding event can suffer from mental anguish, trauma, anxiety and depression.^{xi} Mental health is an important component to health and the effects of living through, witnessing, or fearing a potentially life-threatening hazard because of where one lives can impact other determinants of health.

Secondary Data

Durham is experiencing more extreme precipitation events, including a 129% increase in heavy precipitation events in the time period from 2005-2014 compared to 1950-1959.^{xii} Durham is the 36th highest ranking city in the US for extreme precipitation events overall, and the city with the 12th largest increase in these events over that time.^{xiii} Looking over a longer time period in the Southeast, the number of extreme precipitation events increased by about 58% from 1901-2016 and by 49% between 1958-2016.^{xiv} Each of these patterns are indicators of a changing climate in the Southeast that suggest more heavy precipitation events are likely to continue into the future.

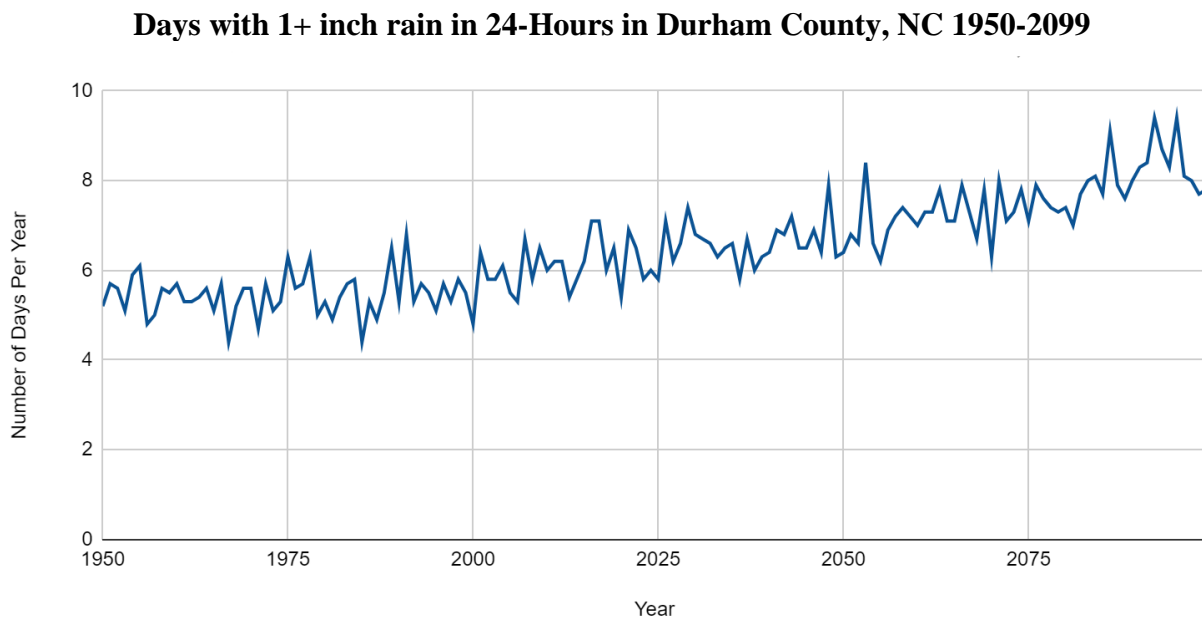


Figure 11.02(a) The number of days per year with 1" of precipitation or more over a 24-hour period, using modeled historical and projected data for Durham County from 1950-2099^v

Approximately 14% of Durham County is in a 500-year floodplain, an area defined by FEMA as having a 0.2% chance annually of flooding.^{xvi,xvii} Census Tract 20.19 in the far southwest corner of the county (Blands, The Downs) has the highest percentage of land in a 500-year floodplain, at 42.9%.^{xviii} Vulnerabilities to flooding in 17 of the 60 census tracts are above the average in Durham County.^{xix} In these 17 tracts which include formerly redlined neighborhoods, 59.9% of the land area lacked tree canopy, 24.4% of the land was covered in impervious surface and 11.6% was in a 500-year floodplain.^{xx} These same tracts showed higher than average percentages of people in rental units (77%), families living in poverty (28.5%) and people who did not speak English fluently (12.3%).^{xxi}

Much of Durham County lies within floodplains or floodways and most census block groups are ranked as “medium” or “high” risk for loss of access due roads being either flooded or damaged during a high precipitation event.^{xxii} The most affected areas were Braggtown, Southeast Durham, East Durham, Northeast Durham and Southwestern Durham County. This affects public health by potentially making it harder for emergency responders to access the property and for residents to leave their homes to get food, supplies and health care.

There are 90 dams in Durham County, of which 27 are listed as “High Hazard Dams” because a potential failure would likely cause loss of life and/or serious damage to structures and infrastructure.^{xxiii} Dam failures can cause flooding that are catastrophic and extremely hazardous downstream with fast-moving walls of water that can carry debris. The probability and severity of dam failure will increase with climate change.^{xxiv} Along with creating the immediate threat to human life, dam failures can also rapidly reduce or contaminate the potable drinking water supply in Durham County, creating a possible public health problem.^{xxv}

Interpretations: Disparities, Gaps, and Emerging Issues

Impacts of extreme rain events are not evenly distributed throughout Durham County geographically or demographically. Rainfall varies across the County and local differences in topography, impervious surface coverage and the condition of storm water infrastructure affect the impact of rain. Typically, areas with more pervious surfaces such as farms, parks or other areas with unpaved soil or vegetation can absorb water that might otherwise cause a flooding event.

Approximately one percent (2,186 people) of City of Durham residents were at risk from flooding, with 375 of those people being elderly or children.^{xxvi} Elderly people and children are more at risk during flooding due to mobility issues and not understanding the risk associated with flooding. People living in poverty have fewer resources to mitigate flood risk and to recover from flood damage or pay for health care associated with flood impacts.

Historical systematic racism has resulted in higher vulnerability to extreme precipitation events for certain populations in Durham. Eight historically redlined neighborhoods, clustered in the areas directly South, Southeast and East of Downtown Durham (Graded by the Home Owner’s Loan Corporation as Grade “D”, which is the lowest grade, typically reserved for neighborhoods with higher than average populations of non-white people) have more risk of extreme precipitation events with lower than average tree coverage and higher than average impervious surface than the

rest of Durham.^{xxvii} As in many Southern cities, formerly enslaved people were forced to settle in low-lying lands that frequently flooded and where mosquitoes were present because it was less expensive and considered undesirable by white land-owners.^{xxviii} These neighborhoods, still predominantly lived in by non-white residents also have among the highest levels of poverty in the County. The average of 40.91% for people living in poverty in the eight census tracts is about 22% higher than Durham County's total average poverty level.^{xxix} Along with being the most vulnerable to climate risk, the people living in these areas have the fewest resources available with which to combat the hazards from flooding or to recover after an event.

Residential Properties with Medium or High Vulnerability and Risk for Flooding, Durham County

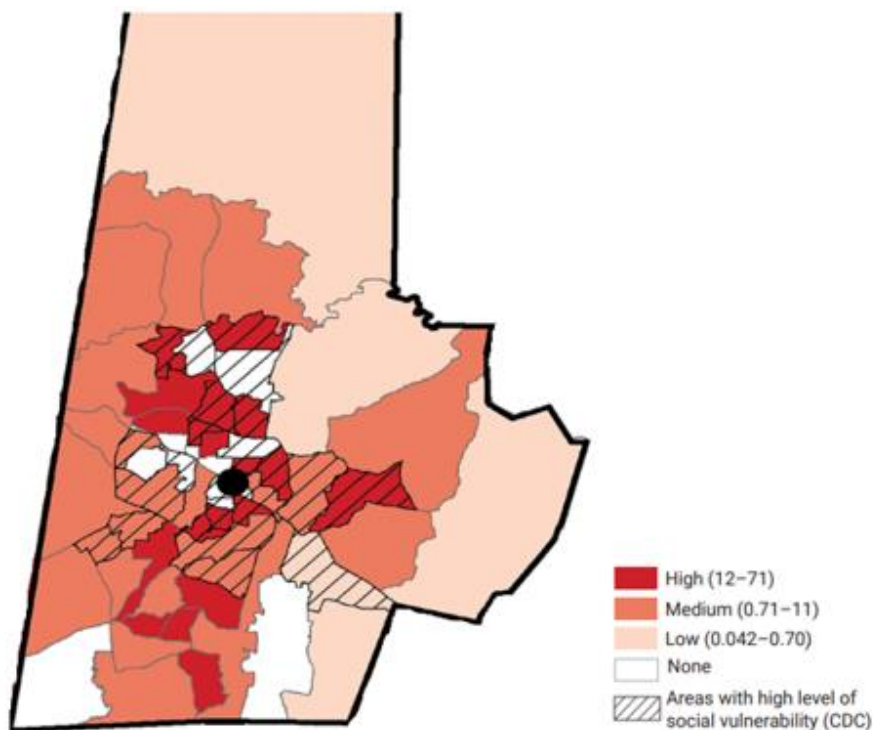


Figure 11.02(b) Residential Properties with Medium or High Combined Vulnerability and Risk for Flooding (properties per square mile)^{xxx}

Figure 11.02(b) shows the overlap of areas that have a medium to high number of residential properties that are at risk for flooding due to elevation or property-type and areas with a high level of social vulnerability due factors such as economic status, lack of transportation options and race.

Recommended Strategies

- Conduct regional mapping assessment of storm water conveyances and assess capacity.

- Create and implement green storm water infrastructure programs and fee credit programs for storm water retention.
- Expand education efforts to include citizen/community science efforts around local flooding such as NOAA Community Collaborative Rain, Hail, and Snow Network (CoCoRaHS)
https://www.cocorahs.org/Content.aspx?page=mod_NOAA#:~:text=NOAA's%20National%20Severe%20Storms%20Laboratory,use%20weather%20information%20more%20effectively.
- Maintain and preserve upstream and urban forestry canopy and vegetation amounts in areas where this has been neglected, including and especially formerly redlined neighborhoods.
- Develop and set standards for canopy percentage per neighborhood and for urban forestry levels.
- Assess which critical infrastructure, neighborhoods, or homes may be cut off by flooding events and develop secondary ways of accessing them.

Current Initiatives & Activities

City of Durham Storm Water Services

Provides services and public education to reduce the impacts of storm water on people and the environment. <https://durhamnc.gov/692/Stormwater-GIS-Services>

Flood Inundation Mapping and Alert Network

Provides rain and stage gage data and flood alerts in real time to support risk-based decisions. <https://fiman.nc.gov/>

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