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Are Stormwater Infrastructure Standards Outdated?

The last several years have been some of the wettest in U.S. history, with record-breaking annual rainfalls according to the National Oceanic and Atmospheric Administration.[1] This unprecedented increase in precipitation has caused some hydrologists to question the sufficiency of current stormwater infrastructure design standards for major transportation projects. Most state and federal infrastructure design standards depend significantly on what is determined to be the regional flood risk in a given area. These topographic "floodlines" are usually calculated to account for storm severity intervals at the 50, 100, and 500 year levels, meaning that they measure major potential floods by the frequency at which they are likely to occur. The floodlines are used in federal and state legal building codes for the purposes of ensuring compliance with safety and resiliency goals established by infrastructure authorities. The methods by which these floodlines are calculated, however, have been recently challenged by some researchers as outdated.

The amount of water corresponding to a specific floodline (i.e. a line for a 100-year flood) is known as a "flood quantile."[2] Estimates for flood quantiles are calculated from data collected at a particular site by the United States Geological Survey ("USGS").[3] That information is used by the Federal Emergency Management Agency (FEMA) and other advisory committees to develop a national flood map demarcating floodlines for specific categories of storms.[4] For example, the National Flood Insurance Program maps must be used to determine issues of encroachment in highway design.[5] Likewise, Title 23 of the Code of Federal Regulations requires that interstate highways "not be less than the flood with a 2-percent change of being exceeded in any given year."[6] This standard is referred to as the "50-year-storm" line, while a flood with a 1-percent chance would be the "100-year-storm" line. But what does a "100-year storm" line really signify?

USGS states that, unlike what the name may suggest, 100-year storms are not really categories of storms or floods that will only occur once every 100 years. What the numbers more accurately state is the probability that a given precipitation event will occur in a twelve month period, also known as a frequency analysis.[7] The "100-year" qualifier actually refers to the percent chance of having a storm of that magnitude occur in a year's time (i.e. 0.1%). This explains why a 100-year flood could occur in two consecutive years, or even twice in one year. Though those odds may be quite low, they are still theoretically possible.

In recent years, researchers have begun to posit that the frequency of severe storms (and severe flooding) is increasing in our climate.[8] In 2020, the First Street Foundation produced a National Flood Risk

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[1] John Leslie, "U.S. has its Wettest 12 Months on Record – Again" National Oceanic and Atmospheric Administration (July 9, 2019) https://www.noaa.gov/news/us-has-its-wettest-12-months-on-record-again.
[2] United States Geological Survey "Why do the Values for the 100-Year Flood Seem to Change with Every Flood?" https://www.usgs.gov/faqs/why-do-values-100-year-flood-seem-change-every-flood?qt-news_science_products=0#qt-news_science_products (last visited Feb. 3, 2021).
[3] Ibid.
[4] Federal Emergency Management Agency, "Technical Mapping Advisory Council" https://www.fema.gov/flood-maps/guidance-reports/technical-mapping-advisory-council (last updated Jan. 15, 2021).
[5] 23 CFR 650.111.
[6] 23 Code of Federal Regulations 650.115(a)(2).
[7] United States Geological Survey "The 100-Year Flood" https://www.usgs.gov/special-topic/water-science-school/science/100-year-flood?qt-science_center_objects=0#qt-science_center_objects (last visited Feb. 3, 2021).
[8] See Henry Fountain, "Climate Change is Making Hurricanes Stronger, Researchers Find" New York Times (May 20, 2020) https://www.nytimes.com/2020/05/18/climate/climate-changes-hurricane-intensity.html; Jeff Berardelli, "How Climate Change is Making Hurricanes More Dangerous" Yale Climate Connections (Jul. 8, 2049) https://yaleclimateconnections.org/2019/07/how-climate-change-is-making-hurricanes-more-dangerous/;

Assessment which found approximately 1.7 times the number of properties in the contiguous U.S. as having a substantial risk of flooding compared to FEMA's 1-in-100 Special Flood Hazard Area designation.[9] Essentially, this equates to nearly 6 million properties whose owners are currently unaware or are underestimating their risk of flooding based on FEMA's designation. The First Street Foundation's peer-reviewed method model is considered a new analysis,[10] but other researchers have come to similar conclusions about miscalculated flood risks in the U.S.

A new study from the University of Wisconsin, Madison and Carnegie Mellon University argues that, despite more comprehensive regulations for stormwater infrastructure, precipitation data used in the design for today's constructs may be obsolete.[11] As current rainfall increasingly surpasses that experienced in past decades, the reliability of current safety and resiliency standards has become questionable. The Wisconsin study argues specifically that using intensity-duration-frequency (IDF) curves has become an outdated method for calculating major storm intervals. [12] The main criticism of this method is that IDF curves assume that rainfall amounts do not change over time – an assumption that seems to be refuted by recent years of precipitation data.[13]

This possible disparity has caused some of the study's lead hydrologists to conclude that infrastructure in many parts of the contiguous U.S. is not performing at the expected level, given these extreme amounts of increasing rainfall.[14] Design engineers at state and local levels, as well as consulting companies, usually rely on the data provided by use of IDF curve models, so identifying deficiencies could be vital to correcting faulty determinations of stormwater levels, flood risks, and the associated legal and safety standards.[15] As the transportation sector prepares for the multitude of infrastructure planning challenges ahead, including electric and autonomous vehicle incorporation, the importance of long-term sustainability will be paramount. Conclusions routine in life cycle cost analyses that govern construction determinations may prove to be unreliable. As a result, the existing federal and state commitments to incorporating resilience into infrastructure planning may require experts to reevaluate methods modern research shows to be dangerously insufficient in transportation decisionmaking.[16]

"Hurricanes and Climate Change" Union of Concerned Scientists (Jul. 16, 2008) https://www.ucsusa.org/resources/hurricanes-and-climate-change#:~:text=The%20projected%20increase%20in%20intense,Atlantic%20experiencing%20the%20largest%20increase.

[9] First Street Foundation, *The First National Flood Risk Assessment: Defining America's Growing Risk,* (2020) https://assets.firststreet.org/uploads/2020/06/first_street_foundation__first_national_flood_risk_assessment.pdf.

[10] Andrew Freedman, et al., "Millions of Homeowners Face Flood Risks without Realizing it, and Climate Change is Making it Worse" The Washington Post (June 29, 2020) https://www.washingtonpost.com/weather/2020/06/29/flood-risk-climate-change/?arc404=true.

[11] https://stormwater.wef.org/2019/08/not-your-fathers-100-year-storms/.

[12] Ibid.

[13] Ibid.

[14] Water Environment Federation, "Not Your Father's 100-Year Storms" *Stormwater Report* (Aug. 21, 2019) https://news.agu.org/press-release/us-infrastructure-unprepared-for-increasing-frequency-of-extreme-storms/.

[15] Ibid.

[16] See Sarah Weilant, et al., *Incorporating Resilience into Transportation Planning and Assessment*, RAND for the Transportation Research Board (2019) at 10 https://www.rand.org/content/dam/rand/pubs/research_reports/RR3000/RR3038/RAND_RR3038.pdf.