

Brief Report

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Abstract

Objectives: Hurricane Ida delivered record rainfall to the northeast, resulting in 11 deaths in New York City. We review these deaths, identify risk factors, and discuss solutions to prevent recurrence.

Methods: Deaths were confirmed by multiple sources. Locations of the deceased were obtained from obituaries and plotted on the NYC.gov flood-hazard map. Risk factor information of the decedents was collected when available. Current emergency response plans and mitigation efforts were identified on the NYC.gov officially sanctioned website.

Results: All descendants resided in basement apartments. None of the deaths occurred in a location previously designated a “flood risk zone.” While a flash flood emergency was issued during Hurricane Ida, guidance was not provided during the emergency. Flooding was compounded by the city’s aging infrastructure and lack of green space.

Conclusions: Aging infrastructure, lack of pre-notification, illegal basement apartments, and lack of a planned response all appear to have played a role in these 11 deaths.

As a major coastal city with much of the topography at or near sea level, New York City (NYC) is at high risk for infrastructure damage and even denizen death due to coastal storms and flash flooding. Studies have predicted an increase in intense precipitation from storms,¹ which has been demonstrated repeatedly. Over the last 10 years, NYC has been hit by multiple “once in a generation” storms, including Hurricane Sandy, Hurricane Irene, Tropical Storm Isaias, and Hurricane Ida in 2021, which delivered record rainfall and flooding to the region. It was not until recently that flash flooding from rainfall, exacerbated by widespread use of non-porous building materials,² was identified as a risk to life and infrastructure. The NYC Department of City Planning created the NYC Flood Hazard Mapper,³ which provides insurance companies with a comprehensive overview of the coastal flood hazards that can threaten NYC. However, this geographic tool only identifies regions that are at risk for flooding due to coastal storm surge and has not been updated since 2015. Areas of freshwater flooding due to heavy rainfall have not been fully identified.

According to the National Oceanic and Atmospheric Administration (NOAA),⁴ when Hurricane Ida hit NYC, areas such as LaGuardia Airport accumulated 6.9 total inches of rainfall. Besides formidable volumes, the established record of 1.94 inches of rain per hour set during hurricane Henri just 1 month prior was broken with 3.15 inches of precipitation during the single hour spanning 8:51 pm - 9:51 pm on September 1, 2021.⁵ This incredible deluge, in addition to a coastal storm surge of 1-3 feet along the eastern seaboard, made adequate street drainage difficult and led to widespread flash flooding. These factors likely contributed to the 11 deaths from drowning and 16 total fatalities when motor vehicle collisions and other causes of storm-related-death were tallied. The city also reported 7.5 to 9 billion dollars in property damage.⁴ In this paper, we plan to evaluate what is publicly known about the 11 flooding-related deaths that occurred during Hurricane Ida, identify possible risk factors that lead to this tragedy, and discuss solutions to prevent future loss of life based on current projects and proposals within NYC.

Methods

The number of deaths was confirmed by multiple independent news sources, as well as NOAA’s 2022 Hurricane Ida Tropical Cyclone Report.⁴ Addresses or locations of the fatalities were obtained from obituaries and similar news reports.⁶ Personal information regarding risk factors of the decedents was collected when available. This data included age and specific details about the living arrangements. The locations of the deaths were plotted on the NYC.gov flood-hazard map³ (Figure 1) to assess how many of the deaths occurred in previously established flood zones. Current emergency response plans and mitigation efforts were identified on the NYC.gov officially sanctioned website (nyc.gov/site/em/ready/flooding.page).

Discussion

The 11 drowning deaths identified after Hurricane Ida came from 6 different locations within the boroughs of Brooklyn and Queens (Table 1). When reviewing the NYC Flood Hazard Mapper, none of these locations are identified as predicted high-risk flood zones.³ Unfortunately, this mapping tool only accounts for coastal storm surge and not fresh water flooding due to rainfall which likely played a role in the above-mentioned fatalities. The Flood Mapper tool was created from the Federal Emergency Management Agency's (FEMA) Preliminary Flood Insurance Rate Maps (PFIRMs), released in 2015. The PFIRM is an updated version of The Effective Flood Insurance Rate Maps (EFIRMs), which was first adopted by New York City in 1983 and then updated in 2007. These flood zone distinctions have not been updated since being released in 2015.

The PFIRM currently serves as the best available flood hazard data for building code and planning purposes. The PFIRM defines high-risk areas vulnerable to flooding from a 1% annual chance storm.³ These maps are divided into 4 zones: The V and A Zones comprise the 1% annual chance floodplain, with the V Zone having risk from waves over 3 feet high and the A Zone being vulnerable to waves between 1.5-3 feet. The Shaded X Zone is the predicted range of flooding expected to surge from a 0.2% annual chance storm. The

PFIRM maps continue to be used in the city to guide the requirements of the National Flood Insurance Program.

Flooding from heavy rainfall produced by major storms can have monumental consequences. When coupled with late notice, insufficient NYC flood response planning, and a lack of preemptive preparation, consequences can be dire. It appears that the deaths during Hurricane Ida were at least in part due to lack of advanced notice and to living in basement apartments. It cannot be discerned if their deaths were due to personal disability or other factors. One also notices that 5 of 6 of the decedent's dwellings were deemed illegal according to ABC news whose data was obtained from the NYC Department of Buildings.⁷ Although the identification of similar basement apartments could help mitigate risk during future flash floods, New Yorkers living in such apartments are often reluctant to be identified due to immigration status or fear of homelessness.

Pre-Notification

Preceding Hurricane Ida, the New York City Office of Emergency Management (NYC OEM) did release a travel advisory stating that from the morning of September 1, 2021 to September 2, 2021 there would be heavy rain and a risk of flash flooding, with the bulk of the rainfall occurring overnight on September 1. The peak of Hurricane

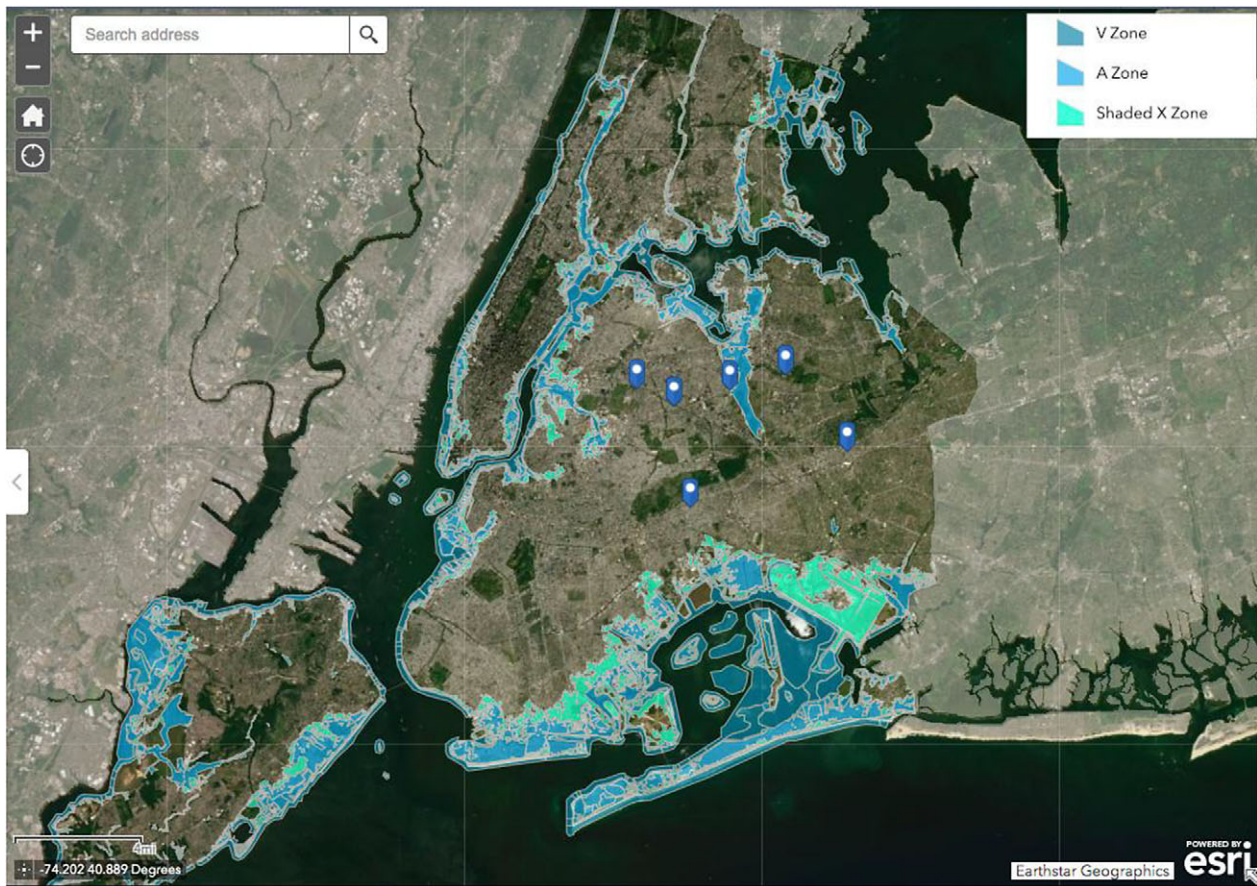


Figure 1. The NYC Department of City Planning “NYC Flood Hazard Mapper” demonstrates the defined flood zones with the locations of the descendants superimposed (Blue pins) to identify where the deaths occurred in relation to their flood zone. The “V Zone” is a high-risk flood zone. The “V” stands for “velocity” because this zone can face damage from waves as well as from flooding. Property owners in V zones will likely be required to purchase flood insurance. The “A Zone” is a high-risk flood zone. Property owners in the A zones will likely be required to purchase flood insurance as well. The “X Zone” is a moderate risk flood zone. Property owners in X Zone are not required to purchase flood insurance unless they have received federal disaster assistance in the past.

Table 1. Identifying characteristics of the individuals whose deaths were attributed to flooding during Hurricane Ida (individual habitation data is included when available)

Fatality number	Age	Location	Flood zone	Living arrangements
1	48	Forest Hills Queens	N	Basement apartment
2	86	Elmhurst Queens	N	Basement apartment
3	66	Cypress Hills Brooklyn	N	Basement apartment
4	2	Woodside Queens	N	Basement apartment
5	48	Woodside Queens	N	Basement apartment
6	50	Woodside Queens	N	Basement apartment
7	43	Jamaica Queens	N	Basement apartment
8	22	Jamaica Queens	N	Basement apartment
9	72	East Flushing Queens	N	Basement apartment
10	71	East Flushing Queens	N	Basement apartment
11	38	East Flushing Queens	N	Basement apartment

Ida's rainfall (for central park and thus central NYC) occurred between 8:51 pm and 9:51 pm. This was consistent with the NYC OEM initial flood warning; however, the flash flood emergency warning was broadcast at approximately 9:30 pm after it had already been raining heavily. Additionally, the flash flood emergency notification was only sent out in English and Spanish while both Queens and Brooklyn are diverse boroughs where many residents do not understand either of these 2 languages.

The Intergovernmental Advisory Commission (IAC) to the Federal Communication Commission (FCC), has already identified multilingual emergency alerts as an area of preparedness that requires expansion. Currently, the government's modes of communications with the public include internet, legacy media (radio and television), and the wireless based emergency alert systems (EAS) broadcast over cellular phones to people who opt in to receive it. While internet and legacy media can deliver messages in English and various other languages when sought, wireless EAS only provides messaging in English and Spanish in NYC. Another mechanism to mitigate the risk from flash flooding would be by translating warnings into the preferred language programmed on an individual's cell phone.

Current Response Planning

Although NYC is planning to update the 2015 flood hazard map, none of the deaths from Hurricane Ida occurred in currently established flood zones. These zones are solely based on storm surge and do not take into consideration heavy rainfall and freshwater flooding. Additionally, while a flash flood emergency was issued during Hurricane Ida, the current alert system does not provide routes of egress for evacuation during an emergency, nor does it call for pre-emptive response from emergency services. The current system relies on individuals to develop their own evacuation plans once notified.

Another possible flooding event response that could be adapted was utilized in the Red Hook community in Brooklyn during Hurricane Sandy. Here, individuals with established comorbidities were identified by a community outreach program and volunteers went door to door to identify those in need of medical assistance following the weather system. Medical personnel in the community

were then able to refill prescriptions, treat infections, and care for other minor acute conditions to avoid emergency department visits at a time when the health care system was already overwhelmed and hospitals were being evacuated.⁸ Although this effort is proof of concept that a community-based outreach program is beneficial, a more robust, all-encompassing program by health care coalitions or government agencies could be developed to aid in future responses throughout NYC. The goals of such an outreach program could be to identify at-risk individuals in high-risk locations and to designate areas to relocate evacuated individuals, as well as help care for those in need during inclement weather events.

Additional Mitigation Efforts

Forecasting technology does not yet predict flash flooding at a neighborhood level, making it difficult to form a reliable local notification plan.⁹ This makes the city's current efforts in flood mitigation even more important. Presently, the NYC Mayor's Office of Climate and Environmental Justice (MOCEJ) is working on several projects to build infrastructure that would improve water drainage in NYC. A proposal has been made to increase the city's green space by planting flora on top of the city bus stops. This proposal estimates that it could prevent 6.5 million gallons of rainwater from becoming run-off annually.¹⁰ Several porous commercial products also exist that allow for increased water absorption compared to typical concrete or blacktop. Some of these materials can be found on the Environmental Protection Agency's (EPA) website: www.epa.gov/soakuptherain.

There are 2 additional major areas of focus identified to help combat flash flooding: updating the NYC sewer system and project Cloud Burst. The NYC sewer system was built in 1849 and cannot handle the increased water flow generated during major storms resulting in flash flooding. There is currently a FEMA grant to insert backwater valves into the sewer system to prevent flooding indoors, but once the NYC sewer system is overwhelmed, city streets would still begin to accumulate water. There is also a multibillion-dollar plan in place to overhaul the NYC sewer system itself, with parts of Staten Island and Brooklyn already undergoing renovation. Although this long-term work is critical for flood mitigation, it will take years to complete. In the meantime, the mayor's office is working on project Cloud Burst where they plan to increase the amount of green space in NYC to help aid natural drainage. By creating green roofs and increasing the amount of green space in parks and our communities, we can increase the amount of water that is absorbed, taking some pressure off our outdated sewer system.⁹

Conclusion

The flooding associated with Hurricane Ida is likely the result of an abundance of ground cover that is impermeable to water and an outdated sewer and drainage system that was overwhelmed by record breaking rainfall. This flooding was exacerbated by late notification, lack of a practiced action plan, and the existence of illegal basement apartments. It is likely that all of these factors contributed to deaths that disproportionately affect immigrants and those undergoing financial hardship. In this review, we have identified several aspects of mitigation and preparedness, such as fast-tracking project Cloud Burst, using more porous building materials, distributing earlier notification during storms, transmitting multilingual alerts, developing clear community-level response plans, and pre-identifying at-risk individuals and developing action plans to evacuate them. Implementing these concepts could help

NYC be better prepared for similarly dangerous storms in the future.

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