# Toxic Floodwaters:

## Public Health Risks and Vulnerability to Chemical Spills Triggered by Extreme Weather

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Coastal communities in the United States are largely unprepared for the projected effects of the climate crisis, including more intense storm surges, sea level rise, increased precipitation, and other drivers of coastal and inland flooding. That flooding is damaging enough on its own, but in recent years, chemical spills triggered by extreme weather, such as hurricanes, have become more frequent, exposing nearby communities to toxic chemicals and hazardous waste in the midst of natural disaster. Extreme weather-related flooding already has a variety of negative public health impacts, including injury, exposure to pathogens and mold, stress, and displacement. Chemical and hazardous waste spills may exacerbate and cause harms such as dermatitis, rashes, burns, headaches, fatigue, abdominal pain, fever, decreased appetite, nausea, sore throat, and eye irritation.

Unfortunately, federal and state governments have failed to develop regulatory safeguards that would prevent chemical spills in the event of these predictable extreme storms. That needs to change. Federal and state agencies should review the many permitted facilities at risk of flooding and focus inspections, outreach, technical assistance, and compliance resources on the most vulnerable facilities. As deemed necessary, agencies should reform regulations and permit programs for industrial facilities to account for future flood risks. State agencies should also assess risks to communities at the fenceline of hazardous facilities and take action to protect these vulnerable communities from harm.

## The effects of climate change are increasing the frequency of coastal floods and chemical releases

As the effects of climate change amplify, changing patterns in hurricanes, precipitation, and sea level rise will increase both the intensity and frequency of storm surges and coastal flooding in the United States.[1,2,3,4] According to the National Oceanic and Atmospheric Administration (NOAA), the regions most vulnerable to flooding and sea level rise are the Gulf Coast, Eastern Seaboard (especially Southeastern states), and the Pacific Northwest.[5] The social and economic implications of these projections are significant. More than half of the U.S. population (164 million people) lives or works in coastal counties, generating 58 percent of the nation's GDP.[6]


*The Texas National Guard performing search and rescue after Hurricane Harvey. Source: USDA.*

The extent of the likely damage from extreme weather-related flooding is difficult to control and related to various factors, such as the presence of flood-resilient infrastructure, population density, and public awareness about flood risks.[7] While some cities and towns are taking action to protect against flood

hazards, a 2015 assessment of local land use plans published in the *Journal of the American Planning Association* found that many do not adequately protect areas most vulnerable to flooding, and in some cases, the plans increase physical and social vulnerability to hazards.[8] Such lack of preparedness was a major factor in the devastating damage from Hurricanes Florence and Harvey in the Carolinas and Houston, Texas, demonstrating just how ill-prepared states and cities are for the effects of climate change.

Even without toxic chemicals in the mix, communities affected by flooding face a variety of hazards, including drowning or contact with debris; exposure to contaminated floodwaters or drinking water; exposure to mold in flood-damaged homes; and displacement.[9] These can result in injury; worsening of chronic illnesses; respiratory, gastrointestinal, or skin infections; mental health effects such as post-traumatic stress disorder (PTSD); and death.[10]

Mindful of events like Hurricane Harvey, experts are increasingly concerned about chemical and hazardous waste releases triggered by extreme weather. Thirty-nine percent of the U.S. population (124 million people) lives within three miles of a high-risk chemical facility.[11] Many of these facilities are in low-lying coastal areas; for example, the hurricane-prone Gulf Coast has 872 highly hazardous facilities within 50 miles of the coast.[12,13] More than 4.3 million people live within 1.5 miles of these facilities.[14]

*A flooded industrial plant in a Texas Port. Source: Creative Commons.*

Focusing on one region, in 2019, a Center for Progressive Reform assessment found that 1,000 industrial facilities housing toxic and hazardous chemicals in Virginia's James River watershed are in the area's most socially vulnerable communities and are at risk of flooding from storm surges or sea level rise.[15] Nearly half a million Virginians live in these communities.[16]

Alongside climate change projections, data show these releases are happening more frequently. A 2012 analysis of reports made to the National Response Center, which tracks oil, chemical, radiological, biological, and etiological discharges, found that hazardous material releases due to natural hazards increased in frequency between 1990 to 2008.[17] Hurricane-related releases increased 15-fold from 2005 to 2008, and weather- and storm-related releases rose by eight and five percent during the study period.

## Chemical releases triggered by extreme weather events harm nearby communities

Plant workers and communities next to hazardous facilities may be exposed to chemicals through chronic leakage into air, water, and soil, or through major releases when facilities are compromised. During a severe storm, above-ground storage tanks or pipes containing chemicals may be dislodged, damaged, or ruptured, and their contents washed into floodwaters.[18] Lightning can also ignite flammable materials, causing fires or explosions, and rising waters can damage the power supply and control processes that contain stored materials. A 2019 assessment of the U.S. Chemical Safety Board's incident screening database, which tracks fires, explosions, and chemical releases at industrial facilities, found 9,406 reported

incidents between 2001 to 2018 (average of roughly 1.5 incidents per day).[19] Approximately 40 percent of incidents in the database led to injury or death among workers and/or the public.

One extreme weather event can have long-lasting and far-reaching impacts. For example, between 2005 to 2008, more than 1,070 hazardous material releases in Louisiana, Mississippi, Alabama, and Florida were attributed to Hurricane Katrina alone.[20] These releases were mainly the result of storage tank failures, which tend to yield the largest releases by volume.[21,22]

The health effects of extreme weather-related chemical releases are difficult to predict with accuracy because communities are exposed to different mixtures of chemicals that, when released and combined with whatever else is present in floodwaters, may produce a variety of effects.[23] People also respond differently to chemical exposure. A study of hurricane-related chemical releases from facilities in Louisiana and Texas in 2005 found that 197 different hazardous substances were released in 166 events.[24] In most cases, only one hazardous substance was released per event, but in some instances, as many as eight were released. Among the more common toxicants released are volatile organic compounds (VOCs), polyaromatic hydrocarbons (PAHs), petroleum, and heavy metals.[25,26] Floodwaters may also stir up existing contaminants present in soil and waterways, forming a "toxic soup."[27]

## Hurricane Harvey: A Cautionary Tale of Climate-Driven Disaster

In 2017, Hurricane Harvey dumped up to 50 inches of rain on Houston, Texas and surrounding areas.[a] Forty-six industrial sites released approximately 4.6 million pounds of hazardous materials from preemptive shutdowns and startups, leaks, or explosions, and several Superfund sites were underwater for days.[b] In particular, flooding at the Arkema chemical plant in Crosby, Texas, disabled the refrigeration system, causing organic peroxides to explode.[c] As a result, 21 people sought medical attention and hundreds within 1.5 miles of the plant evacuated their homes.

Despite presumed dilution of contaminants by floodwaters, heavy metal concentrations in stream water increased after the hurricane, demonstrating the sheer volume of contaminants present.[d] Furthermore, an assessment of Manchester—a Houston neighborhood with 21 toxic facilities within one mile—found that residents were exposed to elevated levels of PAHs through household dust and outdoor soil redistributed by floodwaters.[e] Long-term exposure to PAHs contributes to an elevated risk of developing breast, lung, gastrointestinal, and bladder cancer. Most of Manchester's residents are Hispanic with a median household income one-third less than Houston overall.

After the storm passed, Manchester residents noticed a foul, persistent odor. Sandra Martinez, who lived in the neighborhood with her husband and six children, said, "You could literally smell it in the house…I just pray for my kids. Because you don't know if there was a chemical spill."[f] After 10 days of experiencing bronchitis, asthma, nausea, nosebleeds, headaches, and stomachaches, the family felt they had no option but to move elsewhere.

[a] Friedrich MJ. Determining Health Effects of Hazardous Materials Released During Hurricane Harvey. *JAMA*. 2017;318(23):2283-2285.

[b] Johnston J, Cushing L. Chemical Exposures, Health, and Environmental Justice in Communities Living in the Fenceline of Industry. *Curr Environ Health Rep*. 2020;7(1):48-57.

[c] Anenberg SC, Kalman C. Extreme Weather, Chemical Facilities, and Vulnerable Communities in the U.S. Gulf Coast: A Disastrous Combination. *GeoHealth*. 2019;3;122-126.

[d] Kiaghadi A, Rifai HS. Physical, Chemical, and Microbial Quality of Floodwaters in Houston Following Hurricane Harvey. *Environ Sci Technol*. 2019;53:4832-4840.

[e] Horney JA, et al. Comparing Residential Contamination in a Houston Environmental Justice Neighborhood Before and After Hurricane Harvey. *PLoS One*. 2018;13(2):e0192660.

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The following health outcomes have been reported from flood-related chemical exposure: dermatitis, rashes, burns, headaches, fatigue, abdominal pain, fever, decreased appetite, nausea, sore throat, and eye irritation.[28,29,30] Some contaminants, like heavy metals, may also adsorb to sediments and redistribute throughout an area with floodwaters.[31,32] For example, researchers found elevated levels of lead and arsenic in soil samples following Hurricanes Katrina and Sandy.[33]

Emergency response and clean-up workers are also exposed to hazardous pollutants. Some hydrocarbons can damage neoprene protective wear, and wetsuits may increase skin contact with chemical contaminants.[34] In a survey of New Orleans firefighters three months after Hurricane Katrina, 38 percent reported one or more respiratory symptoms and almost half—most of whom had contact with floodwaters—reported skin rashes.[35] Workers performing post-disaster repairs or demolitions can also inhale dust containing chemical contaminants and heavy metals. Another study, this one of New Orleans construction workers, noted elevated cases of pneumonia, asthma, and transient fever and cough following Hurricane Katrina.[36]

## Low-wealth communities and communities of color are inadequately protected, and as a result, hit the hardest

Due to a legacy of redlining, exclusionary zoning practices, and other systematic forms of housing segregation, the vast majority of people who live near chemical facilities are Black, Hispanic, and have low wealth.[37,38] These communities often grapple with a range of social stressors, such as higher rates of chronic disease, inadequate access to health care, substandard housing, and racism-related stress.[39,40] The cumulative burden of socioeconomic stress, flooding, and pollution from chemical facilities exposes these families to a greater risk of "debilitating damage, uncompensated loss, and long-term suffering."[41] Children, the elderly, incarcerated people, and people with disabilities are also vulnerable to harm from floods.[42]

*A North Carolina worker pumps hog waste into floodwaters after Hurricane Florence. Source: Creative Commons.*

For example, when Hurricane Florence hit North Carolina in 2018, inadequate safety measures led to releases of coal ash and caused hog waste "lagoons" to overflow into nearby communities.[43] Research shows that industrial hog facilities are disproportionately permitted near communities of color in North Carolina, and for years before the hurricane, health outcomes have been worse among residents living near hog concentrated animal feeding operations (CAFOs).[44,45] Flooding and exposure to more toxic contaminants only worsened the existing burden felt by these communities.

## Better oversight and permitting of industrial facilities will protect the most vulnerable communities from harm

Since it is difficult to control the effects of extreme weather-related chemical spills, experts recommend a preventative approach to protect public health.[46] Researchers also project these events to become more frequent, "whether due to more development in hazardous areas, anthropogenic climate change, or natural variation."[47] While awareness of these events has

grown over the last decade, they are inadequately regulated at the federal, state, and local level.[48] Currently, neither the Occupational Safety and Health Administration (OSHA) nor the Environmental Protection Agency (EPA) require facilities to comprehensively address extreme weather and flood risks in required pollution prevention and management programs.[49] Furthermore, few states address flood risks in the permitting of industrial facilities.

## Recommendations

The effects of climate change are upon us, and recent extreme weather events provide ample evidence of the folly of leaving toxic chemicals in the path of perfectly predictable floodwaters. Regulators should utilize their authority under state and federal law to prevent and mitigate climate-driven disasters by:

- Prioritizing inspection and enforcement in the most socially vulnerable communities;
- Ensuring that remediation plans submitted by brownfields developers are responsive to the potential risk of contamination from flooding;
- Improving public access to information about potential chemical hazards; and
- Ensuring that facilities comply with hazardous chemical reporting requirements.

Lawmakers should establish and fund programs creating siting, construction, and monitoring standards for above-ground hazardous chemical storage tanks and other unregulated chemical facilities exposed to extreme weather and flood risks.

*Learn more about the Center for Progressive Reform (https://progressivereform.org) and our Toxic Floodwaters program (bit.ly/3bLO7GT). Contact Darya Minovi at dminovi@progressivereform.org.*

## Endnotes


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