Toxic Floodwaters: Strengthening the Chemical Safety Regime for the Climate Change Era

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Extreme flooding linked to climate change has caused toxic chemical spills across the United States, yet policymakers are not prioritizing industrial chemical safety in planning for climate change. Many scholars and industry executives have argued that existing private law mechanisms, such as insurance and tort-based deterrence, can adequately manage the risk of flood-induced chemical releases from industrial sites. But private law mechanisms have failed to prevent past incidents of mass contamination, and there is little evidence that tort law deters industrial firms from the practices that put communities at risk. In this Article, I engage in a comparative analysis of private law and public law approaches and conclude that the United States needs a robust effort, grounded in public law, to prevent toxic floodwaters incidents. The new effort should involve regulations and performance standards for chemical storage as well as other reforms to close gaps in toxic-chemical management statutes enacted nearly fifty years ago. These changes are necessary to make our chemical regulatory regime more protective as industry faces new risks from floods and rising seas.

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I. INTRODUCTION

In the last decade, hurricanes and massive rainstorms have caused unprecedented chemical disasters in the United States.[1] As rising floodwater moves through industrial sites, it becomes a toxic brew that mobilizes oil, sewage, and carcinogenic chemicals—a pernicious pool of contamination that spreads to nearby communities. When Hurricane Harvey hit Texas in 2017, for example, floods inundated manufacturing plants and electricity generation stations, transporting contaminants such

1. Nicholas Santella et al., *Petroleum and Hazardous Material Releases from Industrial Facilities Associated with Hurricane Katrina*, 30 RISK ANALYSIS 635, 639–43 (2010); Hiroko Tabuchi, *Floods are Getting Worse, and 2,500 Chemical Sites Lie in the Water's Path*, N.Y. TIMES (Feb. 6, 2018), *available at* https://perma.cc/SF8Z-9YZM; John Flesher, *Michigan Flood Raises Fears of Pollution at Toxic Waste Site*, ASSOCIATED PRESS (May 21, 2020), https://apnews.com/article/b223d2e6fea6f2c8d82d60981708e7c6; Steven Mufson, *ExxonMobil Refineries are Damaged in Hurricane Harvey, Releasing Hazardous Pollutants*, WASH. POST (Aug. 29, 2017), *available at* https://perma.cc/23ZW-93TZ.

as heavy metals and carcinogens into homes, schools, and businesses.[2] Widespread contamination also occurred after Hurricane Katrina in 2005 (the Gulf Coast), Hurricane Maria in 2017 (Puerto Rico), and Hurricane Florence in 2017 (the Carolinas). The toxic effects of these floods persist long after the rain stops.[3]

I call these events toxic floodwaters, reflecting the dual danger from massive water flows and the hazardous chemicals they carry. So far, toxic floodwaters have been viewed as isolated weather events and as problems of municipal disaster response and recovery. Policymakers have not prioritized prevention, nor have they fully appreciated how these disasters are linked to each other through climate change.[4] We are unprepared for the intensification of these toxic events that will occur by mid-century when rising seas will permanently submerge parts of coastal cities.[5]

Both the government and the private sector are neglecting this danger. The Trump Administration knee-capped the Chemical Safety Board,[6] which investigates chemical accidents,

2. Avann R. Newkirk III, *Puerto Rico's Environmental Catastrophe*, THE ATLANTIC (Oct. 18, 2017), *available at* https://perma.cc/2MGN-WMQV; Aristos Georgiou, *Pollution from Hurricane Florence Is So Bad You Can See It from Space*, NEWSWEEK (Sept. 25, 2018), *available at* https://perma.cc/M2Q9-NWVU.

3. Frank Bajak & Lise Olsen, *Hurricane Harvey's Toxic Impact Deeper than Public Told*, ASSOCIATED PRESS (Mar. 23, 2018), https://apnews.com/article/e0ceae76d5894734b0041210a902218d; Emily Flitter & Richard Valdmanis, *Oil and Chemical Spills from Hurricane Harvey Big but Dwarfed by Katrina*, REUTERS (Sept. 15, 2017), https://www.reuters.com/article/us-storm-harvey-spills/oil-and-chemical-spills-from-hurricane-harvey-big-but-dwarfed-by-katrina-idUSKCN1BQ1E8.

4. *See* Jacqueline Peel & Hari M. Osofsky, *Sue to Adapt?*, 99 MIN. L. REV. 2177, 2191 (2015) ("[T]he U.S. has mostly responded to adaptation challenges in an incremental, ad hoc manner."); J.B. Ruhl, *Climate Change Adaptation and the Structural Transformation of Environmental Law*, 40 VAND. L. REV. 363, 374 ("Only a few adaptation planning efforts, and even fewer concrete policies, have been adopted, so far mostly . . . by state and local governments.").

5. *See* Kristina A. Dahl et al., *Effective Inundation of Continental United States Communities with 21st Century Sea Level Rise*, 5 ELEMENTA: SCI. ANTHROPOCENE, JULY 12, 2017, AT 10 TBL.1 (PROJECTING THAT UP TO 360 COMMUNITIES IN THE UNITED STATES WILL BE PARTIALLY OR COMPLETELY INUNDATED BY SEA LEVEL RISE BY 2060).

6. President Trump has proposed to eliminate the Chemical Safety Board (CSB) in three separate budget plans and the formerly five-member board was down to a single member in 2020. *See* EPA, OFF. OF THE INSPECTOR GEN., 19-N-0156, REPORT: FISCAL YEAR 2019 U.S. CHEMICAL SAFETY AND HAZARD INVESTIGATION BOARD MANAGEMENT CHALLENGES (2019); Press Release, Chemical Safety Board, Statement from Dr. Katherine Lemos, Chairperson and CEO of the U.S. Chemical Safety Board (Apr. 23,

and weakened the handful of federal regulations that relate to chemical disaster prevention.[7] Industry is failing to secure hazardous materials against super-floods, which will occur more frequently as the planet warms. The water will rise. The question is how to limit the toxic damage.

In this Article, I propose an agenda for preventing toxic floodwaters, situating this problem within the larger challenge of climate change adaptation.[8] The adaptation literature focuses on reducing vulnerability and building resilience in the face of extreme weather.[9] While scholars have provided important recommendations for governments to prepare for coastal calamities such as hurricanes and sea level rise,[10] few have examined the particular challenge of preventing toxic releases from industrial facilities when disaster strikes.[11]

2020), *available at* https://perma.cc/ZR54-7VZN (announcing the beginning of the sole Board member's term). The CSB is responsible for investigating major chemical plant accidents, and while the Board does not hold regulatory power, its recommendations are often adopted as industry standards. *See* Ari Natter, *Trump Budget to Again Propose the End of Chemical Safety Board, Source Says*, BLOOMBERG (Mar. 8, 2019), *available at* https://perma.cc/6HTG-WHH8.

7. In late 2019, the Trump Administration weakened several provisions of the Chemical Disaster Rule that the Obama-era Environmental Protection Agency (EPA) had promulgated under the Clean Air Act. That rule was designed to impose planning and spill prevention requirements on some of the largest manufacturing facilities in the United States. *See* 40 C.F.R. § 68 (2019); Juliet Eilperin, *Trump Administration Scales Back Safety Rules Adopted After Deadly Chemical Explosion*, WASH. POST (Nov. 21, 2019), *available at* https://perma.cc/CA7J-7RDV (noting that under the Trump Administration's proposal, companies will not have to disclose information about chemicals stored at their facilities and can forego several safety measures required under the Obama-era rule).

8. Scholars of climate change adaption examine the policy and legal changes that are necessary for communities to adapt to rising seas, hotter summers, and changes in agriculture and forestry. *See, e.g.*, Robin Kundis Craig, *Stationarity Is Dead—Long Live Transformation*, 34 HARV. ENVTL. L. REV. 10 (2010); Ruhl, *supra* note 4, at 365–66.

9. Daniel H. Cole, *Climate Change, Adaptation, and Development*, 26 UCLA J. ENVTL. L. & POL'Y 1 (2008); Raina Wagner, *Adapting Environmental Justice: In the Age of Climate Change, Environmental Justice Demands a Combined Adaptation-Mitigation Response*, 2 ARIZ. J. ENVTL. L. & POL'Y 153 (2011).

10. *See, e.g.*, Blake Hudson, *Land Development: A Super-Wicked Environmental Problem*, 51 ARIZ. ST. L.J. 1123 (2019); CTR. FOR PROGRESSIVE REFORM, FROM SURVIVING TO THRIVING: EQUITY IN DISASTER PLANNING AND RECOVERY (2018); James Tobey et al., *Practicing Coastal Adaptation to Climate Change: Lessons from Integrated Coastal Management*, 38 COASTAL MGMT. 317 (2010); Jesse Reiblich et al., *Enabling and Limiting Conditions of Coastal Adaptation: Local Governments, Land Uses, and Legal Challenges,* 22 OCEAN & COASTAL L.J. 156 (2017).

11. For articles about climate change adaptation that specifically focus on industry, see Zachary Arnold, *Preventing Industrial Disasters,* 41 HARV. ENVTL. L. REV. 243, 253

Climate change adaptation must include planning for the *toxic* impacts of extreme weather, not just for the immediate damage from water and wind. These toxic impacts are the result of decades of regulatory and land use choices that have led to lax oversight of industrial facilities near population centers. They also result from racist and neglectful policies that have increased the vulnerability of marginalized populations to displacement and toxic chemical exposures.[12] Although flooding itself stems from rain intensity and geography, the degree to which hazardous chemicals become part of the deluge is, to some extent, under our control. Different policy choices and legal regimes can reduce the risk. Accordingly, we should not view toxic floodwaters as Acts of God; they occur because of human decisions about land use, facility siting, engineering, and environmental regulation.

Preventing future disasters will require policy change across all of these arenas of adaptation planning. This project has a more limited scope, however, and I do not attempt to compile an extensive laundry list of policy and legal reforms to prevent toxic floodwaters. Instead, this Article explores the appropriate type of legal regime to address the problem. In particular, I assess whether we can continue to address toxic floodwaters by relying on private law mechanisms such as insurance coverage and tort-based deterrence, or whether the problem requires new public law responses, such as safety regulations and building standards for flood-exposed facilities. To conduct this comparative analysis of private and public law, I engage the literature on the relative merits of liability versus regulation in addressing health and safety risks, drawing heavily on the work of Steve Shavell.[13]

After exploring and comparing risk management approaches, I conclude that private law approaches (the

(2017); Sarah Lamdan & Rebecca Bratspies, *Taking a Page from the FDA's Prescription Medicine Information Rules: Reimagining Environmental Information for Climate Change,* 40 U. ARK. LITTLE ROCK L. REV. 573 (2018); Robin Kundis Craig, *Cleaning up Our Toxic Coasts*, 36 PACE ENVTL. L. REV. 1 (2018).

12. *See, e.g.*, CTR. FOR PROGRESSIVE REFORM, AN UNNATURAL DISASTER: THE AFTERMATH OF HURRICANE KATRINA (2005); KATHLEEN TIERNEY, THE SOCIAL ROOTS OF RISK: PRODUCING DISASTERS, PROMOTING RESILIENCE (2014).

13. Steven Shavell, *Liability for Harm versus Regulation of Safety*, 13 J. LEGAL STUD. 357 (1984).

dominant strategy today) will not sufficiently protect communities from toxic chemical exposure. Insurance, tort law, and contractual arrangements cannot adequately address the threat from toxic floodwaters because of the difficulty of identifying the firms that are sources of hazardous chemical releases and holding those firms responsible for damages. Once oil and hazardous chemicals mix into the "toxic soup" that characterizes toxic floodwaters incidents, it becomes nearly impossible to prove that a particular industrial site was the source of the specific chemicals found in the flood-damaged community. Consequently, deterrent incentives for industry are weak.

After showing why private law is not working to address the toxic floodwaters problem, this Article proposes reforms grounded in public law. I argue that the federal government should strengthen the existing chemical regulatory regime to become more responsive to recurrent flooding and other climate change impacts. The existing regime, a creature of the 1970s and 1980s, was designed for a different time and reflects different priorities. Its focus is regulating *intentional* discharges of toxic substances to air and water, as well as regulating the presence of toxic chemicals in workplaces, food, and consumer products. The regime only loosely regulates the conditions of chemical storage and fails to protect communities from *accidental* chemical releases. By way of illustration, the existing regime would heavily control a factory's routine discharge of effluents into a river, but it would do nothing about a nearby warehouse that stores hazardous substances that could be released when the river floods.[14]

14. Throughout this Article, I use the terms "toxic chemicals" and "hazardous substances" to refer to a broad set of chemicals that are harmful to human health in small doses. *See* JOHN S. APPLEGATE ET AL., THE REGULATION OF TOXIC SUBSTANCES AND HAZARDOUS WASTES 3 (3d ed. 2018) (noting the lack of any firm dividing line between "toxic" and "non-toxic" substances because toxicity depends on dosage). The U.S. government has a number of different lists defining toxic chemicals under various environmental statutes. *See* EPA, LIST OF LISTS: CONSOLIDATED LIST OF CHEMICALS SUBJECT TO THE EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW ACT (EPCRA), COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION AND LIABILITY ACT (CERCLA) AND SECTION 112(R) OF THE CLEAN AIR ACT, https://www.epa.gov/sites/production/files/2015-03/documents/list_of_lists.pdf. There are vast inconsistencies in the number and type of chemicals regulated under different environmental statutes, with no standard federal definition of a "toxic" chemical. *See*

Congress and the U.S. Environmental Protection Agency (EPA) should close these gaps by requiring improved standards for chemical storage, restrictions on siting, inspections of vulnerable facilities, and reforms to the Emergency Planning and Emergency Right to Know Act (EPCRA). EPCRA is the principal federal law that governs public notification of inventories of hazardous chemicals and communication of chemical releases.[15] If the federal government does not act to establish a stronger regulatory regime, then states should enact these needed reforms under their own police powers.

This Article proceeds as follows. In Part II, I examine the problem of toxic floodwaters, highlighting the common sources of contamination and the damages from recent flooding events. Part III compares private law and public law mechanisms for preventing toxic floodwaters, assessing the merits of liability and regulation as risk management tools. I conclude that private law approaches for toxic floodwaters provide inadequate incentives for firms to curtail their externalized risk to the public, and I call for increased regulation of industrial facilities vulnerable to flooding. Finally, in Part IV, I sketch a bolder chemical safety agenda that closes unwarranted gaps in how we manage toxic chemicals, an agenda that would better protect communities from toxic flooding.

II. TOXIC CHEMICAL FALLOUT FROM EXTREME WEATHER EVENTS

Toxic contamination from flooding is not a new problem,[16] but it was not until Hurricane Katrina in 2005 that researchers used rigorous methodology to track flood-induced contamination and document the chemical exposures of people affected by the

John C. Dernbach, *The Unfocused Regulation of Toxic and Hazardous Pollutants,* 21 HARV. ENVTL. L. REV. 1 (1997).

15. 42 U.S.C. §§ 11001, 11002 (1986).

16. Bob Strickley, *79 Years Ago the 1937 Flood Crests at 79.9 Feet*, CIN. ENQUIRER (Jan. 27, 2016), *available at* https://perma.cc/N9V5-RSEJ (recounting that during the 1937 Ohio River Flood, oil fires ignited on the river after gas tanks exploded); Earl Benton, *February 26, 1972: Coal Mining Dam Collapses in Buffalo Creek*, W.V. PUB. BROAD. (Feb. 26, 2019), *available at* https://perma.cc/6EYR-6MM6 (recounting that during the 1972 Buffalo Creek flood in West Virginia, a coal waste dam collapsed, releasing 132 million gallons of contaminated water).

storm.[17] After Katrina, researchers found that New Orleans and surrounding parishes soaked for weeks in carcinogenic volatile organic compounds and heavy metals such as mercury, zinc, arsenic, and lead.[18] Katrina, a Category 3 hurricane when it struck Louisiana, was not the most powerful hurricane possible. Yet it was still able to rip oil storage tanks off their foundations and cause the discharge into the ocean of over eight million gallons of oil.[19]

The worst toxic floodwaters incidents have occurred during and after hurricanes, when torrential downpours and storm surges have flooded industrial areas. Toxic floodwaters can also occur as a result of heavy rainstorms, unrelated to any hurricane, that overwhelm municipal sewer systems and cause rivers to rise.[20] Because the problem is not just a coastal issue, policymakers across the United States need to understand the origins of these events, their impacts, and the increasing risk of these chemical disasters due to climate change.

A. Toxic Floodwaters Incidents and Health Effects

Toxic floodwaters incidents now occur almost every year, yet we continue to view these incidents as unconnected and fail to learn the lessons from past catastrophes.[21] In 2012, Hurricane

17. Danny Reible, *Hurricane Katrina: Environmental Hazards in the Disaster Area*, 9 CITYSCAPE 53 (2007); *see also* Danny Reible et al., *Toxic and Contaminant Concerns Generated by Hurricane Katrina*, 36 THE BRIDGE 5 (2006).

18. Robin Kundis Craig, *Of Sea Level Rise and Superstorms: The Public Health Police Power as a Means of Defending Against "Takings" Challenges to Coastal Regulation*, 22 N.Y.U. ENVTL. L.J. 84, 103 (2014).

19. Luis A. Godoy, *Performance of Storage Tanks in Oil Facilities Damaged by Hurricanes Katrina and Rita*, 21 J. PERFORMANCE CONSTRUCTED FACILITIES 441, 443–45 (2007); DONALD W. DAVIS, THE AFTERMATH OF HURRICANES KATRINA AND RITA ON SOUTH LOUISIANA (2006), https://archive.epa.gov/emergencies/content/fss/web/pdf/davis.pdf.

20. *See* Hayley T. Olds et al., *High Levels of Sewage Contamination Released from Urban Areas After Storm Events: A Quantitative Survey with Sewage Specific Bacterial Indicators*, 15 PLOS MED. 2 (2018) ("With the prediction of more intense rain events in certain regions due to climate change, sewer overflows . . . may increase, resulting in increases in waterborne pathogen burdens in waterways."); Charles Duhigg, *As Sewers Fill, Waste Poisons Waterways*, N.Y. TIMES (Nov. 22, 2009), *available at* https://perma.cc/E54P-WMKD ("[M]any sewer systems are still frequently overwhelmed . . . [and] sewage is spilling into waterways.").

21. Richard J. Lazarus, *Environmental Law After Katrina: Reforming Environmental Law by Reforming Environmental Lawmaking*, 81 TUL. L. REV. 1019, 1037 (2007) ("We seem poised, perversely, to demonstrate our human spirit by rebuilding in flooded areas

Sandy, a Category 2 storm, caused massive damage to industry in the New York area, including a 300,000-gallon oil spill at a refinery in New Jersey and damage to about 80 sewage treatment plants.[22] In 2017, Hurricane Harvey hit Galveston and Houston, killing eighty-eight people, leaving thousands without homes, and dropping more than forty inches of rain in just forty-eight hours.[23] Beaumont, Texas, received 64.58 inches of rain, a record for a single storm in the United States.[24]

Hurricane Harvey is the most vivid example of the toxic consequences of extreme weather. Petrochemical firms along the Gulf Coast were unprepared for a storm of such magnitude, and more than 650 facilities in Texas and Louisiana were exposed to Harvey's floodwaters.[25] Industry reported nearly 100 releases of hazardous substances to the National Response Center, which tracks reports of oil spills and chemical releases.[26] In addition to the flooding of industrial plants, Harvey flooded more than 800 sewage treatment facilities and 13 Superfund sites, carrying hazardous materials across the region.[27] Within

and our resolve by restoring the industrial, commercial, and residential activities ill-suited for those locations.").

22. *Sandy Responsible for 300,000 Gallon Oil Spill on U.S. East Coast*, THE MARITIME EXECUTIVE (Nov. 1, 2012), *available at* https://perma.cc/HZU7-QGMG; John Manuel, *The Long Road to Recovery: Environmental Health Impacts of Hurricane Sandy*, 121 ENV. HEALTH PERSP. 152 (2013). One plant on the Passaic River spilled an estimated 2.75 billion gallons of untreated human waste into Newark Bay. *Id*.

23. HOUS. HEALTH DEPT., HURRICANE HARVEY 2017 RESPONSE REPORT 2 (2017), *available at* https://perma.cc/EVW3-EAJA.

24. John D. Harden, *Weather Service Confirms a New Record 64 Inches of Rain Fell During Harvey*, HOUS. CHRON. (Sept. 28, 2017), *available at* https://perma.cc/2XRN-LYKQ.

25. *Hurricane Harvey's Impact on Energy and Industrial Facilities*, ARCGIS ONLINE (citing G.R. Brakenbridge & A.J. Kettner, *DFO Flood Event 4510*, DARTMOUTH FLOOD OBSERVATORY (Aug. 31, 2017), *available at* https://perma.cc/V9BV-DUXX), https://arcg.is/i40nr (identifying the facilities—such as wastewater treatment plants, petroleum refineries, and Superfund sites—that were potentially exposed to Harvey's floodwaters, shown in blue).

26. Troy Griggs et al., *More Than 40 Sites Released Hazardous Pollutants Because of Hurricane Harvey*, N.Y. TIMES (Sept. 8, 2017), *available at* https://perma.cc/8WDV-JD8M. The largest spill was from ExxonMobil's plant in Baytown, Texas, which released about 457 million gallons of stormwater mixed with untreated wastewater, including oil and grease. Bajak & Olsen, *supra* note 3.

27. Arelis R. Hernández et al., *Texas Faces Environmental Concerns as Wastewater, Drinking Water Systems Compromised*, WASH. POST (Sept. 3, 2017), *available at* https://perma.cc/VS5U-Z22S; *Hurricane Harvey Rains Flood Toxic Superfund Sites in Texas*, CNBC (Sept. 3, 2017), *available at* https://perma.cc/252U-2ULR.

days, Houston residents reported skin infections and respiratory problems,[28] and contamination was found in homes, schools, and businesses.[29]

Hurricane Harvey demonstrated that massive rainfall events can cause not only extensive water contamination, but also toxic air emissions.[30] Pounding rain caused roof damage that led to chemical releases to the air, and floodwaters damaged containment, refrigeration, and pressurized tank systems, resulting in releases of hazardous gases.[31] At the Arkema chemical plant in Crosby, Texas, rising water from Harvey knocked out the refrigeration system and backup generators, causing an explosion of organic peroxides, highly combustible compounds used to make plastics. The explosion released more than 23,000 pounds of toxic constituents, including carcinogens such as ethylbenzene and 1,2,4-trimethylbenzene.[32] Subsequent tests showed elevated levels of metals, dioxins, and other contaminants in nearby soils.[33]

28. ENV'T TEX., *Fact Sheet: Environmental Concerns About Oil and Gas Spills After Hurricane Harvey* (Sept. 12, 2017), *available at* https://perma.cc/NXT4-2YMD.

29. Sheila Kaplan & Jack Healy, *Houston's Floodwaters Are Tainted, Testing Shows*, N.Y. TIMES (Sept. 11, 2017), *available at* https://perma.cc/9KVC-EBKN ("[S]cientists found what they considered astonishingly high levels of E. coli in one family's living room – levels 135 times those considered safe – as well as elevated levels of lead, arsenic and other heavy metals in sediment from the floodwaters in the kitchen."); Leslie Sanchez, *Toxic Homes: The Invisible Threat after Hurricane Harvey*, CBS NEWS (Aug. 24, 2018), *available at* https://perma.cc/J4PT-GZMQ (finding that, after Hurricane Harvey, the air quality in flooded homes "matched the outdoor pollution of some of the world's most contaminated cities such as Mumbai and Beijing").

30. Adam Allington, *Flooded Houston Facing Air Threat, Too, With Toxic Gas Releases*, BLOOMBERG LAW (Oct. 2017); *see also* EPA, OFF. OF THE INSPECTOR GEN., 20-P-0062, EPA NEEDS TO IMPROVE ITS EMERGENCY PLANNING TO BETTER ADDRESS AIR QUALITY CONCERNS DURING FUTURE DISASTERS (2019).

31. U.S. CHEM. SAFETY AND HAZARD INVESTIGATION BD., EXTREME WEATHER, EXTREME CONSEQUENCES: CSB INVESTIGATION OF THE ARKEMA CROSBY FACILITY AND HURRICANE HARVEY (2018), *available at* https://perma.cc/5EXX-2TRT. According to Texas regulators, Hurricane Harvey caused the petrochemical industry alone to release more than two million pounds of toxic air pollutants during five days in August 2017, roughly 40 percent of the total air toxics that the entire Houston area released in all of 2016. Griggs et al., *More Than 40 Sites Released Hazardous Pollutants Because of Hurricane Harvey*, N.Y. TIMES (Sept. 8, 2017), *available at* https://perma.cc/5KGL-5XAL.

32. Lauren Mulhern, Comment, *The Arkema Chemical Facility Incident: How Regulation of Reactive Chemicals and Incorporation of Climate Change Risks in Emergency Response Planning Could Mitigate and Prevent Future Accidental Chemical Releases*, 30 COLO. NAT. RES., ENERGY & ENVTL. L. REV. 143, 150 (2019).

33. Dianna Wray, *Arkema Released Thousands of Pounds of Chemicals in Air and Water, New Lawsuit Says*, HOUS. PRESS (Oct. 5, 2017),

In rural areas, toxic floodwaters present yet another kind of threat to humans: agricultural contamination containing *E. coli* and other harmful bacteria. In 2018, for example, flooding from Hurricane Florence inundated hog-waste lagoons in North Carolina, spreading fecal contamination throughout the state's southeastern communities.[34] In 2019, severe flooding in Midwestern farm communities spread bacterial contamination from animal waste across 300 counties.[35] Although there was no immediate sampling of private water wells for contamination, the impacted area was estimated to include nearly one million private wells.[36]

The high levels of harmful contaminants in floodwaters pose both immediate dangers and long-term health risks that continue long after the floodwaters recede. After hurricanes Florence and Harvey, for example, researchers documented that residents in North Carolina and Texas experienced headaches, nausea, and eye irritation for weeks.[37] In Louisiana, sediment samples showed elevated levels of arsenic ten months after the end of Hurricane Katrina.[38]

This lingering chemical contamination is an environmental justice issue, disproportionately affecting low-income and minority communities in close proximity to hazardous

https://www.houstonpress.com/news/arkema-residents-say-they-were-hit-by-chemical-releases-in-both-air-and-water-during-hurricane-harvey-9847626.

34. Rebecca Beitsch, *Few Wells Tested for Contamination After Major Flooding from Hurricanes*, PEW CHARITABLE TRS.: STATELINE (Dec. 14, 2018), *available at* https://perma.cc/56Y8-996R (discussing contamination of water supplies by hog waste and coal ash).

35. Nadia Kounang, *Midwest Flooding Threatens the Water Safety in 1 Million Wells*, CNN (Mar. 29, 2019), *available at* https://perma.cc/4D36-E7DY.

36. *Id.*

37. Pamela D'Angelo, *Report Details the Potential Danger of Toxic Floodwaters*, VA. PUB. RADIO (Mar. 6, 2019), *available at* https://perma.cc/FW62-E2R8; Frank Bajak & Lise Olsen, *Hurricane Harvey's Toxic Impact Deeper Than Public Told*, ASSOCIATED PRESS (Mar. 23, 2018), *available at* https://perma.cc/GT4S-DSTV; Jen Christensen, *The Hidden Dangers of Flooding*, CNN (Sept. 13, 2018), *available at* https://perma.cc/9GJP-XVK9; Juanita Constible, *The Emerging Public Health Consequences of Hurricane Harvey*, NRDC: EXPERT BLOG (Aug. 29, 2018), *available at* https://perma.cc/5CXZ-EXX9; Timothy B. Erickson & Julia Brooks, *After a Disaster, Contaminated Floodwater Can Pose a Threat for Months to Come*, THE CONVERSATION (Oct. 3, 2017), *available at* https://perma.cc/6KCX-UEAZ.

38. Miriam Rotkin-Ellman et al., *Arsenic Contamination in New Orleans Soil: Temporal Changes Associated with Flooding*, 110 ENVTL. RES. 19 (2010).

facilities.[39] Race is correlated with topography in many U.S. cities, with communities of color isolated in low-lying areas through exclusionary zoning and construction of public housing in unfavorable, flood-prone terrain.[40] This correlation was made vivid during and after Hurricane Katrina, when low-lying, African-American neighborhoods, such as the Lower Ninth Ward, were devastated by flooding.[41] The correlation between race and topography was confirmed in a comprehensive study by geographers that examined 146 cities in the South.[42] They found a "strong pattern" of statistically significant correlations between neighborhoods of color and neighborhoods at low elevation, with the pattern holding in 36% of the southern cities.[43] The reverse pattern, with white people in low-lying areas, was found in 17% of the cities.[44] Many of these cities were coastal cities in Florida and the Carolinas, where white residents dominated the pricey real estate near the beaches.[45]

Toxic floodwaters do not affect people equally. In addition to the important variable of topography, lack of transportation options in low-income communities makes these residents more likely to shelter during a storm rather than evacuate.[46] Children and the elderly also appear to be more at risk from the pollution carried by floodwaters. Children are vulnerable because they have more skin surface area per unit of body weight than adults,

39. *See* Brie Sherwin, *After the Storm: The Importance of Acknowledging Environmental Justice in Sustainable Development and Disaster Preparedness*, 29 DUKE ENVTL. L. & POL'Y F. 273, 278 (2019) (explaining that flooding after natural disasters leads to an increase in water-borne contaminants in low-income communities that are disproportionately located near industrial areas); Danny Vinik, *'People Just Give Up': Low-income Hurricane Victims Slam Federal Relief Programs*, POLITICO (May 29, 2018), *available at* https://perma.cc/EB5F-9Q8Y; Emily Badger, *Pollution is Segregated, Too*, WASH. POST (Apr. 15, 2014), *available at* https://perma.cc/HW2L-M5W5.

40. Jeff Ueland & Barney Warf, *Racialized Topographies: Altitude and Race in Southern Cities*, 96 THE GEOGRAPHICAL REV. 50, 55–56 (2006).

41. John Simerman, *New Orleans' Lower 9th Ward Is Still Reeling from Hurricane Katrina's Damage 15 Years Later*, TIMES-PICAYUNE (Aug. 29, 2020) (noting that the neighborhood was 98% Black when Katrina struck and has become a world symbol for "poverty, neglect and utter devastation").

42. Ueland & Warf, *supra* note 40.

43. *Id*. at 59, 73.

44. *Id*. at 59.

45. *Id*. at 62.

46. Adrian Florido, *Why Stay During a Hurricane? Because It's Not As Simple As 'Get Out'*, NPR (Oct. 18, 2018), *available at* https://perma.cc/5VCF-7DJB.

and therefore face higher exposure through skin absorption.[47] The elderly are vulnerable because they are less likely to evacuate than other adults.[48]

Researchers have documented a range of illnesses linked to toxic floodwaters, including respiratory distress, gastrointestinal diseases,[49] and diseases of the brain, blood, and kidneys.[50] More research is needed, however, on the long-term health effects of toxic floodwaters. One of the challenges of identifying these effects is that researchers have difficulty sampling and testing the waters at the point of maximum human exposure, during the high water mark of a flood before the waters recede.[51] Further, researchers have documented that toxic floodwaters release hazardous chemicals in multiple forms over time: first through water, then via sediments, and ultimately through airborne dust, making it difficult to trace illnesses to discrete contaminants.[52] Compounding the complexity of studying this problem, chemicals in toxic floodwaters have synergistic effects.[53] That is, they act in tandem with each other and elevate health risks in communities exposed to multiple chemicals.[54]

47. WORLD HEALTH ORGANIZATION, SUMMARY OF PRINCIPLES FOR EVALUATING HEALTH RISKS IN CHILDREN ASSOCIATED WITH EXPOSURE TO CHEMICALS 22 (2011).

48. Vincanne Adams et al., *Aging Disaster: Mortality, Vulnerability, and Long-Term Recovery Among Katrina Survivors*, 30 MED. ANTHROPOLOGY 247, 251 (May 2011) (65% of the elderly in New Orleans lacked transportation options to evacuate before Hurricane Katrina).

49. Dell D. Saulnier et al., *No Calm After the Storm: A Systematic Review of Human Health Following Flood and Storm Disasters*, 32 PREHOSPITAL & DISASTER MED. 568, 572 (2017).

50. Erickson & Brooks, *supra* note 37.

51. Mike Martindale & Kalea Hall, *After Flood Reached Dow, Superfund Pollution Regulators Have Yet to Test Water*, DET. NEWS (May 21, 2020), *available at* https://perma.cc/ZG28-CJXL.

52. *Hurricane Katrina: Assessing the Present Environmental Status: Hearing Before the Subcomm. on Env't and Hazardous Materials of the H. Comm. on Energy and Commerce*, 109th Cong. 88–89 (2005) (statement of Erik D. Olson, Senior Attorney, NRDC).

53. Karen A. Gottlieb, *The Environmental Setting—The Toxicity of Mixtures*, *in* 1 TOXIC TORTS PRAC. GUIDE § 3:21 (2019); Sanne H. Knudsen, *Regulating Cumulative Risk*, 101 MINN. L. REV. 2313 (2017).

54. In the aftermath of Katrina, mixtures of carcinogens and nephrotoxicants were found that could cause a range of health issues including cardiovascular, kidney, gastrointestinal, and neurological complications. Floodwater sampling showed mixtures of at least two toxic substances in more than 43% of sample locations. Mary Fox et al.,

B. Sources of Contamination

To prevent toxic floodwaters, policymakers and emergency managers need information about which facilities might pose a threat to surrounding communities. Due to lax oversight, however, there is no comprehensive inventory of vulnerable facilities. This unfortunate data gap hampers both public and private emergency planning efforts.

Identifying such facilities involves understanding both details of the chemicals stored on site and the facility's degree of flood-exposure. The risk that a facility poses to a community depends on the volume and toxicity of substances on site, the storage conditions of those substances, the proximity of the facility to residences, and the facility's flood exposure.[55] Flood exposure, in turn, depends on the elevation of the facility, its proximity to water bodies, and its proximity to the ocean (which increases hurricane storm-surge exposure even if there is no water body adjacent to the facility).[56]

The U.S. experience with toxic floodwaters since Hurricane Katrina highlights two important points about the sources of potential contamination.

First, it is clear that the problem is not confined to the chemical industry, major manufacturers, or large facilities that might have millions of gallons of hazardous chemicals on site. Instead, nearly *any* flood-exposed facility that stores toxic chemicals, pesticides, oil, gasoline, human sewage, or animal waste is a potential source of contamination. While large industrial plants tend to get the most attention in the wake of a storm, the true risk is much broader. Policymakers, therefore, need to look beyond industry-specific or neighborhood-specific approaches to reduce the risk of chemical releases. Planning must proceed from the recognition that thousands of small facilities—from gas stations to manufacturing operations to

Potential for Chemical Mixture Exposures and Health Risks in New Orleans Post-Hurricane Katrina, 15 HUM. & ECOLOGICAL RISK ASSESSMENT 831, 837–839 (2009).

55. *See* NOAH SACHS & DAVID FLORES, CTR. FOR PROGRESSIVE REFORM, TOXIC FLOODWATERS: THE THREAT OF CLIMATE-DRIVEN CHEMICAL DISASTER IN VIRGINIA'S JAMES RIVER WATERSHED 11–13 (2019).

56. *Id.* at 3, 11, 13.

metal finishing plants—may need to harden their infrastructure against flooding.

Second, an effective legal regime to address toxic floodwaters must include an inventory process to identify at-risk facilities. In the United States, we have barely begun this task. There is no comprehensive national inventory of industrial facilities that are both flood-exposed and that store hazardous substances.

Some studies have attempted to identify such facilities regionally. In 2019, for example, researchers identified more than 840 facilities in the Hampton Roads area of Virginia that are both flood-exposed and that likely store hazardous substances, based on the statutes under which they are regulated.[57] The study highlights that flood-exposed industrial facilities are often concentrated together and are often located in close proximity to low-income communities. For example, the study identified 164 such facilities in a single census tract in Norfolk.[58]

Past studies have obscured the gravity of the threat from toxic floodwaters by failing to identify the full scope of vulnerable facilities. The *New York Times*, for example, used Toxic Release Inventory (TRI) data to identify industrial facilities that have the potential to release chemicals during floods because of their elevation or location near waterways.[59] It found more than 2,500 such facilities across the United States and documented the potential for widespread contamination.[60] The study significantly understated the risk, however, because only large manufacturing operations in certain industries that use specific EPA-listed chemicals are subject to TRI reporting.[61] The study did not capture the risks from smaller facilities or from oil and chemical storage facilities that do not ordinarily release pollutants to the environment. Such storage facilities are not subject to TRI reporting, yet they are among the most

57. *Id.* at 19.
58. *Id.* at 14.
59. Tabuchi, *supra* note 1.
60. *Id.*
61. Facilities are subject to TRI reporting if they have ten or more employees; are in certain industries, such as mining, chemicals, or paper manufacturing; and manufacture or process more than 25,000 pounds of certain listed chemicals annually. *See* 40 C.F.R. § 372.

worrisome facilities in terms of flood exposure because of their location along waterways and the vast volumes of hazardous liquids stored in tanks. Similarly, numerous studies have explored the impacts of floods on existing Superfund sites near the coasts.[62] But these studies are too narrow in scope. Superfund sites are just one component of a larger problem: there are tens of thousands of facilities that could become sources of hazardous contamination during a storm.

C. Climate Change as a Threat Multiplier

In addition to identifying facilities that are currently at risk of flooding, policymakers should approach the toxic floodwaters problem with a long-term planning horizon that accounts for extreme weather and climate change.[63] Policymakers need to understand how climate change will contribute to increased rainfall and flooding, which will put more facilities in the path of floodwaters and increase the risk that toxic contaminants will spread across communities. The legal regime to address toxic floodwaters needs to be flexible, adaptable, and resilient.

One of the core principles of climate change adaptation planning is that "stationarity is dead."[64] That is, policymakers cannot assume that present conditions of weather or physical infrastructure will continue, and they must build adaptability and resilience into planning scenarios. Planning for the vast climatic changes of the coming decades will require collecting huge amounts of scientific information, sharing that information with all levels of government and the private sector, and likely

62. *See, e.g.*, EPA, OFF. OF LAND & EMERGENCY MGMT., EVALUATION OF REMEDY RESILIENCE AT SUPERFUND NPL AND SAA SITES (2018); U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-20-73, SUPERFUND: EPA SHOULD TAKE ADDITIONAL ACTIONS TO MANAGE RISKS FROM CLIMATE CHANGE (2019); Jason Dearen et al., *AP Finds Climate Change Risk for 327 Toxic Superfund Sites*, ASSOCIATED PRESS (Dec. 22, 2017), *available at* https://perma.cc/T3ZQ-L5ZV.

63. As of late 2020, the majority of states have no climate adaptation plans or legislation. *See* GEORGETOWN CLIMATE CTR., STATE AND LOCAL ADAPTATION PLANS, *available at* https://perma.cc/H5S9-ZSDU(last accessed Oct. 11, 2020) (reporting that seventeen states have adopted some kind of state climate adaptation plan; most adopted over a decade ago).

64. *See* Craig, *supra* note 8, at 9.

spending hundreds of billions of dollars on new infrastructure investments.[65]

Effective adaptation planning for toxic floodwaters will need to examine two distinct stages of the threat. In the first stage, which will unfold between now and mid-century, climate change will lead to widespread flooding through hurricane storm surge and heavy rainfall events unrelated to hurricanes.[66] In the second stage, after mid-century, rising seas will permanently submerge some coastal industrial areas, creating contamination zones and forcing population retreat.

1. Near-term Climate Change Impacts

In the near-term, climate change will increase the threat of toxic floodwaters by producing more rainfall and more frequent hurricanes compared to 20th-century averages. According to federal government scientists, the number of Category 4 and Category 5 hurricanes in the North Atlantic is expected to increase by 50% compared to last century, with a 20% increase in average rainfall volume from each hurricane.[67] Storm surge flood levels will increase,[68] and storm surge will travel farther inland.[69] All of these changes will put more industrial facilities in the path of flooding. More flooding will in turn lead to more toxic chemical releases because the mechanisms that industry uses to avoid chemical releases, such as steel storage tanks, secondary containment, and temperature control devices, can fail or corrode when inundated.[70]

65. *Id.*

66. *See* REIDMILLER ET AL., U.S. GLOB. CHANGE RESEARCH PROGRAM, *Summary Findings, in* FOURTH NATIONAL CLIMATE ASSESSMENT, VOL. II: IMPACTS, RISKS, AND ADAPTATION IN THE UNITED STATES 30 (2018) [hereinafter FOURTH NATIONAL CLIMATE ASSESSMENT VOL. II].

67. Kevin Walsh et al., *Tropical Cyclones and Climate Change*, 7 WIRES CLIMATE CHANGE 65–89 (2016).

68. Ning Lin et al., *Physically Based Assessment of Hurricane Surge Threat Under Climate Change*, 2 NATURE CLIMATE CHANGE 462, 462–467 (2012).

69. Lynne Carter et al., *Southeast*, *in* FOURTH NATIONAL CLIMATE ASSESSMENT VOL. II at 744, *available at* https://perma.cc/ZN62-P6VT. Brad Plumer, *Rising Seas Could Menace Millions Beyond Shorelines, Study Says*, N.Y. TIMES (July 30, 2020), *available at* https://perma.cc/JRH2-SBJV (discussing study that found that only one-third of future coastal flooding risk came from rising sea itself, while two-thirds of the risk came from a likely increase in extreme high tides, storm surge, and breaking waves).

70. SACHS & FLORES, *supra* note 55, at 9.

Inland areas are not immune from the danger. Warmer air holds more moisture, creating conditions for torrential rainfall far away from the coasts, massive inland flooding, and dam breaches.[71] Scientists predict heavier rainfall for most of the United States in the coming decades.[72] In the southeast, for example, scientists predict that, by 2100, the number of heavy rainfall incidents will double compared to the historic average, and the volume of rainfall during these events will increase by 21%.[73]

The devastating floods in Iowa and Nebraska in the spring of 2019 are an example of toxic contamination spread by heavy inland precipitation. In the year preceding the floods, Iowa experienced 50.73 inches of precipitation, the wettest twelve-month period ever recorded there.[74] Rivers, already running high due to the intense rain, were further fed by rapid snowmelt caused by warm temperatures.[75] The flood damage was estimated at $2 billion in Iowa and over $1.3 billion in Nebraska.[76]

71. For many major American cities, the past decade has been the wettest decade since rainfall records began in the nineteenth century. *See* Azi Paybarah, *Yes, The Weather Has Been Crazy Rainy*, N.Y. TIMES (Jan. 3, 2019), *available at* https://perma.cc/T6AD-ZZZT (noting 2018 as New York City's fourth wettest year on record); *Houston's Annual Top 10 List*, NAT'L WEATHER SERV. & NAT'L OCEANIC AND ATMOSPHERIC ADMIN., *available at* https://perma.cc/AXS9-CDM6 (noting 2017 as Houston's wettest year on record); Jennifer Larino, *A Look Back at the 20 Rainiest Years in New Orleans History*, TIMES-PICAYUNE (Jan. 12, 2018), https://www.nola.com/news/weather/article_7da3a9a4-fe30-5a45-97ba-3d2abc87ba75.html (reporting that five of the top twenty rainiest years on record in New Orleans occurred between 2007 and 2017).

72. Katherine Hayhoe et al., *Our Changing Climate*, *in* FOURTH NATIONAL CLIMATE ASSESSMENT VOL. II, *supra* note 66, at 88, https://perma.cc/5RUS-UYL5.

73. Carter et al., *supra* note 69, at 762.

74. Gage Miskimen, *It's a Record: Iowa Has Wettest 12-month Period Since Official Records Began in 1895*, DES MOINES REG. (June 14, 2019), *available at* https://perma.cc/E5M7-AB2D.

75. Sam Bloch, *Historic Flood Losses Faced by Nebraska Farmers "Will Impact Food on Your Table"*, THE COUNTER (Mar. 19, 2019), *available at* https://perma.cc/ET2M-KEFP; Mitch Smith et al., *'It's Probably over for Us': Record Flooding Pummels Midwest When Farmers Can Least Afford It*, N.Y. TIMES (Mar. 18, 2019), *available at* https://perma.cc/X4U3-HU2K.

76. Donnelle Eller, *Farm Losses Drive Iowa's Flood Damage to $2 Billion, Farm Bureau Economists Estimate*, DES MOINES REG. (Apr. 3 2019), https://perma.cc/WU67-KRFP; Matthew S. Schwartz, *Nebraska Faces over $1.3 Billion in Flood Loss*, NPR (Mar. 21, 2019), https://perma.cc/5G23-JSJC.

2. Long-term Climate Change Impacts

Around mid-century, the toxic floodwaters threat in the United States will become far more serious. Wetter weather and intense hurricanes will remain major problems, but the new challenge will be the permanent inundation of coastal areas by rising seas.

The U.S. Global Climate Change Research Program, created by Congress to report on climate science and inform federal policy, projects that global average sea levels will rise anywhere from 0.3 meters to 2.5 meters by 2100.[77] The mid-range estimate (1.5 meters by 2100) is a useful estimate for planning purposes because the estimated chance of exceeding it is less than 5%.[78] In the United States, 1.5 meters of sea level rise would put hundreds of oil terminals, refineries, and sewage treatment plants under water and would submerge large sections of low-lying cities like New York, Washington, Boston, and Miami.[79] The Global Climate Change Research Program also estimates that nearly the entire U.S. coastline, with the exception of Alaska, will experience sea level rise greater than the global average.[80]

Sea level rise is both an environmental threat and among the biggest long-term threats to the economy of the United States.[81] More than half of the U.S. population lives in coastal counties, and those counties generate 58% of U.S. GDP.[82] As sea levels rise, water will inundate industrial zones, contaminate potable water supplies, and push hurricane-related storm surge farther

77. WILLIAM V. SWEET ET AL., NAT'L OCEANOGRAPHIC & ATMOSPHERIC ADMIN., GLOBAL AND REGIONAL SEA LEVEL RISE SCENARIOS FOR THE UNITED STATES 14 (2017), *available at* https://perma.cc/V8QJ-ADEL.

78. *Id.* at 22.

79. Leslie-Ann L. Dupigny-Giroux et al., *Northeast*, *in* FOURTH NATIONAL CLIMATE ASSESSMENT VOL. II, *supra* note 66, at 694–695, *available at* https://perma.cc/3ECQ-WZJ2; Elizabeth Fleming et al., *Coastal Effects*, *in* FOURTH NATIONAL CLIMATE ASSESSMENT VOL. II, *supra* note 66, at 329–331 (2018), *available at* https://perma.cc/ZJ93-ZUKC.

80. SWEET ET AL., *supra* note 77, at 30.

81. *Sea Level Rise to Cause Major Economic Impact in the Absence of Further Climate Action*, Science Daily (Jan. 27, 2020), *available at* https://perma.cc/A7BA-SS8V.

82. DARYA MONOVI, CTR. FOR PROGRESSIVE REFORM, PUBLIC HEALTH RISKS AND VULNERABILITY TO CHEMICAL SPILLS TRIGGERED BY EXTREME WEATHER (2020), *available at* https://perma.cc/N4QA-YYK9.

inland.[83] Sea level rise is a threat to power plants, manufacturing facilities, and refineries, as well as to municipal drinking water and the sanitary infrastructure that cities have built up over 100 years to remove waste and sewage.[84]

The United States will not have to wait until the end of the century before coastal infrastructure is submerged. By 2050—within the timespan of a typical 30-year residential mortgage—researchers project that global sea levels could rise a half-meter.[85] Studies of over a dozen large U.S. cities, prepared by the Virginia Institute of Marine Science, confirm the projection of a half-meter of sea level rise by 2050.[86] Such an increase would likely flood thousands of facilities that store hazardous substances. Yet most cities have not even begun to examine how to protect industrial infrastructure—and nearby communities—from this risk.[87]

3. Climate Change and the End of Stationarity

In identifying the industrial operations most at risk, policymakers should adhere to the "stationarity is dead" principle by projecting weather conditions as they will change over decades rather than relying on past weather records.[88] Facilities that have never flooded in the past may pose a grave danger of toxic releases in the future because of changing weather patterns and increased rainfall.

Unfortunately, FEMA flood-plain maps, which remain one of the major planning tools used to guide real estate development, still reflect stationarity. Created from past weather records, FEMA flood-plain maps do not reflect projections of future flooding due to climate change, yet these maps are used for

83. *See* JEFF GOODELL, THE WATER WILL COME: RISING SEAS, SINKING CITIES, AND THE REMAKING OF THE CIVILIZED WORLD (2017).

84. *Id.*

85. SWEET ET AL., *supra* note 77, at 23 tbl.5.

86. *U.S. Sea Level Rise Report Cards*, VA. INST. MARINE SCI., *available at* https://perma.cc/DH88-NBXV.

87. *See* Dahl, *supra* note 5; Xinyu Fu et al., *Adaptation Planning for Sea Level Rise*, 60 J. ENVTL. PLANNING & MGMT. 249, 253–256 (2017).

88. Southeast Texas, for example, has experienced four 500-year flood events since 2014 (a 500-year flood event is one with a 1-in-500 chance of occurring in any year). Erica Grieder, *Judge's Ruling in Harvey Flooding Case Holds Message for Government*, HOUS. CHRON. (Dec. 21, 2019), https://www.houstonchronicle.com/news/columnists/grieder/article/Judge-s-ruling-in-Harvey-flooding-case-holds-14923326.php.

everything from zoning plans to building inspections to insurance-rate determinations.[89] With storms dropping more rain in shorter timespans, however, climate scientists now widely believe that these maps do not accurately depict flood risk.[90] According to one federal study, while FEMA flood maps depict about 13 million Americans living in 100-year flood plains, the true number is 40.8 million and is projected to rise to over 60 million by 2050 with current population growth trends.[91]

The flaws in FEMA flood-plain maps have serious consequences. Because of the shortcomings of these maps, managers of facilities that store hazardous substances may not be aware that their facilities are vulnerable to floods. They may not take any precautions, such as elevating hazardous substances or building secondary containment for chemical storage tanks, because they do not realize that the facilities they manage are located in a flood zone. Correspondingly, nearby communities are left in the dark about the true nature of their contamination risk. Policymakers, insurers, and facility managers should not rely solely on FEMA flood maps to determine vulnerability; they need to supplement the FEMA maps with more accurate elevation and weather data that incorporates future projections for rainfall and sea level rise. By relying on FEMA maps, we are driving forward through the climate crisis while looking in the rearview mirror.

89. *Technical Fact Sheet No. 1.3.: Using a Digital Flood Insurance Rate Map (DFIRM)* 1, 2, *in* FED. EMERGENCY MGMT. AGENCY, FEMA P-499, HOME BUILDER'S GUIDE TO COASTAL CONSTRUCTION TECHNICAL FACT SHEET SERIES (Dec. 2010) (noting that FEMA flood maps are used for "community planning, zoning, and building inspection programs that require specific structure design and new construction in high-hazard coastal floodplains."). *See also* Evan Isaacson, *Stormwater Infrastructure and Management: Unsafe for Human Contact* 57, *in* CTR. FOR PROGRESSIVE REFORM, FROM SURVIVING TO THRIVING: EQUITY IN DISASTER PLANNING AND RECOVERY 57, 57–64 (2018) (discussing flaws in FEMA flood plain designations around Houston).

90. U.S. DEP'T OF HOMELAND SECURITY, OFF. OF THE INSPECTOR GEN., OIG-17-110, FEMA NEEDS TO IMPROVE MANAGEMENT OF ITS MAPPING PROGRAMS (2017) (describing FEMA's mismanagement and lack of oversight resulting in inadequate or outdated flood mapping); Michael Keller et al., *Outdated and Unreliable: FEMA's Faulty Flood Maps Put Homeowners at Risk*, BLOOMBERG (Oct. 6, 2017), https://perma.cc/A3P4-GRW6 (noting that FEMA's floodplain maps do not account for factors such as rapid rain accumulation, climate change, or unexpected population growth).

91. Oliver E.J. Wing et al., *Estimates of Present and Future Flood Risk in the Conterminous United States*, 13 ENVTL. RES. LETTERS 034023, 2018, at 1, 3 fig.2.

To be sure, toxic contamination is not the only impact for which policymakers need to prepare as the oceans rise. They must also adopt plans and policies for evacuating communities, replacing housing, protecting people during blackouts, safeguarding the electric grid, and managing the retreat of communities from the coasts. It is useful to situate prevention strategies for toxic floodwaters in the context of these broader challenges of adapting to rising seas. As Alex Camacho has noted, climate change adaptation policy can either aim at altering the environment to minimize adverse effects of climate change (such as constructing sea walls to protect against hurricanes) or at altering the way private actors interact with the environment (such as requiring the elevation of critical utilities within buildings).[92] The most promising strategies for preventing toxic floodwaters fall into the latter category. By altering the incentives and requirements for industrial operators, policymakers can mitigate risk "inside the fenceline"; that is, they can reduce the risk that toxic chemicals stored inside industrial facilities will escape when extreme weather strikes.

III. RESPONSES TO TOXIC FLOODWATERS THROUGH PRIVATE AND PUBLIC LAW

Despite repeated toxic floodwater disasters that have affected multiple states and millions of Americans, prevention of toxic floodwaters has largely been left to ad hoc private sector decision making. Some observers see this as a good thing: scholars and industry executives have argued that firms have a financial incentive to maintain control of their chemical inventory and prevent releases, so new forms of ex ante government regulation are unnecessary to prevent toxic floodwaters. In this view, firms are sufficiently motivated to take safety precautions through economic incentives and liability exposure for any chemical releases. Many

92. Alejandro E. Camacho, *Adapting Governance to Climate Change: Managing Uncertainty Through a Learning Infrastructure*, 59 EMORY L.J. 1, 21–22 (2009).

environmental groups, in contrast, are calling for increased federal oversight of industrial facilities to manage flood risks.[93]

This argument over how to address toxic floodwaters is, at its core, an argument over the relative merits of private law and public law in responding to a growing threat to public health.

The private law approach relies on the incentive of firms to limit tort liability, maintain control over valuable chemical inventory, and reduce premiums for liability insurance. The private law approach modifies behavior in a decentralized way by exposing firms to potential damage claims after a storm hits if they do not reasonably contain hazardous chemicals.

Under a public law approach, in contrast, public agencies would set regulatory standards for flood-exposed facilities and enforce those standards through inspections, facility registration, spill-prevention planning, and fines. The public law approach modifies behavior of firms in a more direct way, through enforcing compliance with regulatory standards and requiring vulnerable firms to take precautionary measures before any release of chemicals occurs.

In this Part, I explore this crucial question of whether toxic floodwaters can be addressed adequately through continued reliance on private law and private incentives, or whether the problem instead needs to be addressed through a new regulatory regime. In the comparative analysis that follows, I draw heavily on Steve Shavell's classic article, *Liability for Harm Versus Regulation of Safety*.[94] Shavell's article provides a broad framework for risk assessment and decision-making in diverse fields from medicine to pesticides to air pollution. Here, it provides useful guidance for designing the optimal legal regime for toxic floodwaters.

A. The Choice of Legal Regimes

The choice of the optimal legal regime to manage a health or safety risk depends on the characteristics of the risk. According to Shavell, there are four factors that determine the optimal approach: the knowledge gap between firms and regulators, the

93. ENV'T. TEX., *supra* note 28; CTR. FOR PROGRESSIVE REFORM, *supra* note 10; SACHS & FLORES, *supra* note 55.

94. Shavell, *supra* note 13.

risk-producing party's ability to financially cover any damage claims, the likelihood that firms may not face the threat of suit for harm done, and the relative administrative costs of relying on private law or public law.[95]

The first factor identified by Shavell is the difference between the level of knowledge about the nature or degree of risk possessed by private parties compared to regulatory authorities.[96] Where crucial information about the nature or degree of risk is in the hands of private actors, private law is preferable. As an example, Shavell discusses the risk posed by chopping down a tree, where the activity poses some risk that the tree or branches will fall on neighboring property.[97] In that situation, the property owners can observe the nature of the risk far more readily than a government agency, which lacks the personnel to inspect every tree. A regulatory system for cutting down trees would "sometimes be too restrictive" and would "impos[e] needless precautions."[98] If the owner of the tree unreasonably ignores the risk and the tree causes damage to the neighboring property, tort provides a viable remedy.[99] On the other hand, where governmental actors know more about the true nature or degree of risk (such as the risk from radioactive materials), public regulation is preferable because agencies have "better access to, or a superior ability to evaluate, relevant medical, epidemiological, and ecological knowledge."[100]

The second factor is whether private parties are capable of paying for the full magnitude of harm done.[101] If a private party can cause damage in an amount that exceeds its assets, then its motivation to reduce risk is weakened: it may simply declare bankruptcy in the case of excess liability.[102] According to

95. *Id.* at 359–64.
96. *Id.* at 364–65.
97. *Id.* at 366–67.
98. *Id.* at 367.
99. *Id.* at 359.
100. *Id.* at 369.
101. *Id.*
102. Michael G. Faure, *In the Aftermath of the Disaster*, 52 STAN. J. INT'L L. 95, 112 (2016) ("The insolvency problem will obviously arise in all cases where smaller operators may also cause high damage whose potential magnitude may outweigh their personal assets.").

Shavell, some form of ex ante regulation to reduce risk is appropriate under these circumstances.[103]

The third factor identified by Shavell is whether parties might escape the threat of suit for harm done. Where harm is spread across hundreds or even thousands of people, each individual lacks concentrated injury and therefore incentive to sue. In many cases, the harm may be so diffuse that the injured individuals may not even be aware that they have been harmed.[104] In such situations, tort law is unlikely to provide accountability for the risk-producing firm or its decisionmakers.[105] On the other hand, in circumstances where risk-producing firms can readily be held liable for harms that they cause through tortious behavior, private law provides a deterrent incentive.[106]

Finally, Shavell's fourth factor is the administrative costs imposed on society from managing the risk.[107] Public law approaches, grounded in regulation, inspection, and enforcement, put far more of a financial burden on taxpayers than private law approaches, and that burden must be incurred whether or not the regulated facility is creating any harm. The higher governmental costs of regulation may be unjustifiable for categories of risk that can be handled adequately through a liability regime. On the other hand, these administrative costs may be necessary for some types of risk for which private law tort remedies are inadequately protective (such as controlling air pollution or other kinds of diffuse harms). Shavell suggests that a cost-benefit analysis should be employed to compare private and public law risk management tools in any given circumstance.[108]

Together, Shavell's four factors suggest that when a *risk* of harm to the public comes from thousands of actors, but the *actual* harm (when it occurs) is traceable to one or a small number of actors, we should opt for ex post private remedies such as tort law, given the limited ability of the administrative

103. Shavell, *supra* note 13, at 361.
104. *Id*. at 363.
105. *Id*.
106. *Id*.
107. *Id*. at 363.
108. *Id*. at 364.

state to monitor, inspect, and regulate thousands of firms on an ex ante basis. On the other hand, a public law regulatory regime is appropriate where firms create diffuse risks of harm to the public, individuals harmed by an activity may not know that they are being harmed, experts have better information about the full magnitude of risk than members of the public, and private parties may not have assets to cover damage claims if injury occurs. In those circumstances, any deterrent incentive from tort law is weakened and an ex ante regulatory approach is preferable.

B. Weaknesses of Private Law as an Approach to Toxic Floodwaters Risks

How should Shavell's four considerations apply in the particular context of harms from toxic floodwaters? Toxic floodwaters is a category of harm where (1) the magnitude of harm from the escape of hazardous substances during flood events can be greater than the assets of the risk-producing firms, and (2) the harm is diffuse and difficult to trace back to its source. Because firms under these conditions may not face liability for the harms they cause, private law is not likely to be effective in managing the problem. A public law regulatory regime is preferable to prevent releases and manage the risk, as long as it can be implemented at reasonable cost.

For decades, however, the United States has relied primarily on private law to prevent toxic floodwaters incidents. There are few federal or state standards governing industrial chemical storage.[109] There are no mandatory standards governing storage tank performance, inspections, record-keeping, or setback requirements from waterways, and there are no FEMA regulations governing chemical storage in floodplains.[110] The result of this lax regulation is that private firms, storing millions of gallons of hazardous substances near waterways, operate without regulatory oversight of their storage practices or their flood preparedness.

109. *See* 40 C.F.R. §§ 112.1–112.21 (2019) (oil tank regulations).

110. *See* 44 C.F.R. § 206.400 (2019) (FEMA minimum standards); 44 C.F.R. pts. 59, 60 (2019) (National Flood Insurance Program standards).

Making the case for continued reliance on private law, industry executives have argued that no new regulatory regimes are needed because firms have voluntary programs in place to prevent accidental releases during flood events.[111] Moreover, industry executives contend that no new regulatory regimes are needed because firms are subject to safety mandates from their own insurance carriers.[112]

Scholars have made similar arguments about the superiority of private law for managing many types of disaster risks to industry. Michael Faure, for example, has argued that liability rules provide adequate incentives for disaster prevention:

> By exposing them to the costs of their activities via liability rules, parties will be given appropriate incentives for taking optimal care to prevent accidents. Since it is the level of care that minimizes the costs of prevention and the expected damage costs, taking optimal care would reduce the total social costs of accidents. This basic insight can apply to the damage resulting from disasters as well: the exposure of the risk taker to liability provides incentives for disaster mitigation.[113]

111. *See, e.g.*, Press Release, Am. Chem. Council, Statement by ACC President and CEO Cal Dooley in Response to Hurricane Harvey (Aug. 31, 2017), *available at* https://perma.cc/D96W-KK8F (highlighting the ACC's voluntary Responsible Care initiative and citing the industry's "comprehensive and well-rehearsed emergency plans"). *See also* Comments of Util. Solid Waste Activities Grp. on Docket ID No. EPA-HQ-OLEM-2018-0024 (Aug. 24, 2018), *available at* https://perma.cc/Z6K5-7C98; Comments of Nat'l Mining Assoc. on Docket ID No. EPA-HQ-OLEM-2018-0024 (Aug. 24, 2018), *available at* https://perma.cc/NV96-S9C8; Comments of Am. Chem. Council on Docket ID No. EPA-HQ-OLEM-2018-0024 (Aug. 24, 2018), *available at* https://perma.cc/P8DZ-Q9FE; Comments of Soc'y of Chem. Mfrs. & Affiliates on Docket ID No. EPA-HQ-OLEM-2018-0024 (Aug. 23, 2018), *available at* https://perma.cc/8C6P-6DPW.

112. Alexander H. Tullo, *Bracing for Climate Change, the Chemical Industry Learns from Hurricane Harvey*, CHEM. & ENG'G NEWS (Feb. 10, 2020), *available at* https://perma.cc/EQ8U-A4RX.

113. Faure, *supra* note 102, at 105 (promoting use of liability rules for disaster risk management and discussing the conditions under which these rules can be effective). *See also* Arnold, *supra* note 11, at 259 (criticizing public law regulatory strategies and advocating an approach to disaster risk management grounded in liability and financial assurance mechanisms).

These arguments for continued reliance on private law ring hollow, however, when viewed against Shavell's four-factor framework and the clear weaknesses of private law in managing diffuse risks. In the case of toxic floodwaters, private law approaches are unlikely to provide an adequate deterrent for firms because once chemicals mix with floodwaters and the contamination spreads, it becomes difficult to trace the harm back to any particular source. Individuals may not know they have been exposed to harmful chemicals, nor would they likely be able to identify the source of these chemicals. Consequently, tort law is unlikely to provide either a remedy for injured individuals or deterrence.[114] Below, I present further reasons why the decentralized mechanisms of tort liability, profit incentives, and insurance will underprotect communities.

1. Tort Liability

There is a long-running scholarly debate about the role of tort law in addressing environmental, health, and safety risks.[115] Many scholars contend that tort doctrine, which evolved to address discrete bodily injury to an individual plaintiff, is ill-suited for managing widespread, diffuse harms to public health and the environment. As Chris Schroeder has explained:

> For many environmental risks the ability of tort to prevent harm will depend entirely on the success of its deterrent effect, which must inevitably be an indirect effect of the signal or message that the tort system sends. It is not enough that tort cases send a message, either. That message must be heard, understood, and acted upon before deterrence succeeds. These downstream

114. *See* Note, *Causation in Environmental Law: Lessons from Toxic Torts*, 128 HARV. L. REV. 2256 (2015); Katalin Sulyok, *Managing Uncertain Causation in Toxic Exposure Cases: Lessons for the European Court of Human Rights from U.S. Toxic Tort Litigation*, 18 VT. J. ENVTL. L. 520 (2017); Lazarus, *supra* note 21, at 1031.

115. *See, e.g.,* Joanna M. Shepherd, *Products Liability and Economic Activity: An Empirical Analysis of Tort Reform's Impact on Businesses, Employment, and Production*, 66 VAND. L. REV. 255, 281-84 (2013); Adam D. K. Abelkop, *Tort Law as an Environmental Policy Instrument*, 92 OR. L. REV. 381 (2013); DON DEWEES, DAVID DUFF & MICHAEL TREBILCOCK, EXPLORING THE DOMAIN OF ACCIDENT LAW: TAKING THE FACTS SERIOUSLY (1996).

> components to the mechanism of deterrence depend on individuals, incentive structures and institutions that tort cannot affect directly.[116]

There are many reasons why owners and managers of firms do not invest in appropriate safety precautions even when they face a clear prospect of liability in the event of an accident; these include over-optimism, short planning horizons, and the liability protections of the corporate form.[117] In the specific context of toxic floodwaters, the threat of tort liability is unlikely to provide a strong deterrent signal because after massive flooding events, the effects of chemical exposure may not manifest for years. The more time between cause and effect, the more difficult it becomes to obtain evidence and prove causation, and the greater possibility that responsible parties will be judgment-proof when plaintiffs file suit. Consequently, few tort suits over flood-related chemical releases are likely to succeed, even in communities that have experienced widespread contamination. Fundamentally, tort law is not well-suited to address this kind of disaster. As Doug Kysar has noted, tort law is primarily aimed at "settling matters of right and responsibility within a particular, localised relationship. The possibility for incomplete and inconsistent judgments is therefore rife within the use of tort law to serve environmental, health, and safety objectives."[118]

A further hurdle to reliance on private law mechanisms is that in most states, storage of oil or other hazardous chemicals is not considered an "abnormally dangerous" activity that would trigger strict liability in tort.[119] Consequently, holding firms accountable for chemical releases requires a plaintiff to prove the negligence of the facility owner or operator. But there are enormous evidentiary hurdles for a plaintiff to show that a firm fell below a standard of reasonable care in how it stored or managed hazardous substances during an extreme weather event. Such a tort suit would require that the plaintiff not only

116. Christopher H. Schroeder, *Lost in Translation: What Environmental Regulation Does that Tort Cannot Duplicate*, 41 WASHBURN L.J. 583, 591 (2002).

117. *Id.* at 592.

118. Douglas Kysar, *The Public Life of Private Law: Tort Law as a Risk Regulation Mechanism*, 9 EUR. J.RISK REG. 48 (2018).

119. RESTATEMENT (SECOND) OF TORTS § 520 (AM. LAW INST. 1977).

trace their injuries back to the source of the contamination, but also document unreasonably dangerous conditions that existed inside the facility before and during the flood that led to a chemical release. The plaintiff would have to prove that the firm's chemical storage policies or practices were unreasonably lax. Of course, in many cases, the facility would be so damaged by flooding as to preclude gathering that kind of proof during discovery.[120]

Finally, the strongest argument against continuing to rely on a private law risk management regime is simply that it has not worked in the past. The threat of tort suits has not prompted industry to invest in measures to prevent weather-related chemical releases, such as elevating chemical storage tanks or building secondary containment systems. Further, the handful of tort suits that have been filed, alleging injury from chemical releases during extreme weather events, have failed.[121] Courts have rejected arguments that firms knew or should have known about potential dangers from flooding and therefore had a duty to secure their facilities.[122] The suddenness of weather emergencies (as well as defendants' portrayal of them as *force majeure* events) undercut plaintiffs' arguments that a defendant should have known about the danger.[123] Tort plaintiffs also have difficulty proving that the defendant failed to use ordinary or

120. *See* Faure, *supra* note 102, at 112 (noting that "[p]rivate parties may in some cases lack adequate information on preventive technology" that could have been used by the risk-creating enterprise to avoid the disaster).

121. Dena Adler, *Turning the Tide in Coastal and Riverine Energy Infrastructure Adaptation: Can an Emerging Wave of Litigation Advance Preparation for Climate Change?*, 4 OIL & GAS, NAT. RESOURCE & ENERGY J. 519 (2018) (noting weaknesses of "failure to adapt" lawsuits against energy infrastructure owners and arguing that facilities are often shielded from civil liability by weak permits); Peel & Osofsky, *supra* note 4, at 2179-80 (2015) (analyzing suits alleging that firms have failed to take reasonable steps to adapt to climate change and arguing that Australia offers a more promising model for these suits than the U.S.); Jenna Shweitzer, *Climate Change Legal Remedies: Hurricane Sandy and New York City Coastal Adaptation*, 16 VT. J. ENVTL. L. 243, 290 (2014) (examining cases against New York City for failure to adapt to climate change and arguing that these cases are not likely to succeed).

122. Adler, *supra* note 121.

123. Arkema Chemicals, for example, defended its work to secure chemicals before the arrival of Hurricane Harvey by emphasizing that the flooding during Harvey was "unprecedented." Stephanie Ebbs, *Noxious Chemical Fire During Hurricane Harvey Caused by Failure of "All Levels of Protection," Probe Reveals*, ABC NEWS, (May 25, 2018), https://abcnews.go.com/Politics/noxious-chemical-fire-hurricane-harvey-caused-failurelayers/story?id=55410407.

customary care, given the widespread damage that storms cause throughout communities.[124] If hundreds of firms experience chemical releases during extreme weather, then it is difficult to show that a particular defendant's level of care with respect to its own hazardous substances was uncustomarily lax. Instead, a level of care that resulted in the release of hazardous substances would appear to be the industry standard in the wake of a major storm. For this reason, we should not let industry custom be the sole measuring stick for the appropriate level of care with respect to storage and management of hazardous substances.

2. Profit Incentives

If the tort system is unlikely to incentivize prevention of chemical releases during floods, what about firms' profit incentive to maintain control of their inventory and protect their own property? Here too, private incentives, standing alone, are unlikely to lead firms to undertake necessary preventive measures. To be sure, firms have a profit motive to prevent valuable chemicals or fuel from escaping from facilities. Such releases involve loss of valuable inventory and potential contamination of the facility itself, leading to prolonged plant closures. In theory, firms in a competitive market should be seeking cost-effective solutions to prevent flood-related chemical releases.

Despite these market incentives, firms' level of safety investment is likely to be suboptimal if there is no accountability for the mass contamination events that can result when hazardous substances escape. Firms will undertake risk-reducing measures to protect their own property, but only up to the point where the cost of precautionary measures equals the expected cost *to the firm* of future potential property damage. The cost *to the surrounding communities* from their operations does not enter into the equation. Industrial chemical releases during extreme weather events, in other words, present an externality problem not easily remedied through the market.[125]

124. Shweitzer, *supra* note 121, at 290.

125. *See* Hudson, *supra* note 10, at 1138 (criticizing land development policies, especially those that encourage development in flood plains, and arguing that "[w]hile

3. Insurance Incentives

Advocates of the status quo, perhaps recognizing these weaknesses of tort law and profit incentives, nonetheless continue to argue against new regulation by emphasizing the role of insurance in preventing chemical releases.[126] They argue that insurers can incentivize firms to take *ex ante* measures to prevent flood-related toxic releases, without the need for burdensome government regulations.

To be sure, insurance plays a vital role in managing flood risk, but it is far from a comprehensive solution to the externality problem from toxic floodwaters. First-party insurance can, of course, help firms manage the risk of extreme weather to their own enterprises.[127] But it is important to distinguish such insurance from liability insurance, which would insure companies against third-party claims brought by individuals or businesses harmed by chemical releases. Most flood insurance is first-party insurance that is not designed to compensate injured individuals off-site.[128]

Insurance should not be the primary tool for preventing toxic chemical releases for several additional reasons. Small firms have little incentive to purchase liability insurance coverage that is greater than the firm's assets, even if the potential damage from chemical releases far exceeds the value of the firm's assets.[129] For larger firms, purchasing liability insurance will not lead to risk-reducing measures unless the insurer closely verifies each firm's efforts to reduce risk and lowers premiums for firms that take risk-reducing measures.[130] Furthermore, liability insurance markets will not operate efficiently to reduce risk if there are few examples of successful

the landowner bears the full benefit of their economic decision, it is society that collectively bears the incremental environmental harms caused by a collection of property owners converting their land from natural capital to the built environment").

126. Arnold, *supra* note 11.

127. Jeffrey O'Connell & John Linehan, *Neo No-Fault Early Offers: A Workable Compromise Between First and Third-Party Insurance*, 41 GONZ. L. REV. 103, 105 (2005) (exploring the differences between first- and third-party insurance).

128. Saul J. Singer, *Flooding the Fifth Amendment: The National Flood Insurance Program and the "Takings" Clause*, 17 B.C. ENVTL. AFF. L. REV. 323, 328 (1990).

129. Shavell, *supra* note 13, at 361.

130. Robert H. Jerry II, *Managing Hurricane (and Other Natural Disaster) Risk*, 6 TEX. A&M L. REV. 391, 410 (2019).

liability lawsuits involving flood-related chemical releases. If tort suits are not a significant threat to insureds, then liability insurance covering these claims will be cheap to obtain, and some firms may decide to forego liability insurance coverage for offsite releases altogether, given the low litigation risk.[131] Finally, as a practical matter, liability insurance that would cover chemical releases due to flooding is not readily available in the marketplace.[132] Many liability policies exclude coverage for hazardous substance releases, claims related to flooding, and *force majeure* events.[133]

For all of these reasons, private law is likely to lead to suboptimal risk outcomes for toxic floodwaters incidents.[134] Tort liability cannot sufficiently deter facilities from risky chemical storage practices because of the nature of toxic floodwater incidents and the many obstacles to bringing a successful suit. Insurance, while providing some *ex ante* incentive to enact safety measures and adopt emergency plans, cannot alone incentivize firms to prevent flood-related chemical releases. The existing private law regime for toxic floodwater risk underprotects adjacent communities and leaves injured individuals without a viable remedy for damages.

Next, I turn to some promising public law approaches for preventing toxic floodwaters. In examining regulatory options, it is important to recognize that public law should supplement, rather than supplant, the existing private law regime for toxic floodwaters. In other words, federal or state regulatory standards governing chemical and oil storage and spill prevention should not preempt or preclude the possibility of state tort suits over chemical or oil releases in the wake of major storms. Firms that comply with applicable regulations on chemical or oil storage should not be shielded from private

131. For this same reason, proposals to mandate that firms in coastal industries purchase insurance or surety bonds to cover disaster risks—so-called financial assurance mandates—are unlikely to offer much risk-reduction benefit. *See* Arnold, *supra* note 11.

132. JUSTIN R. PIDOT, GEO. ENVTL. L. & POL'Y INST. COASTAL DISASTER INSURANCE IN THE ERA OF GLOBAL WARMING, (2007); Jerry, *supra* note 130, at 427.

133. *Id*. at 427–28.

134. *See* Faure, *supra* note 102, at 114 (although liability rules "can provide incentives for disaster risk mitigation, in practice the impact of liability rules may not be that large. Due to high barriers to entry, the liability regime may turn out to be merely an ad hoc system available to only a small percentage of accident victims.").

lawsuits for injuries. The reasons for not recognizing such a regulatory compliance defense, in the specific context of toxic floodwaters, parallel the reasons why courts have rejected the defense in other areas of tort law.[135] These considerations include federalism, efficiency, and the fact that regulatory standards, though important for preventing harm to the public, do not compensate individuals and businesses when harm occurs. Therefore, the analysis that follows should not be interpreted as negating any role for tort law as a response to toxic floodwaters incidents.

IV. HARNESSING PUBLIC LAW TO STRENGTHEN THE CHEMICAL SAFETY REGIME

The United States has more than a dozen major statutes that address discharges of toxic substances to the environment,[136] yet there are significant gaps in the chemical regulatory regime that leave communities vulnerable to toxic floodwaters. Existing statutes, for example, do not limit where industrial facilities can be sited. Instead, through permitting regimes, existing statutes regulate facilities' discharges of pollutants into air and water from whatever location they are sited. These statutes poorly regulate risks from the storage of toxic chemicals, even where such storage could lead to widespread chemical releases in the event of a natural disaster. Although there is a yawning regulatory gap at the federal level, only fourteen states have

135. *See, e.g.*, Robert L. Rabin, Keynote Paper, *Reassessing Regulatory Compliance*, 88 GEO. L J. 2049 (2000); Alan Schwartz, *Statutory Interpretation, Capture, and Tort Law: The Regulatory Compliance Defense*, 2 AM. L. & ECON. REV. 1 (2000); Mark A. Geistfeld, *Tort Law in the Age of Statutes*, 99 IOWA L. REV. 957 (2014); RESTATEMENT (SECOND) OF TORTS § 288C (AM. LAW INST. 1965) ("[c]ompliance with a legislative enactment or an administrative regulation does not prevent a finding of negligence where a reasonable man would take additional precautions."); RESTATEMENT (THIRD) OF TORTS: PROD. LIABILITY § 4(b) (AM. LAW INST. 1998) ("[A] product's compliance with an applicable product safety statute or administrative regulation . . . does not preclude as a matter of law a finding of product defect.").

136. *See, e.g.*. Clean Air Act, 42 U.S.C. § 7401 (1990); Clean Water Act, 33 U.S.C. § 1311(a) (1995); Safe Drinking Water Act, 42 U.S.C. §§ 300f–300j-27 (2016); Federal Food, Drug and Cosmetic Act, 21 U.S.C. § 346(a) (1960); Consumer Product Safety Improvement Act of 2008, Pub. L. No. 110-314, 112 Stat. 3016 (2008).

enacted laws governing the conditions of chemical storage.[137] Given this longstanding regulatory weakness, new legislation (or, in some cases, new regulation) is needed to reduce the risk that industrial facilities will release hazardous substances during major floods.

The gaps in the existing chemical regulatory regime make little sense from the standpoint of risk management. The regulations for the 1976 Resource Conservation and Recovery Act (RCRA), for example, contain extensive requirements for the handling, labeling, and storage of hazardous waste.[138] RCRA applies, however, solely to actual wastes (i.e. substances that firms intend to discard),[139] not to useful chemicals intended for sale or as inputs to manufacturing processes.[140] But commercially useful chemicals, if they escape into the environment, can be just as harmful to human health as hazardous waste.[141] Federal law also has extensive requirements for the storage of oil in tanks,[142] including a requirement that tank owners draft and implement spill prevention plans,[143] but there are no similar requirements for

137. Clean Water Act Hazardous Substances Spill Prevention, 83 Fed. Reg. 29,499, 29510 n.18 (Jun. 25, 2018). *See also* Judd Schechtman, NYU Tandon Sch. of Eng'g, Presentation at the National Working Waterfront Symposium: Toxic Storm: The Challenge and Solutions to Hazardous Materials in Industrial Floodplains, (2015) (discussing state laws aimed at preventing toxic contamination from flooding).

138. 40 C.F.R. § 265.51(a) (2018) (requiring facilities which produce, handle, or dispose of hazardous waste to develop contingency plans that "minimize hazards to human health or the environment from fires, explosions, or any unplanned sudden or non-sudden release of hazardous waste or hazardous waste constituents to air, soil, or surface water").

139. 42 U.S.C. § 6903(27) (2014) (definition of solid waste).

140. Clean Water Act Hazardous Substances Spill Prevention, 83 Fed. Reg. 29,499, 29506-10 (Jun. 25, 2018) (summarizing federal regulations that are relevant to chemical storage and releases).

141. The International Agency for Research on Cancer (IARC), for example, has identified 120 agents as known carcinogens, including commonly used industrial chemicals such as benzene, trichlorethylene, and vinyl chloride. The IARC has identified 88 additional agents as probable human carcinogens. *See Agents Classified by the IARC Monographs, Volumes 1-128*, INTL. AGENCY FOR RESEARCH ON CANCER, *available at* https://perma.cc/Y56R-RZWF (last accessed Oct. 23, 2020). *See also Known and Probable Human Carcinogens,* AM. CANCER SOC'Y, *available at* https://perma.cc/2ZQS-SKPX (last accessed Oct. 13, 2020).

142. 40 C.F.R. pt. 112 (2002).

143. *Id.*

the storage of hazardous substances other than oil.[144] Federal law does authorize civil and criminal penalties for unpermitted releases of both oil and hazardous substances into water,[145] but violations of these statutes have rarely led to substantial penalties in the wake of mass flooding events.[146]

As a first step toward a stronger regulatory regime, policymakers should compile an inventory of flood-exposed facilities that store oil and hazardous chemicals—as well as flood-exposed sewage treatment plants—to identify the most dangerous facilities. Regulators may already be aware of some "at-risk" facilities if the facilities are subject to federal or state permitting for other reasons (e.g., they are a "major source" for air permitting purposes).[147] But many hazardous chemical storage facilities (e.g., warehouses, retailers, liquid storage terminals) are not subject to any ongoing environmental permitting or regular inspections because they do not discharge pollutants to the environment in the ordinary course of their business.[148] Depending on their location, such facilities may need to be added to the inventory of flood-exposed industrial facilities and should be subject to regular inspection.

144. Another unjustified regulatory gap is that RCRA heavily regulates underground storage tanks (USTs) that store hazardous chemicals, but there are no similar requirements for tanks that store hazardous substances aboveground. USTs must meet a number of technical standards, and owners maintain financial responsibility in the event of a spill. *See* 40 C.F.R. pt. 280; EPA, *Learn About Underground Storage Tanks (USTs)*, https://perma.cc/PHH6-SNFF (last accessed Oct. 14, 2020); DEF. LOGISTICS AGENCY, DLA ENERGY ENVIRONMENTAL GUIDE FOR FUEL FACILITIES, ch. 3.2–3.3 (2019). The federal regulations for USTs also dictate appropriate filling practices, owner and operator training, leak detection procedures, and reporting requirements. *Id.*

145. *See* Clean Water Act, 33 U.S.C. § 1311(a) (1995) (prohibiting discharge of pollutants without a permit); 40 C.F.R. § 112.1 (2011) (requiring preparation of spill prevention, control, and countermeasure plans for certain facilities that store oil).

146. For an example of enforcement actions to flood-related toxic releases, see Lise Olsen, *A Year Later, Texas Regulators Start to Act Against Harvey's Polluters*, HOUS. CHRON. (Aug. 31, 2018, 4:08 PM), *available at* https://perma.cc/7FNE-XADG. *See also* David Grunfield, *Stolthaven Fined $12,000 for Failing to Quickly Report Chemical Release Following Hurricane Isaac*, TIMES-PICAYUNE (Sep. 19, 2012), *available at* https://www.nola.com/news/weather/article_1338ec4e-8b54-5332-b5a3-f281c5b36365.html.

147. 42 U.S.C. § 7475 (1977).

148. Warehouses and other storage locations are obligated to provide an annual inventory of the hazardous chemicals on site, pursuant to the Emergency Planning and Community Right to Know Act (EPCRA), 42 U.S.C. § 11022 (2018). But EPCRA is a disclosure statute with few substantive requirements governing the conditions of chemical storage. *See infra* Part IV(B).

Once the inventory process is underway, policymakers should take three additional steps to prevent industrial chemical releases: (1) establish federal standards for chemical storage and spill prevention; (2) reform outdated emergency planning and notification requirements; and (3) prohibit the construction of new industrial facilities in flood-exposed areas.

A. Establishing Standards for Chemical Storage and Spill Prevention

While the United States has comprehensive performance and monitoring standards for aboveground oil tanks to prevent oil spills,[149] one of the largest gaps in the existing chemical regulatory regime is the lack of any regulatory standards for aboveground storage of hazardous substances other than oil. No federal regulations mandate that hazardous substances be kept in suitable, flood-proof storage tanks and no federal regulations mandate chemical tank inspection, leak detection, corrosion prevention, or secondary containment measures. With sparse regulatory oversight, firms can continue to store extremely toxic substances in aging containers, indoors or outdoors, within just a few feet of waterways prone to flooding.[150] It is unconscionable that the federal government has not promulgated regulatory standards for storage of hazardous chemicals in aboveground tanks, especially since the risk to human health is, in many cases, far greater from the industrial chemicals left unregulated than it is from oil.[151]

The failure to enact these standards is glaring because the 1972 Clean Water Act mandated that EPA establish storage and spill prevention standards for oil and other hazardous substances.[152] Within a year, EPA promulgated regulatory

149. 40 C.F.R. pt. 112 (2002).

150. The aging of existing chemical storage tanks is a serious and overlooked problem. West Virginia, one of the few states to enact legislation regulating aboveground chemical storage, has reported that more than 25% of the chemical storage tanks in the state are more than 30 years old. W. VA. DEPT. OF ENVTL. PROT., AST Registration Graphical Information, *available at* https://perma.cc/3JSM-F8QS (last accessed Oct. 13, 2020).

151. IARC, *supra* note 141.

152. 33 U.S.C. § 1321(j)(1)(C) (2018) ("[T]he President shall issue regulations . . . establishing procedures, methods, and equipment and other requirements for equipment to prevent discharges of oil and hazardous substances from vessels and from onshore facilities and offshore facilities, and to contain such discharges.").

standards for storage of oil.[153] Nearly fifty years after the Clean Water Act's enactment, however, EPA has failed to promulgate similar safety standards for the storage of other hazardous substances. This inordinate delay (and abdication of regulatory responsibility) helps to explain why industry is unprepared for the challenges of preventing weather-related chemical releases. A comprehensive federal regulatory program focusing on containment, preparedness, and spill prevention simply never got off the ground.

In 2015, several environmental groups sued EPA to compel it to issue regulations for hazardous substances required by the Clean Water Act. As a result, EPA agreed to a 2016 consent decree that required the agency to begin the rulemaking process addressing hazardous substances.[154] Once the Trump Administration took office, however, EPA concluded that no new regulation was necessary.[155] In EPA's view, other federal regulatory programs were effective in preventing and responding to hazardous substance spills, and any new regulation on this issue would be superfluous.[156]

EPA's conclusion was plagued by both legal and factual inaccuracies.[157] Significantly, EPA ignored the clear command of the Clean Water Act that EPA "shall issue regulations" governing storage of hazardous substances and prevention of

153. 38 Fed. Reg. 34,165 (Dec. 11, 1973). Under the Clean Water Act, facilities that store large quantities of oil (above 1,320 gallons) above or below ground must take measures to prevent, prepare for, and respond to accidental discharges of oil and must prepare a Spill Prevention, Control, and Countermeasure (SPCC) plan. The largest oil storage facilities (above 1 million gallons) must prepare a more detailed Facility Response Plan (FRP) that includes planning for worst-case oil discharges. 40 C.F.R. pt. 112 (2002).

154. Envtl. Justice Health Alliance for Chem. Policy Reform v. EPA, 15-cv-5705 (S.D.N.Y. Jul. 21, 2015).

155. 84 Fed. Reg. 46,100 (Sep. 3, 2019).

156. *Id.*

157. One crucial factual inaccuracy is that EPA, relying on spill data from the National Response Center (NRC), asserted that few hazardous substance spills have occurred in the United States. The NRC, however, relies on self-reporting, and it is widely believed to underestimate the true number of spills. U.S. GOV'T ACCOUNTABILITY OFFICE, CLEAN WATER: BETTER INFORMATION AND TARGETED PREVENTION EFFORTS COULD ENHANCE SPILL MANAGEMENT IN THE ST. CLAIR-DETROIT RIVER CORRIDOR 11 (2006). In a prior rulemaking, EPA said that National Response Center data should be understood to "represent the minimum number of spills" because "it is likely that [the NRC] greatly underestimate[s] the actual number of spills because of significant underreporting." 62 Fed. Reg. 54,508, 54,527 (Oct. 20, 1997).

accidental discharge.[158] When Congress has delegated authority to an agency to decide whether regulatory action is necessary (or is instead superfluous given other regulatory action), Congress has made this intent clear with plain language.[159] Under the Clean Water Act, however, Congress used plain language to indicate the opposite: EPA does *not* have such discretion.

Even if EPA did have the authority to determine that existing regulations can take the place of regulatory standards for hazardous substance storage under the Clean Water Act, its own analysis shows that the coverage of the other regulations is partial, at best.[160] The other regulations for hazardous substances discussed by EPA are nowhere near as comprehensive as EPA's oil spill rules, nor do they address the same risks that comprehensive hazardous substance spill regulations would cover.[161]

Enacting hazardous substance spill prevention regulations under the Clean Water Act is the most important regulatory step that EPA could take to manage toxic floodwater risk without new Congressional authority. EPA could set performance, construction, and leak detection requirements for chemical storage tanks and could require facilities that store chemicals above a certain volume threshold to prepare spill prevention and response plans. New regulations could specify siting and construction standards to limit flood risk, including standards that would require elevating any chemical storage tanks in flood zones.

However, promulgating these Clean Water Act regulations would not be a panacea for the toxic floodwaters problem. If EPA enacts such regulations, they would apply only to the 330

158. 33 U.S.C. § 1321(j)(1)(C) (2018). The statute says that "the President" shall issue these regulations, and that authority was delegated to EPA in 1973. Exec. Order No. 11,735 § 1(4) (1973); 38 Fed. Reg. 21,243 (Aug. 7, 1973).

159. *See, e.g.,* 33 U.S.C. § 1317(a)(2) (2018) (requiring EPA to "take into account…the extent to which effective control is being or may be achieved under other regulatory authority" before issuing effluent standards for companies' intentional discharge of toxic pollutants under the Clean Water Act).

160. 84 Fed. Reg. 46,100, 46,102 (Sep 3, 2019).

161. *See* Letter from 55 Groups Opposed to EPA's Do-Nothing Chemical Spill Plan, RE: Docket ID No. EPA-HQ-OLEM-2018-0024, Clean Water Act Hazardous Substance Spill Prevention Action (Aug. 24, 2018) (explaining differences between coverage of other regulations and the required regulations under the Clean Water Act).

chemicals that EPA has designated as "hazardous substances" under the Clean Water Act.[162] EPA originally created the hazardous substances list in 1978 and has not updated it in decades.[163] That short list is a far cry from the 30,000 chemicals commonly used in commercial applications in the United States.[164] To ensure that a fuller suite of chemicals is covered by hazardous substance spill prevention regulations, EPA will have to go through the rulemaking process to expand the list, or the states will have to supplement any EPA action with expanded, state-promulgated lists of hazardous chemicals.[165]

B. Reforms to Emergency Planning and Notification

The second component of a more robust regulatory regime is strengthening the 1986 Emergency Planning and Community Right to Know Act (EPCRA)[166] by adding substantive provisions on chemical storage and spill prevention. EPCRA is the principal federal law designed to promote emergency planning by communities and public access to industry information on chemical storage and releases. Since its enactment, however, EPCRA has been a paper tiger, underfunded and underenforced.[167]

EPCRA operates through disclosure requirements, rather than substantive mandates to the industries subject to the

162. 40 C.F.R. § 116.4 (Jul. 1, 2011).

163. 43 Fed. Reg. 10,474 (Mar. 13, 1978).

164. APPLEGATE ET AL., *supra* note 14, at 25.

165. The states that have enacted their own legislation on the threat of chemical releases have largely focused on one sub-issue: protecting coal ash pits from flooding. These pits are commonly located near coal-burning power plants and along waterways. *See, e.g*, N.C. Gen. Stat. §§ 130A-309.200-239 (2014); Coal Ash Pollution Prevention Act, S.B. 0009, 101st Gen. Assemb., Reg. Sess. (2019); *Illinois House and Senate Pass Landmark Decision to Clean Up Coal Ash*, EARTHJUSTICE (May 28, 2019), *available at* https://perma.cc/BA3L-HZWE.

166. 42 U.S.C. §§ 11001-11005 (1986).

167. *See* Danielle Purifoy, *EPCRA: A Retrospective on the Environmental Right-to-Know Act*, 13 YALE J. HEALTH POL'Y, L. & ETHICS 375, 401 (2013) (noting that Local Emergency Planning Committees (LEPCs)—committees required by EPCRA to create emergency plans and keep the public informed of chemical hazards—are "largely an unfunded mandate," and they are "in constant competition for the few federal grants available for emergency planning…."); Lamdan & Bratspies, *supra* note 11, at 599 ("studies show that LEPCs often fail to provide public notice about their activities and meetings, and they do not receive public inquiries, as most of the public does not even know that LEPCs exist.").

statute. Each year, firms must disclose to state and local officials an inventory of the amounts and names of toxic chemicals being stored on site.[168] The chemicals subject to this inventory reporting include substances such as heavy metals, corrosive acids, ammonia, and petroleum products.[169] EPCRA also requires annual reporting of releases of toxic chemicals to the air, water, and land (the so-called Toxic Release Inventory, or TRI).[170] This TRI reporting principally applies to chemicals that have been legally discharged to the environment under state and federal permits.[171]

The theory behind EPCRA is that information disclosure will help communities make sound decisions about disaster prevention and assist first responders in emergency situations. But EPCRA performs poorly even with respect to this limited aim. There is a broken link between the disclosure of chemical storage inventory data that may indicate a potential risk to waterways or communities and the ability of regulators to do anything about the problem. Moreover, while many states make industry TRI information readily available on websites, most do not make the chemical inventory forms public, often citing the risk that publicizing the data will lead to terrorist attacks on industrial plants.[172] However, inventory forms are the crucial information that the public needs to determine which chemicals are being stored at facilities. The inventory forms are directly relevant for preparing for, and responding to, toxic floodwaters incidents. They contain the crucial data on chemical hazards that would be needed in flooding scenarios, yet citizens do not

168. 42 U.S.C. §11022 (2018).

169. *See* 40 C.F.R. pt. 355.

170. 42 U.S.C. §11024.

171. Rebecca S. Weeks, *The Bumpy Road to Community Preparedness: The Emergency Planning and Community Right-to Know Act*, 4 ENVTL. L. 827, 845-48 (1998).

172. *See, e.g.*, Jim Morris & Joe Wertz, *A Common Fertilizer Can Cause Explosions. Uneven Regulation Puts People at Risk.* CTR. FOR PUB. INTEGRITY (Jan. 29, 2020), *available at* https://perma.cc/2V5S-JPAV (discussing the Texas Attorney General's determination that chemical inventory forms should not be released because of a state law that limits release of information "more than likely to assist in the construction or assembly of an explosive weapon or a chemical, biological, radiological, or nuclear weapon of mass destruction"). *See also* Trevor Bossi, "*Hey, What Chemicals Do You Have in There?" Homeland Security and Right-to-Know Laws Clash in Texas*, 9 HOUS. L. REV.: OFF THE REC. 129 (2019).

have access to them in many jurisdictions, despite the "right to know" intent of the federal legislation.[173]

State and local regulators do have access to these chemical inventory forms (when firms choose to submit them), but their receipt of the data rarely triggers any risk reduction measures or regulatory response. EPCRA mandates only disclosure of the bare facts of chemical storage. The statute provides no authority for officials to check whether reported hazardous substances are stored *properly* at a facility, nor does it provide authority to inspect or determine the age of storage tanks.[174] Few states have filled this gap by giving state regulators such authority under state law.[175]

EPCRA prioritizes industry autonomy, not community safety. A warehouse storing tools in a populated area, for instance, could switch to storing hazardous pesticides without notifying neighbors and without confronting any substantive standards for protecting the warehouse from flooding or other extreme weather.[176] True, the warehouse would ultimately have to disclose to regulators (but not neighbors) that it is storing pesticides, but because EPCRA requires these annual disclosures to be made by March 1 of each year regulators and first responders may not become aware of the storage of these pesticides during the prior calendar year for more than twelve months. That lag-time in disclosure would very likely encompass a hurricane season.

In short, industry's autonomy to bring hazardous chemicals on site remains sacrosanct, even if the decisions put nearby

173. Illinois appears to be the only state that makes the chemical inventory information public and searchable online. *See* CTR. FOR EFFECTIVE GOV'T, *Chemical Hazards in Your Backyard*, TRUTHOUT (Apr. 20, 2015), *available at* https://perma.cc/Y3E2-C7WG; Lamdan & Bratspies, *supra* note 11, at 576 (stating "information access is a cornerstone of effective chemical disaster preparation").

174. *See* Linda-Jo Schierow, *The Emergency Planning and Community Right-to-Know Act (EPCRA): A Summary*, CONG. RESEARCH SERV. (Apr. 5, 2012), *available at* https://perma.cc/797A-DT5Q (noting the lack of substantive standards within EPCRA).

175. *See* Clean Water Act Hazardous Substances Spill Prevention, 83 Fed. Reg. 29,499, 29510 n.18 (Jun. 25, 2018); *see also* Schechtman, *supra* note 137.

176. By March 1 of the year following this switch in the materials stored, the warehouse would become obligated to provide chemical inventory data disclosing the pesticide storage to its LEPC and its state government. 42 U.S.C. § 11022 (2018). LEPCs are notoriously underfunded, however, and an LEPC would be unlikely to take any risk reduction measures once it was in possession of this chemical data. *See* Purifoy, *supra* note 167, at 401.

communities at risk. Further, EPCRA has no provisions that would incentivize plant operators to shift to less hazardous chemical substitutes. This is a pitiable system for protecting communities from chemical accidents, whether flood-related or otherwise. As Sarah Lamdan and Rebecca Bratspies have noted, information about chemical hazards needs to be widely distributed to the public, not just held in the files of the fire department or other local officials:

> Easy access to information about toxic chemical sites is especially important in the aftermath of hurricanes, floods, wildfires, and other natural disasters. In weather disasters, people are often left to make health and safety decisions on their own, without the ability to coordinate with neighbors and emergency responders when the normal routes of communication like internet access and electrically-powered devices fail. History has shown that when people do not know about nearby chemical hazards, they are far more likely to be injured by chemical releases.[177]

Due to Congress's reluctance to impose any substantive requirements on industry in 1986, EPCRA today amounts to a paperwork exercise for industry and an unfunded mandate for localities. Local emergency planning, when it occurs, rarely requires firms to make changes to their facilities' operations, and instead focuses on emergency notification procedures and training of first responders.[178]

EPCRA could become one of the major regulatory tools for prevention of toxic floodwaters if it were amended to impose substantive requirements regarding safe storage of toxic chemicals, rather than shifting the burden to local authorities to engage in emergency planning. To transform the statute into a tool for disaster prevention, Congress should take two steps.

First, it should increase federal funding for Local Emergency Planning Committees (LEPCs) so that these committees can fulfill their assigned emergency-planning tasks, with robust

177. Lamdan & Bratspies, *supra* note 11, at 590.
178. *See* Purifoy, *supra* note 167, at 382.

public disclosure and input. LEPCs bring together elected officials, police and fire departments, and other first responders to prepare and implement emergency response plans.[179] The emergency plans include identification of hazardous facilities, responsible personnel, evacuation routes, public notification procedures, and training and emergency response procedures.[180] Most LEPCs lack a dedicated funding source to focus on EPCRA's chemical hazards mandate,[181] and the role of LEPCs has often expanded far beyond EPCRA's original chemical hazards mission.[182] In many jurisdictions, the LEPC is the central local planning agency for all kinds of emergencies, including terrorist attacks and pandemics.[183] Moreover, enforcement against industry is rare for violations, such as failure to file inventory forms or misreporting, due to lack of LEPC staff support.[184] Adequate resources are key to EPCRA's functioning: if Congress will not appropriate new funding, states should levy fees upon industry to fund robust local and state planning for chemical emergencies.

Second, Congress should amend EPCRA to impose construction, siting, and performance standards for storage of hazardous chemicals above a certain volume threshold. Such standards should apply to the thousands of chemicals subject to inventory reporting under EPCRA, including the 366 chemicals that EPA has designated as "extremely hazardous chemicals" under the statute.[185]

Under this amendment, firms that choose to use or store hazardous chemicals should be subject to strict requirements for storage tank location and age, secondary containment, inspection, and flood protection. The amendment should require that firms elevate newly-constructed chemical storage tanks in

179. EPA, Local Emergency Planning Committees, *available at* https://www.epa.gov/epcra/local-emergency-planning-committees (last accessed Jan. 2, 2021).

180. *Id.*

181. Purifoy, *supra* note 167, at 403; Llewelyn M. Engel, Note, *Emergency Planning and Community Right to Know: Environmental Justice Concerns with Disclosure-Based Laws*, 6 GEO. J. L. & MOD. CRITICAL RACE PERSP. 117, 130 (2014).

182. Purifoy, *supra* note 167, at 403.

183. *Id.*

184. Lamdan & Bratspies, *supra* note 11, at 599.

185. *See* 40 C.F.R. pt. 355, app. A (2006) (listing EPCRA-classified extremely hazardous substances).

flood-exposed areas to reduce the risk of flood-related releases, and it could put conditions on storage of designated "extremely hazardous chemicals" in flood zones. For example, such storage could trigger annual inspection of the storage tanks by a professional engineer. Congress should also require that firms post bonds or provide other financial security for large chemical storage tanks to ensure that funds are available for clean-up, emergency response, and damages, in the event of a catastrophic chemical release. Under this amendment, firms would retain their autonomy to manufacture whatever products they choose at a given facility, but if plant owners choose to utilize hazardous chemicals subject to EPCRA reporting, they must ensure that operations can be conducted with a reasonable degree of safety.

To be sure, this amendment would transform EPCRA from an information disclosure statute into one that has substantive safety provisions for chemical storage. But this change is warranted given that the information disclosure provisions, standing alone, have failed to create necessary upgrades in chemical storage standards. EPCRA prioritizes industry autonomy over community safety. Under today's EPCRA, industrial facilities can store whatever chemicals they choose, under any conditions they choose, in whatever locations they choose, so long as, once a year, they provide an inventory of the hazardous substances stored on-site to state and local regulators. These minimal requirements are not fulfilling the larger goals of EPCRA, which Congress enacted in the wake of the deadly cyanide explosion at the Union Carbide chemical plant in Bhopal, India.[186] The purpose of the statute was to protect communities from toxic chemical releases, not just to inform state and local governments of the potential for releases. It is time, therefore, for Congress to add some teeth to EPCRA by imposing substantive safety mandates.

C. Siting Standards for New Industrial Facilities

The third component of a more robust chemical regulatory regime is enacting zoning and siting standards that would

186. Lamdan & Bratspies, *supra* note 11, at 581–82.

constrain construction of new industrial facilities that store hazardous chemicals in flood-exposed areas. These land-use restrictions would be controversial, but it is not feasible to mitigate risks from toxic floodwaters without engaging with the central issue of where hazardous facilities should be sited. Indeed, any sensible national strategy for climate change adaptation must involve reorienting land-use policy to reduce disaster risks from sea level rise and flooding.

Land-use reforms should focus on newly-constructed industrial facilities, without attempting to force unrealistic location changes on existing plants. States and localities could enact strict limits on where new facilities that store oil or hazardous substances can be located, including restrictions on construction in flood-prone areas and areas that may become flood-prone during the expected lifetime of the planned facility.

Restricting land development is one of the most politically fraught issues in climate adaptation. Zoning restrictions affect local economies, housing prices, and the decisions of tens of thousands of businesses, rather than a handful of major polluters.[187] Proposed land-use restrictions affect the interests of developers who have already purchased land with the expectation of developing it, creating fierce opposition.[188] In addition, channeling future industrial development away from flood-exposed areas may result in increased costs for firms, including longer transportation distances for raw materials and finished products. These costs, however, would be borne by firms (and ultimately, consumers) as the price of avoiding the serious environmental externalities that are currently borne by communities.

Despite these political obstacles, land-use restrictions are essential to avoid flood-related chemical releases from industrial facilities. Not only would such restrictions help to protect nearby residences and businesses, but they would also protect the stability of regional economies. Without such restrictions on siting hazardous facilities in flood-prone areas, toxic floodwater incidents can force businesses to shut down for extended periods,

187. Hudson, *supra* note 10, at 1138–39.

188. *Id.* at 1127 ("If you really want to see pushback from a regulated community, tell them they cannot put a facility on a piece of property that they own and plan to develop or lease for development.").

creating losses for suppliers, customers, and employees.[189] Furthermore, allowing industrial development in flood-prone areas, including the installation of acres of asphalt and other impervious surfaces, could exacerbate the potential for flooding in other parts of a region.[190] Addressing this problem at the initial stages of development will make it easier to avoid future toxic incidents.

What would appropriate land use restrictions look like? Well-crafted regulations should prohibit siting new industrial facilities that store hazardous substances in FEMA-designated flood plains, areas projected to be inundated by five feet of hurricane storm surge, and areas projected to be regularly flooded by 2050. The prohibition should be linked to a volume threshold for hazardous substances (e.g., applying the prohibition only to facilities storing more than 100,000 gallons of oil or hazardous substances on-site). Exemptions to the prohibition should be provided for facilities that are necessarily water-dependent (e.g., ports and shipbuilding) and must be located near major rivers and harbors. States or localities could use special overlay zones on zoning maps to define which flood-exposed areas would be off limits to new industrial facilities.[191]

In an era of extreme weather, these kinds of strict prohibitions on siting industrial facilities in flood-exposed areas will become necessary. Past efforts to use incentives or subsidies to channel industrial development away from flood zones have failed. By far the largest such voluntary effort is the National Flood Insurance Program (NFIP), established by Congress in 1968 to keep development out of high risk areas and constrict "the development of land which is exposed to flood damage."[192]

189. Meri Davlasheridze et al., *Economic Impacts of Storm Surge and the Cost-Benefit Analysis of a Coastal Spine as the Surge Mitigation Strategy in Houston-Galveston Area in the USA*, 25 MITIGATION & ADAPTATION STRATEGIES FOR GLOB. CHANGE 329, 332 (2019) ("In areas with high concentrations of industrial activities . . . disruption of strategic assets could reverberate throughout not only the local or regional economy but may have significant economic and social implications nationwide.").

190. Hudson, *supra* note 10, at 1131 (noting that the wide geographic extent of property destruction from Hurricane Katrina was "due in no small part to the commercial development of floodplains that both destroyed natural wetland buffer systems and placed citizens on land at high risk of flooding").

191. Reiblich et al., *supra* note 10, at 177.

192. 42 U.S.C. § 4001(e) (1994).

Over five decades, however, the program has had the opposite effect. It has facilitated the siting of buildings in high-risk zones by offering subsidized flood insurance rates to firms that would find private insurance to be prohibitively expensive.[193]

There have been multiple efforts in Congress to reform the flood insurance program and assess actuarially appropriate rates for insureds, based on their expected flood risk.[194] These reform efforts have failed, under intense lobbying from realtors, the mortgage industry, and the National Association of Home Builders.[195] These same lobbying interests would likely defeat any broad effort at the local or state level to restrict new residential development in flood zones. Land-use restrictions targeted at *industrial* facilities in flood zones—those that store hundreds of thousands of gallons of oil or hazardous chemicals—could see broader support, however, where the restrictions apply only to new construction.

Regulation of land use is primarily a state and local function, with state governments delegating zoning authority to localities pursuant to states' police powers.[196] To date, few states have used their power over land use to keep hazardous facilities out of flood-exposed areas. While all coastal states —with the exception of Alaska—have adopted coastal zone management plans pursuant to the 1972 Coastal Zone Management Act,[197] the plans are primarily focused on dune and wetland protection and erosion prevention, not on protection of the coasts from flood-related chemical releases.[198] Fourteen coastal states have established construction setback requirements under their plans, but the required setbacks from the ocean only range from 25 feet to 250 feet—far too short to serve as a buffer to protect

193. Hudson, *supra* note 10, at 1147 (the National Flood Insurance Plan "has acted as a massive market distortion").

194. *See* David Hunn, Ryan Maye Handy & James Osborne, *Developing Storm: Part 2, Build, Flood, Rebuild: Flood Insurance's Expensive Cycle*, HOUS. CHRON. (Dec. 9, 2017), *available at* https://perma.cc/7WR4-V7M8.

195. *Id.*

196. Vill. of Euclid v. Ambler Realty Co., 272 U.S. 365, 387 (1926); JULIAN CONRAD JUERGENSMEYER & THOMAS E. ROBERT, LAND USE PLANNING & DEVELOPMENT REGULATION LAW, ch. 3.5, 3.6 (Thomson West 3d ed. 2018)

197. 16 U.S.C. §§ 1451–1466 (1990).

198. *See* CONN. GEN. ASSEMBLY OFFICE OF LEGISLATIVE RESEARCH, COASTLINE CONSTRUCTION RESTRICTIONS, ASSEMB. 2012-R-0046 (2012), *available at* https://perma.cc/Z5WV-B3RM (compiling state coastal zone restrictions).

industrial facilities from flooding or hurricanes.[199] Furthermore, many cities continue to channel industry toward bodies of water by designating waterfront areas as manufacturing zones on zoning maps.[200]

Delaware, which is home to a large number of chemical manufacturers, has gone the furthest in prohibiting industrial development in coastal areas, and it offers a model for other states facing rising seas and more frequent hurricanes. The Delaware Coastal Zone Act of 1971[201] banned new industrial facilities in the Delaware coastal zone, which extends roughly 2 miles inland along 115 miles of coast.[202] Under the statute, then-existing industrial facilities could continue to operate at fourteen legacy sites.[203] All new industrial development was barred from the area, with the goal of avoiding oil spills and further chemical contamination along the coast, which is highly valued for tourism.[204] The law was amended in 2017 to allow limited new industrial development under a permitting system (not as-of-right) at the fourteen legacy sites, which comprise an area that collectively represents less than 2% of Delaware's coastal zone.[205] Even as amended by the 2017 law, the Delaware Coastal Zone Act remains the most ambitious example of a state using land-use law to channel industrial development away from the coast for environmental and public health reasons.

In other coastal areas in the United States, and in inland riparian areas prone to flooding, state and local officials should enact similar restrictions on the siting of new industrial facilities that use more than a specified threshold volume of oil or hazardous materials (with certain exemptions as noted above). If such restrictions are not enacted at the state or local level, Congress could step in to enact land-use and siting standards for

199. *Id.*

200. *See, e.g.*, New York City Zoning & Land Use Map, NYC PLANNING, RESEARCHGATE (2018), https://www.researchgate.net/figure/New-York-Citys-Zoning-and-Land-Use-Map-source-NYC-Planning-2018_fig2_334492041.

201. DEL. CODE ANN., tit. 7, §§ 7001–7015 (2020).

202. Jon Hurdle, *Putting Delaware's Protected Coast Back to Work*, N.Y. TIMES (June 27, 2017), *available at* https://perma.cc/6ZECKX67.

203. DEL. DEP'T OF NAT. RES., *History of the Coastal Zone Act*, (Oct. 13, 2020), *available at* https://perma.cc/XU3B-QSPM.

204. *Id.*

205. Hurdle, *supra* note 202.

industrial facilities storing large volumes of hazardous substances.

To be sure, the Supreme Court has declared that regulating land use is a "quintessential state and local power."[206] Nonetheless, as a constitutional matter, federal siting standards for major industrial facilities would likely be upheld under the Commerce Clause.[207] As a policy matter, federal land-use restrictions should be enacted only where state and local governments are failing to act in the face of significant health risks from hazardous facilities. There is ample statutory precedent for federal involvement in determining the locations and siting standards for major industrial facilities. For example:

- RCRA establishes siting and construction standards for hazardous waste treatment, storage, and disposal facilities (TSDFs),[208] including requirements for TSDFs located in 100-year flood plains.[209]

- The Nuclear Regulatory Commission must approve the location of new nuclear power plants.[210]

- The Federal Aviation Administration must approve siting of commercial airports.[211]

- The Federal Energy Regulatory Commission has exclusive authority over the siting of new import/export terminals for natural gas.[212]

If Congress were to enact restrictions on the siting of hazardous facilities in flood-exposed areas, it would not need to

206. Rapanos v. United States, 547 U.S. 715, 738 (2006) (citing FERC v. Mississippi, 456 U.S. 742, 767 n.30 (1982)).

207. *See* NFIB v. Sebelius, 567 U.S. 519, 542 (2012) (the Commerce power is "expansive" and extends to intrastate activities that have a "substantial effect" on interstate commerce). *See also* Catherine J. LaCroix, *Land Use and Climate Change: Is It Time for a National Land Use Policy?*, 35 ECOLOGY L. CURRENTS 124 (2008) (discussing benefits and drawbacks of federal involvement in land use policies).

208. 40 C.F.R. pt. 264 (1980).

209. 40 C.F.R. § 270.14(b)(11) (1983).

210. 10 C.F.R. § 50.30 (2008).

211. 14 C.F.R. § 151.21 (1970).

212. 15 U.S.C. § 717(b) (2005); 49 C.F.R. pt.193 (1980).

resort to a federal permitting program akin to licensing of airports or nuclear power plants. Rather, federal law could simply establish flood-sensitive facility-siting standards under which firms could build as-of-right as long as they comply with the standards. This way, federal siting restrictions could avoid the delays inherent in agency review of proposals for new industrial facilities. Such a permitting procedure would concentrate too much discretionary power in federal agencies and would unnecessarily trigger environmental impact review under the National Environmental Policy Act.[213]

Enacting land use restrictions, as well as the standards for chemical storage and the reforms to EPCRA that I outlined above, would no doubt be challenging. The chemical industry and the broader manufacturing sector present a formidable lobbying force,[214] and the sheer number of firms that could become sources of contamination during flooding raises the complexity and expense of any regulatory program governing chemical storage.[215] Regulating the conditions of chemical storage at industrial plants is a more technically complex endeavor than other kinds of climate change adaptation measures, such as enacting residential building codes or building irrigation systems for drought-afflicted areas.[216] But private law has proved ineffective to protect the public from this disaster risk. As climate change exacerbates the flooding problem, near-term political challenges should not deter policymakers from creating a more robust chemical regulatory regime, sensitive to climate impacts.

V. CONCLUSION

Flood-induced chemical disasters pose a serious and underappreciated risk to communities throughout the United States. We have experienced many wake-up calls in recent years, yet we have failed to act. Without an urgent and

213. 42 U.S.C. § 4321 (1970).

214. The chemical industry alone spent over $43 million on lobbying in 2019. *See* CTR. FOR RESPONSIVE POLITICS, *Industry Profile: Chemical and Related Manufacturing*, *available at* https://perma.cc/FLP3-W2Z5.

215. Emily Atkin, *America Has a Toxic Waste Hurricane Problem*, NEW REPUBLIC (Sep. 8, 2017), *available at* https://perma.cc/DX6M-PWF8.

216. Arnold*, supra* note 11, at 260.

meaningful response to this threat, communities will remain vulnerable to community-wide contamination incidents like those that occurred during Hurricanes Katrina, Harvey, Maria, and Florence.

Once toxic floodwaters occur, weeks and months pass before contamination can be thoroughly identified and remediated, and there are substantial hurdles to linking community harms with particular sources of contamination in *ex post* tort suits. The many hurdles to identifying defendants and proving culpability make private law mechanisms unattractive as a tool to manage this risk. Ex ante efforts to prevent flood-related chemical releases should therefore guide climate change adaptation in this area. A preventive approach, grounded in public law and focused on making industrial facilities secure before a storm hits, is the best path forward.

The risk from toxic floodwaters is just one of the many challenges that policymakers face in adapting to a warmer planet. While we may not be able to prevent flooding, policymakers can, and should, act to reduce the risk that toxic chemicals become part of the deluge.