

# PREVENTING INDUSTRIAL DISASTERS IN A TIME OF CLIMATE CHANGE: A CALL FOR FINANCIAL ASSURANCE MANDATES

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## INTRODUCTION

When Hurricane Katrina tore through southern Louisiana, it left more than downed trees and standing water in its wake: over one million gallons of oil coated the streets, homes, and businesses of the small city of Meraux, home of a Murphy Oil refinery. Katrina's fierce winds and storm surge had torn a massive tank off its foundations and carried it away on the floodwaters, gushing oil as it went.<sup>1</sup> The damage could have been far greater. Katrina was by no means a worst-case storm,<sup>2</sup> and luckily, only one of the refinery's many tanks ruptured—and it leaked less than a third of the oil it contained.<sup>3</sup> Nonetheless, the spill devastated the surrounding area, causing hundreds of millions of dollars in damage to thousands of homes and businesses and choking nearby canals

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1. See EPA, MURPHY OIL SPILL FACT SHEET 1 (2006), <https://perma.cc/8VQU-4YHA>.  
 2. See, e.g., *Katrina Was Category 3, Not 4*, CNN (Dec. 21, 2005), <https://perma.cc/J35Y-PQTP> (“When it slammed ashore on the Gulf Coast in August, Hurricane Katrina was a strong Category 3 storm, not a Category 4 as initially thought . . . . New Orleans . . . likely escaped the storm's strongest winds.”).  
 3. See MURPHY OIL SPILL FACT SHEET, *supra* note 1.

with oil.<sup>4</sup> When reporters returned to the scene a year later, they found “abandoned houses and overgrown lawns,” and neighbors lamenting the loss of a community.<sup>5</sup>

The Murphy Oil incident may be a sign of things to come. Consensus projections of climate change and its impacts suggest that over the next several decades, sea levels will rise, coastal flooding will become more and more prevalent, and hurricanes may become stronger and more frequent as ocean temperatures warm. In turn, industrial facilities along the coasts will become more and more likely to experience destructive floods and storms.

This trend has sobering implications. America’s population and economy are disproportionately coastal. In densely developed seaside cities from New Orleans and Houston to Los Angeles, Boston and New York, industrial facilities sit in vulnerable, low-lying areas, often close to residential neighborhoods. Rising sea levels, more powerful and frequent storms, and increased flooding threaten to wreak havoc on these facilities, causing grave harm to life, property, and natural resources in surrounding communities.<sup>6</sup> Consider Houston, America’s fourth largest city, where scores of refineries and industrial facilities line one of the nation’s busiest ports:<sup>7</sup>

It isn’t as if industries in the [port] are unaware of the threat from hurricanes. Most of the channel has protection to avoid catastrophic damage if the storm surge is 15 feet or less. . . . But what if the surge is stronger, approaching Katrina’s record 28 feet? “We think you can easily get up to 25 feet of surge in the ship channel if you start cranking those winds and get a really serious storm in,” [a Rice University expert] said. “That level of inundation in the ship channel is abso-

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4. See *§330 Million Settlement Deal in Katrina Oil Spill*, NBC NEWS (Sept. 25, 2006), <https://perma.cc/779P-KW44>.
  5. See *id.*
  6. See, e.g., Eric Berger, *Models Show ‘Massive Devastation’ in Houston*, HOUSTON CHRON. (Feb. 20, 2005), <https://perma.cc/SJ9J-UPA6>; Tom Fowler, *Houston-Area Facilities Say They’re Prepared*, HOUSTON CHRON. (Sept. 21, 2005), <https://perma.cc/A37M-FXNH>; David A. Graham, *The Mothers of All Disasters*, THE ATLANTIC (Sept. 2, 2015), <https://perma.cc/28YX-XQCW>; Scott Gurian, *New Jersey’s Industrial Coast Remains Vulnerable to the Next Extreme Storm*, NJ SPOTLIGHT (Dec. 8, 2015), <https://perma.cc/TA5L-U7LE>. On environmental disasters related to coastal industry, see, e.g., Ana Maria Cruz et al., *Identifying Hurricane-Induced Hazardous Material Release Scenarios in a Petroleum Refinery*, 2 NAT. HAZARDS REV. 203, 203 (2001) (listing several historical examples); Luis A. Godoy, *Performance of Storage Tanks in Oil Facilities Damaged by Hurricanes Katrina and Rita*, 21 J. PERFORMANCE OF CONSTRUCTED FACILITIES 441, 443–45 (2007); Perri Zeitz Ruckart et al., *Hazardous Substances Releases Associated with Hurricanes Katrina and Rita in Industrial Settings, Louisiana and Texas*, 159 J. HAZARDOUS MATERIALS 53, 54–55 (2008).
  7. Graham, *supra* note 6; *The 30 Most Populous Cities*, NAT’L LEAGUE OF CITIES (2013), <https://perma.cc/E2U6-QRV7>; *Overview*, PORT OF HOUSTON AUTH. (2016), <https://perma.cc/R88W-Y6QD>.

lutely devastating, because the ship channel is mostly protected to about 15 feet. Anything above that, you start flooding out tanks, you start flooding out industries . . . The environmental and economic disaster would be off the charts.”<sup>8</sup>

This sort of disaster is largely avoidable. Coastal industries have many ways to reduce climate risk. For example, they can relocate from vulnerable areas or upgrade their facilities to withstand extreme weather. However, coastal industries will probably underinvest in these measures for two reasons. First, they are able to pass much of the cost of failing to adapt on to society at large. Generally, a rational company concerned about (for example) the risk of property damage or production interruptions from severe weather will invest in risk-reducing measures until the cost of doing so equals the cost to the company of the future harms contemplated. Here, many potential costs may not be borne by businesses directly and thus may not factor into this cost-benefit calculus.<sup>9</sup> Second, the coastal impacts of climate change are uncertain and largely distant. Even the most sophisticated businesses do not act rationally in response to such risks. In fact, many are foregoing investment even in cost-justified climate adaptation, to say nothing of adaptation to risks whose costs they will not bear. In short, coastal industries can be expected to underinvest, and are in fact underinvesting, in reducing the risks their operations pose in an era of climate change.<sup>10</sup>

Lawmakers can and should act to correct this problem. Yet, the two most common regulatory approaches to encouraging coastal climate adaptation have serious drawbacks. Command-and-control regulations, such as zoning and building codes, are often inflexible, poorly tailored, and difficult to enforce. Adaptation subsidy programs entail many of the same problems and can be enormously costly to boot.<sup>11</sup>

This paper proposes a different approach. I argue that financial assurance mandates (“FAMs”) can effectively induce coastal industries to invest in adaptation. FAMs require companies to prove that they can pay for the liabilities they may incur—whether by drawing on their own resources or by bringing in a third party, such as an insurer or surety, to pick up the tab. Through FAMs, and especially private insurance requirements, adaptation policymakers at all

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8. Graham, *supra* note 6. For thorough explorations of Houston’s vulnerability to a major storm, and the devastating economic and environmental consequences that might result, see Neena Satija et al., *Hell and High Water*, PROPUBLICA (Mar. 3, 2016), <https://perma.cc/9E8V-33L4>, and Kate Spinner, *For Chemical Disaster, Just Add Storm Surge*, SARASOTA HERALD-TRIBUNE (Sept. 19, 2010), <https://perma.cc/KBS6-JS4W>.
  9. See *infra* notes 69–73 and accompanying text.
  10. See *infra* notes 80–81 and accompanying text.
  11. See *infra* notes 100–103 and accompanying text.

levels of government can harness the expertise and resources of the private sector to drive cost-effective adaptation among coastal industries.<sup>12</sup>

FAMs are familiar tools whose strengths have been demonstrated in practice as well as in theory.<sup>13</sup> Federal, state, and local regulators use them to reduce the risk of catastrophes of all sorts, from nuclear incidents and oil spills to impacts resulting from abandonment of dangerous facilities. History shows that these measures can be effective and reasonable in cost. And crucially, because they are relatively simple to design and enforce, FAMs are particularly appropriate for use by state and local policymakers, making them well-suited to an era of federal gridlock and geographically uneven climate impacts.

Many legal scholars have written about the virtues of FAMs, but few have considered their potential role in climate adaptation,<sup>14</sup> and none have recognized their relevance to industrial adaptation—even though FAMs are currently used to regulate industry in many other contexts. Drawing on the literature on climate adaptation, the economic theory behind FAMs, and the history of their implementation at all levels of government, I argue for the first time in favor of coastal industry FAMs. Specifically, I argue that policymakers should require many coastal firms to buy insurance for the harms their operations may cause to others as a result of the coastal impacts of climate change. Well-designed insurance mandates can reduce the serious risks coastal industries pose with minimal economic distortion and legal complication. They should be a central element of climate adaptation policy.

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12. Of course, coastal industries are not the only industries that are exposed to climate risk and that expose their communities to risk in turn. Although (as I explain in this paper) a variety of factors, including the magnitude of the societal risks involved, political considerations, and the current state of liability law, make coastal industrial disasters a reasonable starting point for climate FAM implementation, the regulatory approach I propose in this paper suits other climate risks as well. See *infra* note 263 and accompanying text.
  13. See *infra* Part III.D.
  14. The only source I know of that links financial assurance requirements to coastal adaptation in general terms (albeit briefly) is John R. Nolon, *Land Use and Climate Change: Lawyers Negotiating Above Regulation*, 78 BROOK. L. REV. 521, 560 (2013) (“[A] developer and a local land use board could agree that if a project becomes inundated or damaged by storm surges within an agreed-upon period, the local board may draw funds from an escrow account to cover its remediation costs, or it could secure developer’s contingent liabilities with a bond, insurance policy, or underlying indemnity agreement.”). Several others discuss climate change and climate adaptation in arguing for stronger residential flood insurance mandates, but do not consider how similar mandates might be used outside the residential context. See Michael Faure & Véronique Bruggeman, *Catastrophic Risks and First-Party Insurance*, 15 CONN. INS. L.J. 1, 16, 33–43 (2008); Alexander Lemann, *Rolling Back the Tide: Toward an Individual Mandate for Flood Insurance*, 26 FORDHAM ENVTL. L. REV. 166 (2015); Charlene Luke & Aviva Abramovsky, *Managing the Next Deluge: A Tax System Approach to Flood Insurance*, 18 CONN. INS. L.J. 1 (2011); Adam F. Scales, *A Nation of Policyholders: Governmental and Market Failure in Flood Insurance*, 26 MISS. C. L. REV. 3, 44 (2006).

The Article is in six parts. In Part I, I describe the implications of climate change for coastal regions, and the outsize risks that coastal industries may pose to their communities in an era of rising seas, stronger storms, and more frequent floods. I also show that these industries are underinvesting in measures to reduce these risks, and absent regulation, will keep underinvesting. Part II reviews regulatory strategies to encourage such investment, and discusses the advantages FAMs have over more familiar adaptation policy tools. Part III demonstrates that FAMs can be workable and effective through a review of existing policies at the federal, state, and local levels. In Part IV, I suggest some basic design considerations, and in Part V, I address potential objections to my proposal. Part VI concludes. Finally, in an appendix, I offer a draft FAM ordinance for policymakers' consideration.

## I. THE COASTAL IMPACTS OF CLIMATE CHANGE AND THE NEED FOR INDUSTRIAL ADAPTATION

### A. Climate change threatens the economy and human life

The costs of extreme weather are mounting.<sup>15</sup> “Over the past three decades,” a 2012 report observed, “global economic losses from weather-related events have increased at a rate of U.S. \$2.7 billion per year in real terms; that is, a tripling of annual damages over the period.”<sup>16</sup> Catastrophic events have come to play an outsize role in overall loss figures. In real terms, losses from catastrophic events increased by a factor of eight between the 1960s and the end of the 20th century.<sup>17</sup> Natural disasters causing one billion dollars in damage or more have been more than five times more frequent since 2010 than they were in the 1980s.<sup>18</sup>

These trends have complex causes. Most importantly, society has become richer, and development has increasingly encroached upon areas vulnerable to natural disasters.<sup>19</sup> Meanwhile, the climate is changing.<sup>20</sup> Storms, floods, and

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15. See, e.g., INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2014: IMPACTS, ADAPTATION, AND VULNERABILITY 680 (2014), <https://perma.cc/4228-XGP3>; Evan Mills, *Insurance in a Climate of Change*, 309 SCI. 1040, 1041 (2005).

16. Trevor Maynard & Nicola Ranger, *What Role for “Long-term Insurance” in Adaptation? An Analysis of the Prospects for and Pricing of Multi-Year Insurance Contracts*, 37 GENEVA PAPERS 318, 318 (2012).

17. Mills, *supra* note 15, at 1041.

18. ANNE SIDERS, COLUM. LAW SCH. CTR. FOR CLIMATE CHANGE LAW, MANAGED COASTAL RETREAT: A LEGAL HANDBOOK ON SHIFTING DEVELOPMENT AWAY FROM VULNERABLE AREAS 1 (2013), <https://perma.cc/765Y-QFKL>.

19. See, e.g., Jamison Colburn, *The Fire Next Time: Land Use Planning in the Wildland/Urban Interface*, 28 J. LAND RES. & ENVTL. L. 223 (2008); Lisa Grow Sun, *Smart Growth in Dumb Places: Sustainability, Disaster, and the Future of the American City*, 2011 B.Y.U. L. REV. 2157; Alan Feuer, *Building for the Next Big Storm*, N.Y. TIMES (Oct. 25, 2014), <https://>

heat waves are becoming more frequent in the United States,<sup>21</sup> and surface temperatures, an important correlate of economic losses,<sup>22</sup> rose between 1.3 and 1.9 degrees Fahrenheit over the course of the twentieth century.<sup>23</sup>

Scientists continue to debate whether and to what extent these climatic shifts are already increasing disaster costs. As of 2014, the Intergovernmental Panel on Climate Change (“IPCC”) identified socioeconomic, not climatic, factors as the primary culprit thus far, observing that “[global] loss trends have not been conclusively attributed to anthropogenic climate change.”<sup>24</sup> But regardless, both climatic and socioeconomic trends make disaster costs likely to keep rising in the years to come. Experts expect U.S. Gross Domestic Product (“GDP”) to increase steadily through the foreseeable future, and for development to keep increasing in vulnerable regions.<sup>25</sup> Meanwhile, climate change will very likely accelerate. The IPCC’s “business as usual” scenario projects that global mean surface temperatures will increase between five and ten degrees Fahrenheit by the end of the twenty-first century. Even assuming massive global emissions reductions, increases between three and five degrees are expected.<sup>26</sup>

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/perma.cc/US8K-Q8YW (“During the [Mayor] Bloomberg era . . . almost 40 percent of [New York City] was rezoned for population growth, much of it along the waterfront. Even now, there are ambitious plans afoot to continue building in low-lying areas.”); John Schwartz, *No Easy Way to Restrict Construction in Risky Areas*, N.Y. TIMES (Mar. 28, 2014), <https://perma.cc/WR6T-PVVR>.

20. See INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, *supra* note 15, at 4, 7.
21. See Jerry M. Melillo et al. eds., *Climate Change Impacts in the United States: The Third National Climate Assessment*, U.S. GLOBAL CHANGE RESEARCH PROG. 1, 7, 9 (2014), <https://perma.cc/4YWC-HTW8> [hereinafter NATIONAL CLIMATE ASSESSMENT].
22. Mills, *supra* note 15, at 1041, 1043.
23. NATIONAL CLIMATE ASSESSMENT, *supra* note 21, at 8.
24. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, *supra* note 15, at 680–81.
25. See CONG. BUDGET OFFICE, THE BUDGET AND ECONOMIC OUTLOOK: 2014 TO 2024, 1 (2014), <https://perma.cc/3WS5-U6ZB>; Pete Spotts, *Surging Storms: Can the U.S. Adapt in Time to Avert Coastal Damage?*, CHRISTIAN SCI. MONITOR (Nov. 13, 2012), <https://perma.cc/J4SR-VQ88> (“Along the US East Coast . . . [f]orty-two percent of the dry land up to one meter above sea level is already developed, and another 15 percent is slated for partial or complete development. . . .”).
26. NATIONAL CLIMATE ASSESSMENT, *supra* note 21, at 8, 26. See also *id.* at 13 (“[G]lobal [greenhouse gas] emissions are still rising and are on a path to be even higher than the high emissions scenario . . . analyzed in this report.”); *Signs of Stress Must Not Be Ignored, IEA Warns in Its New World Energy Outlook*, INT’L ENERGY AGENCY (Nov. 12, 2014), <https://perma.cc/CMF6-ABCG> (discussing International Energy Agency (“IEA”) projections that fossil fuels will still account for about seventy-five percent of world energy supply in 2040 and that cumulative global greenhouse gas emissions will exceed the two degrees Celsius “carbon budget” by that time); *Too Late for Two Degrees?: Low Carbon Economy Index 2012*, PRICEWATERHOUSECOOPERS 1 (2012), <https://perma.cc/E8VL-FUM4> (“Even doubling our current rate of decarbonisation, would still lead to emissions consistent with 6 degrees of warming by the end of the century. . . . [B]usinesses, governments and communities across

As the heat builds, so do disaster risks.<sup>27</sup> In particular, climate change threatens disaster for coastal areas.<sup>28</sup> Some evidence already links climate change to more frequent severe precipitation events. Modeling also suggests that it may make hurricanes more severe and increase the frequency of the most violent storms, although it may also make hurricanes less frequent overall.<sup>29</sup> Regardless of whether storms become more frequent or severe, sea level rise will make each coastal storm more likely to cause significant damage. As a result of climate change, global sea levels rose eight inches over the last century, and will rise up to several feet over the coming one. The northeast and Gulf Coast may see especially large increases.<sup>30</sup> Rising seas are already exacerbating flooding and erosion in coastal areas, especially (but not only) during major storms.<sup>31</sup>

These coastal threats have chilling implications for the nation as a whole. America's wealth, population, and vital infrastructure are disproportionately located on or near the coasts. In 2012, "with 18% of the land area . . . shore-

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the world need to plan for a warming world—not just 2°C, but 4°C, or even 6°C.”); Ross Konigstein & David Fork, *What It Would Really Take to Reverse Climate Change*, IEEE SPECTRUM (Nov. 18, 2014), <https://perma.cc/KYG6-8VZY> (“[O]ur best-case scenario, which was based on our most optimistic forecasts for renewable energy, would still result in severe climate change, with all its dire consequences: shifting climatic zones, freshwater shortages, eroding coasts, and ocean acidification, among others. . . . [R]eversing the trend would require both radical technological advances in cheap zero-carbon energy, as well as a method of extracting CO<sub>2</sub> from the atmosphere and sequestering the carbon.”).

27. See, e.g., INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, *supra* note 15, at 21–25 (detailing disaster risks from climate change on a region-by-region basis).
28. See *id.* at 17 (predicting with “very high confidence” that “due to sea level rise projected throughout the 21st century and beyond, coastal systems and low-lying areas will increasingly experience adverse impacts such as submergence, coastal flooding, and coastal erosion”).
29. Thomas R. Knutson et al., *Tropical Cyclones and Climate Change*, 3 NATURE GEOSCIENCE 157, 157 (2010); NATIONAL CLIMATE ASSESSMENT, *supra* note 21, at 9. *But see* Elizabeth A. Barnes et al., *Model Projections of Atmospheric Steering of Sandy-Like Superstorms*, 110 PROC. NAT'L ACAD. SCI. 15211, 15211 (2013) (arguing that “future atmospheric conditions are less likely than at present to propel storms westward into the [East C]oast”); Willie Drye, *Scientists: Climate Change May Offer Hurricane Help*, NAT'L GEOGRAPHIC (Sept. 2, 2013), <https://perma.cc/AAW3-P3LY> (discussing various doubts about and qualifications of the Barnes et al. study).
30. NATIONAL CLIMATE ASSESSMENT, *supra* note 21, at 9–10; HAL NEEDHAM ET AL., CTR. FOR CLIMATE AND ENERGY SOLUTIONS, IMPACTS AND ADAPTATION OPTIONS IN THE GULF COAST 4 (2012), <https://perma.cc/43PU-SM3P>; Spotts, *supra* note 25. See generally Justin Gillis, *Climate Model Predicts West Antarctic Ice Sheet Could Melt Rapidly*, N.Y. TIMES (Mar. 30, 2016), <https://perma.cc/L93Q-NWVA> (recent research raises the possibility of five to six feet of sea level rise by 2100, and rises of a foot per decade thereafter); Justin Gillis, *Seas Are Rising at Fastest Rate in Last 28 Centuries*, N.Y. TIMES (Feb. 22, 2016), <https://perma.cc/S855-93CB>.
31. See, e.g., Justin Gillis, *Flooding of Coast, Caused by Global Warming, Has Already Begun*, N.Y. TIMES (Sept. 3, 2016), <https://perma.cc/N6CW-2BVA>. See generally NATIONAL CLIMATE ASSESSMENT, *supra* note 21, at 9; Spotts, *supra* note 25.



adjacent counties account[ed] for 37% of the U.S. population and 42% of the national economic output.<sup>32</sup> And between 2007 and 2012, coastal counties accounted for nearly twenty percent of domestic GDP growth, and over thirty percent of national population growth.<sup>33</sup> The National Climate Assessment reports that “nearly five million Americans and hundreds of billions of dollars of property [sic] are located in areas that are less than four feet above the local high-tide level.”<sup>34</sup> Another recent analysis concluded that:

[i]f sea levels rise as much as climate scientists predict by the year 2100, almost 300 U.S. cities would lose at least half their homes, and 36 U.S. cities would be completely lost. . . . Nationwide, almost 1.9 million homes (or roughly 2 percent of all U.S. homes)—worth a combined \$882 billion—are at risk of being underwater by 2100.<sup>35</sup>

Meanwhile, coastal areas are particularly attractive for companies seeking access to shipping and proximity to major population centers, so many systemically vital industries, including petrochemicals and electricity, are concentrated on the coasts.<sup>36</sup>

### B. *Adaptation as a means of reducing losses from climate change*

Efforts to avoid climate-related losses may be classified in three ways.<sup>37</sup> Mitigation strategies seek to reduce greenhouse gas emissions, with the goal of slowing or reversing the pace of climate change and the losses it could cause.<sup>38</sup>

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32. JUDITH T. KILDOW ET AL., NAT'L OCEAN ECON. PROG., STATE OF THE U.S. OCEAN AND COASTAL ECONOMIES 2014, 18 (2014), <https://perma.cc/C9UJ-NGUT>.
  33. *Id.* at 21; See generally Scott K. Johnson, *Population Trends in the US Put More at Risk of Sea Level Rise*, ARS TECHNICA (Mar. 14, 2016), <https://perma.cc/T6H6-PDSR>.
  34. NATIONAL CLIMATE ASSESSMENT, *supra* note 21, at 10. See also *Superstorm Sandy: History in the Making*, WILLIS RE (Oct. 29, 2013), <https://perma.cc/V22S-2L3N>; Justin Pierce, *Uncovering Florida Hurricane Risk with the Catastrophe Bond Database*, AIR WORLDWIDE (Nov. 22, 2013), <https://perma.cc/3XKP-CJWA>; Nate Silver, *A New York Hurricane Could Be a Multibillion-Dollar Catastrophe*, N.Y. TIMES: FIFTYTHREEEIGHT (Aug. 26, 2011), <https://perma.cc/Z4KL-94JH>.
  35. Krishna Rao, *Climate Change and Housing: Will a Rising Tide Sink All Homes?*, ZILLOW (Aug. 2, 2016), <https://perma.cc/Y6E2-UNFH>.
  36. See, e.g., NEEDHAM ET AL., *supra* note 30, at 14; U.S. ENERGY INFO. AGENCY, FLOOD VULNERABILITY ASSESSMENT MAP, <https://perma.cc/CQJ4-64LB> (mapping energy infrastructure located in flood hazard zones); Spinner, *supra* note 8 (“A quarter of all the gas, 40 percent of jet fuel and 60 to 70 percent of military jet fuel is all refined in the hurricane surge zone in Texas.”).
  37. See, e.g., ANDREW E. DESSLER, INTRODUCTION TO MODERN CLIMATE CHANGE 182 (2011); David W. Keith, *Geoengineering the Climate: History and Prospect*, 25 ANN. REV. ENERGY & ENV'T 245, 248 (2000); THE ROYAL SOC'Y, GEOENGINEERING THE CLIMATE: SCIENCE, GOVERNANCE AND UNCERTAINTY, at ix (2009), <https://perma.cc/6M3A-4NYB>.
  38. NATIONAL CLIMATE ASSESSMENT, *supra* note 21, at 13.

Geoengineering strategies, which are still largely speculative, aim to reduce climate change by directly intervening in the Earth's physical and geochemical processes, for example, by removing carbon dioxide from the atmosphere or blocking solar radiation from reaching the Earth's surface.<sup>39</sup> Adaptation strategies seek to improve society's ability to withstand climate change, rather than avert climate change itself.<sup>40</sup>

Mitigation strategies dominated climate policy debates until recently.<sup>41</sup> But in the past few years, as global emissions have continued to rise—and prominent mitigation policy initiatives, such as domestic cap-and-trade and the United Nations Framework Convention on Climate Change international emissions reduction negotiations, have sputtered—adaptation's profile has risen.<sup>42</sup> Still, serious adaptation efforts have barely begun. In 2014, the National Climate Assessment noted that “[s]ubstantial adaptation planning is occurring in the public and private sectors and at all levels of government; however, few measures have been implemented and those that have appear to be incremental changes.”<sup>43</sup>

The coastal impacts of climate change have loomed large in adaptation policy discussions.<sup>44</sup> There are three basic types of coastal adaptation measures: protection, accommodation, and retreat.<sup>45</sup> Protection strategies aim to keep the sea out, using structures such as seawalls and dikes to shield coastal infrastructure from flooding and storm surge. In contrast, accommodation strategies seek to ensure that property will not be damaged, and vital functions not disrupted, if and when the sea rushes in. Examples include elevating utilities and essential equipment above floodlines or installing systems to automatically shut down

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39. See Keith, *supra* note 37, at 259; Henry Fountain, *Climate Tools Seek to Bend Nature's Path*, N.Y. TIMES (Nov. 9, 2014), <https://perma.cc/T62Z-CPVF>.

40. NATIONAL CLIMATE ASSESSMENT, *supra* note 21, at 13.

41. See *id.* at 671 (“The study and application of adaptation in the climate change realm is nascent compared to the many analyses of mitigation policies and practices to reduce emissions.”); NAT'L RESEARCH COUNCIL, THE NAT'L ACADS., ADAPTING TO THE IMPACTS OF CLIMATE CHANGE 3 (2010), <https://perma.cc/73KF-4D3X> [hereinafter NAS REPORT] (“Until very recently, adapting to climate change has been a low national priority, and limited research has been completed to identify options for adaptation and evaluate their benefits, costs, potential, and limits.”).

42. See, e.g., NATIONAL CLIMATE ASSESSMENT, *supra* note 21, at 13, 671.

43. NATIONAL CLIMATE ASSESSMENT, *supra* note 21, at 671. See generally NAS REPORT, *supra* note 41 (advocating the development of a national adaptation strategy and enumerating current barriers to adaptation planning and implementation).

44. See, e.g., KILDOW ET AL., *supra* note 32; NEEDHAM ET AL., *supra* note 30; SIDERS, *supra* note 18; Spotts, *supra* note 25.

45. See, e.g., J.T.E. Gilbert & P. Vellinga, *Coastal Zone Management*, in INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE: THE IPCC RESPONSE STRATEGIES 131, 146–47 (1990), <https://perma.cc/2AZJ-HUXP>; Robert J. Nicholls & Anny Cazenave, *Sea Level Rise and Its Impact on Coastal Zones*, 328 SCI. 1517, 1519 (2010); SIDERS, *supra* note 18, at 2.

electricity or industrial processes in the event of extreme weather. Retreat strategies entail relocating away from low-lying coastal areas altogether.<sup>46</sup>

*C. Because Climate Change Threatens Coastal Industry in Particular, Coastal Industrial Adaptation Is Crucial*

Protection, accommodation, and retreat are all currently being deployed against the coastal impacts of climate change. Each has its costs and benefits, and debates continue over which should be favored in which circumstances. At a more general level, however, there is broad consensus that coastal adaptation efforts are both essential and underdeveloped.<sup>47</sup> A small literature has emerged on the legal dimensions of the challenge, and on the constitutional and statutory strategies that might be used to accelerate U.S. coastal adaptation efforts.<sup>48</sup>

Notably, this literature has had little to say about how the law might foster *industrial* adaptation to the coastal impacts of climate change. Legal scholars have extensively studied coastal development regulations, but have mostly focused on those affecting homes and small businesses. In part, this may be because high-profile, doctrinally intricate constitutional cases frequently involve such restrictions.<sup>49</sup> And with the population concentrated in coastal areas, residential coastal adaptation is undeniably important. Yet, many of America's vital industries are also concentrated on the coasts, and their exposure to the floods and storms that climate change threatens poses grave risks for society at large. If industry fails to adapt to this heightened risk environment, coastal communities and the nation as a whole will face serious harm.

First, extreme weather and flooding could cause huge economic losses by disrupting systemically important industries.<sup>50</sup> In 2005, for example, Hurricanes

46. See generally SIDERS, *supra* note 18, at 2 (discussing retreat strategies).

47. See, e.g., NAT'L OCEANIC & ATMOSPHERIC ADMIN., ADAPTING TO CLIMATE CHANGE: A PLANNING GUIDE FOR STATE COASTAL MANAGERS 1, 16 (2010), <https://perma.cc/VZG5-9K9V> (“[W]hile federal, state, and local governments continue to attend to climate change mitigation, they must also develop strategies for adapting to the impacts of climate change they will not be able to avoid. . . . [C]oastal managers need to begin planning for the effects of climate change in the coastal zone.”); Nolon, *supra* note 14, at 545 (“Since 1990, policymakers have done little to advance effective responses to sea-level rise.”).

48. See, e.g., SIDERS, *supra* note 18; JESSICA GRANNIS, GEO. CLIMATE CTR., ADAPTATION TOOL KIT: SEA-LEVEL RISE AND COASTAL LAND USE (2011), <https://perma.cc/YH4L-RJFK>; Edna Sussman et al., *Climate Change Adaptation: Fostering Progress Through Law and Regulation*, 18 N.Y.U. ENVTL. L.J. 55 (2010); Nolon, *supra* note 14.

49. See, e.g., *Dolan v. City of Tigard*, 512 U.S. 374 (1994); *Severance v. Patterson*, 566 F.3d 490 (5th Cir. 2009); *State of Oregon ex rel. Thornton v. Hay*, 254 Or. 584 (Or. 1969).

50. See, e.g., NEEDEDHAM ET AL., *supra* note 30, at 16–20; SATIJA ET AL., *supra* note 8. See also MEG CRAWFORD & STEPHEN SEIDEL, CTR. FOR CLIMATE AND ENERGY SOLUTIONS, WEATHERING THE STORM: BUILDING BUSINESS RESILIENCE TO CLIMATE CHANGE 3 (2013), <https://perma.cc/DQX7-83Z5> (describing the impacts of recent extreme weather on major industries).

Katrina and Rita shut down almost one-third of total U.S. oil and gas refining capacity, forcing domestic producers to increase imports and tap the Strategic Petroleum Reserve; even six months later, eight percent of U.S. capacity was still offline.<sup>51</sup> Looking farther afield, in 2011, Tropical Storm Nock-ten unleashed massive flooding throughout the heart of the Thai manufacturing sector, idling 600,000 workers and submerging factories central to high-tech global supply chains under several meters of water.<sup>52</sup> The disaster caused \$32 billion in losses to the manufacturing sector alone, but its economic effects rippled much further.<sup>53</sup> Factories from Japan and Malaysia to Indiana and West Virginia went idle or reduced output, and major corporations such as Honda and Nissan reported significantly reduced earnings.<sup>54</sup>

Second, storms and flooding could cause environmental and public health catastrophes. The industrial facilities lining our coasts store and process dangerous substances, and when facilities are damaged, inundated, or hastily taken offline, these substances can and do escape. Again, present-day Houston offers a sobering case study. The city and surrounding region:

hold mind-boggling amounts of hazardous chemicals, most of which are stored in areas where hurricanes are a significant, yearly threat. . . . On any given day, 20.5 million tons—41 billion pounds—of hazardous substances flow through pipelines or sit stored in tanks within the storm surge evacuation zone on the western side of Galveston Bay alone. Of that, 1.45 million tons are considered extremely hazardous. . . . If a storm unleashed even a tenth of the hazardous substances in Galveston Bay's surge zone, the tonnage would more than double the [Deepwater Horizon] oil spill.<sup>55</sup>

Houston narrowly dodged disaster in 2008, when Hurricane Ike turned slightly away from the city at the last minute.<sup>56</sup> The 2005 hurricane season illustrates

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51. LAWRENCE KUMINS & ROBERT BAMBERGER, CONG. RESEARCH SERV., RL33124, OIL AND GAS DISRUPTION FROM HURRICANES KATRINA AND RITA 3–4 (2006), <https://perma.cc/3UJJ-DBVG>.
  52. See Alan Raybould & Prapan Chankaew, *Thai PM Pledges Flood Relief as Fight for Bangkok Goes On*, REUTERS (Nov. 9, 2011), <https://perma.cc/4PJW-EURM>; Seth Mydans, *Thai Prime Minister to Take Command of Flood Control Efforts*, N.Y. TIMES (Oct. 21, 2011), <https://perma.cc/Q5N3-RA86>.
  53. *The World Bank Supports Thailand's Post-Floods Recovery Effort*, WORLD BANK (Dec. 13, 2011), <https://perma.cc/Q3X5-Z52G>; see, e.g., Tarun Iyer, *HDDs Return to Pre-Flood Prices*, TOM'S HARDWARE (Apr. 22, 2013), <https://perma.cc/G4XH-5JVK>.
  54. Anna Mukai et al., *Thai Floods Disrupting Japanese Car Production*, BLOOMBERG NEWS (Oct. 31, 2011), <https://perma.cc/S53G-CUH7>. Honda alone lost \$250 million. CRAWFORD & SEIDEL, *supra* note 50, at 3.
  55. Spinner, *supra* note 8.
  56. Spinner, *supra* note 8. As a result, Ike caused “only” \$30 billion in damage and several dozen deaths. Satija et al., *supra* note 8.

some of the ways in which that disaster might have played out. As Katrina made landfall, many feared that its floodwaters would mingle with petrochemicals and hazardous substances released from Louisiana's ubiquitous industrial plants to brew "toxic soup" in the streets of New Orleans.<sup>57</sup> In fact, although the floodwaters were undoubtedly tainted and initially posed an acute health risk, they do not seem to have produced life-threatening contamination at a large scale.<sup>58</sup> However, Katrina and Rita did cause over 150 reportable releases of hazardous substances in Louisiana and Texas.<sup>59</sup> Together, they constitute one of the largest environmental disasters in American history.<sup>60</sup> During Katrina—which, as noted above, was nowhere near a worst-case storm<sup>61</sup>—more than 9 million gallons of oil spilled from factories, refineries, and storage facilities.<sup>62</sup> The storm's winds and powerful surge breached and buckled storage tanks; in some cases, tanks were ripped off their foundations altogether.<sup>63</sup> The Murphy Oil incident was only a medium-size spill compared to others during Katrina; luckily, the other spills, some in the millions of gallons, did not occur as close to residential areas.<sup>64</sup>

Third, and relatedly, storm and flood hazards, and the potential liabilities and business risks they entail, could lead companies to simply abandon facilities, leaving unsecured and dangerous structures containing hazardous substances to blight the coasts—and, potentially, to cause releases and spills. Although few, if any, coastal facilities seem to have been abandoned thus far because of climate change, strategically abandoning unprofitable, environmentally dangerous facilities is a familiar tactic in industries from manufacturing and petrochemicals to waste management and coal mining.<sup>65</sup>

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57. See, e.g., Rogene Fisher, *Katrina Creates a 'Toxic Soup'*, ABC NEWS (Aug. 31, 2005), <https://perma.cc/2GDY-W39M>.
  58. See Danny D. Reible et al., *Toxic and Contaminant Concerns Generated by Hurricane Katrina*, THE BRIDGE, 11 (Spring 2006).
  59. See Ruckart et al., *supra* note 6, at 54–55.
  60. See John Henry, *Murphy Oil Says Gulf Spill Covered by Insurance*, ARK. BUS. (Dec. 5, 2005).
  61. See *Katrina Was a Category 3, Not 4*, *supra* note 2.
  62. See Godoy, *supra* note 6, at 443–45; Henry, *supra* note 60.
  63. See Godoy, *supra* note 6, at 443–45.
  64. See *id.* at 444–45.
  65. See David A. Dana & Hannah J. Wiseman, *A Market Approach to Regulating the Energy Revolution: Assurance Bonds, Insurance, and the Certain and Uncertain Risks of Hydraulic Fracturing*, 99 IOWA L. REV. 1523, 1527–28, 1561–62 (2014); James Boyd, *Financial Responsibility for Environmental Obligations: Are Bonding and Assurance Rules Fulfilling Their Promise?* 5–8 (Resources for the Future Discussion Paper 01-42, Aug. 2001), <https://perma.cc/9D9B-SHEP>.

D. *Coastal industry will probably underinvest in adaptation on its own*

Industrial operation on the coasts poses serious risks in our era of climate change. These risks will greatly increase if industrial facilities do not protect their operations from the worsening floods and storms of the future.

This does not necessarily mean that the law must *make* them act. Coastal industry should already have strong economic incentives to adapt. At its highest levels, corporate America generally understands that climate change is occurring and likely to accelerate in the future, and that it entails serious business risks.<sup>66</sup> For example, the extreme weather that climate change induces is likely to interrupt production processes (e.g., by causing power outages and input shortages), damage facilities, and interfere with transportation.<sup>67</sup>

In deciding whether to invest in adaptation, a rational business will weigh the costs of adapting against the costs of the problems it will face if it does not adapt. If the business will be able to avoid paying to fix some of those problems, it will exclude them from this calculus, and in turn, it will be unwilling to invest extra in order to prevent them. In theory, the production risks described above, if they materialize, should be borne by each business—for example, a flooded, idled factory will cause production revenues to cease, as Thai manufacturers learned all too well in 2011. Businesses should therefore be willing to invest in adaptation to prevent production risks, and some appear to be doing so.<sup>68</sup>

However, coastal businesses may not fully bear other costs. In particular, corporations have a number of ways to “externalize” environmental damage. Lawsuits over environmental disasters entail tricky questions of causation and valuation. In turn, they are difficult and expensive for plaintiffs to litigate, and companies frequently evade liability.<sup>69</sup> Even if a plaintiff prevails, the liable company may have limited its exposure—whether formally, by incorporating its risky facilities as separate limited liability entities, or informally, by limiting capitalization.<sup>70</sup> And, if faced with environmental claims it cannot pay, a business may declare bankruptcy as a last resort, leaving claimants to haggle over whatever remains in the bankruptcy estate with the rest of the entity’s equally entitled creditors.<sup>71</sup>

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66. CRAWFORD & SEIDEL, *supra* note 50, at x (“[T]he vast majority of [Global 100] companies recognize risks from extreme weather and climate change, and many see these risks in the present or near term”).

67. *See id.* at xi.

68. *See id.* at ix, xii.

69. *See, e.g.*, PAUL K. FREEDMAN & HOWARD KUNREUTHER, MANAGING ENVIRONMENTAL RISK THROUGH INSURANCE 18–19 (1997); Dana & Wiseman, *supra* note 65, at 1557.

70. Dana & Wiseman, *supra* note 65, at 1557; Boyd, *supra* note 65, at 3–4.

71. *See* Boyd, *supra* note 65, at 3–4; Joel M. Gross, *The Interface Between Bankruptcy and CER-CLA: Where Does New Legislation Belong?*, 5 FORDHAM ENVTL. L. REV. 287, 293–94 (2011). *See generally* Milissa A. Murray & Sandra Franco, *Treatment of Environmental Liabilities in Bankruptcy*, in ENVIRONMENTAL ASPECTS OF REAL ESTATE AND COMMERCIAL

To be sure, businesses may not be able to avoid *all* environmental liabilities through these strategies, and reputational concerns may also lead them to take some precautions.<sup>72</sup> Fundamentally, however, the environmental risks and costs of operating in coastal areas are only partially internalized to industry.<sup>73</sup> In turn, without regulation, even perfectly informed and rational businesses will engage in less adaptation than is socially optimal.

And, of course, real-world businesses deciding whether to invest in adaptation—even where it will prevent losses entirely internalized to the firm—are neither perfectly informed nor perfectly rational.<sup>74</sup> Their decision makers often have limited capital and short investment time horizons. Many know little about the potential impacts of climate change, or have more immediate concerns competing for their attention.<sup>75</sup> They tend to rely on past experience to project future climate-related challenges and losses, even though climate change is expected to usher in a sharply different future.<sup>76</sup> Even those concerned about climate change often struggle to find actionable information and face skepticism from colleagues and superiors.<sup>77</sup>

Climate change impacts' unfamiliarity, uncertainty, and deferred nature all suppress business investment in adaptation. Recent research illustrates that

TRANSACTIONS 341 (James B. Witkin ed., 4th ed. 2011). For a vivid recent example, see Michael Wines, *Owners of Chemical Firm Charged in Elk River Spill in West Virginia*, N.Y. TIMES (Dec. 17, 2014), <https://perma.cc/R7SR-LQ9G> (discussing a tank farm operator “whose toxic chemical spill tainted a West Virginia river . . . forcing a prolonged cutoff of drinking water to nearly 300,000 residents . . . declared bankruptcy days after the spill”).

72. See generally Charles J. Fombrun et al., *Opportunity Platforms and Safety Nets: Corporate Citizenship and Reputational Risk*, 105 BUS. & SOC'Y REV. 85 (2000).
73. See Boyd, *supra* note 65, at 1 (“Bankruptcy, corporate dissolution, and outright abandonment are disturbingly common means by which polluters avoid responsibility for environmental costs.”); *id.* at 11 n.42 and sources cited therein (listing numerous academic analyses of how bankruptcy and strategic corporate structuring tend to lessen risk avoidance incentives).
74. See, e.g., Richard Dobbs et al., *Building the Healthy Corporation*, MCKINSEY Q., 63 (2005), <https://perma.cc/YVL9-KELP> (discussing “shortsighted behavior” among corporate managers). Cf. Faure & Bruggeman, *supra* note 14, at 16, 21–26 (finding that “empirical evidence . . . suggests that there is generally no adequate interest in and thus no demand for voluntary [first-party] insurance protecting against natural catastrophes” and discussing various cognitive and informational explanations) (citations omitted); Sean B. Hecht, *Climate Change and the Transformation of Risk: Insurance Matters*, 55 UCLA L. REV. 1559, 1591–93 (2008) (reviewing behavioral psychology findings concerning underinvestment in insurance).
75. CRAWFORD & SEIDEL, *supra* note 50, at 21–22 (“Companies’ investment in building resilience competes with other business objectives and resources, many of which are more immediate and tangible. Short-term costs and cash flows are often considered more important than benefits that may not be realized until much later.”).
76. See, e.g., *id.* at 8 (noting that corporate adaptation “frameworks typically draw from a historical picture of risk and often do not adequately consider the changing character—such as frequency and intensity—of extreme weather events”).
77. See *id.* at 21–22.

real-world businesses are reluctant to adapt.<sup>78</sup> In 2015, researchers affiliated with Notre Dame polled “a small but robust sample of 37 companies, spread across eight different sectors” on climate adaptation practices. Within this sample—whose constituents were “likely to be more educated and more concerned about climate change than their peers at large”—fewer than one in five companies had a climate adaptation plan in place, and more than half had yet to even begin developing one.<sup>79</sup> Similarly, a 2013 survey of extreme weather risk adaptation among the Global 100 companies—a group consisting of sophisticated, deep-pocketed, multinational businesses,<sup>80</sup> that is, businesses that might reasonably be thought *most* likely to understand and act on climate change—found that:

[O]nly a few [firms] have developed plans that fully reflect the profile of increasing risks. Current business activities to build resilience are largely a continuation of existing practices and policies. . . . Few companies are taking action beyond no-cost or low-cost measures (if taking any action at all) and are adopting a “wait-and-see” approach. . . .<sup>81</sup>

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78. In addition to the sources discussed below, see MAX MESSERVY ET AL., CERES, INSURER CLIMATE RISK DISCLOSURE SURVEY REPORT & SCORECARD: 2014 FINDINGS & RECOMMENDATIONS, 6 (2014), <https://perma.cc/7RJ5-Z999> (“most of the companies responding to the survey reported a profound lack of preparedness in addressing climate-related risks and opportunities”); ARE UK COMPANIES PREPARED FOR THE INTERNATIONAL IMPACTS OF CLIMATE CHANGE?: FTSE 350 CLIMATE CHANGE REPORT 2013, CARBON DISCLOSURE PROJECT (2013), <https://perma.cc/75WE-4TY7> (“[FTSE 350] companies’ current focus on risks and opportunities needs broadening. While the majority of FTSE 350 companies identify risks (86%) and opportunities (82%) from climate change, the focus remains relatively narrow, looking primarily at direct, shorter-term risks. Only 32% of companies report risks (14% opportunities) which have timeframes of ten years or more and 13% of companies report that they have not identified any climate change related risks at all.”). See also Cruz et al., *supra* note 6, at 203 (noting that “emergency management preparations to deal with natural disaster-induced hazmat releases, however, are very limited, if they exist at all” among Gulf Coast petroleum refineries).
79. See ALEKA SAVILLE ET AL., NOTRE DAME GLOBAL ADAPTATION INDEX, 2015 CORPORATE ADAPTATION SURVEY 6–7, 17 (2015), <https://perma.cc/L953-P86C>.
80. On the Global 100, see *S&P Global 100 Methodology*, S&P DOW JONES INDICES 3 (Sept. 2016), <https://perma.cc/G6V6-N2SR>.
81. CRAWFORD & SEIDEL, *supra* note 50, at 21.



## II. APPROACHES TO COASTAL INDUSTRIAL ADAPTATION: THE ROLE OF FINANCIAL ASSURANCE MANDATES

### A. *The typical regulatory strategies—command-and-control mandates and subsidies—are inadequate*

Part I demonstrated that in the absence of targeted regulation, coastal industries are underinvesting, and will likely keep underinvesting, in climate adaptation. This Part discusses several regulatory approaches to climate adaptation. Already, policymakers have implemented command-and-control rules in other contexts, such as design requirements for new and existing buildings, and have heavily subsidized adaptation measures along the coasts. But, both approaches have serious drawbacks, especially in the context of industrial adaptation.

Command-and-control rules figure prominently in regulators' current efforts to promote coastal climate adaptation.<sup>82</sup> By definition, command-and-control regulations require regulated entities to take specified measures and impose penalties for noncompliance.<sup>83</sup> In the adaptation context, many states and localities have imposed command-and-control regulations in the form of building codes and land use regulations.<sup>84</sup> For instance, after Hurricane Andrew wrecked homes across southern Florida in 1992, the state and many of its localities bolstered structural standards for new construction.<sup>85</sup> New York City similarly revised its building code after Hurricane Sandy, requiring new buildings' lowest floors to be raised significantly above historical flood levels.<sup>86</sup> Many other jurisdictions, anticipating sea level rise, have now imposed mandatory setbacks, forbidding development within a certain distance of the shore.<sup>87</sup> Typically, such regulations only restrict new construction, but they could also be applied to existing facilities. New York City, for example, has proposed a building code revision that would require extensive upgrades to existing large buildings in flood-prone areas.<sup>88</sup>

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82. See, e.g., Dana & Wiseman, *supra* note 65, at 1449 (“The reality of environmental regulation is that, while there is much talk of market-based or financial-oriented regulation, command-and-control regulation dominates and is often the exclusive content of the regime.”).

83. See, e.g., Richard B. Stewart, *Controlling Environmental Risks Through Economic Incentives*, 13 COLUM. J. ENVTL. L. 153, 153 (1988); Dana & Wiseman, *supra* note 65, at 1547–48.

84. See generally GRANNIS, *supra* note 48 (describing a variety of relevant regulatory strategies).

85. Curtis Morgan, *Impact of Hurricane Andrew: Better Homes*, MIAMI HERALD (June 2, 2012), <https://perma.cc/3CE8-6EVY>.

86. See DEP'T OF CITY PLANNING, CITY OF NEW YORK, *Flood Resilience Zoning Text Amendment* (Oct. 9, 2013), <https://perma.cc/BA84-G5DG>.

87. See GRANNIS, *supra* note 48, at 27–28.

88. PLANYC, CITY OF NEW YORK, A STRONGER, MORE RESILIENT NEW YORK 84 (June 11, 2013), <https://perma.cc/9JG3-EYR8> (hereinafter “PLANYC REPORT”); see also PLANYC, CITY OF NEW YORK, PROGRESS REPORT 2014 60–61 (2014), <https://perma.cc/XQN6->

Command-and-control policy may have a role to play in coastal industry adaptation, but its well-known disadvantages counsel against a primarily command-and-control approach to the issue. Command-and-control rules require regulators to distinguish between acceptable and unacceptable conduct. Drawing such distinctions to promote regulatory goals without undue cost can require immense information and expertise, especially when the field of regulation is technically complex.<sup>89</sup> Moreover, the “one-size-fits-all” tendency of rulemaking can be inefficiently oblivious to variations among regulated entities. This inefficiency can be mitigated through case-by-case rulemaking or adjudication, but only at great cost.<sup>90</sup> Once implemented, command-and-control rules tend to be difficult to change, and therefore unresponsive to economic or technological developments that might justify revision.<sup>91</sup> In the meantime, all else equal, regulated firms have little incentive to make improvements beyond those required by regulation, even if such improvements would be beneficial overall.<sup>92</sup> The regulators tasked with overseeing firms’ compliance are often overworked and under-resourced, rendering enforcement more of a theoretical notion than a reality. And without financial incentives to produce thoughtful rules and implement them with alacrity, regulators may prove sluggish—or worse, beholden to the very interests they are meant to control.<sup>93</sup>

These disadvantages would likely hinder command-and-control approaches to coastal industrial adaptation. Coastal adaptation is a technically demanding field. Differences among facilities and the sites on which they are located strongly influence which measures are appropriate and how much they cost.<sup>94</sup> Moreover, the industrial facilities that would be subject to a coastal industrial adaptation mandate are considerably more complex than the homes current mandates tend to target. For these reasons, efficiently regulating coastal industrial adaptation through command-and-control mandates would be a tall

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J9B5 (noting the measure did not pass the City Council as planned in 2013, and will be reintroduced).

89. See Stewart, *supra* note 83, at 156.

90. *Id.*

91. See Dana & Wiseman, *supra* note 65, at 1548.

92. See *id.*

93. See *id.* at 1552–54 (describing industry capture of state and federal regulators through industry lobbying and pressure, groupthink, and “revolving door” personnel exchange).

94. See, e.g., John R. Headland et al., *Coastal Structures & Sea Level Rise: Adaptive Management Approach*, in COASTAL ENGINEERING PRACTICE 449 (Orville Magoon et al. eds., 2011) (modeling the financial viability of a rubble seawall under different sea level rise scenarios and construction schedules and discussing the complex, site-specific adaptation strategy used in a real-life development); James Neumann et al., *The Economics of Adaptation Along Developed Coastlines*, 2 WILEY INTERDISC. REVS.: CLIMATE CHANGE 89 (2011) (combining a high-level coastal adaptation conceptual framework with various site-specific data to propose optimal adaptation strategies).

task even for federal technocrats, let alone the state and local regulators traditionally responsible for building and land use regulation.

Policymakers may instead choose to subsidize coastal adaptation, rather than (or in addition to) mandating that industries enact particular measures. Indeed, federal programs already subsidize *residential* coastal adaptation. The U.S. Army Corps of Engineers has spent billions of dollars to erect protective dunes in vulnerable areas and to “renourish” storm-eroded beaches with dredged sand.<sup>95</sup> The National Flood Insurance Program (“NFIP”) heavily subsidizes reconstruction of homes and small businesses in flood zones, as demonstrated by its \$24 billion debt (as of 2013).<sup>96</sup>

States and localities have also directly subsidized coastal adaptation. Until 2009, for example, Florida provided thousands of dollars per house in matching funds for residential storm resilience retrofits.<sup>97</sup> After Sandy, New York State encouraged residents in certain low-lying areas to relocate by offering buyouts at prices above pre-storm fair market values.<sup>98</sup> More recently, New York City proposed a \$1.2 billion flood adaptation incentive program to accompany new adaptation mandates in its building code.<sup>99</sup>

Subsidies, like command-and-control regulation, have serious weaknesses. Most fundamentally, subsidizing coastal industrial adaptation would funnel the general public’s tax dollars to subsidy recipients, raising issues of equity and political feasibility.<sup>100</sup> Moreover, subsidies are essentially reverse command-and-control mandates; rather than specifying behavior to be punished, they specify behavior to be rewarded. For this reason, subsidy design implicates the same problems of scarce information, inflexibility, inertia, and capture as regulatory design does. Subsidy designers must decide which measures will be subsidized,

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95. Josh Boatwright, *Endless Erosion Battle a Matter of Money*, TAMPA TRIB. (July 13, 2014), <https://perma.cc/S7EM-U7AC>; David Vergun, *\$5.35 Billion Sufficient for Hurricane Sandy Relief, USACE Chief Tells Congress*, ARMY NEWS SERVICE (Nov. 14, 2013), <https://perma.cc/WTL7-38L9>.

96. U.S. GOV’T ACCOUNTABILITY OFFICE, GAO-13-858T, NATIONAL FLOOD INSURANCE PROGRAM: CONTINUED ATTENTION NEEDED TO ADDRESS CHALLENGES 4 (2013), <https://perma.cc/2C79-4UNJ>. NFIP consistently runs a deficit because in many cases, it charges premiums “that represent only about 40–45 percent of the full flood risk.” *Id.* at 2. In turn, “the annual amount that NFIP collects in both full-risk and subsidized premiums is generally not enough to cover its operating costs, claim payments, and principal and interest payments to Treasury, especially in years of catastrophic flooding.” *Id.* at 4.

97. GRANNIS, *supra* note 48, at 25.

98. See GOVERNOR’S OFFICE OF STORM RECOVERY, STATE OF NEW YORK, *NY Rising Buyout and Acquisition Programs* (2014), <https://perma.cc/TS88-DTAK>.

99. PLANYC REPORT, *supra* note 88, at 83–84.

100. A similar redistributive mechanism is already at work in the residential adaptation context in the guise of NFIP, through which all taxpayers subsidize coastal residents’ living expenses by paying for the gap between NFIP’s premiums and claims paid. See, e.g., Mark Fogarty, *Industry Victory on Flood Insurance Will Be Taxpayers’ Loss*, NAT’L MORTGAGE NEWS (Apr. 15, 2014), <https://perma.cc/TNR8-9TC4>.

who will be eligible, and how much funding the state will provide. Even if subsidy programs could be custom-tailored to recipients' particular situations, regulators are unlikely to know enough to be able to optimize these variables, and equally unlikely to be able to quickly revise policies in response to changing economic and technological circumstances. And powerful interests are just as able to co-opt subsidy-granting bureaucracies as regulation-enforcing ones.<sup>101</sup> Adaptation subsidies also encourage coastal residents to stay in risky areas, both by reducing risk and by substituting for harsher policies. If subsidized adaptation measures do not fully mitigate risk (a likely proposition), subsidies could, on balance, have the perverse effect of maintaining or even increasing overall risk exposure.

Finally, coastal industrial adaptation subsidies would face practical hurdles. Government budgets may not be able to bear additional subsidy initiatives; indeed, even NFIP's extremely popular subsidized flood insurance rates were recently scaled back (albeit temporarily).<sup>102</sup> And although residential adaptation subsidy programs such as NFIP and the Army Corps' beach renourishment efforts have been warmly received,<sup>103</sup> voters may be less likely to support hand-outs to coastal businesses.

The two most commonly used adaptation policy tools, command-and-control mandates and adaptation subsidies, are seriously flawed: they threaten to impose undue cost on coastal industries and their customers, to encourage ineffective or even counterproductive measures, and to unfairly tax the many to subsidize the few. FAMs may be able to avoid these pitfalls.

### B. *Financial Assurance Mandates: a Brief Overview*

FAMs require individuals or companies to prove their ability to meet potential liabilities, ensuring that if liability arises, the liable parties ultimately pay

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101. For a suggestive example from the coastal adaptation context, see Bill Dedman, *Why Taxpayers Will Bail Out the Rich When the Next Storm Hits US*, NBC NEWS (Feb. 18, 2014), <https://perma.cc/6JNG-AA2Q> (claiming that the Federal Emergency Management Agency ("FEMA") manipulated flood zone maps to include wealthy owners' high-risk properties in lower-risk zones, effectively subsidizing those owners' NFIP rates).
102. Biggert-Waters Flood Insurance Reform Act of 2012, Pub. L. No. 112-141, 126 Stat. 405, 916 (2012); Homeowner Flood Insurance Affordability Act of 2014, Pub. L. No. 113-89, 128 Stat. 1020 (2014) (repealing Biggert-Waters). See Bruce Alpert, *Senate Passes Bill Averting Largest Flood Insurance Increases Under Biggert-Waters*, NEW ORLEANS TIMES-PICAYUNE (Mar. 13, 2014), <https://perma.cc/KVC9-F2XL>.
103. See, e.g., Coral Davenport, *Popular Flood Insurance Law Is Target of Both Political Parties*, N.Y. TIMES (Jan. 28, 2014), <https://perma.cc/BGM5-RZGH> (describing a "grass-roots lobbying campaign" against cuts to NFIP insurance subsidies, resulting in a bill to scale back those cuts with "more than 180 [House] co-sponsors from both parties"); Matthew Schurman, *Cuomo Limits Sandy Buyout Program to Three City Nabes*, WNYC (Apr. 11, 2014), <https://perma.cc/N77V-9B8P> (New York's buyout program was "wildly popular").

rather than those to whom they are liable.<sup>104</sup> Auto insurance mandates, for example, are especially well-known FAMs. Every driver risks incurring liabilities to third parties, i.e., by culpably causing a car accident that harms other people or their property. States require drivers to carry insurance in order to ensure that drivers (through their insurers) pay for the costs of the accidents they cause, rather than leaving the victims to pay. Similarly, in the environmental context, various FAMs ensure that potential polluters, rather than society at large, are financially accountable in practice as well as on paper for whatever environmental problems they may cause.<sup>105</sup>

Individuals and businesses can comply with FAMs in various ways. In the automotive context, the traditional FAM is insurance: a commitment from a financially capable outsider to pay for any liability the driver may incur.<sup>106</sup> In other contexts, surety bonds are commonly used. A surety bond is an instrument requiring a financially capable third party (the surety), typically an insurer or specialized bonding company, to pay a specified amount (the bond) if certain conditions are fulfilled.<sup>107</sup> For some bonds, the only condition is that the purchaser incurs a liability, so the bond can be redeemed (that is, the third party can be made to pay the bond amount) regardless of whether the purchaser is able or willing to pay. Other bonds can be confiscated only if the purchaser defaults.<sup>108</sup>

Insurance and bonds both use third parties to assure the availability of funds. Other financial assurance tools do not. For example, some FAMs require regulated entities to set money aside in anticipation of potential liability.<sup>109</sup> Others allow regulated entities to “self-insure” by demonstrating to a regulator’s satisfaction that they are financially secure enough to be able to meet any future liability.<sup>110</sup>

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104. See Boyd, *supra* note 65, at 1. FAMs are also known as financial requirements or bonding requirements. *Id.* at 1.

105. Boyd, *supra* note 65, at 29.

106. *Id.* at 23.

107. *Id.* at 24. Letters of credit are akin to surety bonds but are provided by banks. *Id.* at 23–24. Some bonds require the surety to perform the obligation defaulted on by the purchaser rather than paying money. Barlow Burke, *Reclaiming the Law of Suretyship*, 21 S. ILL. U. L.J. 449, 451 (1997).

108. Boyd, *supra* note 65, at 24.

109. *Id.* at 25.

110. *Id.* at 20–21, 26–27.

C. *The Virtues of Financial Assurance Mandates and the Superiority of Insurance*

1. *Insurance vs. Other Financial Assurance Tools*

FAMs serve two essential functions. First, by requiring regulated individuals and businesses to have enough funds to fulfill their potential liabilities regardless of solvency, corporate form, or capitalization, FAMs ensure that victims or society at large do not have to bear financial burdens that the law allocates to those individuals and businesses alone. In this way, FAMs complement command-and-control regulations and tort law, both of which prescribe duties that might otherwise be avoided through one of the liability-limiting mechanisms described above.

Second, and more relevant to adaptation policy, FAMs do not merely ensure that harms are redressed by their creators: they also help prevent harm in the first place. Under a cost internalization mandate, a rational company should be willing to engage in investments that cost less than the future harm they prevent. FAMs both ensure cost internalization (by ensuring that regulated entities can pay, and can therefore be made to pay, any costs that materialize) and assign a clear and immediate value to those future costs. That value is the price of obtaining financial assurance—for example, an insurance premium, the purchase price and annual payments for a surety bond, or the opportunity cost involved in setting aside a cash reserve.<sup>111</sup> In turn, FAMs both encourage cost-preventing investment and discourage inherently costly activities (i.e., activities whose costs cannot be reduced through investment).<sup>112</sup>

This dynamic is clearest and most potent when insurance is used as the FAM. An insurance policyholder pays a premium in exchange for an insurer's agreement to fulfill the policyholder's liabilities, should any arise. The premium is proportional to the insurer's risk of having to pay. In other words, if the insurer expects that insuring the policyholder will prove costly, it will charge the policyholder more. Likewise, if the policyholder reduces her risk of incurring liability, the insurer should be willing to charge a lower premium.<sup>113</sup> And com-

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111. See, e.g., Omri Ben-Shahar & Kyle D. Logue, *Outsourcing Regulation: How Insurance Reduces Moral Hazard*, 111 MICH. L. REV. 197, 207 (2012) ("Differentiated insurance premiums provide explicit prices to people's choices of care in much the same way as Pigouvian taxes."); see also *id.* at 233 ("By converting the uncertain expected cost of liability into a certain cost of the insurance premium, insurance premiums enable insureds to make more informed choices regarding activity levels. Since most regulated parties do not have the information necessary to accurately convert expected ex post liability awards and fines into an exactly equivalent Pigouvian tax, and since the government does not provide such estimates to help people plan, insurers fill this void.").

112. See Dana & Wiseman, *supra* note 65, at 1563–65.

113. See, e.g., FREEDMAN & KUNREUTHER, *supra* note 69, at 24–25; Hecht, *supra* note 74, at 1614; Howard C. Kunreuther & Erwann O. Michel-Kerjan, *Climate Change, Insurability of*

panies with dangerous practices may find themselves unable to obtain insurance at any price.<sup>114</sup> There is much real-world evidence to show that insurers do, in fact, monitor their customers' activities, and vary premiums and underwriting standards (that is, the requirements they impose on their insureds) in turn, in order to reduce their exposure to losses.<sup>115</sup>

The fine-grained, dynamic risk mitigation incentives inherent in insurance are less present in other FAMs. Surety bonding and self-insurance, in particular, are commonly allowed under existing FAMs. Surety bonding, like any FAM that uses a third-party provider, assigns an explicit upfront cost (i.e., the bond price) to the bondholder's liability risk, and thereby discourages risky behavior to some extent.<sup>116</sup> However, a surety is not obligated to pay whenever a bondholder incurs a liability. Rather, the surety pays only if the bondholder cannot. For this reason, the price of a surety bond is directly responsive to the bondholder's credit risk, but only indirectly (if that) to its liability risk.<sup>117</sup> Bonded companies therefore do not necessarily face a fully dynamic price incentive to mitigate liability risk. Self-insurance, meanwhile, does not create an upfront price on liability risk at all. Although self-insured liability risk is theoretically wholly internalized to the self-insured company, which should in turn be willing to cost-effectively mitigate liability risk, without a third party to impose an immediate price on that uncertain and far-off risk, mitigation is unlikely.<sup>118</sup>

For these reasons, third-party insurance should more effectively encourage risk-mitigating behavior than other common financial assurance tools. These latter mechanisms can theoretically help ensure that the costs of accidents are borne by those who produced them, but are not as effective in preventing accidents in the first place.<sup>119</sup>

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*Large-Scale Disasters, and the Emerging Liability Challenge*, 155 U. PA. L. REV. 1795, 1839 (2007); Michael P. Vandenbergh, *The Private Life of Public Law*, 105 COLUM. L. REV. 2029, 2063–64 (2005). See also Ben-Shahar & Logue, *supra* note 111, at 208–09 (discussing the similar function performed by deductibles and copayments).

114. See Ben-Shahar & Logue, *supra* note 111, at 209.

115. See, e.g., Dana & Wiseman, *supra* note 65, at 1566–67; FREEDMAN & KUNREUTHER, *supra* note 69, at 24–25; Bradley C. Karkkainen, *Information as Environmental Regulation: TRI and Performance Benchmarking, Precursor to a New Paradigm?* 89 GEO. L.J. 257, 324 n.280 (2001); Vandenbergh, *supra* note 113, at 2064.

116. See *supra* notes 111–112 and accompanying text.

117. See Boyd, *supra* note 65, at 20; Burke, *supra* note 107, at 470. Surety bond prices may be indirectly responsive to liability risk, at least for major (i.e., bankruptcy-threatening) liabilities, because major liability events can affect solvency.

118. See *supra* notes 74–81 and accompanying text; Dana & Wiseman, *supra* note 65, at 1581.

119. This is not to say, of course, that insurance will prevent every accident. Indeed, the Murphy Oil refinery was insured to some extent. See Henry, *supra* note 60.

## 2. Insurance vs. Command-and-Control Regulation

Financial assurance mechanisms, and especially insurance, internalize the costs of harms and thereby reduce the risk that harms will occur in the first place. Of course, command-and-control regulations can do the same, at least in theory. But there are at least three reasons to think that insurers can be more effective in these tasks than their counterparts in the command-and-control bureaucracy.

First, insurers have a strong profit motive to accurately price risk.<sup>120</sup> Premiums that do not fully reflect policyholders' risks will attract risky customers, tending to cause the insurer to pay out more than it takes in; premiums disproportionate to policyholders' risks will drive potentially profitable customers away.<sup>121</sup> By reducing premiums in proportion to the effectiveness of risk-mitigating measures, insurers attract clients who can save more on premiums than they will have to spend on those measures. In this way, insurers can build business without having to take on undue risk.<sup>122</sup>

The profit motive gives insurance certain advantages over command-and-control regulation. In order to build business, insurers should be willing to grant premium reductions for *any* measure that reduces risk.<sup>123</sup> This allows policyholders to take measures that are most cost-effective for them, in contrast to many technology-mandating command-and-control mandates, and induces insurers to identify, develop, and promote cost-effective risk mitigation measures.<sup>124</sup> For these reasons, regulation through insurers can sometimes be more economically efficient than command-and-control regulation.<sup>125</sup>

120. See Ben-Shahar & Logue, *supra* note 111, at 234.

121. See *id.* at 204.

122. See *id.* (“[I]nsurers that can identify cheap risk-reduction measures can mandate adherence to those measures and attract more business by offering lower premiums that more than offset the cost of the mandated measures. . . . In their relentless search for profitable subpools of insureds, insurers use their clients’ propensity to reduce risk, or willingness to install safety measures, as a screening device.”).

123. See *supra* note 115 and accompanying text.

124. See Vandenberg, *supra* note 113, at 2074, 2080; Ben-Shahar & Logue, *supra* note 111, at 233–34 (“To be sure, government agencies can also engage in information gathering. But unlike with insurers, the information practices of government agencies do not have to be accurate for the agencies to perform their primary tasks. The agencies are not themselves insuring the externality, and thus they do not have to bear the costs of the harm or of imperfect tailoring.”) (internal citation omitted).

125. Cf. Dana & Wiseman, *supra* note 65, at 1549 (“In some accounts, enforcement of market regulation is also less costly and difficult than for command and control regulation, because some regulated entities have a greater affirmative buy-in to the regulatory regime.”) (internal citation omitted); Vandenberg, *supra* note 113, at 2079–80 (suggesting that private regulatory arrangements can “create monitoring and enforcement incentives and authority in the hands of private actors who are subject to market pressure to perform these tasks effi-



Second, as specialists in risk management, insurers develop and draw on deep expertise and proprietary knowledge as they assess the risks posed by their policyholders, craft incentives to mitigate those risks, and monitor policyholders to ensure that their premiums reflect their behavior.<sup>126</sup> Such resources may be beyond the reach of federal agencies, to say nothing of the state and local bureaucracies that administer much environmental regulation.<sup>127</sup> Superior resources, along with private insurers' market incentives, may allow insurers to more efficiently govern policyholders than public regulators in some cases.<sup>128</sup> And, of course, private insurers may be less susceptible to the political influences that often prevent government agencies from advancing their mandates.<sup>129</sup>

Third, and crucially, these institutional advantages also render insurance requirements more practically and politically viable than command-and-control regulations. Command-and-control regimes are costly to establish and run. By opting for insurance requirements, a regulator can effectively subcontract the design and enforcement of finer-grained rules to the insurer. All the regulator needs to do is define which entities are subject to the mandate, and verify that each of them in fact obtains insurance. In an era of tight public resources, this sort of regulatory "outsourcing" may be vital—especially at the state and local level, where funds and expertise are often particularly scarce.<sup>130</sup> By regulating through insurers, coastal states and cities on the frontlines of climate change may be able to make real progress on industrial adaptation despite dysfunction

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ciently. . . . Lower private compliance costs may lead to increased compliance with government regulations . . . .").

126. See Ben-Shahar & Logue, *supra* note 111, at 205–06, 233.

127. See, e.g., Dana & Wiseman, *supra* note 65, at 1553–54.

128. See, e.g., *id.* at 1567 ("An environmental management system designed to achieve a strict insurer-approved code, and combined with internal firm auditing and external third-party auditing, may provide a far superior form of *ex ante* regulation of unconventional development than the current motley and often unrigorous mix of state regulations that are enforced, to the extent they are, by infrequent inspection by an overworked and possibly insufficiently independent corps of state inspectors.").

129. See Vandenberg, *supra* note 113, at 2081. Of course, insurers are regulated and are therefore politically constrained to some extent. However, this indirect political influence is arguably strongest with regard to issues of high public salience, such as residential flood insurance. See, e.g., Alpert, *supra* note 102; Davenport, *supra* note 103. It is less clear that political interference through regulation would strongly shape insurance premiums for coastal industries. Business insurance markets, unlike residential insurance markets, frequently experience large fluctuations and increases in prices without political interference. See, e.g., Julia Kollewe, *BP Disaster Raises Oil Industry's Insurance Costs*, THE GUARDIAN (June 3, 2010), <https://perma.cc/R5JY-LC5F>.

130. See, e.g., TRACY GORDON, RUSSELL SAGE FOUND. & STAN. CTR. POVERTY & INEQUALITY, STATE AND LOCAL BUDGETS AND THE GREAT RECESSION (2012), <https://perma.cc/QU3P-NSTH>.

and inertia at the federal level and limited resources closer to home.<sup>131</sup> Indeed, as the next Part illustrates, states and cities have extensively deployed insurance requirements and other FAMs in other contexts to supplement or stand in for national regulation.

### III. HISTORICAL PRECEDENT: EXAMPLES OF FINANCIAL ASSURANCE MANDATES

The many theoretical virtues of FAMs—their potency as cost internalization tools, their relative simplicity and ease of implementation, and their ability to mobilize private sector resources—have led to their enactment in environmental laws at the federal, state, and local levels. This Part describes real-world FAMs at each level, and suggests two basic insights. First, FAMs are viable in practice and can be deployed by regulators with varying degrees of sophistication and resources. Second, FAMs can effectively promote public ends—but the devil is in the details. The history of the various federal FAMs, in particular, shows that differences in regulatory design, and especially in regulators' choice of FAM, strongly affect whether the theoretical benefits of FAMs materialize in practice.

#### A. Federal Assurance Mandates

##### 1. Underground Storage Tanks

Leaking underground storage tanks (“USTs”) are a major cause of groundwater pollution. In 1984, responding to a handful of highly publicized UST releases and to growing concern over the risks the tanks posed,<sup>132</sup> Congress authorized FAMs for the owners and operators of USTs.<sup>133</sup>

EPA regulations codified in 1988 gave detail to these FAMs and provided multiple means of compliance.<sup>134</sup> Subject entities—chiefly retail gas stations—can purchase \$1 million per incident in private environmental liability and site remediation financial assurance, or buy equivalent coverage from a state-operated UST insurance fund.<sup>135</sup> Self-insurance, bonding, and other mechanisms are also allowed, but have been little used since the regulations were enacted.<sup>136</sup>

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131. See, e.g., Gillis, *supra* note 31 (describing halting local progress on coastal climate adaptation despite opposition and dysfunction at the federal and (sometimes) state levels).

132. Laura J. Nagle, *RCRA Subtitle I: The Federal Underground Storage Tank Program*, 24 ENVTL. L. REP. 10057 (1994), <https://perma.cc/8A3B-DSUP>. See also Haitao Yin et al., *Does Private Insurance Reduce Environmental Accidents?*, REG. 37 (2012) (mentioning an “average cleanup cost of \$125,000 per release”).

133. 42 U.S.C. § 6991b(d) (2012).

134. 40 C.F.R. §§ 280.90–280.116 (2014).

135. *Id.* §§ 280.93, 280.100–280.101; Yin et al., *supra* note 132, at 38.

136. Yin et al., *supra* note 132, at 38.

Instead, subject entities have overwhelmingly opted to participate in state insurance programs where they exist, and have lobbied state legislators to create them where they do not.<sup>137</sup> Insurance through state programs is much cheaper than private insurance; the programs are usually funded through fuel taxes, and participants only pay a nominal flat fee, rather than risk-sensitive premiums.<sup>138</sup> Unfortunately, then, the state fund option typically neutralizes the cost internalization objective inherent in FAMs, and should in turn increase the risk of accidents and reduce participants' incentives to enact risk-reducing measures.

But although most states have created public insurance funds, many, including major states such as Texas, Florida, and New Jersey, have either refused to create funds, closed funds to new subscribers, or created funds that insure only for past releases.<sup>139</sup> UST owners in those states have therefore turned to the private market. The results demonstrate that appropriately designed FAMs can mobilize private insurers to effectively regulate risk. A robust private market in UST insurance has emerged.<sup>140</sup> Commercial UST insurers offer discounts for customers who use risk-mitigating technology, such as double-walled tanks and leak detection systems, and monitor their customers' compliance with safety best practices.<sup>141</sup>

UST FAMs that require private insurance significantly reduce the risk of accidents, as recent research by Haitao Yin, Howard Kunreuther, and Matthew White confirms.<sup>142</sup> Yin et al. took advantage of a natural experiment in state UST policy. In the mid-1990s, Michigan and Illinois's UST insurance funds both became insolvent.<sup>143</sup> In response, Michigan scrapped its fund, forcing UST owner/operators into the private insurance market. Illinois instead raised the fuel tax that supported its fund. Thereafter, Michigan UST owner/operators faced risk-sensitive insurance premiums and insurer monitoring, while their Illinois counterparts enjoyed flat fees regardless of their practices. After analyzing UST release and closure rates in these two states and comparing

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137. *Id.*

138. *Id.*

139. EPA, *State UST Financial Assurance Funds* (Mar. 14, 2014), <https://perma.cc/EF4T-R36Y>.

140. See OFFICE OF UNDERGROUND STORAGE TANKS, EPA, *LIST OF KNOWN INSURANCE PROVIDERS FOR UNDERGROUND STORAGE TANK OWNERS AND OPERATORS* (2013), <https://perma.cc/A69X-G4WK>.

141. See, e.g., *Services*, PETROLEUM MARKETERS MGMT. INS. CO. (2016), <https://perma.cc/U62M-H2EL> ("We provide financial responsibility coverage that satisfies state and federal requirements. . . . Although we will offer coverage for tanks of any age, we provide premium discounts for better systems. Discounts are available for double walled systems, dispensers with intact containment, sumps with intact containment, 15 gallon or larger spill buckets, electronic line leak detectors, and proactive leak detection systems. . . . We utilize an on-site inspection process to evaluate each insured UST system.").

142. Yin et al., *supra* note 132.

143. *Id.* at 38.

them with those of Indiana, which made no changes to its state fund program over the same period, Yin et al. concluded:

After Michigan changed to a private insurance market, overall release rates in the state fell by 20 percent more than in adjacent states. . . . [N]ot only did ongoing establishments make greater risk-reducing efforts in Michigan than in other states after 1995, but tank owners in Michigan also tended to permanently close facilities that had a high propensity to leak.<sup>144</sup>

## 2. Oil Production and Transport

The federal Oil Pollution Act (“OPA”), enacted in the wake of the Exxon Valdez spill and other releases,<sup>145</sup> defined liability for oil spills<sup>146</sup> and authorized FAMs corresponding to that liability.<sup>147</sup> OPA and its interpreting regulations impose FAMs on onshore oil facilities, such as land-based pipelines; offshore facilities, such as drilling rigs and ocean pipelines; and seafaring vessels carrying oil.<sup>148</sup> It permits a wide range of FAMs, including self-insurance.<sup>149</sup>

OPA sets forth several categories of damage for which facility and vessel operators are liable, including natural resource damages, lost profits, and remediation costs.<sup>150</sup> Its liability caps were increased to match inflation after the Deepwater Horizon disaster. Currently, they range from the low seven figures (for small vessels) to over \$400 million for deepwater ports and onshore facili-

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144. *Id.* at 41, 46.

145. *See, e.g.,* Rice v. Harken Expl. Co., 250 F.3d 264, 266 (5th Cir. 2001) (“The OPA was enacted in 1990 in response to the Exxon Valdez oil spill in Prince William Sound, Alaska, and was intended to streamline federal law so as to provide quick and efficient cleanup of oil spills, compensate victims of such spills, and internalize the costs of spills within the petroleum industry.”); S. REP. NO. 101-94, at 2 (1990), *reprinted in* 1990 U.S.C.C.A.N. 722, 723 (“The 11-million gallon spill from the Exxon Valdez in Prince William Sound, Alaska, and the three spills within a 24-hour period just months later in the coastal waters of Rhode Island, the Delaware River and the Houston Ship Channel, have demonstrated that oil pollution from accidental tanker spills is a real and continuing threat to the public health and welfare and the environment.”).

146. 33 U.S.C. § 2702 (2012).

147. *Id.* § 2716; *see* 30 C.F.R. §§ 553.1-553.62 (2014) (facilities); 33 C.F.R. §§ 138.10-138.150 (2014) (vessels). OPA’s FAMs built on and extended an assortment of facility and vessel FAMs imposed under various federal laws. Boyd, *supra* note 65, at 13-14.

148. 33 U.S.C. § 2716(a), (c); *see* 30 C.F.R. §§ 553.1-553.62 (facilities); 33 C.F.R. §§ 138.10-138.150 (vessels).

149. 33 U.S.C. § 2716(e); 30 C.F.R. § 138.80; *id.* § 253.20; *see also* Kenneth S. Abraham, *Catastrophic Oil Spills and the Problem of Insurance*, 64 VAND. L. REV. 1769, 1776 (2011) (indicating that “the principal means” of complying with OPA’s FAMs “is through the purchase of liability insurance”).

150. 33 U.S.C. § 2702(b).

ties. Offshore platforms like the Deepwater Horizon have a \$134 million liability cap.<sup>151</sup> However, subject facilities and vessels face *unlimited* liability in cases of gross negligence, willful misconduct, or violation of certain federal laws.<sup>152</sup> Moreover, OPA explicitly does not preempt state laws imposing greater liability.<sup>153</sup>

OPA separately establishes financial responsibility mandates. Vessel operators and deepwater ports are required to provide financial assurance to the full extent of their liability.<sup>154</sup> Offshore facilities' FAMs vary according to the facilities' "worst-case oil spill discharge volumes," but are capped in any event at \$150 million.<sup>155</sup> Onshore facilities are not subject to any FAM.<sup>156</sup> Again, however, OPA explicitly does not preempt state laws imposing additional or greater FAMs.<sup>157</sup>

"The Oil Pollution Act of 1990 is widely viewed as an enormous success," notes a leading casebook:

It is credited with improving the safety of oil tankers operating in U.S. waters. . . . Two years after the legislation was enacted, a study by the Petroleum Industry Research Foundation found a "sea change" in the shipping industry's safety practices, including improved operational procedures and new inspection regimes. A 1998 study by the National Research Council . . . noted that there has been a substantial reduction in the amount of oil spilled in U.S. waters. The study concluded that this decline "was the result of a number of actions that are in process or emerging, [including] the increased liability, financial responsibility, and other provisions of OPA 90."<sup>158</sup>

In addition, OPA's liability and financial responsibility provisions have generally (although not always) proved adequate to cover the cost of those disasters it has not prevented.<sup>159</sup> In recent years, however, many have urged Congress to

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151. See Consumer Price Index Adjustments of the Oil Pollution Act of 1990 Limit of Liability for Offshore Facilities, 79 Fed. Reg. 73832, 73840 (Dec. 12, 2014) (to be codified at 30 C.F.R. § 553.702); Consumer Price Index Adjustments of Oil Pollution Act of 1990 Limits of Liability—Vessels, Deepwater Ports and Onshore Facilities, 79 Fed. Reg. 42905, 42919 (proposed Aug. 19, 2014) (to be codified at 30 C.F.R. § 138.230).

152. 33 U.S.C. § 2704(a), (c).

153. See 33 U.S.C. § 2718.

154. 33 U.S.C. § 2716(a), (c)(2).

155. 30 C.F.R. § 553.13 (2014).

156. See Consumer Price Index Adjustments of Oil Pollution Act of 1990 Limits of Liability—Vessels, Deepwater Ports and Onshore Facilities, 79 Fed. Reg. at 42914 n.34.

157. See 33 U.S.C. § 2718.

158. ROBERT V. PERCIVAL ET AL., ENVIRONMENTAL REGULATION: LAW, SCIENCE, AND POLICY 145 (7th ed. 2013) (internal citations omitted).

159. See Jennifer Dlouhy, *Feds Boosting Oil Spill Liability Limits*, FUELFIX (Aug. 19, 2014), <https://perma.cc/UD87-JL9V>.

further increase OPA's liability caps and financial responsibility requirements to match the massive potential costs of major spills. The national commission on the Deepwater Horizon disaster argued:

If a less well capitalized company had caused the spill, neither a multi-billion dollar compensation fund nor the funds necessary to restore injured resources, would likely have been available. . . . The relatively modest liability cap and financial responsibility requirements provide little incentive for oil companies to improve safety practices.<sup>160</sup>

### 3. Nuclear Reactor Accidents and Decommissioning

FAMs have been an integral, if somewhat compromised, element of the nuclear regulatory landscape for decades. Since the enactment of the Price-Anderson Act in 1957, the Nuclear Regulatory Commission ("NRC") has required nuclear reactor owners to carry insurance for personal injury, property damage, incident response costs, and litigation and investigation expenses. Currently, each reactor owner must carry \$375 million in insurance per reactor. Any liabilities exceeding \$375 million are jointly paid for by all reactor owners, up to roughly \$12 billion in total (\$111.9 million per owner). Reactor owners face no liability past that point, and total potential liability is therefore capped at \$12 billion—far less than the potential harm of a significant nuclear accident.<sup>161</sup>

The NRC separately requires nuclear power plant operators to provide financial assurance for plant decommissioning. Operators can comply either by contracting with a financially sound third party, such as an insurer or parent entity, or by establishing a separate decommissioning fund.<sup>162</sup> The required amount of such a fund is determined on a plant-by-plant basis according to a regulatory formula.<sup>163</sup> In most cases, the NRC does not require plant operators to fill decommissioning funds ahead of time; rather, they may pay into the fund over time, typically as decommissioning surcharges are collected from the plant's customers.<sup>164</sup> The NRC is responsible for overseeing decommissioning

160. NAT'L COMM'N ON THE BP DEEPWATER HORIZON OIL SPILL AND OFFSHORE DRILLING, *DEEP WATER: THE GULF OIL DISASTER AND THE FUTURE OF OFFSHORE DRILLING*, 283–84 (2011), <https://perma.cc/55F7-UVD4>.

161. See 42 U.S.C. § 2210 (2012); U.S. NUCLEAR REG. COMM'N, *BACKGROUNDERS ON NUCLEAR INSURANCE AND DISASTER RELIEF* (Dec. 12, 2014), <https://perma.cc/2RXT-EJ8K>; *Price-Anderson Act: The Billion Dollar Bailout for Nuclear Power Mishaps*, PUB. CITIZEN (Sept. 2004), <https://perma.cc/H9GQ-XFXX>.

162. 10 C.F.R. § 50.75 (2014).

163. *Id.* § 50.75(c).

164. *Id.* § 50.75(e)(1)(ii)–(iii); NUCLEAR REG. COMM'N, *BACKGROUNDERS: DECOMMISSIONING NUCLEAR POWER PLANTS* (Aug. 6, 2014), <https://perma.cc/QN2A-MCWB>.

funds. In 2012, the Government Accountability Office (“GAO”) criticized NRC’s oversight, observing that the agency’s decommissioning fund formula was vague and inconsistently implied, that the NRC lacked written procedures and adequate documentation, and that it was not properly enforcing investment standards for decommissioning funds.<sup>165</sup>

#### 4. Mine Reclamation

Regulators have long used bonding to make miners restore the land they disturbed.<sup>166</sup> Building on this history, the federal Surface Mining Control and Reclamation Act of 1977 (“SMCRA”) established a nationwide bonding scheme and raised minimum bond amounts beyond the levels many states had previously required.<sup>167</sup> Bond amounts are determined on a case-by-case basis,<sup>168</sup> and bonds are released gradually as mining companies fulfill milestones in the reclamation process.<sup>169</sup> Companies in adequate financial health can self-insure, or “self-bond,” rather than buying bonds from third-party providers.<sup>170</sup> SMCRA empowers the federal Office of Surface Mining Reclamation and Enforcement (“OSM”) to oversee this process and confiscate bonds when miners fail to fulfill their reclamation obligations. However, states can supplant federal regulators by implementing their own reclamation bonding regimes, provided that these regimes meet SMCRA’s basic requirements and pass muster with OSM.<sup>171</sup>

SMCRA has met a mixed reception. Industry and federal agency commentators argue that SMCRA has driven significant reclamation.<sup>172</sup> On the other hand, environmental advocates and nonpartisan analysts have consistently

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165. U.S. GOV’T ACCOUNTABILITY OFFICE, GAO-12-258, NUCLEAR REGULATION: NRC’S OVERSIGHT OF NUCLEAR POWER REACTORS’ DECOMMISSIONING FUNDS COULD BE FURTHER STRENGTHENED 18–19 (2012), <https://perma.cc/X6KS-FTRF>. The GAO also questioned whether the formula required sufficient funds. *Id.*

166. *See* Boyd, *supra* note 65, at 16.

167. *See id.*; 30 U.S.C. §§ 1259, 1269 (2012); 30 C.F.R. §§ 800.11–800.70 (2014).

168. *See* Boyd, *supra* note 65, at 16.

169. HARRIS EPSTEIN ET AL., NAT. RES. DEF. COUNCIL & W. ORG. RES. COUNCILS UNDERMINED PROMISE: RECLAMATION AND ENFORCEMENT OF THE SURFACE MINING CONTROL AND RECLAMATION ACT, 1977–2007, 15 (2007), <https://perma.cc/6BMR-4EHA>.

170. *See* 30 C.F.R. § 800.23; Patrick Rucker, *Coal Giant Peabody Faces Federal Scrutiny Over Clean-Up Insurance*, REUTERS (June 4, 2015), <https://perma.cc/HYC7-XJRD>.

171. Boyd, *supra* note 65, at 19.

172. *See* Kathrine L. Henry, *Coal Mining in the United States: SMCRA’s Successful Blueprint*, 11 NAT. RES. & ENV’T 7, 61 (1997); Vern R. Pfannenstiel & Gary W. Wendt, *Twenty-Plus Years After SMCRA: Reflecting On the Results*, AM. SOC. MINING & RECLAMATION 992, 992 (2002).

criticized the SMCRA bonding regime.<sup>173</sup> A decade after the statute was enacted, GAO studies of state SMCRA implementation found that many states' bond requirements were inadequate and that OSM was not providing sufficient oversight.<sup>174</sup> Analyses in the 1990s reached similar conclusions.<sup>175</sup> And in 2007, a critique by two environmental non-profits contended that SMCRA was still failing to achieve timely, comprehensive reclamation, noting that "[a]s OSM has acknowledged on a number of occasions, the current bond levels are too low to produce the desired results."<sup>176</sup> More recently, as worsening market conditions have spurred losses and bankruptcies in the coal sector, many have worried aloud that companies' self-bonding will prove woefully inadequate.<sup>177</sup> In August 2016, OSM moved toward reforming SMCRA's self-bonding regulations, noting that the industry's instability had "exposed the limitation[s] of the current self-bonding rule."<sup>178</sup>

### B. State Financial Assurance Mandates

FAMs are fixtures of state environmental policy. For example, state mining regulators were imposing reclamation bond requirements on surface mining operations well before Congress enacted SMCRA.<sup>179</sup> Today, state FAM statutes and regulations can be classified in three ways.

First, some states impose FAMs in accordance with federal law and in lieu of federal FAMs. SMCRA exemplifies this cooperative federalist approach to FAMs: the statute establishes a federal financial assurance system, but allows states to replace federal regulation with their own reclamation bonding regimes. Federal financial assurance statutes for hazardous waste facilities, landfills, and underground storage tanks have similar delegation mechanisms.<sup>180</sup> In theory, the state replacements authorized under these statutes must meet or exceed the relevant federal FAMs, although they may not in practice (as SMCRA demonstrates).

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173. See, e.g., Boyd, *supra* note 65, at 42 ("Mining bonds have been required for decades, and there is ample evidence that mining bond levels have been, and in many cases remain, inadequate."); *id.* at 42–43 nn.172–78 and sources cited therein; EPSTEIN ET AL., *supra* note 169.

174. Boyd, *supra* note 65, at 42. See, e.g., U.S. GOV'T ACCOUNTABILITY OFFICE, GAO/RCED-86-38, SURFACE MINING: INTERIOR DEPARTMENT OVERSIGHT OF STATE PERMITTING AND BONDING ACTIVITIES 35, 37–39 (1985), <https://perma.cc/BU29-T3C7>.

175. Boyd, *supra* note 65, at 42–43 nn.175–78.

176. EPSTEIN ET AL., *supra* note 169, at 17–19 (cataloging OSM regional offices' admissions that SMCRA bonding is inadequate).

177. See, e.g., Rucker, *supra* note 170; Steven Mufson & Joby Warrick, *Can Coal Companies Afford to Clean Up Coal Country?*, WASH. POST (Apr. 2, 2016), <https://perma.cc/MJC3-5JZT>.

178. Heather Richards, *Feds Wade in on Self-Bonding Debate*, CASPER STAR-TRIBUNE (Aug. 21, 2016), <https://perma.cc/7DXE-F6L8>.

179. Boyd, *supra* note 65, at 16.

180. *Id.* at 18 (citing 42 U.S.C. §§ 6926(b), 6943, 6991(c) (2012)).



Second, some states impose their own FAMs on top of federal FAMs where the latter already exist. In particular, numerous states have imposed FAMs on offshore oil vessels and facilities that exceed those of the OPA, both in scope and amount required.<sup>181</sup> Washington State, for example, requires oil tankers to provide \$1 billion in financial assurance, far exceeding the relevant OPA limits.<sup>182</sup> It also requires financial assurance for both offshore and onshore oil facilities, with limits determined by state regulators on a case-by-case basis.<sup>183</sup>

Third, some states require financial assurance for environmentally damaging activities outside the scope of federal FAMs. State FAMs of this type are as diverse as the states themselves.<sup>184</sup> The Kansas Department of Health and Environment requires operators to provide financial assurance for the costs of closing “swine facilities” and “swine waste-retention lagoons or ponds.”<sup>185</sup> In Michigan, sand dune mining permit holders must file reclamation bonds with the state.<sup>186</sup> And Illinois and Maryland require fracking permit holders to carry millions of dollars in environmental liability insurance for each well drilled.<sup>187</sup>

### C. Local Financial Assurance Mandates

FAMs are also familiar tools of local government. In their capacities as landowners and infrastructure developers, local governments have long required performance bonds, general liability insurance, and other such assurances from those who construct their roads, rent their facilities, and so on.<sup>188</sup> Local officials also commonly impose FAMs in their capacities as environmental and land use regulators.<sup>189</sup> Like state FAMs, these fine-grained local requirements respond to a wide variety of local conditions and concerns. For example:

- In Cleveland, anyone who operates a wind energy turbine taller than thirty-five feet must “maintain a performance bond or equivalent finan-

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181. See *id.* at 17–18 (discussing California, Alaska, and Washington law).

182. See WASH. REV. CODE §§ 88.40.020(2)(a), (c) (2014); see also *id.* § 88.40.030 (listing permissible financial assurance methods).

183. *Id.* § 88.40.025.

184. See Boyd, *supra* note 65, at 18 (summarizing various state-only FAMs).

185. KAN. ADMIN. REGS. §§ 28-18a-23, 28-18a-24 (2014).

186. MICH. COMP. LAWS § 324.63712 (2014).

187. 225 ILL. COMP. STAT. 732/1-35(a)(3)–(b)(19) (2014) (\$5 million); MD. CODE ANN. 14-111(a)(7) (West 2014) (\$1 million). But see Austin L. Mitchell & Elizabeth A. Casman, *Economic Incentives and Regulatory Framework for Shale Gas Well Site Reclamation in Pennsylvania*, 45 ENVTL. SCI. & TECH. 9506, 9508 (2011) (“In general, the dollar amount of state and federal bonds for oil and gas wells often do not reflect expected reclamation costs.”).

188. See, e.g., James F. Nagle, *Bonds: A Fact of Life*, CONSTRUCTION LAWYER 35 (1998) (book review).

189. See, e.g., Nolon, *supra* note 14, at 556.

cial instrument sufficient to cover the demolition and removal of the wind turbine.”<sup>190</sup>

- Westport, Connecticut requires owners of private on-site wastewater disposal systems to establish cash reserves “in an amount sufficient to fund the cost of at least five years . . . of monitoring, inspection, operation, maintenance, repair and replacement of the [system] and all components thereof,” as well as additional emergency reserves.<sup>191</sup>
- Oklahoma City requires well drillers “proposing to drill at a location within the Garber-Wellington Aquifer recharge area” to carry \$1 million in private environmental liability insurance.<sup>192</sup> Meanwhile, Dallas mandates \$10 million in coverage for gas wells within the city limits.<sup>193</sup>

#### *D. Lessons From Experience*

Although the theoretical advantages of FAMs are well-established, there has been little systematic study of whether real-world environmental FAMs (especially state and local FAMs) have produced results in line with their theoretical promise.<sup>194</sup> Moreover, as this Part has shown, political pressure and bureaucratic failure have sometimes compromised FAMs in both the design and implementation stages. Nonetheless, the brief case studies offered in this Part offer three reasons to believe that FAMs can succeed in practice as well as in theory.<sup>195</sup>

First, all sorts of regulators can implement FAMs. As these case studies show, officials from small towns to the upper echelons of the federal government rely on them to promote a variety of environmental and public health goals. This is unsurprising, given the regulatory “outsourcing” and relatively light enforcement burden inherent in FAMs.<sup>196</sup> Nor have regulated industries found existing FAMs impossibly complex or expensive to satisfy. Rather, at least for FAMs that have been studied in detail, it appears that compliance is

190. CLEVELAND, OHIO, CODE OF ORDINANCES ch. 354A.08(b) (2014).

191. WESTPORT, CONN., CODE OF ORDINANCES § 30-233 (2014).

192. OKLA. CITY, OKLA., MUN. CODE § 37-42 (2014).

193. DALLAS, TEX., CODE OF ORDINANCES § 51A-12.203(e)(5) (2014).

194. See Boyd, *supra* note 65, at 2 (“Relatively little analysis of the rules’ practical implementation exists.”); see also *id.* at 67 (“[M]any of the most significant environmental obligations guaranteed by assurance mechanisms have yet to come due. Long-tailed hazards associated with landfills, for example, will not reveal themselves for decades. Accordingly, the legal and financial security provided by current assurance rules will be tested in earnest only in the years to come.”).

195. *Accord id.* at ii (“From the standpoint of both legal effectiveness and economic efficiency, assurance rules can be improved. On the whole, however, cost recovery, deterrence, and enforcement are significantly improved by the presence of existing assurance regulations.”).

196. See *supra* note 30 and accompanying text.

widespread, and the costs of compliance have generally proven much lower than anticipated.<sup>197</sup>

Second, although cost-internalizing measures invariably face political headwinds, FAMs with “bite” are politically attainable and can be strengthened over time. For example, after the *Exxon Valdez* spill, the architects of the original OPA dramatically increased liability and FAMs for oil facilities and vessels relative to prior law, overcoming strenuous opposition.<sup>198</sup> More recently, following the Deepwater Horizon disaster, federal regulators again increased these requirements (although likely not enough).<sup>199</sup> And with the OPA’s blessing, states with particular interests in oil spill prevention have pushed these FAMs even further, defying the industry and its allies in the process.<sup>200</sup>

Third, and most importantly, even when real-world FAMs fail to achieve the theoretical ideal of full cost internalization, they can still produce significant benefits for society. Oil spill and UST FAMs, although imperfect, demonstrate how real-world FAMs can make a difference. Both of these FAMs use private, profit-driven insurers to manage and mitigate risk, and both establish liability and require financial responsibility at levels high enough to provide a strong incentive for firms to behave safely (even if those levels are not necessarily high enough in every case). In turn, they have measurably shaped behavior in the sectors to which they apply and have likely helped prevent environmental disasters. As I discuss in the next Part, a coastal industry FAM should incorporate these lessons.

#### IV. SKETCHING A COASTAL INDUSTRY FEDERAL ASSURANCE MANDATE

In previous Parts, I discussed the dangers that coastal industries pose in our era of accelerating climate change, and argued that financial assurance mandates, and especially mandates to purchase insurance, can effectively reduce these dangers. This Part discusses the basic choices involved in bringing coastal industry FAMs from the drawing board into the real world.

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197. On the cost of compliance, see *infra* Part V.A.1. On the extent of compliance, see, e.g., Yin et al., *supra* note 132, at 38 (“State and federal regulators believe that compliance with [UST] financial responsibility requirements is (essentially) universal.”); OFFICE OF UNDERGROUND STORAGE TANKS, EPA, EPA STUDY ON THE EFFECTIVENESS OF UST INSURANCE AS A FINANCIAL RESPONSIBILITY (FR) MECHANISM 7 (2011), <https://perma.cc/2R7W-2A75> (noting that in a sample of twenty-five representative commercial UST policies, the policies “generally complied with a majority of the federal UST FR regulations applicable to UST pollution insurance policies”).

198. See PERCIVAL ET AL., *supra* note 158, at 142–43.

199. See *supra* note 151 and accompanying text.

200. See PERCIVAL ET AL., *supra* note 158, at 143.

*A. For Which Liabilities Should Financial Assurance Be Required?*

FAMs ensure that funds will be available to pay potential liabilities. Therefore, a FAM can only exist if liabilities also exist. Some statutes establish FAMs for liabilities that already existed under the law.<sup>201</sup> In other cases, statutes simultaneously create a liability and require assurance. Thus, for example, the OPA both created liability for environmental damage resulting from oil spills, and required financial assurance of firms that risked incurring that liability.<sup>202</sup>

Initially, at least, I suggest that coastal industry FAMs should cover only existing liabilities. Specifically, I propose requiring coastal industries to provide financial assurance sufficient to fully remediate worst-case spills, releases, and other such environmental disasters. As discussed above, the costs of these disasters are not fully internalized to firms, and climate change will make them much more likely. And coastal industries are already liable, or could at least plausibly be argued to be liable, for the resulting harms under existing environmental law, whether statutory (e.g., the federal environmental statutes) or common law (e.g., nuisance doctrines that outlaw pollution and the abandonment of dangerous or potentially dangerous facilities). Moreover, FAMs that address only existing liabilities will require less legal revision and impose fewer costs and uncertainties on subject businesses than FAMs that impose novel liabilities. Overall, then, the former should be less politically and legally contentious than the latter, while still mitigating important and increasing risks.

*1. Which Facilities Should Be Subject to Financial Assurance Mandates?*

A FAM aimed at climate-related coastal environmental disasters should logically apply to facilities that are vulnerable to the coastal impacts of climate change, and that contain substances and operations capable of serious harm if disrupted. Luckily for policymakers, existing regulations provide proxies for both of these characteristics:

- **Vulnerability to the coastal impacts of climate change:** All coastal facilities are vulnerable to some of the expected impacts of climate change, such as lightning and high winds accompanying stronger storms. However, some facilities are of particular concern given their exposure to flooding and storm surge. The Federal Emergency Management Agency's ("FEMA") flood insurance maps provide estimates of flood risk at any

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201. This is true, for example, of state FAM statutes that require financial assurance for the costs of closing polluting facilities or for potential environmental accidents resulting from oil and gas drilling. *See supra* note 188. Even without the FAMs, the enterprises regulated under these laws would presumably be liable for these costs under state environmental statutes or under the common law of nuisance.

202. *See supra* Part III.A.2.

location in the United States, and designate certain areas as especially vulnerable. Properties in Special Flood Hazard Areas (“SFHA”) have (according to FEMA) a one percent chance of inundation in any given year.<sup>203</sup> (For this reason, the SFHA is often referred to as the “100-year flood zone.”) FEMA also designates “moderate flood hazard areas” in which properties have an annual chance of inundation between 1% and 0.2% (hence, “500-year flood zones”).<sup>204</sup>

- **Presence of potentially harmful substances and operations:** The Emergency Planning and Community Right-to-Know Act of 1986 (“EPCRA”) and its implementing regulations identify certain facilities as posing a particular risk of dangerous contamination, and require those facilities to make disclosures to state and local regulators. Specifically, a facility is subject to EPCRA reporting requirements if it contains any one of a long list of “hazardous chemicals” in a quantity exceeding the relevant regulatory threshold.<sup>205</sup>

Together, FEMA’s flood maps and EPCRA’s reporting standards suggest a rough “rule of thumb” for identifying facilities to subject to the FAM. Any facility that is in a coastal jurisdiction, that is located within a FEMA 100- or 500-year flood zone, and that contains substances of a type and quantity sufficient to trigger EPCRA’s reporting requirements, can reasonably be said to pose an elevated danger as a result of the coastal impacts of climate change. To be sure, this rule of thumb is imperfect. FEMA’s flood maps, in particular, have been widely criticized as both under- and over-inclusive in certain areas.<sup>206</sup> Nonetheless, the combination of EPCRA and flood map data offers a coherent,

203. 44 C.F.R. § 59.1 (2014).

204. *Id.*; FED. EMERGENCY MGMT. AGENCY, U.S. DEP’T HOMELAND SECURITY, FLOOD ZONES (2014), <https://perma.cc/8ZVM-H7F5>. FEMA has also established sub-zones within the 100- and 500-year flood zones. For example, properties in V zones are “subject to inundation by the 1-percent-annual-chance flood event with additional hazards associated with storm-induced waves.” FED. EMERGENCY MGMT. AGENCY, U.S. DEP’T HOMELAND SECURITY, ZONE V (2014), <https://perma.cc/S9KA-5ABA>; *see* 44 C.F.R. § 64.3.

205. 42 U.S.C. § 11002 (2012); 40 C.F.R. § 370.10, 370.12, 370.40. Threshold quantities range from 500 pounds or less (for certain very dangerous substances) to 100,000 gallons (for diesel fuel at a retail gas station). *Id.* Current law defines over 500,000 “hazardous chemicals.” *EPCRA Sections 311-312*, EPA (July 7, 2014), <https://perma.cc/PZW2-XY7S>.

206. *See, e.g.*, Andy Horowitz, Op-Ed, *New Orleans’s New Flood Maps: An Outline for Disaster*, N.Y. TIMES (June 1, 2016), <https://perma.cc/J9DS-GQWY>; Christopher Joyce, *Outdated FEMA Flood Maps Don’t Account for Climate Change*, NAT’L PUB. RADIO (Sept. 15, 2016), <https://perma.cc/82QK-8JFQ>; Theodoric Meyer, *Using Outdated Data, FEMA Is Wrongly Placing Homeowners in Flood Zones*, PROPUBLICA (July 18, 2013), <https://perma.cc/V4N7-RTYD>; Al Shaw et al., *Federal Flood Maps Left New York Unprepared for Sandy—and FEMA Knew It*, PROPUBLICA (Dec. 6, 2013), <https://perma.cc/A6HF-NT3F>.

reasonably robust, and easily implementable initial framework for policymakers, and allows for additions and revisions as needed.<sup>207</sup>

*B. Which Assurance Mechanism(s) Should the Financial Assurance Mandate Use?*

The FAM must also identify acceptable mechanisms of assurance (e.g., insurance, bonds, self-insurance, etc.). In previous Parts, I discussed how real-world FAMs vary in this regard. Some provide laundry lists of acceptable mechanisms.<sup>208</sup> Others leave the decision to individual regulators, rather than (or in addition to) making a choice in the law itself.<sup>209</sup> Still others emphasize or require a particular mechanism.<sup>210</sup>

The discussion above highlighted two framing concerns in selecting among different FAMs. The first is regulatory complexity. FAMs that allow self-insurance require regulators to confirm and monitor regulated parties' financial stability. Even the most sophisticated regulators have struggled with this task.<sup>211</sup> Implementation is simpler if the regulated party purchases financial assurance—the regulator needs only to verify that the party in fact did so, and that the terms of the assurance (e.g., the type and amount of liability covered) meet the FAM's requirements.<sup>212</sup>

207. See, e.g., Ivan Maddox, *Why FEMA Flood Maps Don't Tell the Whole Risk Story*, INTERMAP: THE RISKS OF HAZARD (Dec. 3, 2014), <https://perma.cc/3ESP-XVTZ> (mapping industry commentator explaining that “[w]hen it comes to flood risk, the Federal Emergency Management Agency (FEMA)’s Flood Insurance Rate Maps (FIRMs) are the authority—and rightly so. They have decades of engineering intelligence built into them and are refined regularly. . . . [P]redicting 100% of a flood event is usually a sign of a weak flood model . . . . [T]he sweet spot is around 75% or 80% of flooding predicted. . . . This is about where FEMA’s FIRMs were on Sandy.”). FEMA’s ongoing map revision process may help fix some of the maps’ errors. See, e.g., Joyce, *supra* note 206; Al Shaw, *How Well Did FEMA’s Maps Predict Sandy’s Flooding?*, PROPUBLICA (Dec. 6, 2013), <https://perma.cc/4U2Z-Q8UW> (“[A]reas with newer [FEMA] maps using newer technology predicted . . . flood extents far more accurately overall”). But see Horowitz, *supra* note 206. Moreover, state and local policymakers may choose to supplement them with other data. See, e.g., Ron Hurtibise, *FEMA: New Palm Beach County Flood Maps Should Be in Effect by Spring 2017*, SUN-SENTINEL (April 26, 2016), <https://perma.cc/KU7F-PUDH> (noting that Palm Beach County policymakers drew on local analyses and engineering data in negotiating flood map revisions with FEMA).

208. The OPA is one example. See *supra* note 149 and accompanying text.

209. See, e.g., CLEVELAND, OHIO, CODE OF ORDINANCES § 354A.08(b)(1) (2016) (requiring a “performance bond or equivalent financial instrument . . . sufficient to guarantee full and faithful performance of the requirements of this chapter and . . . satisfactory to” certain city officials).

210. SMCRA, for example, emphasizes bonding. 30 U.S.C. § 1259 (2012).

211. See Boyd, *supra* note 65, at 61–66.

212. See *id.* at 21 (“[C]orporate financial auditing is not a traditional strength of environmental regulators. In contrast, purchased assurance is relatively easy to monitor.”).

The second framing concern is the extent and immediacy of risk mitigation incentives. In theory, all FAMs ensure that those subject to FAMs bear the costs at issue. This should theoretically drive risk mitigation no matter which FAM is chosen. However, for the psychological and organizational reasons discussed above, businesses are unlikely to take strong action if they do not face immediate, risk-responsive financial incentives.<sup>213</sup>

In the case of a coastal industry FAM, both of these factors favor a private insurance requirement. Coastal industry FAMs are perhaps most likely to be enacted by the states and localities most vulnerable to the coastal impacts of climate change. These resource-strained governments may not be able to effectively manage informationally intensive assurance mechanisms such as self-insurance.<sup>214</sup> Private insurance, and the private regulatory apparatus it entails, also provides the upfront risk mitigation incentives lacking in other FAMs.<sup>215</sup>

For these reasons, coastal industry FAMs should favor or require private insurance.<sup>216</sup> This, of course, is easier said than done. Regulated entities favor self-insurance because it is cheaper than private insurance. In turn, most federal FAMs allow self-insurance.<sup>217</sup> Ultimately, political factors will determine the viability of whether FAMs that exclude self-insurance can be enacted. However, as I will explain, there is reason to believe that the politics of coastal industry FAMs may favor stronger measures.<sup>218</sup>

## V. CONFRONTING POTENTIAL OBJECTIONS TO A COASTAL INDUSTRY FEDERAL ASSURANCE MANDATE

Having described how a coastal industry FAM might be designed, in this final Part, I respond to several arguments against creating one.

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213. See *supra* notes 74–81 and accompanying text; Dana & Wiseman, *supra* note 65, at 1581. Cf. Thomas W. Merrill, *Insurance and Safety Incentives* 10 (Nat'l Comm'n on the BP Deepwater Horizon Oil Spill and Offshore Drilling, Working Paper, 2011), <https://perma.cc/P7U4-D4ME> (“A firm that self-insures may encounter difficulty justifying precautionary measures to its accounting department based on internal calculations of expected liabilities. But a firm faced with higher insurance premiums based on loss experience or failure to adopt particular safety measures should find it easier to justify improved safety measures.”).

214. See *supra* notes 127–130 and accompanying text. But see *infra* Part V.D (discussing difficulties in defining the required amount of assurance, regardless of the assurance mechanism chosen).

215. See *supra* note 118 and accompanying text.

216. See Dana & Wiseman, *supra* note 65, at 1581; Merrill, *supra* note 213, at 10–12 (suggesting “eliminat[ing] self-insurance as an acceptable form of Oil Pollution Act insurance”).

217. See *supra* Part III.A.

218. See *infra* Part V.B.

*A. Financial Assurance Will Be Very Expensive or Even Unavailable at Any Price, Forcing Coastal Industries Out of Business or Into Other Jurisdictions*

The first and most obvious counterargument goes something like this: Insurance is expensive. It may be especially expensive for climate impacts, which are highly uncertain, potentially severe, and likely to affect many insured businesses at once. Insurers will demand high premiums in order to have enough money on hand if a coastal disaster produces many expensive claims.<sup>219</sup> In especially risky areas, they may refuse to provide insurance altogether, forcing businesses to close or relocate. In other areas, high premiums will increase the cost of doing business so much that companies will be at a significant disadvantage relative to those in unregulated areas. In turn, they will close their doors, or flee for other jurisdictions.

This argument has some merit. A FAM imposes a new expense—the cost of obtaining assurance—whose magnitude cannot be predicted with certainty.<sup>220</sup> All else equal, industries in jurisdictions with FAMs will be at a competitive disadvantage relative to jurisdictions without them. For three reasons, however, this dynamic should not worry policymakers too much. Private firms will probably be able to provide the requisite insurance at a reasonable price. And even if FAM-compliant insurance is somewhat expensive, this alone is unlikely to prompt many businesses to relocate. Finally, to the extent that businesses do relocate or close as a result of coastal industry FAMs, the resulting social benefit may well outweigh the cost.

*1. Private Insurance Is Unlikely to Be Very Expensive or Unattainable*

Historical and theoretical evidence both suggest that the costs of complying with coastal industry FAMs will be modest. Predictions of sky-high premiums, unavailable insurance, widespread insolvencies, and the like were heard ad nauseam when many modern FAMs were enacted, yet none of these consequences came to pass. As James Boyd observes:

The history of assurance implementation speaks for itself. Assurance does not bankrupt whole industries, and it does not mean the end of small business. In every regulatory context to date, private financial markets have developed to provide the insurance, bonds, and other

219. See, e.g., FREEDMAN & KUNREUTHER, *supra* note 69, at 40–48; Kunreuther & Michel-Kerjan, *supra* note 113, at 1821–22.

220. Cf. Dana & Wiseman, *supra* note 65, at 1573 (suggesting that the argument that mandated insurance will be unavailable “can be powerful precisely because until there is an insurance mandate, no one can say with certainty how the insurance markets will or will not respond.”).



financial instruments necessary to demonstrate assurance, and they provide these products at reasonable cost.<sup>221</sup>

Moreover, from a theoretical perspective, it is not clear that coastal climate risk specifically should be unusually difficult or expensive to insure. To simplify slightly, insurers set premiums in light of four basic considerations.<sup>222</sup> First, insurers will charge higher premiums for ambiguous risks, that is, risks with large variances in the likelihood of losses arising and/or in the magnitude of those losses.<sup>223</sup> Second, they will charge more if they cannot tell whether their customers are especially likely to make claims (adverse selection).<sup>224</sup> Third, they will charge more if customers are likely to act more dangerously once insured (moral hazard).<sup>225</sup> Fourth, they will charge more if risks are correlated, that is, if many customers are likely to make claims at the same time.<sup>226</sup>

In the context of insuring coastal industrial exposure to climate risk, these four factors should have countervailing effects. On the one hand, moral hazard and adverse selection probably would not cause insurance premiums to rise, because customers would not have an informational advantage over insurers. Rather, insurers should be equally or more able than the customers themselves to discern whether their customers are vulnerable to climate risk. This is because insurers can monitor customers and draw on superior proprietary information (e.g., hurricane models, sea level rise projections, experience from insuring other customers and industries, etc.) to evaluate risk exposure.<sup>227</sup> Simi-

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221. Boyd, *supra* note 65, at 30; *see id.* at 30–34; Dana & Wiseman, *supra* note 65, at 1573–75 (observing that “[d]espite the predictions made in the face of mandatory insurance proposals, insurance markets have consistently produced adequate insurance capacity once a mandate was enacted” and providing examples). Accounts of insurers and FAM-subject entities crying wolf abound. *See, e.g.*, Dana & Wiseman, *supra* note 65, at 1574 n.195 (“[I]n 2010—just three months after the industry testified it would be impossible to insure at that level [amidst discussions of raising the OPA liability cap]—Munich Re proposed to provide insurance of up to \$10 to \$20 billion on a rig-by-rig basis for offshore wells.”); Lawrence I. Kiern, *Liability, Compensation, and Financial Responsibility Under the Oil Pollution Act of 1990: A Review of the First Decade*, 24 TUL. MAR. L.J. 481, 570 (2000).

222. *See, e.g.*, Faure & Bruggeman, *supra* note 14, at 33 (“Due to problems of ambiguity, adverse selection, moral hazard, and highly correlated losses, insurance companies will want to charge a risk premium that considerably exceeds the expected loss. This premium can, however, be so high that there would be very little demand for coverage at that rate.”); FREEDMAN & KUNREUTHER, *supra* note 69, at 40–48. A fifth factor, which I will set aside here, is administrative costs. I see little reason to believe that the administrative costs of providing climate-related environmental insurance will be wildly different from those of providing other forms of individualized specialty insurance.

223. *See* FREEDMAN & KUNREUTHER, *supra* note 69, at 40–43.

224. *See id.* at 43–44.

225. *See id.* at 17–19.

226. *See id.* at 19–20.

227. *See* Kunreuther & Michel-Kerjan, *supra* note 113, at 1824.

larly, by monitoring customers and varying their premiums according to the risks uncovered, insurers should be able to ward off moral hazard.

On the other hand, ambiguity and correlation should tend to raise premiums, as the impacts of climate change are uncertain and can produce many losses all at once (as in the case of a hurricane or major flood). It is impossible to determine *ex ante* how strongly these factors would influence the price of coastal climate risk insurance. Nonetheless, there is cause for optimism. Insurers have been able to provide affordable insurance even in markets with similarly high ambiguity and correlation, such as offshore drilling, where a robust and risk-responsive private insurance market exists.<sup>228</sup> Moreover, in the past decade, insurers and the specialists that serve them have heavily invested in climate modeling and other ambiguity-reducing technical tools, and have begun to more systematically incorporate these tools into their underwriting and premium-setting practices.<sup>229</sup> And by encouraging risk-mitigating behavior, insurers can narrow the range of potential losses, further reducing ambiguity.<sup>230</sup>

## 2. *A Financial Assurance Mandate's Costs Will Not Necessarily Drive Industries Away*

Even if a coastal industry FAM raises costs, businesses subject to the FAM will not necessarily flee. After all, the coasts offer easy access to port facilities, fuel terminals, and other important infrastructure, as well as to major population centers.<sup>231</sup> Partially for this reason, many coastal areas have developed robust networks of upstream product producers, downstream input suppliers, and specialized contractors and service providers, allowing productivity-enhancing informational exchanges and fostering deep labor markets.<sup>232</sup> In the United States, the energy industry exemplifies this agglomeration phenomenon, with coastal hubs in the Houston area and in southern Louisiana accounting for

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228. See, e.g., Mark A. Cohen et al., *Deepwater Drilling: Law, Policy, and Economics of Firm Organization and Safety*, 64 VAND. L. REV. 1853, 1901 (2011); Dana & Wiseman, *supra* note 65, at 1573–74.

229. *Id.* at 1828–29, 1840–41; see, e.g., Karen Clark & Co. Launches U.S. Storm Surge Risk Model, ARTEMIS (Jan. 20, 2015), <https://perma.cc/S3S4-H6SK>.

230. See, e.g., Celine Herweijer et al., *Adaptation to Climate Change: Threats and Opportunities for the Insurance Industry*, 34 GENEVA PAPERS 360, 366 (2009) (citing industry studies suggesting that adaptation investments may reduce the magnitude and variability of future insured losses).

231. See *supra* note 36 and accompanying text.

232. See generally Glenn Ellison et al., *What Causes Industry Agglomeration? Evidence from Coagglomeration Patterns*, 100 AM. ECON. REV. 1195, 1196 (2010); David Schleicher, *The City as a Law and Economic Subject*, 2010 U. ILL. L. REV. 1507, 1509–10, 1514, 1517–28 (2010) (providing an accessible summary of agglomeration dynamics in the urban context, and describing how the presence of transportation infrastructure historically catalyzed economic agglomeration).

an outside share of the industry's production facilities, labor force, and innovative and technical capacity.<sup>233</sup>

Energy producers and businesses in other coastally concentrated industries cannot easily forsake the locational amenities available along the coasts. A coastal industry FAM would have to be oppressive indeed to make businesses give them up, and as I have explained, this is unlikely. That is not to say that a coastal FAM could never prompt relocation—it is always possible that the latest regulation, even if only modestly costly, will be the “straw that breaks the camel's back,” and within industries, different firms and producers may be mobile to different degrees—but generally, coastal industry's limited mobility should give regulators some wiggle room.

### 3. *High Costs or Relocation, If They Occur, May Actually Be Socially Beneficial*

Lastly, insofar as the FAM does increase costs or drive industry from the coasts, this may be a good thing. In principle, the cost of financial assurance merely reflects the risk a business's operations pose to society. To the extent that FAMs “increase” the cost of doing business, they do not create that cost, but rather shift it from society back to those regulated.<sup>234</sup> From a social welfare perspective, then, businesses whose operations are so socially risky that they cannot afford to mitigate or insure them *should not continue to exist*, and businesses that can only avoid crippling insurance costs by relocating *should* be forced to do so.<sup>235</sup>

It could be argued in response that relocation will not decrease society's overall exposure to climate risk if businesses relocate to equally risky areas. What if a chemical plant in a FAM-adopting coastal jurisdiction relocates to an inland, no-FAM area threatened by increased wildfires and droughts, or to a neighboring coastal town without a FAM?

A few rebuttals are possible. If risky no-FAM destinations are enticing some businesses away from other, FAM-implementing jurisdictions, the appro-

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233. See, e.g., sources cited *supra* note 36; *Number and Capacity of Operable Petroleum Refineries by PAD District and State as of January 1, 2014*, U.S. ENERGY INFO. ADMIN. (2014), <https://perma.cc/E5W5-P297> (U.S. refinery capacity is disproportionately concentrated in Texas and Louisiana); Matt Hudgins, *A Boom in Houston Is Led by the Energy Industry*, N.Y. TIMES (Dec. 4, 2012), <https://perma.cc/LU4C-APSM> (“The global energy industry is headquartered here; [a real estate executive] said. ‘It’s not just oil and gas, it’s alternatives, too. Intellectual capital in the energy field is heavily concentrated here.’”); Pam Radtke Russell, *What’s Houston Got That N.O. Doesn’t? Plenty*, NEW ORLEANS TIMES-PICAYUNE (Aug. 4, 2007), <https://perma.cc/6PYL-YG5Y>.

234. See, e.g., Boyd, *supra* note 65, at 29.

235. Cf. Dana & Wiseman, *supra* note 65, at 1582 (“[T]o the extent small firms simply cannot afford to comply with the kind of risk minimization and mitigation insurers may require, it could, potentially, be socially optimal for larger firms to replace them.”).

appropriate remedy from a broader cost-benefit perspective is to regulate risk in the destinations as well, not to give up on regulation entirely. Moreover, although climate risk is widespread beyond the coasts, it is not totally pervasive. There are, in fact, large areas of the country that are expected to experience less climatic disruption than others, allowing them to avoid implementing strict FAMs (or, perhaps, justifying exempting them from a federal- or state-level FAM).<sup>236</sup> If climate-related risks threaten devastating outcomes, society might be better off if businesses migrate to these less risky areas.

*B. A Financial Assurance Mandate Is Politically Implausible*

A coastal industry FAM might also face vigorous opposition from the sectors to be regulated and their employees.<sup>237</sup> Because the FAM would ward against harms that are uncertain and potentially far-off, there would be no broad pro-FAM lobby to counter this opposition. In turn, the FAM would either fail or be diluted to the point of ineffectiveness.

Again, there is some merit to this argument. At the national level, it will likely take a major disaster for legislators to consider a robust coastal industry FAM. Indeed, several federal FAMs were enacted only after high-profile contamination disasters.<sup>238</sup> At the state and local level, too, jurisdictions that have experienced major weather disasters, such as Florida and New York City, have poured effort into designing and implementing coastal adaptation strategies.<sup>239</sup>

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236. See, e.g., *Vulnerability and Climate Change in the U.S. Southeast*, OXFAM AM. (2013), <https://perma.cc/N7GE-QYJ4> (mapping differences in climate risk exposure across southeastern U.S. counties).

237. The FAM's opponents could also choose to litigate. But they would likely have better luck in legislatures than in court, as the most obvious grounds for an anti-FAM lawsuit appear uncertain at best. The great quantity and wide geographic spread of existing state and local FAMs suggest that relevant federal and state laws generally do not preempt FAMs at lower levels of government. The most likely federal constitutional challenges would also probably fail. Enacting a federal coastal industry FAM would seem to be well within Congress's commerce power. And although coastal development restrictions are frequently litigated as regulatory takings, a coastal industry FAM would not fit into any of the per se takings categories. See *Lucas v. S.C. Coastal Council*, 505 U.S. 1003 (1992) (total diminution in value); *Loretto v. Teleprompter Manhattan CATV Corp.*, 458 U.S. 419 (1982) (physical intrusion). Moreover, as a broadly applicable law that applied to businesses already facing extensive regulation and that imposed costs directly proportional to those businesses' potential liabilities, it would almost certainly pass the *Penn Central* regulatory takings test. See *Penn Cent. Transp. Co. v. New York City*, 438 U.S. 104, 124 (1978).

238. See, e.g., *supra* notes 132 & 145 and accompanying text.

239. See *supra* notes 85–86 and accompanying text. See generally John Schwartz, *Pragmatism on Climate Change Trumps Politics at Local Level Across U.S.*, N.Y. TIMES (Oct. 24, 2014), <https://perma.cc/N4BU-P934>.

Similarly, only after disasters like Hurricane Sandy have coastal residents mobilized in support of adaptation.<sup>240</sup>

Yet, although they face political headwinds for the time being, coastal industry FAMs have at least three important political advantages. First, as I have shown, the costs of a coastal industry FAM will probably be modest. Although coastal industries have reason to oppose any increase in the cost of doing business, and are likely to claim that costs will be high, FAMs' history of cost-effective implementation may reassure legislators and the public. Moreover, if businesses expect adaptation regulations of some sort to be enacted (for example, after a major disaster), they may choose to lobby for FAMs over potentially more expensive and burdensome command-and-control mandates.<sup>241</sup>

Second, even if coastal industry FAMs raise costs, many jurisdictions may be willing to enact them anyway. Because states and localities can implement FAMs on their own, as discussed above, FAMs can emerge piecemeal even in the absence of a properly functioning Congress (or even state legislature) or a nationally galvanizing catastrophe. Jurisdictions that have suffered major disasters or that are particularly concerned about the coastal impacts of climate change can implement FAMs without waiting for higher levels of government to embrace the issue, and without having to contend with the institutional dysfunction and ideological conflict that often hinder lawmaking at higher levels.<sup>242</sup> Indeed, in recent years, local and state governments have outpaced the federal government with regard to climate policy in particular.<sup>243</sup>

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240. See, e.g., Marisol Bello, *Recovery from Superstorm Sandy Ignites Fight over Dunes*, USA TODAY (Aug. 29, 2013), <https://perma.cc/LV8Y-33HV> (reporting that, after Sandy, "About 1,000 oceanfront property owners . . . refus[ed] to sign easements that would allow the corps to build 22-foot-high dunes and 200-foot-wide beaches. . . . Mayors and businesses posted the names of holdouts on websites and storefronts. [The governor] derided the property owners as selfish. Residents bombarded them with phone calls, visits to their homes and letters calling them out in newspapers."); Schuerman, *supra* note 103.

241. See *supra* note 125.

242. This is not to say, of course, that state and local governments always lack similar counterproductive dynamics. See, e.g., Aaron K. Chatterji, Op-Ed, *Don't Look to States for New Ideas*, N.Y. TIMES (Jan. 11, 2015), <https://perma.cc/TMK7-5D4V>. But in many cases, these pressures may be reduced; Meghan Reilly, CONN. GEN. ASSEMBLY OFFICE OF LEGISLATIVE RESEARCH, 2009-R-0249, STATES LIMITING LEGISLATIVE DEBATE (July 8, 2009), <https://perma.cc/V97D-P5DS> (noting that most state legislatures do not allow filibusters and other similar tactics). See Bridget Bowman, *U.S. Conference of Mayors Moving Past Congressional Gridlock*, ROLL CALL: HILL BLOTTER (Jan. 23, 2015), <https://perma.cc/DED4-LJA3>. Moreover, opposition, even if procedurally empowered, may be less likely to derail strong adaptation measures when the entire polity has been directly affected by a climatic disaster. In seeking strong adaptation measures in Congress, a state on the frontlines of climate change may have to contend with the opposing interests of other states (and their industries), but its lawmakers will face no such challenges in their own government.

243. See, e.g., Gillis, *supra* note 31; Judith Resnik, Joshua Civin & Joseph Frueh, *Ratifying Kyoto at the Local Level: Sovereignism, Federalism, and Translocal Organizations of Government Actors (TOGAs)*, 50 ARIZ. L. REV. 709, 718–19 (2008); Schwartz, *supra* note 239; Mark Muro

Third, coastal industry FAMs will not directly affect most coastal residents, so they may provoke less political resistance than other adaptation initiatives have. Before Hurricane Sandy, and even afterward to a lesser extent, many coastal New Jersey residents doggedly resisted the Army Corps' plans to build protective dunes, fearing they would ruin ocean views and reduce property values.<sup>244</sup> Similarly, proposed reforms to NFIP aimed in part at encouraging residential adaptation foundered amidst stiff opposition from coastal homeowners and their legislative allies.<sup>245</sup> A coastal industry FAM, in contrast, would affect a relative handful of businesses, all of which are already subject to extensive environmental and safety regulation. The politics of the FAM, in turn, might more closely resemble those of conventional environmental regulations. These are not easy to enact, of course, but may be more attainable than regulations that threaten to directly increase costs for coastal homeowners.<sup>246</sup>

C. *Self-insurance and Rate Regulation Will Prevent the Financial Assurance Mandate from Mitigating Risk*

Even those who favor FAMs in theory might doubt whether their theoretical advantages will translate to the real world. In practice, it could be argued, coastal industry FAMs will be compromised in two ways. First, regulators can allow businesses to self-insure by demonstrating sound finances and ample reserves. Self-insurance removes the third-party monitoring and upfront financial incentives that cause companies to reduce risks.<sup>247</sup> It is important to note, however, that FAMs that allow self-insurance should still promote the core

& Devashree Saha, *Climate Response Goes Local*, BROOKINGS INST.: THE AVENUE (Aug. 28, 2014), <https://perma.cc/M6G6-2ZPG>. This dynamic also plays out within states. *See, e.g.*, Bill Dawson, *It's Houston Versus Texas in a Looming Court Battle over Climate Rules*, TEX. CLIMATE NEWS (Jan. 14, 2016), <https://perma.cc/4LMP-UKWD>.

244. *See, e.g.*, Bello, *supra* note 240.

245. *See* Alpert, *supra* note 102; Davenport, *supra* note 103.

246. If recent history is any indication, the American public broadly supports environmental regulations that apply directly to businesses, and implementing new regulations is possible despite vociferous business opposition. *See, e.g.*, FREDERICK MAYER ET AL., DUKE UNIV. NICHOLAS INST. FOR ENVTL. POLY SOL., AMERICANS THINK THE CLIMATE IS CHANGING AND SUPPORT SOME ACTIONS 2-3 (2013), <https://perma.cc/422Y-J4GT>; Zack Colman, *Most Americans Support Climate Regulations Even with Costs: Poll*, WASH. EXAMINER (Nov. 20, 2014), <https://perma.cc/ELU2-EFF5>; Juliet Eilperin, *Autos Must Average 54.5 MPG by 2025, New EPA Standards Say*, WASH. POST (Aug. 28, 2012), <https://perma.cc/9GEC-MNHR>; Amy Harder, *Obama Carbon Rule Backed by Most Americans—WSJ/NBC Poll*, WALL STREET J. (June 18, 2014), <https://perma.cc/K72V-CD45>. *But see* Coral Davenport, *EPA Funding Reductions Have Kneecapped Environmental Enforcement*, NAT'L J. (Mar. 3, 2013), <https://perma.cc/FN9T-8TY4>.

247. Dana & Wiseman, *supra* note 65, at 1580-82. Self-insurance may also benefit large enterprises at the expense of smaller businesses, which are less capable of self-insurance and must therefore purchase potentially expensive private insurance on the market. *Id.*

goal of cost internalization to some extent. That is, FAMs allowing self-insurance would still be of some value. Moreover, self-insurance is not inevitably allowed in real-world FAMs. Many, especially at the state and local level, do not explicitly allow it, and self-insurance is certainly not the only form of insurance that major corporations are willing to obtain.<sup>248</sup> To promote upfront risk mitigation, jurisdictions implementing FAMs can and should choose not to allow self-insurance, as argued above.<sup>249</sup>

Second, legislators and insurance regulators may prevent insurers from charging fully risk-sensitive premiums, reducing coastal businesses' incentives to adapt and possibly causing private insurers to leave the market altogether.<sup>250</sup> But this has not happened with existing industry FAMs, in sharp contrast to residential FAMs. Premiums in economic sectors subject to FAMs vary widely according to insurers' perceptions of risk, as do business insurance premiums in general.<sup>251</sup> The political economy of rate regulation thus appears to be quite different for businesses and for residences.<sup>252</sup>

#### *D. Regulators Will Struggle to Determine How Much Assurance to Require*

As noted above, FAM implementation might be fairly simple if purchased financial assurance is required. Nevertheless, regulators will face a tricky design question regardless of their chosen assurance mechanism: how much assurance to require. A FAM that attempts to align financial responsibility with the full extent of potential liability (as I have advocated) must estimate potential damages from a worst-case disaster and translate those damages into a minimum policy limit for insurance regimes, a minimum bond amount for surety bond regimes, a minimum self-insurance capacity for self-insurance regimes, and so on. Setting the amount too low could cause shortfalls if disaster strikes, but setting it too high could burden facilities with costs out of proportion to the risks they actually pose.

This is a real challenge, but it should not be overstated. Regulators can make the task of defining appropriate assurance levels easier on themselves—albeit at the cost of insensitivity to differences in dangerousness among individ-

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248. See, e.g., *Deepwater Horizon Disaster Not a Watershed Event for P&C Insurance Market*, TOWERS WATSON (Aug. 2010), <https://perma.cc/SN8G-UUV6> (describing private insurance held by major players in the Deepwater Horizon disaster); Abraham, *supra* note 149, at 1787.

249. See *supra* note 118 and accompanying text.

250. See, e.g., Bradley G. Bodiford, *Florida's Unnatural Disaster: Who Will Pay for the Next Hurricane?*, 21 U. FLA. J.L. & PUB. POL'Y 147, 158–60 (2010) (discussing the woes of Florida's state-operated property insurer). See generally Richard A. Epstein, *Exit Rights and Insurance Regulation: From Federalism to Takings*, 7 GEO. MASON L. REV. 293, 303–08 (1999).

251. See, e.g., Kollewe, *supra* note 129.

252. See *supra* notes 102–103 and accompanying text.

ual operations—by setting sector-wide required policy limits. This is the approach of most FAMs, including those in the OPA and federal UST regulations. Conceivably, regulators might also be able to enlist insurers and the specialist firms that serve them to help determine probable exposure and set assurance mandates accordingly (especially if the FAM is designed such that determination need not be made on a case-by-case basis). In any event, in opting for FAMs, regulators take up the task of determining required assurance amounts, but they avoid many other informationally intensive tasks inherent in other regulatory approaches.<sup>253</sup>

*E. A Financial Assurance Mandate Is Unnecessary Because Coastal Businesses Are Already Insured*

Coastal industry FAMs will obviously be superfluous if the businesses they target already have private insurance for the impacts the FAMs address. However, this is probably not the case. Data on the prevalence of insurance against the potential coastal impacts of climate change are scarce, and many vulnerable facilities are no doubt already insured to some extent.<sup>254</sup> However, as I have argued, there is strong evidence that coastal businesses are underpreparing generally for these impacts—even when they directly threaten core operations.<sup>255</sup> They should be even less likely to purchase protection against potential liabilities to third parties (e.g., those arising from environmental contamination), given that the costs of those harms are indirectly and incompletely internalized.<sup>256</sup>

Moreover, current shortfalls in the broader environmental liability insurance market suggest that coastal businesses are unlikely to be consistently and adequately insured. To the contrary, industry publications suggest that the market is growing but underdeveloped and that regulatory mandates are needed to drive demand. Insurers claim that “80 percent of risk managers do not purchase environmental liability coverage outside of the insurance they are forced by regulation to buy.”<sup>257</sup> A recent article in the trade press explains:

While at-risk companies increasingly face contractual obligations to purchase pollution insurance, most others see little reason to purchase it. “Part of that is because pollution claims are low-frequency and high-severity [events], so many entities don’t see themselves in that situation,” explains broker Chris Smy . . . . In the United States . . .

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253. See *supra* notes 89–91 and accompanying text.

254. In fact, the Murphy Oil refinery was insured. See Henry, *supra* note 60.

255. See CRAWFORD & SEIDEL, *supra* note 50.

256. See *supra* notes 69–73 and accompanying text.

257. Chad Hemenway, *Environmental Liability Market Still Has Plenty of Room for Growth*, NAT’L UNDERWRITER PROP. & CASUALTY 12 (Jul. 19, 2010).



pollution insurers have been able to tap only a fraction of their potential market. Mary Ann Susavidge, chief underwriting officer for the North American property/casualty environmental unit at XL Group, estimates that pollution insurers have penetrated only 20% to 30% of the US market.<sup>258</sup>

This shortfall derives in part from businesses' reliance on self-insurance, which theoretically internalizes costs but may fail to drive investment in risk mitigation in practice.<sup>259</sup> However, the demand-suppressing institutional and psychological factors described previously also appear to play a role.<sup>260</sup> Whatever the reason, although the broader market for environmental insurance does appear to have grown in recent years,<sup>261</sup> it is still sorely underdeveloped.<sup>262</sup> Given

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258. Dave Lenckus, *The Polluter Pays*, GLOBAL FIN. (Jan. 3, 2013), <https://perma.cc/26RL-6GPV>. See also Judy Greenwald, *Environmental Liability Insurance Market Stabilizes on Increased Capacity*, BUS. INS. (Feb. 2, 2014), <https://perma.cc/H7UH-5JA7> (noting that rates have decreased in recent years and insurers are actively competing with one another for business); Hemenway, *supra* note 257 (citing insurer representatives' assertions that "[l]ess than 10 percent of all environmental claims are covered by insurance . . . even as the cost remains relatively inexpensive for moderate risks."); *Ten Things to Know About Environmental Liability*, INS. J. (Apr. 7, 2014), <https://perma.cc/A49J-R25P> ("The market for environmental insurance products remains fluid and highly competitive. Although some carriers raised rates, aggressive pricing and terms are still prevalent.").
259. See Abraham, *supra* note 149, at 1787; Dana & Wiseman, *supra* note 65, at 1581.
260. See *supra* notes 74–81 and accompanying text; Hemenway, *supra* note 257 ("It is a low-frequency, high-severity line," said Mr. Beauchamp of Beazley. He added that given 'the financial consequences—even for an event you had nothing to do with—one would figure companies would be more sensitive.' . . . However, he suggested that the expense of adding environmental liability coverage to a standard program might be difficult to justify to a risk manager's superiors, particularly given the cost-consciousness in this tough economic environment. . . . the choice of many risk managers with potential pollution exposures to pass on this coverage continues to baffle insurers.").
261. See, e.g., Rosalie L. Donlon, *ACE: There Is a Global Need for Environmental and Pollution Protection Insurance*, PROPERTYCASUALTY360 (May 13, 2015), <https://perma.cc/6SC5-8TBZ>; Heather Turner, *Environmental Insurance Activity Is on the Rise*, INS. BUS. AM. (Mar. 30, 2016), <https://perma.cc/2HH2-NTSN>; Brian Anderson, *Environmental Trends and Market Prospects: Part 3*, INS. BUS. AM., <https://perma.cc/U57V-EKXW> (2014) ("The customary rap on environmental insurance is that it's a specialised product only purchased by companies with an exposure so obvious that they're legally required to carry some sort of cover. . . . Today however a combination of severe weather events, expensive lawsuits and highly publicised environmental risks are leading many smaller companies to consider their exposures and seek appropriate coverage.").
262. See, e.g., David Dybdahl, *A Big Picture on Environmental Insurance*, INTL. RISK MGMT. INST. (July 2016), <https://perma.cc/5PFV-49QJ> ("In abundant and continuous supply since 1975, the market penetration of the environmental insurance product line is currently less than 10 percent. . . . Although the number of environmental insurance policies sold every year is growing, . . . the majority of insurance buyers remain needlessly and ignorantly uninsured on both property and liability insurance policies for losses arising from a broad spec-

this, it seems unlikely that coastal businesses are already well insured against liabilities to third parties resulting from climate change.

### CONCLUSION

The seas are rising, coastal economies continue to grow, and from Washington to New Orleans, Miami, and Manhattan, policymakers are debating how to encourage adaptation to the floods and storms of the future. I have sought to show that FAMs can efficiently and equitably promote climate adaptation. FAMs ensure that those who cause harm pay for it, rather than those harmed or society at large. If properly designed and enforced, and especially if they rely on private insurance, FAMs mobilize the expertise and resources of the private sector to cost-effectively catalyze risk-reducing behavior. FAMs are suitable for implementation by all levels of government, and their history shows that they can be workable and effective in practice as well as in theory.

This paper has emphasized how FAMs might be used to promote climate adaptation among coastal industries. Those industries appear to be under-preparing for climate change, risking devastation for the communities in which they are concentrated. By internalizing the potential costs of those disasters to industry through risk-attuned private regulation, FAMs, and especially insurance mandates, can help reduce the chance of disaster.

Spills and releases are a logical starting point for coastal adaptation FAMs, but these policies could also help tackle other problems. Climate change and its coastal impacts implicate many sources of liability under existing law, and as these impacts mount, policymakers may be inclined to create new liabilities as well.<sup>263</sup> FAMs can help ensure that liable parties pay up, and can encourage investment in measures that reduce the risk of liabilities in the first place. For example, to encourage resilience upgrades in coastal multifamily housing, local officials might impose FAMs on landlords, requiring them to insure their tenants against the harms they may suffer if storms and flooding cause structural

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trum of potential contaminated losses.”); Hemenway, *supra* note 257; Lenckus, *supra* note 258; Turner, *supra* note 261 (“99 percent of the marketplace [is] wide open.”).

263. An analysis of the legal and policy merits of expanded liability is beyond the scope of this paper. However, the previous Parts have indicated a few ways in which policymakers might choose to expand liability. They might, for example, impose liability (and require financial assurance) for natural resource damages—that is, “damages to land, fish, wildlife, biota, air, water, groundwater, and other resources . . . that are owned, controlled, or managed by federal, state, or other governmental entities.” JAMES BOYD, FINANCIAL ASSURANCE RULES AND NATURAL RESOURCE DAMAGE LIABILITY: A WORKING MARRIAGE? 7 (2001), <https://perma.cc/6E4W-T5YT>. Many state statutes impose liability (and corresponding FAMs) for natural resource damages, as do CERCLA and OPA. *Id.* at 7–11. For systemically vital industries, policymakers might also consider imposing liability (perhaps in the form of a restitution obligation) when climate impacts force business shutdowns and trigger the provision of governmental aid.

damage or utility shutdowns.<sup>264</sup> Such mandates could complement more traditional approaches to the same problem, such as building code mandates. Meanwhile, inland officials might impose FAMs to protect their communities from industrial accidents caused by wildfires, droughts, and extreme temperatures. More ambitiously, policymakers could require carbon-emitting industries to purchase insurance against liabilities they may accrue as a result of their emissions, for example, as a result of nuisance suits or under future statutes governing greenhouse gas pollution.<sup>265</sup> Insurers, in turn, would charge high-emitting companies higher premiums, providing an immediate incentive for emissions reductions.

As these brief suggestions indicate, FAMs are versatile and potentially potent regulatory tools. Policymakers pondering how to prevent the next Murphy Oil spill—or worse—should take a close look at insurance mandates and other FAMs. As the waters rise and the storm clouds gather, FAMs can and should play a leading role in protecting coastal communities from the dangers of climate change.

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264. Landlords may be liable to their tenants for such harms under existing law. *See, e.g.*, Barbara Ross, *Landlord of Two Downtown Manhattan Buildings Accused of Gross Negligence in Preparing for Sandy*, N.Y. DAILY NEWS (Nov. 21, 2012), <https://perma.cc/WL9Q-ZU25>.

265. *See generally* Anastasia Telesetsky, *Insurance as a Mitigation Mechanism: Managing International Greenhouse Gas Emissions Through Nationwide Mandatory Climate Change Catastrophe Insurance*, 27 PACE ENVTL. L. REV. 691 (2010).

## APPENDIX: LOCAL ORDINANCE DISCUSSION DRAFT

*The following draft ordinance contains language adapted from federal, state, and local FAMs. Optional and modifiable provisions are denoted in italics.*

## 1) Definitions

- a) "Decommission" means to remove a facility safely from service.
  - b) "Department" means the city department of environmental protection.
  - c) "Facility" means all buildings, equipment, structures, and other stationary items that are located on a single site or on contiguous or adjacent sites and that are owned or operated by the same person (or by any person that controls, is controlled by, or is under common control with, such person).
  - i) "Facility" includes manmade structures, as well as all natural structures in which hazardous chemicals are purposefully placed or removed through human means such that it functions as a containment structure for human use.
  - d) "Financial responsibility" means financial resources, the legal entitlement to receive financial resources, or the legal entitlement to compel the transfer of financial resources. The forms of financial responsibility include, but are not limited to, the following:
    - i) Insurance policies;
    - ii) Cash reserves;
    - iii) Surety bonds;
    - iv) Letters of credit;
    - v) Guarantees; and
    - vi) Self-insurance.
  - e) "Flood zone" means a Special Flood Hazard Area or moderate flood hazard area, as determined by the Federal Emergency Management Agency.
  - f) "Hazardous chemical" means any hazardous chemical as defined under 29 C.F.R. § 1910.1200(c).
  - g) "Occurrence" means an incident, including continuous or repeated exposure to conditions, giving rise to damages or to a decommissioning as set forth in subsection 4.
    - i) This definition is intended to assist in the understanding of these regulations and is not intended either to limit the meaning of "occurrence" in a way that conflicts with standard insurance usage or to prevent the use of other standard insurance terms in place of "occurrence."
  - h) "Subject facility" means a facility subject to the requirements of this chapter according to subsection 2.
- 2) It shall be unlawful to own or operate a subject facility without demonstrating financial responsibility to the department according to the requirements of this section.

- a) If the owner and operator of a subject facility are separate persons, only one person is required to demonstrate financial responsibility; however, both parties are liable in event of noncompliance.
- 3) A facility is a subject facility if:
  - a) A hazardous chemical is present in the facility, or was present in the facility in the preceding 12 months; and
  - b) The presence of that chemical obligates or would have obligated the owner or operator of the facility to comply with the hazardous chemical reporting requirements of the Emergency Planning and Community Right to Know Act and its implementing regulations; and
  - c) The facility is wholly or partially located within a flood zone.
- 4) Owners and operators of subject facilities must demonstrate financial responsibility in a form and amount sufficient, in the determination of the department:
  - a) to compensate affected third parties (including the city) for damages:
    - i) that might occur during a reasonable worst case release of hazardous chemicals from that facility; and
    - ii) for which the owner or operator of the subject facility would be liable under current law; and
  - b) to fund the decommissioning of the facility.
- 5) The financial responsibility demonstrated by the subject facility shall in no event be for an amount less than [*\$100 million per occurrence*].
  - a) The department may require a subject facility to demonstrate financial responsibility in a greater amount if it determines that [*\$100 million per occurrence*] is inadequate for the purposes set forth in subsection 4.
  - b) In determining to what extent to require financial responsibility in excess of [*\$100 million per occurrence*], the department shall consider such matters as:
    - i) the amount of hazardous chemicals that could be released from the facility;
    - ii) the potential cost of remediating the resulting damage;
    - iii) the frequency of operations at the facility;
    - iv) the commercial availability and affordability of financial responsibility; and
    - v) the financial stability and resources of the facility.
- 6) The financial responsibility demonstrated by the subject facility shall be in the form of an insurance policy or policies issued by an insurance company that:
  - a) is authorized to do business in the United States; and
  - b) has an A.M. Best rating of “A” or above.
- 7) [*Notwithstanding any of the above, the department may allow a subject facility to demonstrate financial responsibility in a form or forms other than an insurance policy if it determines that:*

- a) The subject facility would be unable to procure an insurance policy meeting the requirements of this section without extreme hardship; and*
  - b) The alternate form of financial responsibility is sufficient for the purposes set forth in subsection 4.]*
- 8) The subject facility shall demonstrate financial responsibility to the department:
    - a) within 30 days of the date on which it became a subject facility; and
    - b) thereafter, on an annual basis; provided, however, that upon the department's request, the operator shall provide copies of all relevant documentation at no cost to the city.
    - c) Failure of the department to request required documentation of financial responsibility does not constitute a waiver of the financial responsibility requirement.
  - 9) This section shall not apply to a facility owned or operated by the federal government or by the state or city government.
  - 10) The department shall have the authority to issue regulations to further the purposes of this section.