

## ISSUE BRIEF

# TOXIC AIR POLLUTION IN THE HOUSTON SHIP CHANNEL: DISPARITIES SHOW URGENT NEED FOR ENVIRONMENTAL JUSTICE

*By Yukyan Lam, Ramya Sivasubramanian, and Marisa Guerrero (NRDC);  
Juan Parras and Ana Parras (Texas Environmental Justice Advocacy Services)*

Houston, Texas, has some of the worst air quality in the United States.<sup>1</sup> The Houston region is home to a petrochemical manufacturing complex that is the largest in the Americas and the second largest in the world.<sup>2</sup> Along both sides of the 50-mile Houston Ship Channel, the thoroughway for port traffic between the Gulf of Mexico and the Port of Houston, numerous chemical and industrial facilities contribute to high levels of air pollution (see figure 1).<sup>3</sup> Expert analysis commissioned by Texas Environmental Justice Advocacy Services (TEJAS) and the Natural Resources Defense Council (NRDC) reveals that the burden of this pollution is being “disproportionately shouldered by people of color, people living in poverty, and limited-English households.”<sup>4</sup>



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A children's playground located next to the Valero Refinery in Houston, Texas.

For more information, please contact:  
**Ivan Moreno**  
imoreno@nrdc.org

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FIGURE 1: MAP OF THE HOUSTON SHIP CHANNEL



## AIR POLLUTION IN HOUSTON COMES FROM MANY SOURCES

Along the Houston Ship Channel, major industrial facilities emit large quantities of air pollution during ongoing operations, as well as during nonroutine activities like start-ups and shutdowns.<sup>5</sup> While mobile sources of pollution such as heavy-duty diesel vehicles and passenger vehicles also contribute to poor air quality, the chemical processes occurring at industrial facilities—for example, refining, crude oil and fuel handling, and evaporation—are among the most significant sources, if not *the* most significant source, of harmful air pollutants around the Houston Ship Channel.<sup>6</sup> Toxic emissions also occur during acute emergencies, such as the March 2019 multiday petrochemical fire at the Intercontinental Terminals Company facility,<sup>7</sup> the fatal explosion and fire occurring only weeks later at the KMCO chemical facility,<sup>8</sup> and, more recently, the explosion and subsequent fire caused by the rupture of an underground pipeline at the Lone Star natural gas liquids storage complex.<sup>9</sup> Further, extreme weather events in the Gulf can trigger emergencies at the Ship Channel’s industrial facilities, as occurred with Hurricane Harvey in 2017.<sup>10</sup>

Houston’s communities are thus continuously exposed to a variety of dangerous air pollutants, which have been linked to a range of negative health effects.<sup>11</sup> Three categories of pollution that are particularly concerning are fine particulate matter (PM<sub>2.5</sub>), coarse particulate matter (PM<sub>10</sub>), and volatile organic compounds (VOCs). Exposure to coarse and fine particulate matter can damage the heart and lungs and has been associated with premature death and cardiovascular disease.<sup>12</sup> Exposure to VOCs, which are released from the burning of fuels (among other sources), is also associated with serious health problems, including eye and respiratory tract irritation, memory problems, and damage to the liver, kidneys, and central nervous system, as well as cancer.<sup>13</sup> Inhalation of air pollutants is especially dangerous for infants, the elderly, and those with preexisting heart or lung conditions.<sup>14</sup>

## FAILURES COMPOUNDING THE POLLUTION PROBLEM IN HOUSTON

Houston’s pollution issues are compounded by lax enforcement of pollution regulations by state and federal agencies and a lack of real zoning laws. Houston’s existing zoning laws allow industrial facilities to be located in proximity to homes, putting residents at risk of breathing in toxic air pollutants. Moreover, the Texas Commission on Environmental Quality, the environmental agency of a state known to oppose many federal pollution regulations, is currently charged with enforcing the Clean Air Act—a responsibility it seems disinclined to vigorously carry out. Concerned about inadequate enforcement, advocates have even called on the U.S. Environmental Protection Agency to take over statewide enforcement responsibilities.

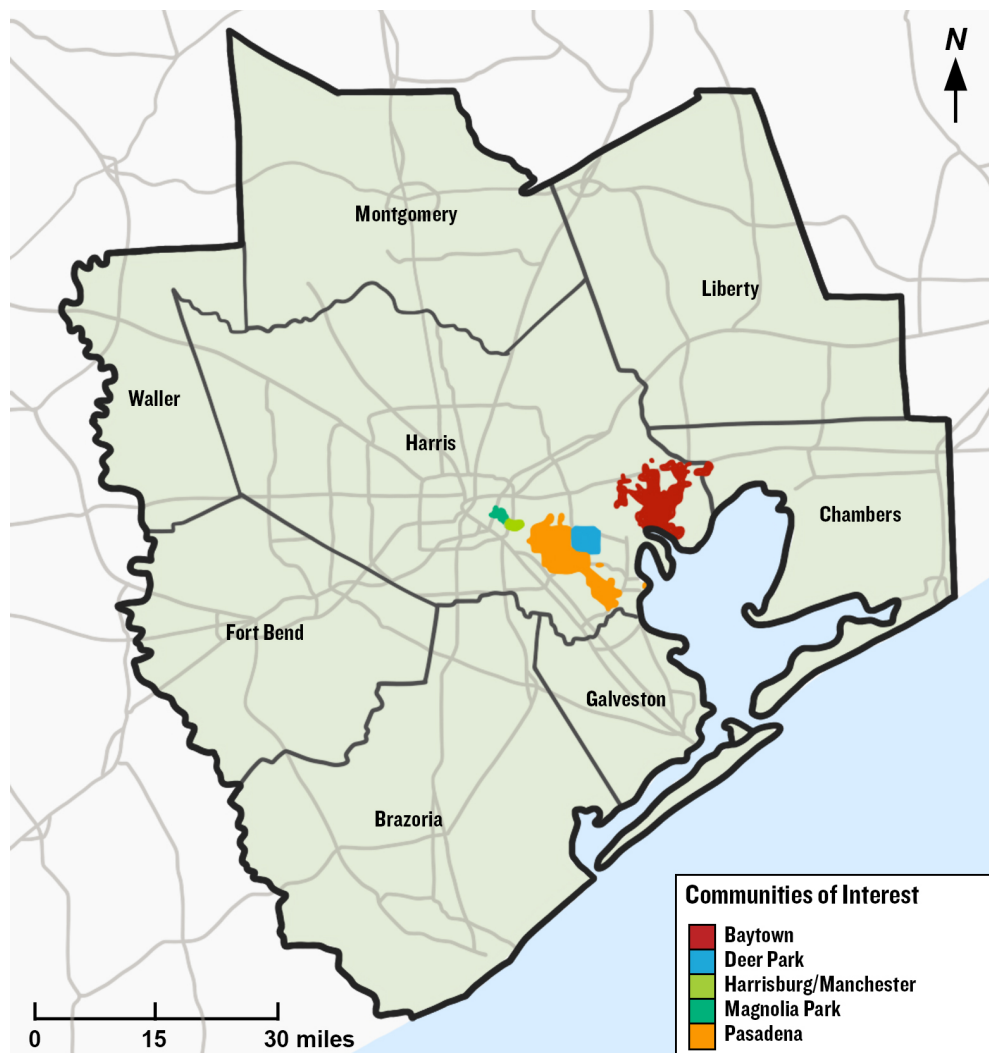
## THIS POLLUTION DISPROPORTIONATELY IMPACTS COMMUNITIES FACING OTHER RISKS

Communities situated along the Houston Ship Channel who live on the front lines of these serious environmental hazards are composed predominantly of people of color. These communities experience a number of compounding vulnerabilities, including high rates of poverty, food insecurity including a lack of access to healthy foods, substandard housing, and a lack of access to quality healthcare.<sup>15</sup> These sociodemographic stressors are known to increase vulnerability to the negative impacts of pollution.<sup>16</sup> For example, residents in disadvantaged circumstances may not have access to transportation to a hospital, may be without health insurance coverage, or may not be able to understand public notifications about pollution incidents that are posted in English. Additionally, wealthier neighborhoods may be more able to grapple with the effects of pollution events because they have more resources or their baseline health status may be better to begin with.<sup>17</sup> In short, the hazards from diverse sources of pollution do not exist in a vacuum; they co-occur with multiple sociodemographic vulnerabilities. These overlapping stressors, known as *cumulative impacts*, must be considered in any assessment of the full range of dangers faced by communities living along the Houston Ship Channel.<sup>18</sup>

## JOINT STUDY REVEALS THE EXTENT OF THESE CUMULATIVE IMPACTS

TEJAS and NRDC commissioned expert analysis from Sustainable Systems Research (SSR) to better understand the burden of air pollution on specific populations and communities in the eight-county Houston region (see Figure 2).<sup>19</sup> On the basis of the Texas Commission on Environmental Quality's (TCEQ) point source emissions inventory, SSR analyzed emissions from four pollution categories over three time periods (2007–2016, 2012–2016, and in 2016 alone).<sup>20</sup> The analysis calculated the pollution burden as the amount of pollutant emitted per square mile per year for every census tract in the Houston region.<sup>21</sup>

**FIGURE 2: EIGHT-COUNTY HOUSTON REGION AND SPECIFIC COMMUNITIES STUDIED**



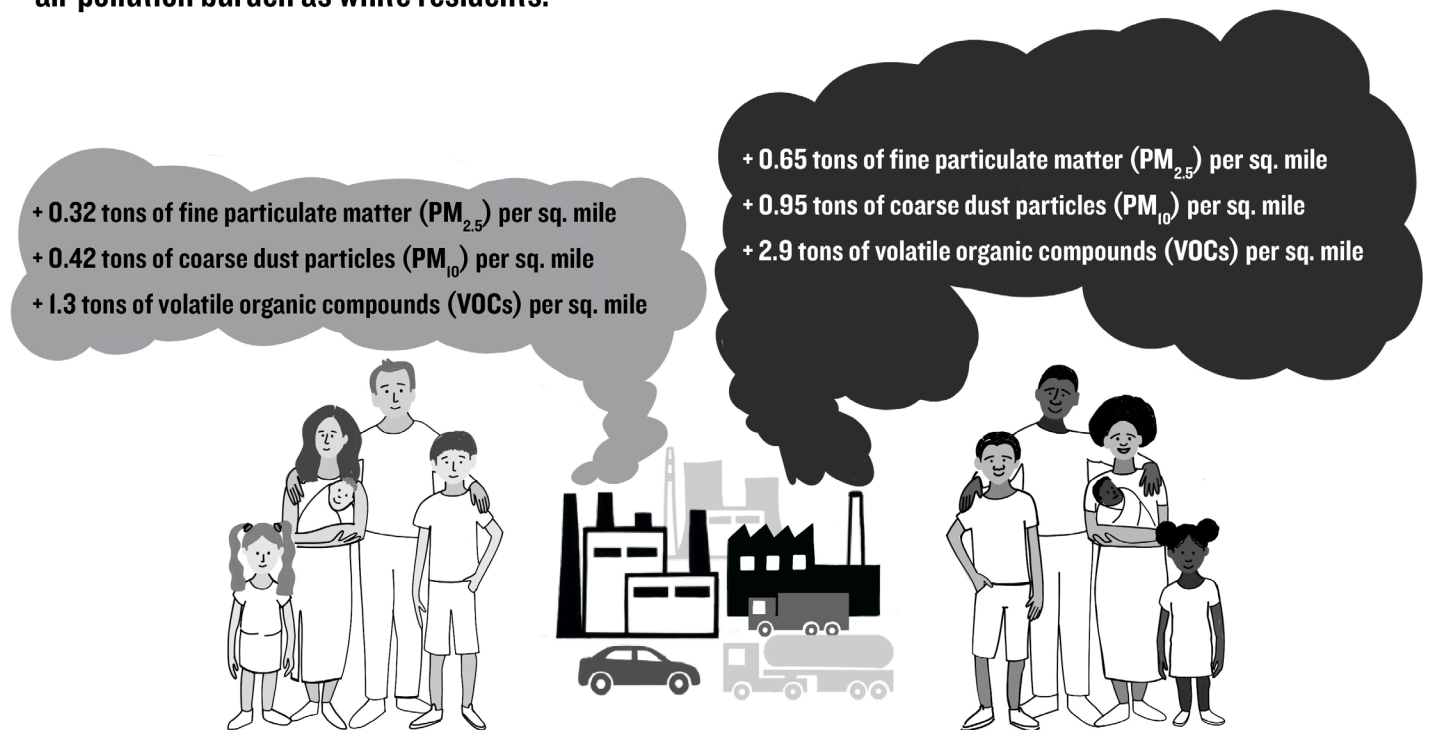
To better understand how pollution overlaps with sociodemographic factors that can heighten vulnerability, the tract-level pollution burdens were analyzed together with several sociodemographic characteristics of each census tract, drawing on U.S. Census data. Specifically, SSR examined the percentage of individuals living in poverty, the percentage of linguistically isolated households (those in which no one over age 14 speaks English “very well”), and the percentage of residents identifying as nonwhite. This yielded the average pollution burdens experienced by those specific subpopulations and allowed comparison of the burdens faced by those groups versus those faced by their more advantaged counterparts.

Additional analysis was done at the community level for five Houston Ship Channel communities of interest—Magnolia Park, Harrisburg/Manchester, Baytown, Deer Park, and Pasadena. By examining the pollution and sociodemographic makeup of the census tracts contained in each of those communities, SSR was able to compare the burden for each community with the burden for the eight-county Houston region as a whole.

SSR’s analysis found that in the Houston region, people of color, people living in poverty, and linguistically isolated households on average live in areas (specifically, census tracts) with more pollution than their white, wealthier, and English-fluent counterparts. These disparities are substantial. The average pollution burdens for coarse and fine particulate matter and VOCs were about 50 percent higher for people living in poverty compared with wealthier Houston residents.<sup>22</sup> The burden of these three pollutants for people of color was twice as high as the burden for white residents (see Figure 3).<sup>23</sup> The findings were generally consistent across the three periods studied.

**FIGURE 3. POLLUTION DISPARITIES BETWEEN PEOPLE OF COLOR AND WHITE RESIDENTS IN HOUSTON<sup>24</sup>**

## The Larger Cumulative Burden of Toxic Air Pollution on People of Color In Houston, residents of color on average live in areas with twice the deadly air pollution burden as white residents.\*

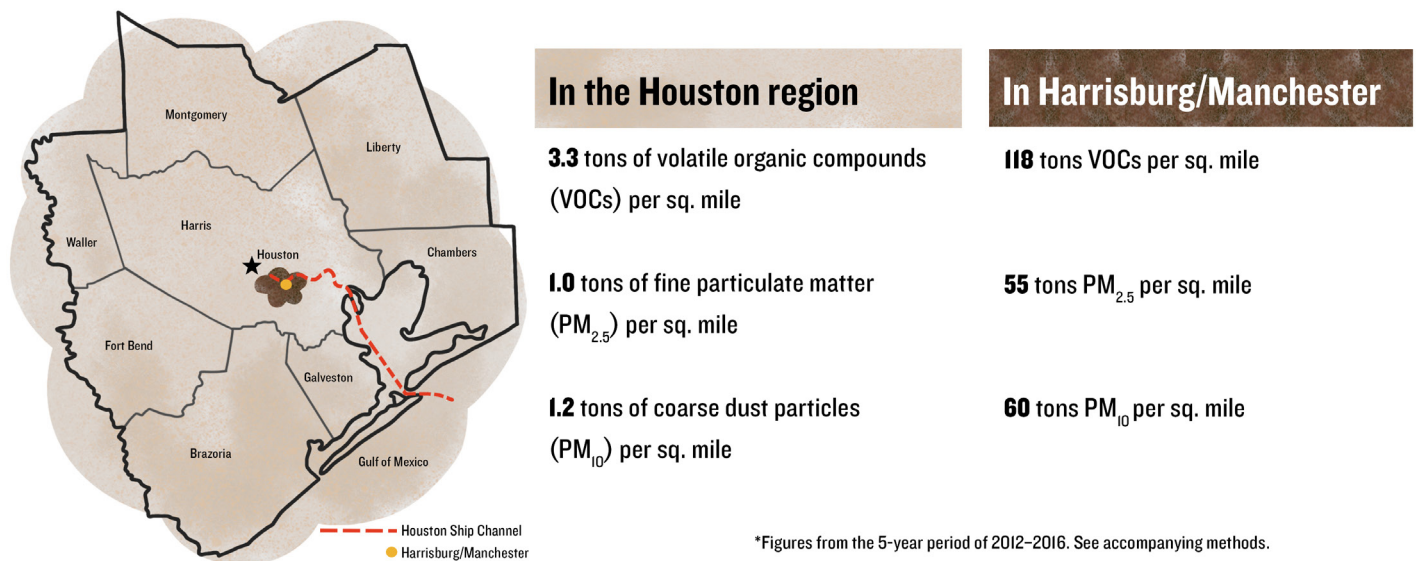


\*Figures from the five-year period of 2012–2016. See accompanying methods.

Moreover, Harrisburg/Manchester, one of the specific communities studied, appears to be particularly impacted: The community's percentages of residents living in poverty, linguistically isolated households, and nonwhite residents were respectively 1.9, 3.1, and 1.6 times as high as for the eight-county region, while its pollution burdens for the 10-year period 2007 to 2016 were 28 to 61 times the levels found in the broader region.<sup>25</sup> For the five-year period of 2012 to 2016, the pollution burdens from coarse and fine particulate matter in Harrisburg/Manchester were 55 and 50 times the burdens experienced in the Houston region overall, respectively (see Figure 4). And looking just at 2016, the most recent year studied, the magnitude of disparity between the community and the region for these two pollutants was more than 60-fold.<sup>26</sup>

**FIGURE 4. POLLUTION DISPARITIES IN HOUSTON'S MANCHESTER/HARRISBURG COMMUNITY<sup>27</sup>**

## Toxic air pollution burdens in the Harrisburg/Manchester neighborhood are far greater than the eight-county Houston region as a whole.\*



TCEQ's emissions inventory—the focus of the analysis above—includes authorized emissions and unauthorized emissions. While authorized emissions derive from routine operations and planned maintenance, many facilities also generate unauthorized emissions, for example, during unplanned activities or equipment failures.<sup>28</sup> Because these releases are not permitted in advance, they are more likely to be uncontrolled and/or occur over a short period, potentially leading to spikes in pollution exposure and harm to public health.<sup>29</sup> SSR also examined whether the disparities observed for total emissions were reflected in the unauthorized emissions for one category of pollutant: VOCs. Troublingly, it found that similar to total reported VOCs, unauthorized VOCs also disproportionately impact people of color, people living in poverty, and linguistically isolated households relative to white, wealthier, and English-fluent households.<sup>30</sup>

Finally, it is worth noting that the analysis focused on emissions as reported to the TCEQ. Unreported emissions constitute yet another burden on communities in the Houston Ship Channel but were beyond the scope of the analysis.<sup>31</sup>

### BOTTOM LINE

**People of color, those living in poverty, and limited-English households bear a disproportionate air pollution burden from emissions generated along the Houston Ship Channel. This injustice warrants immediate attention, especially since these communities endure circumstances that make them more vulnerable to the harmful impacts of pollution than their white, wealthier, and English-fluent neighbors.<sup>32</sup>**



A plume of smoke rises from a petrochemical fire at the Intercontinental Terminals Company in Deer Park, Texas, on March 18, 2019.

## RECOMMENDATIONS FOR ACTION

TEJAS and NRDC have three recommendations that can help address these disproportionate impacts.

**1. Regulatory agencies at all levels should look at emissions in a regional context, as well as on a facility-by-facility basis.** Setting permit limits for a single facility without considering the number of polluting facilities nearby allows emissions to build up and create hot spots, which perpetuates disparities and fails to protect already overburdened communities. Instead, agencies should look at all pollutant emissions in a regional context. For example, local agencies could establish a regional air plan that considers emissions burdens region-wide. Such a plan would create transparency around emissions regulations across the Houston region and help identify opportunities to address emissions issues above and beyond existing requirements. In addition, agencies at all levels should consider the cumulative impacts on a given area in determining an individual facility's permit. The proposed Environmental Justice for All Act underlines the importance of examining cumulative impacts and overlapping stressors, mandating that cumulative impacts be considered in all permitting decisions under the Clean Water Act and Clean Air Act and that permits be denied if a project cannot demonstrate that it will not harm human health.<sup>33</sup> Had Texas Senate Bill 1243 moved forward, it would have been an important step in this direction by requiring consideration of the aggregated effects of nearby facilities in issuing or renewing emissions permits.<sup>34</sup>

**2. Regulatory agencies at all levels should improve opportunities for public participation in the permitting process.** Agencies should make notices and hearings on permit applications more accessible, both physically and linguistically, by holding hearings locally and by providing translations of notices and interpreters at hearings. Hearings should take place during non-work hours, and ideally, childcare should be provided to ensure broad public participation. For example, Texas Senate Bill 180 (which did not move forward) acknowledged the need to better ensure public participation and would have added translation, notice, and hearing requirements for facilities in environmental justice communities seeking permits.<sup>35</sup> The proposed federal Break Free From Plastic Pollution Act is another useful instance of incorporating language accessibility to ensure more just policies; that legislation would require that outreach and education efforts, including agency notices, decisions, and other materials, be translated and thereby made accessible to multilingual communities.<sup>36</sup> Beyond these examples, requiring the presence of professional interpreters at hearings and other in-person events would also be a crucial step toward ensuring that participation is genuine and inclusive.

**3. Regulatory agencies at all levels should prioritize pollution monitoring and enforcement in disproportionately burdened communities.** The Texas Water Code already requires TCEQ to “give priority to monitoring and enforcement in areas in which regulated facilities are concentrated.”<sup>37</sup> This approach should be expanded beyond the water code to all forms of pollution. Agencies can, for example, require facilities in communities that are disproportionately burdened and vulnerable, particularly those with repeat violations, to install pollution monitoring equipment or expand existing monitoring. In addition, designing and employing a cumulative impacts screening tool, such as one that builds on the U.S. Environmental Protection Agency's EJSCREEN tool and other data, could help identify these cumulatively impacted communities.<sup>38</sup>

A full copy of the technical report is available at <https://www.nrdc.org/sites/default/files/houston-stationary-source-pollution-202009.pdf>.

## About Texas Environmental Justice Advocacy Services

Texas Environmental Justice Advocacy Services (TEJAS) is dedicated to providing community members with the tools necessary to create sustainable, environmentally healthy communities neighborhoods. TEJAS educates individuals on health concerns and implications arising from environmental pollution, empowers individuals with an understanding of applicable environmental laws and regulations and promotes their enforcement, and offers community-building skills and resources for effective community action and greater public participation. TEJAS is based in Houston.

## About NRDC

NRDC is an international nonprofit environmental organization with more than three million members and online activists. Since 1970, our lawyers, scientists, and other environmental specialists have worked to protect the world's natural resources, public health, and the environment. NRDC has offices in New York City, Washington, D.C., Los Angeles, San Francisco, Chicago, Montana, and Beijing. Visit us at [nrdc.org](http://nrdc.org).

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### ENDNOTES

- 1 American Lung Association. *State of the Air 2019*, 2019, <http://www.stateoftheair.org/assets/sota-2019-full.pdf>.
- 2 Port of Houston, "Port Houston: The International Port of Texas," <https://porthouston.com/> (accessed August 31, 2020).
- 3 Glenn Johnson et al., "Air Quality and Health Issues Along Houston's Ship Channel: An Exploratory Environmental Justice Analysis of a Vulnerable Community (Pleasantville)," *Race, Gender and Class* 21, no. 3-4 (2014): 273-303. [https://www.researchgate.net/publication/288832510\\_Air\\_quality\\_and\\_health\\_issues\\_along\\_Houston's\\_Ship\\_Channel\\_An\\_exploratory\\_environmental\\_justice\\_analysis\\_of\\_a\\_vulnerable\\_community\\_Pleasantville](https://www.researchgate.net/publication/288832510_Air_quality_and_health_issues_along_Houston's_Ship_Channel_An_exploratory_environmental_justice_analysis_of_a_vulnerable_community_Pleasantville).
- 4 Sustainable Systems Research (hereinafter SSR), *Evaluation of Vulnerability and Stationary Source Pollution in Houston*, 2020, <https://www.nrdc.org/sites/default/files/houston-stationary-source-pollution-202009.pdf>.
- 5 See, e.g., Ayşe Bozlaker et al., "Insights Into PM<sub>10</sub> Sources in Houston, Texas: Role of Petroleum Refineries in Enriching Lanthanoid Metals During Episodic Emission Events," *Atmospheric Environment* 69 (April 2013): 109-17. [https://www.researchgate.net/publication/235348370\\_Insights\\_into\\_PM10\\_sources\\_in\\_Houston\\_Texas\\_Role\\_of\\_petrolium\\_refineries\\_in\\_enriching\\_lanthanoid\\_metals\\_during\\_episodic\\_emission\\_events](https://www.researchgate.net/publication/235348370_Insights_into_PM10_sources_in_Houston_Texas_Role_of_petrolium_refineries_in_enriching_lanthanoid_metals_during_episodic_emission_events).
- 6 Michael Leuchner and Bernhard Rappenglück, "VOC Source-Receptor Relationships in Houston During TexAQS-II," *Atmospheric Environment* 44, no. 33 (October 2010): 4056-67. [http://easd.geosc.uh.edu/rappenglueck/pdf/2010/2010\\_leuchner\\_TRAMP.pdf](http://easd.geosc.uh.edu/rappenglueck/pdf/2010/2010_leuchner_TRAMP.pdf). Henry W. Wallace et al., "Source Apportionment of Particulate Matter and Trace Gases Near a Major Refinery Near the Houston Ship Channel," *Atmospheric Environment* 173 (January 2018): 16-29. <https://www.sciencedirect.com/science/article/abs/pii/S1352231017307148?via%3Dihub>.
- 7 Kiah Collier, "Deer Park Terminal Fire Extinguished After Three Days of Burning," *Texas Tribune*, March 19, 2019, <https://www.texastribune.org/2019/03/19/everything-you-need-know-about-deer-park-terminal-fire/>. Zach Despart and Mike Morris, "New Fire Erupts at Deer Park Plant as Leaking Toxins Close Ship Channel," *Houston Chronicle*, March 22, 2019, <https://www.houstonchronicle.com/news/houston-texas/houston/article/New-fire-erupts-at-Deer-Park-plant-as-leaking-13710439.php#photo-17112238>.
- 8 Tom Abrahams and Jessica Willey, "KMCO Chemical Plant Fire in Crosby Kills 1, Injures 2," ABC 13, April 3, 2019, <https://abc13.com/live-coverage-kmco-chemical-plant-fire-in-crosby-injures-2/5230466/>.
- 9 Tierra Smith, "Gas Pipeline in Mount Belvieu Erupts in Flames After Cut by Contractor, Officials Say," Click2Houston.com, July 29, 2020, <https://www.click2houston.com/news/local/2020/07/29/explosion-reported-at-lone-star-ngl-facility-in-mont-belvieu-police-says/>. Marialuisa Rincon, "Explosion, Fire at Lone Star NGL: Update," Argus Media, July 30, 2020, <https://www.argusmedia.com/en/news/2127733-explosion-fire-at-lone-star-ngl-update>.
- 10 Peter Holley, "Why One Expert Predicts a Major Hurricane Hitting Houston Would Be 'America's Chernobyl,'" *Texas Monthly*, August 21, 2020, <https://www.texasmonthly.com/news/houston-hurricane-ship-channel-orourke/>. John Schwartz and Hiroko Tabuchi, "When Hurricanes Lead to Industrial Fires, Minority Neighborhoods Can Take a Hit," *New York Times*, August 27, 2020, <https://www.nytimes.com/2020/08/27/climate/hurricane-laura-fire-pollution.html>. Frank Bajak and Lise Olsen, "Hurricane Harvey's Toxic Impact Deeper Than Public Told," Associated Press, March 23, 2018, <https://apnews.com/e0ceae76d5894734b0041210a902218d/Hurricane-Harvey's-toxic-impact-deeper-than-public-told>.
- 11 Heidi Bethel et al., "A Closer Look at Air Pollution in Houston: Identifying Priority Health Risks," summary of the *Report of the Mayor's Task Force on the Health Effects of Air Pollution*, 2007, <https://www3.epa.gov/ttnchie1/conference/eil6/session6/bethel.pdf>.
- 12 C. Arden Pope, Richard Burnett, and Michael Thun, "Lung Cancer, Cardiopulmonary Mortality, and Long-Term Exposure to Fine Particulate Air Pollution," *Journal of the American Medical Association* 287, no. 9 (2002): 1132-41. <https://jamanetwork.com/journals/jama/fullarticle/194704>. U.S. Environmental Protection Agency (hereinafter EPA), "Particle Pollution and Your Health," September 2003, <https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1001EX6.txt>.
- 13 Vipin Soni et al., "Effects of VOCs on Human Health," in *Air Pollution and Control*, Nikhil Sharma et al., eds. (Singapore: Springer, 2018), 119-42.

- 14 Antonella Zanobetti, Joel Schwartz, and Diane Gold, "Are There Sensitive Subgroups for the Effects of Airborne Particles?," *Environmental Health Perspectives* 108, no. 9 (September 2000): 841-45, <https://doi.org/10.1289/ehp.00108841>. Marzia Simoni et al., "Adverse Effects of Outdoor Pollution in the Elderly," *Journal of Thoracic Disease* 7, no. 1 (January 2015): 34-45, <https://doi.org/10.3978/j.issn.2072-1439.2014.12.10>. Jason Sacks et al., "Particulate Matter-Induced Health Effects: Who Is Susceptible?," *Environmental Health Perspectives* 119, no. 4 (April 2011): 446-54, <https://doi.org/10.1289/ehp.1002255>.
- 15 Ronald White, *Life at the Fenceline: Understanding Cumulative Health Hazards in Environmental Justice Communities*, Environmental Justice Health Alliance for Chemical Policy Reform, Coming Clean, and Campaign for Healthier Solutions, September 2018, <https://new.comingcleaninc.org/assets/media/documents/Life%20at%20the%20Fenceline%20-%20English%20-%20Public.pdf>. Union of Concerned Scientists and Texas Environmental Justice Advocacy Services, *Double Jeopardy in Houston: Acute and Chronic Chemical Exposures Pose Disproportionate Risks for Marginalized Communities*, August 22, 2016, <https://www.ucsusa.org/resources/double-jeopardy-houston>.
- 16 Rachel Morello-Frosch et al., "Understanding the Cumulative Impacts of Inequalities in Environmental Health: Implications for Policy," *Health Affairs* 30, no. 5 (2011): 879-998. Yukyan Lam et al., "Seeing the Whole: Using Cumulative Impacts Analysis to Advance Environmental Justice," NRDC, forthcoming 2021. Gina Solomon et al., "Cumulative Environmental Impacts: Science and Policy to Protect Communities," *Annual Review of Public Health* 37 (March 2016): 83-96. <https://www.annualreviews.org/doi/pdf/10.1146/annurev-publhealth-032315-021807>.
- 17 Murray Finkelstein et al., "Relation Between Income, Air Pollution and Mortality: A Cohort Study," *Canadian Medical Association Journal* 169, no. 5 (2003): 397-402. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC183288/pdf/20030902s00013p397.pdf>. Mark Eisner et al., "Socioeconomic Status, Race, and COPD Health Outcomes," *Journal of Epidemiology and Community Health* 65, no. 1 (2011): 26-34. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3017471/pdf/nihms250249.pdf>.
- 18 Morello-Frosch et al., "Understanding the Cumulative Impacts." Lam et al., "Seeing the Whole."
- 19 The eight counties are Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller. This eight-county region is in ozone nonattainment and subject to stricter reporting requirements. EPA, "Current Nonattainment Counties for All Criteria Pollutants," <https://www3.epa.gov/airquality/greenbook/ancl.html> (accessed August 31, 2020). EPA, "State Implementation Plan (SIP) Status Reports," <https://www.epa.gov/air-quality-implementation-plans/sip-status-reports> (accessed August 31, 2020).
- 20 By evaluating the most recently available emissions data, from 2016, as well as evaluating prior 5- and 10-year periods, we were able to gain an understanding of community air pollution burdens over time.
- 21 Census tracts are areas within counties designated for purposes of the U.S. Census, generally with a population size of 2,500 to 8,000. U.S. Census Bureau, *Geographic Areas Reference Manual*, <https://www.census.gov/programs-surveys/geography/guidance/geographic-areas-reference-manual.html> (accessed September 1, 2020). The analysis did not model the mixing of pollutants in the atmosphere nor the dispersion of pollutants from a given census tract to neighboring tracts. These issues were beyond the scope of the study. Details on data sources and methods are described in SSR, *Evaluation of Vulnerability*.
- 22 SSR, *Evaluation of Vulnerability*, Table 2.
- 23 Ibid.
- 24 Ibid.
- 25 Ibid., Appendix G.
- 26 Ibid.
- 27 Ibid.
- 28 See, e.g., Emma Pabst et al., *Illegal Air Pollution in Texas: Air Pollution From Startups, Shutdowns, Malfunctions and Maintenance at Industrial Facilities in Texas in 2018*, Environment Texas Research & Policy Center and Frontier Group, December 2019, [https://environmenttexas.org/sites/environment/files/reports/TX\\_Pollution\\_scrn%20%281%29.pdf](https://environmenttexas.org/sites/environment/files/reports/TX_Pollution_scrn%20%281%29.pdf).
- 29 Kiah Collier and Ryan Murphy, "Pass to Poison: How the State of Texas Allows Industrial Facilities to Repeatedly Spew Unauthorized Air Pollution—With Few Consequences," *Texas Tribune*, July 17, 2017, <https://apps.texastribune.org/pass-to-poison/>.
- 30 SSR, *Evaluation of Vulnerability*, 24-25.
- 31 See, e.g., Bozlaker et al., "Insights Into PM<sub>10</sub> Sources." Mark Estes et al., "Preliminary Emission Adjustment Factors Using Automated Gas Chromatography Data," Texas Commission on Environmental Quality, November 2002, [https://www.tceq.texas.gov/assets/public/implementation/air/am/docs/hgb/tsdl/attachment7-age\\_ei\\_adjustment.pdf](https://www.tceq.texas.gov/assets/public/implementation/air/am/docs/hgb/tsdl/attachment7-age_ei_adjustment.pdf).
- 32 Cassandra O'Lenick et al., "Ozone and Childhood Respiratory Disease in Three US Cities: Evaluation of Effect Measure Modification by Neighborhood Socioeconomic Status Using a Bayesian Hierarchical Approach," *Environmental Health* 16, no. 1 (December 2017): 36. <https://ehjournal.biomedcentral.com/track/pdf/10.1186/s12940-017-0244-2.pdf>. Christina Fuller et al., "Air Pollution, Cardiovascular Endpoints and Susceptibility by Stress and Material Resources: A Systematic Review of the Evidence," *Environmental Health* 16, no. 1 (December 2017): 58, <https://doi.org/10.1186/s12940-017-0270-0>. Marianthi-Anna Kiomourtoglou et al., "PM<sub>2.5</sub> and Mortality in 207 U.S. Cities: Modification by Temperature and City Characteristics," *Epidemiology* 27, no. 2 (March 2016): 221-7, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4748718/pdf/nihms757378.pdf>. Vivian C. Pun, Justin Manjourides, and Helen Suh, "Association of Ambient Air Pollution With Depressive and Anxiety Symptoms in Older Adults: Results From the NSHAP Study," *Environmental Health Perspectives* 125, no. 3 (March 2017): 342-8, <http://dx.doi.org/10.1289/EHP494>. Kerry Ard, "By All Measures: An Examination of the Relationship Between Segregation and Health Risk From Air Pollution," *Population and Environment* 38, no. 1 (2016): 1-20. <https://link.springer.com/article/10.1007%2Fs11111-015-0251-6>.
- 33 Environmental Justice for All Act, 117th Cong. (2021), <https://naturalresources.house.gov/imo/media/doc/Environmental%20Justice%20for%20All%20Act%202021.pdf>.
- 34 An Act relating to the consideration of the cumulative effects of air contaminant emissions in the emissions permitting process, Tex. S.B. 1243, 86<sup>th</sup> Leg. (Introduced March 2019), <https://capitol.texas.gov/tlodocs/86R/billtext/pdf/SB01243I.pdf#navpanes=0>.
- 35 An Act relating to applications for permits issued by the Texas Commission on Environmental Quality for certain new or expanded facilities in certain low-income and minority communities, Tex. S.B. 180, 86<sup>th</sup> Leg. (2019), <https://capitol.texas.gov/tlodocs/86R/billtext/pdf/SB00180I.pdf#navpanes=0>.
- 36 Break Free From Plastic Pollution Act of 2020, H.R. 5845, 116th Cong. (2020), <https://www.congress.gov/bill/116th-congress/house-bill/5845/all-info>.
- 37 Texas Water Code Sec. 5.130 (added by Acts 2001, 77th Leg., ch. 965, Sec. 1.12, eff. Sept. 1, 2001), <https://statutes.capitol.texas.gov/Docs/WA/htm/WA.5.htm>.
- 38 EPA, "EJSCREEN: Environmental Justice Screening and Mapping Tool," <https://www.epa.gov/ejscreen> (accessed March 2, 2020).