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SEEING THE WHOLE:
USING CUMULATIVE IMPACTS ANALYSIS TO ADVANCE ENVIRONMENTAL JUSTICE

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In 2017, NRDC and its environmental justice (EJ) partner groups in Chicago (the Southeast Environmental Task Force, the Southeast Side Coalition to Ban Petcoke, and the Little Village Environmental Justice Organization) and Newark, New Jersey (the Ironbound Community Corporation) began to explore how describing environmental burdens in a cumulative framework could advance advocacy to protect public health in their respective cities. Our objective was to work in close partnership to develop a method of analyzing cumulative environmental burdens in those two cities that could potentially be used in other cities and states. We wanted to build on existing methods, adapt them as needed, and document the lessons learned for cumulative impacts-based advocacy. This issue brief is intended to be a resource for EJ advocates. It describes some of the history, motivation, and evidence behind the cumulative impacts framework and provides a case study of how a cumulative impacts mapping analysis might be leveraged to promote policies that protect low-income communities and communities of color that are disproportionately burdened by environmental and social stressors. Other audiences, including agencies working on public health and environmental protection, may also find the synthesis of evidence contained in this brief useful in making the case for considering cumulative impacts in their work.

Cover photo top: An aerial view of homes in a residential neighborhood of Newark, New Jersey.

Cover photo bottom left: An industrial site as seen from a bridge over the Calumet River in the South Side of Chicago, Illinois, on October 26, 2020.

Cover photo bottom right: An aerial view of an industrial area near a residential neighborhood in Chicago, Illinois, in 2019.

LVEJO, SETF and NRDC give their thanks to Keith Harley and the students and other staff of the Greater Chicago Legal Clinic, Inc., whose longstanding work to support environmental justice and represent groups in Chicago has helped paved the way and continues to demonstrate the need for policies that center a cumulative impacts viewpoint.

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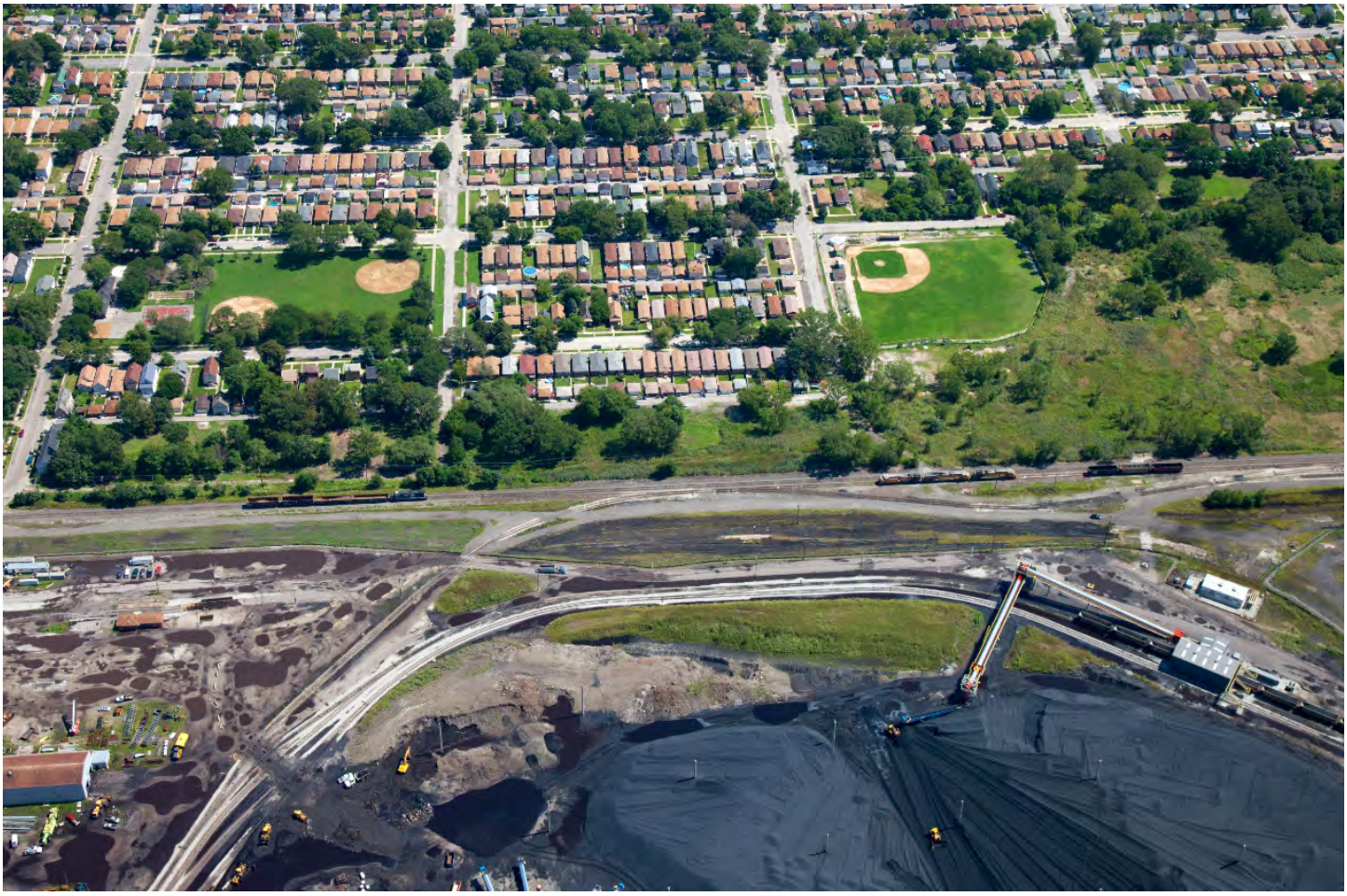
Introduction

The concept of cumulative impacts recognizes that there are multiple, interacting environmental and social stressors that have an impact on environmental justice communities.

Low-income communities and communities of color that bear the brunt of polluted air, water, and soil in the United States know that the harm they face comes from more than a single source. These communities, known as environmental justice (EJ) communities, experience a host of overlapping stressors—that is, physical, chemical, and biological agents as well as nonchemical factors, such as socioeconomic conditions—that have an adverse effect on health.



An aerial view of petcoke piles at KCBX's South terminal located on the banks of the Calumet River, next to a residential neighborhood on the Southeast Side of Chicago, Illinois, on August 27, 2014.

View in the Ironbound neighborhood of Newark, NJ, November 3, 2018.

EJ communities are often disproportionately burdened by environmental stressors, often brought on by the hazardous use of land and natural resources.[1] For example, residents frequently live near industrial sources of pollution and heavily trafficked throughways, on lands and in buildings plagued by a legacy of contamination. Moreover, due to their low-income status, structural racial/ethnic discrimination, or the historical traumas they have experienced, EJ communities are often marginalized, underserved by public and private entities, and underrepresented in decision-making on issues that affect them. The risks they already face from multiple environmental stressors are heightened because of this vulnerability.[2] For example, they may be breathing high levels of air pollution from local industry while at the same time less likely to visit a doctor to treat their aggravated asthma because of language barriers or lack of health insurance.

Stated another way, the same amount of pollution can result in more harm to people who are experiencing additional stressors. **Cumulative impacts** is a way to describe the combination of multiple environmental and sociodemographic stressors experienced by EJ communities, which contribute to persistent health inequities and disparities in environmental health threats.

An aerial view of a biodiesel refinery and shipping facilities on the Passaic River waterfront with Newark, New Jersey, in the background.

However, for many decades, the science and policy to address EJ communities' lived experience of cumulative impacts have been scant to nonexistent. Regulation often occurs in piecemeal fashion, facility by facility, chemical by chemical, or with a narrow focus on one domain—air, soil, or water—at a time. Health risk assessments typically project the amount of harm to an "average" individual, ignoring the hard reality that environmental hazards disproportionately impact people and communities who are more vulnerable than average due to the social conditions in which they live.[3] And policymaking has compounded the problem by allowing environmental hazards such as facilities that handle especially toxic substances to be located more frequently and densely in certain communities.

Science and policymakers must catch up with what EJ communities already know and account for cumulative impacts when creating environmental policy.

The Emergence of a Cumulative Impacts Framework

Urged by EJ communities, advocates, and scholars, environmental agencies began to develop mapping and screening tools to better address communities' lived experience of cumulative impacts.

The study of cumulative impacts in policy and scientific spaces began as a community-driven effort. EJ communities saw that the existing regulatory landscape and tools like health risk assessments, used by agencies to set limits on pollution, were failing to protect them from environmental hazards. At the same time, decision makers were not taking communities' complaints seriously. As Arsenio Mataka, an EJ advocate from California's Central Valley who later worked for the California Environmental Protection Agency (CalEPA) described it, the information presented in local government meetings by community advocates, including his own parents, was deemed "anecdotal information" and was "never acknowledged."[4] Community leaders and academics lending their expertise to EJ communities began working together to tackle this problem. As Mataka recalled, "We were…driven by the belief that if we could somehow figure out how to quantify the cumulative pollution burden and vulnerabilities in poor communities and communities of color, it would change the course and future of those communities forever."[5]

The community-led effort to create cumulative impacts tools and policies faced what EJ advocate Charles Lee described as "consistent political opposition" but was able to make progress thanks to coordinated efforts and strong leadership from many communities, "sometimes in collaboration with public agencies and sometimes in conflict," Lee said.[6] The movement gained traction in the early 2000s, with several important developments at the national level and in California, as well as in other states such as New Jersey.[7] In 2003 the U.S. Environmental Protection Agency (U.S. EPA) issued its *Framework for Cumulative Risk Assessment*, which called for cumulative approaches in the assessment and management of risk that could quantify combined risks from multiple agents or stressors.[8] This framework, which the agency described as the "first step in a long-term effort," emphasized that agents and stressors include not only chemicals but anything causing harm to humans, organisms, or the ecosystem, such as physical events (e.g., automobile crashes) and socioeconomic stressors (e.g., lack of health care).

In late 2010, the U.S. EPA began to develop a new tool capable of visualizing multiple environmental and socio-demographic characteristics and stressors in communities around the United States.[9] The effort built on earlier work, including a mapping tool developed by the agency's Office of Enforcement and Compliance Assurance, called EJSEAT, and a comprehensive review of that tool conducted by the EPA's National Environmental Justice Advisory Council.[10] The U.S. EPA publicly released its new tool, called EJSCREEN, in 2015. Though EJSCREEN falls short of computing a cumulative (i.e., total) score or ranking out of various environmental and socio-demographic indicators, it nonetheless collects these indicators from different data sources in a centralized mapping tool.[11] Information is provided at the U.S. Census block group level—units of area used for collecting census data where roughly 600 to 3,000 people reside.[12] The agency updates EJSCREEN annually and uses it as a "preliminary step when considering environmental justice" in its work and to inform community outreach; actions on permitting, enforcement, and compliance; and other geographically based initiatives.[13]

Southeast Side of Chicago, December 2019.

For any cumulative impacts tool, a chief limitation is that the full range of environmental issues experienced by a community will not be completely captured. In the case of EJSCREEN, no information on drinking water quality or indoor air quality is incorporated, and some of the environmental indicators included in EJSCREEN rely on self-reporting by facilities.[14] Thus, while EJSCREEN can be a useful tool providing a screening-level first look at locations, the U.S. EPA stresses that it should not be the sole basis for policy or decision making.[15]

Alongside this development, the CalEPA, propelled by an intersectoral Advisory Committee on Environmental Justice, adopted an EJ Action Plan in 2004 that expressed a commitment to developing guidance on cumulative impacts.[16] Thereafter, CalEPA's Office of Environmental Health and Hazard Assessment began a multiyear participatory process with EJ advocates, community members, and researchers.[17] The process culminated in April 2013 with the release of version 1.0 of CalEnviroScreen, a screening tool that combines data on environmental hazards and exposures, public health factors, and socioeconomic factors.[18] The tool calculates a cumulative impacts score for each of the state's approximately 8,000 census tracts (the next group up in size from a census block group, typically containing 1,200 to 8,000 people). CalEPA has continued to refine CalEnviroScreen, for example adding updated data and new variables like cardiovascular disease and rent-burdened low-income households.[19] In addition to relying on nationally available data sources, the tool draws on data specific to California collected through the state's monitoring systems, such as its regional water and air quality boards, the California Environmental Health Tracking Program, and its Solid Waste Information System.[20] CalEPA uses CalEnviroScreen to administer EJ grants, promote compliance with environmental regulations, and prioritize site cleanup. The scores are also used to identify "disadvantaged communities" for purposes of investing funds from the state's greenhouse gas emissions cap-and-trade program.[21]

CalEnviroScreen and other state tools that have followed in its footsteps show how cumulative impacts experienced in communities can be initially analyzed to better capture their multiple burdens than previous tools allowed.

Increasing Scientific Support for Cumulative Impacts

Scientific evidence showing the importance of a cumulative impacts framework is growing.

In 2011, researchers in California published a paper summarizing evidence that was "beginning to show how the cumulative effects of social and environmental stressors can work in combination to produce health disparities."[22] The researchers summarized the findings under four key concepts, paraphrased below.[23]

1. **There are significant disparities in the health outcomes of different racial/ethnic and socioeconomic groups, and these disparities exist for diseases linked to social and environmental factors.**[24] For example, Black people and people of lower socioeconomic status (SES) experience higher rates of adverse birth outcomes, including low birth weight and preterm birth, which in turn can contribute to health complications later in the child's life. People of color also experience higher rates of cardiovascular disease and asthma and worse self-described health.
2. **There are significant disparities in levels of exposure to environmental hazards that are related to poor health outcomes.**[25] For example, low-income individuals and people of color are much more likely to live near pollution sources such as industrial facilities and heavily trafficked throughways, and proximity to these pollution sources is connected to harmful health outcomes, including adverse birth outcomes, cardiovascular disease, and respiratory illness. People of color and low-income households are also more likely to be exposed to many harmful chemicals and indoor air pollutants.
3. **Certain intrinsic factors—such as age, genetics and gene expression, and preexisting health conditions—can heighten or lessen a person's sensitivity to pollution.**[26] For example, the same amount of pollution can have a worse health impact on people who are more biologically susceptible due to a preexisting condition like cardiovascular disease, obesity, diabetes, or asthma. Genes—and environmental factors that "turn on" or "turn off" the expression of genes—also affect biological susceptibility.
4. **Certain extrinsic factors, like socioeconomic status and the social constructs of race, ethnicity, and gender, can also amplify a person's vulnerability to environmental hazards.**[27] For instance, the same levels of air pollution appear to lead to worse health outcomes among people who belong to certain racial or ethnic groups, have lower socioeconomic status, or live in poorer neighborhoods.

The evidence supporting each of these four concepts has been accumulating over recent years, strengthening the case for decision makers to use cumulative impacts as a conceptual and analytic framework. Breakout boxes I through IV below present more detailed scientific findings with citations to supplement the examples given above for each of the four concepts. We provide these details for readers who may be less familiar with the literature, and to better equip those who are making the case for cumulative impacts analysis and policies in their own communities. While our search was not exhaustive, we sought to include findings from new or recent research and systematic reviews (those that draw conclusions from looking methodically across multiple studies). Among other topics, there has been important recent evidence on the impact of neighborhood conditions, the effects of noise exposure, and disparities in safe drinking water.

A Note on Terminology

In describing existing scientific studies, data sets, and methodologies, we have, to the extent possible, used the same terminology as the terminology used in the original cited sources. This choice does not reflect our endorsement of that terminology; rather, we have done this to make it clear what data are being referenced. Unfortunately, this means that certain terms may be imprecise and/or different from the terms the referenced groups prefer for self-identification. For example, studies have used terms such as *African-American* or *Hispanic* instead of *Black*, *black*, or *Latinx*, likely reflecting the terminology used in census and other socio-demographic data. Similarly, as of the writing of this brief, the term *minority* is still incorrectly being used as shorthand for *nonwhite* in the U.S. EPA EJSCREEN data set.

I. CUMULATIVE IMPACTS: DISPARITIES IN HEALTH OUTCOMES

There are significant disparities in health outcomes for different racial/ethnic and socioeconomic groups, and these disparities exist for diseases linked to social and environmental factors. Takeaways from the scientific literature include:

ADVERSE BIRTH OUTCOMES

Black people experience higher rates of adverse birth outcomes, such as low birth weight and preterm births.[28] Such outcomes can adversely affect child development and health in adulthood.[29] Moreover, research has linked these disparities to social circumstances and environmental exposures, more so than to genetic factors or shortfalls in medical care alone.[30] For example, premature births have been associated with poor socioeconomic conditions at the individual and neighborhood levels, living in highly segregated areas, life experiences with racism, maternal stress, and environmental exposures (e.g., to air pollutants and other chemicals).[31] Restricted fetal growth and lower birth weight have also been associated with environmental exposures (e.g., to lead, air pollutants, and pesticides), living in highly segregated areas, experiences with racial discrimination, maternal stress, individual socioeconomic status, and neighborhood hardship.[32]

CARDIOVASCULAR DISEASE

Significant disparities along racial/ethnic lines and by socioeconomic status exist in cardiovascular disease (CVD) outcomes (e.g., stroke and heart disease, mortality from CVD events) and CVD risk factors (e.g., hypertension, diabetes, obesity, high cholesterol, low physical activity).[33] Vulnerable subgroups include those with lower income or education, uninsured individuals, Blacks, Hispanics/Mexican Americans, and residents of the southern and southeastern United States and Appalachia.[34] Beyond individual-level factors, place-based factors—such as state-level economic conditions, policy measures, and food environments[35] and neighborhood-level socioeconomic characteristics[36]—are related to disparities in CVD risk factors and certain outcomes. Environmental exposures, such as to air pollution, metal pollutants, and noise, can also impact the development and severity of CVD.[37]

ASTHMA

Socioeconomic and racial/ethnic disparities in asthma prevalence, morbidity, hospitalization, and mortality are well documented in the United States.[38] Disparities have been observed for both adult and childhood asthma.[39] African-Americans, Puerto Ricans, and Native Americans appear to be the most vulnerable racial/ethnic subpopulations.[40] Asthma disparities have been linked to individual-level factors (e.g., maternal smoking, preterm birth, and low birth weight), community-level factors (e.g., neighborhood inequality and disadvantage, and stress), and environmental conditions (e.g., housing quality, indoor environmental exposures, and traffic-related air pollution) as well as disparities in treatment and access to care.[41]

SELF-RATED HEALTH

Disparities in self-rated health have persisted over the years, with Blacks/African-Americans, Hispanics/Latinos, American Indians or Alaska Natives, and lower-income individuals more likely to report poor or fair health status than whites and those living at a level at least two times greater than the poverty level.[42] Moreover, research has revealed self-rated health to be an increasingly valid predictor of mortality and therefore a good indicator of overall health.[43] In addition to individual-level factors, differences in neighborhood socioeconomic context help explain some of the racial disparity in self-rated health.[44]

Altgeld Gardens' breezy tunnel—an underpass in the middle of the neighborhood—in Chicago, Illinois, on October 26, 2020. Thousands of names are listed on a memorial wall inside the tunnel commemorating loved ones who have passed due to cancer, asthma and other respiratory issues.

II. CUMULATIVE IMPACTS: UNEQUAL EXPOSURE TO ENVIRONMENTAL HAZARDS

There are significant disparities in levels of exposure to environmental hazards that are related to poor health outcomes. Ample research has documented this finding. Some examples, grouped by categories that are not mutually exclusive, include:

INDUSTRIAL FACILITIES AND OTHER POLLUTING LAND USES

Low-income individuals, people of color, and those without a high school diploma are more likely to live near industrial facilities, hazardous waste sites, major U.S. freight gateways (e.g., ports and rail yards), and other polluting land uses.[45] Living near these locally unwanted land uses exposes people to a higher risk of adverse health outcomes, such as cancer (including childhood cancer), respiratory illness, cardiovascular disease, birth defects, and low birth weight.[46]

ROADWAYS AND TRAFFIC

There are racial/ethnic and socioeconomic disparities in residential proximity to major throughways[47] and exposures from traffic.[48] For example, a six-city study involving approximately 6,000 participants found that those living in neighborhoods whose population was more than 60 percent Hispanic were exposed to 31 percent higher concentrations of nitrogen oxides, a good marker of traffic-related air pollution, than those residing in neighborhoods with less than 25 percent Hispanic population.[49] Traffic contributes not only to air pollution, but also to noise pollution.[50] Living close to heavily trafficked areas has been associated with adverse health outcomes, such as preterm birth, low birth weight, respiratory illness, and cardiovascular disease.[51] Research suggests that noise from traffic is associated with sleep disturbance as well as various cardiovascular disease risk factors and outcomes, independent of the effect that traffic-related air pollution may have.[52]

CHEMICALS

A 2018 review found that low-income, African-American, and Latino individuals are disproportionately exposed to five classes of environmental endocrine-disrupting chemicals that are associated with diabetes.[53] Sources of exposure to these chemicals—polychlorinated biphenyls, organochlorine pesticides, multiple chemical constituents of air pollution, bisphenol A, and phthalates—include contaminated food products, drinking water, building materials and fixtures, dust, soil, industrial air emissions, combustion, household chemicals, appliances, plastics, and personal care and other consumer products.[54] While in theory anyone can be exposed to such sources, people of color and low-income individuals experience higher exposures due to patterns of employment, housing conditions, and neighborhood infrastructure.[55] Further, discount retail stores ("dollar stores") that serve predominantly low-income communities and communities of color have been slow to eliminate products containing toxic chemicals from their shelves.[56]

DRINKING WATER CONTAMINANTS

There are racial and socioeconomic disparities in the extent to which communities are exposed to drinking water contaminants that can have harmful health impacts, such as elevated risk of cancers, reproductive toxicity, adverse birth outcomes, and developmental effects.[57] A recent national-level analysis found that rates of drinking water violations from June 2016 through May 2019 were higher in U.S. counties with more racial, ethnic, and language vulnerability; crowded housing; limited transportation access; and socioeconomic vulnerability.[58]

INDOOR POLLUTANTS

People of color and low-income households also face higher indoor concentrations of some pollutants, which may be caused by disparities in the quality of indoor residential environments, as well as outdoor pollution that filters inside.[59] For example, research has shown higher lead concentrations in household dust in non-Hispanic Black households than in non-Hispanic white households, even after accounting for characteristics of the home (year of construction, presence of smoker, etc.).[60] Childhood lead poisoning attributed to lead paint and lead-contaminated soil is one of the most notable examples of disparate indoor pollutant exposure,[61] and research reveals persistent disparities by race/ethnicity and socioeconomic status in blood lead levels among children.[62] Higher levels of cockroach allergens (parts of cockroaches that can trigger asthma or allergies) have been associated with lower household income, living in high-poverty areas, less maternal education, and Black or Hispanic race/ethnicity.[63] Low-income households in multifamily buildings may face higher

concentrations of nitrogen dioxide and other combustion pollutants that aggravate respiratory conditions due to poorer ventilation and smaller apartment size.[64]

OCCUPATIONAL/WORKPLACE HAZARDS

Certain racial/ethnic and socioeconomic groups could face high exposure to hazards from employment in specific occupational/workplace conditions. A national study found elevated risks of workplace injury for non-Hispanic Black workers and foreign-born Hispanic workers, even after accounting for gender and education differences.[65] A recent analysis conducted by NRDC similarly found that Blacks, Latinos, and low-wage workers are overrepresented in the occupations most highly exposed to the types of extreme weather associated with climate change.[66] These include buildings and grounds maintenance, transportation and materials transport, and agriculture. In the agricultural sector in particular, there are an estimated 2.5 to 3 million agricultural workers in the United States, of which 73 percent are foreign-born, 69 percent do not speak English well, and 89 percent have no education beyond high school.[67] Farmworkers and their children experience greater exposure to pesticides.[68] There is suggestive evidence linking pesticides to certain cancers,[69] neurological conditions,[70] respiratory conditions,[71] and reproductive health problems.[72] Additionally, farmworkers face a high risk of heat-related illness.[73]

NEIGHBORHOOD ENVIRONMENTS

Beyond these hazards, there are also disparities in neighborhood environments. Neighborhoods with lower socioeconomic status and higher proportions of Black and Hispanic residents have less access to healthy food options and greater exposure to fast-food outlets and convenience stores that sell prepared, high-calorie foods and limited fresh produce.[74] A review of research on park access found that while there is not a straightforward relationship between race and SES and proximity to parks, there appear to be disparities in terms of park quality and park acreage, with whiter and wealthier neighborhoods having an advantage over poorer communities, Blacks, and Latinos.[75] Looking more broadly at green spaces, a national-level study found that urban census tracts with higher poverty or greater percentages of Blacks or Hispanics had less green space coverage than other census tracts.[76] There is growing evidence that contact with nature is associated with positive health benefits, including the findings of one recent study that used a randomized trial to show that a greening intervention could *cause* improved mental health.[77]

The Schroud Property Superfund site in the Hegewisch neighborhood on the Southeast Side of Chicago, formerly used to store and dump slag material from steel manufacturing, December 2019.

III. CUMULATIVE IMPACTS: INTRINSIC FACTORS

Certain intrinsic factors—such as age, genetics and gene expression, and preexisting health conditions—can heighten or lessen a person's sensitivity to pollution. Scientific evidence supports the following:

AGE

Age has an impact on an individual's susceptibility to pollution. For example, young children are more susceptible because their bodies absorb and metabolize chemicals differently; they may also have increased contact with pollution due to recreational behaviors (e.g., hand-to-mouth activity or playing outdoors).[78] Exposure to pollution early in life and at key moments in their growth can affect their development and health as adults.[79] Elderly individuals also appear to be more susceptible to some pollution effects, due to normal and pathological aging and related processes that are associated with declines in immune responses and weakening cardiovascular and respiratory systems.[80] For example, a 2015 review found that the elderly generally faced higher risks from outdoor air pollution than did the rest of the population, especially from short-term exposure.[81] A 2014 meta-analysis of ozone-related mortality found strong evidence that older persons have higher susceptibility to short-term exposure.[82]

HEALTH CONDITIONS

There is evidence—epidemiological and toxicological—suggesting that certain preexisting health conditions can increase susceptibility to pollution.[83] These include diabetes, obesity, hypertension,[84] and cardiovascular disease (e.g., a history of myocardial infarction, congestive heart failure, or coronary artery disease).[85] Asthma can also increase a person's susceptibility, with air pollution triggering symptoms among asthmatics,[86] and one early study showed that asthmatics experience a higher risk of contracting pneumonia when ambient particulate pollution levels are high.[87] Further, as described in breakout box I, above, there are disparities in who is more likely to suffer from these health conditions.

EPIGENETIC FACTORS

Genetics can heighten or lessen a person's susceptibility to the effects of pollution.[88] This is due not only to differences in individuals' genetic code but also to *epigenetic factors*—aspects of the environment that influence biological mechanisms that "switch" certain genes on or off, thereby altering susceptibility to disease. For example, developmental and epigenetic mechanisms link early-life environmental factors, such as stress and discrimination experienced by the mother during pregnancy, to racial disparities observed in adult health outcomes, such as hypertension, diabetes, stroke, and coronary heart disease.[89] One U.S.-based study that followed a group of 105 infants through mid-adolescence found that the amount of DNA methylation (a well-known epigenetic mechanism that has the capacity to modify gene expression and appears linked to health outcomes later in life) observed in the adolescents was associated with the amount of stress reported by the mother during the child's infancy and by the father during the child's preschool years.[90] Another study following 494 participants in the Philippines found that household socioeconomic status and extended absence of a parent during childhood were factors significantly associated with the amount of DNA methylation measured in young adulthood.[91]

Homes next to the S.H. Bell facility on Chicago's Southeast Side, December 2019. The facility, which handles manganese, has been cited by the EPA for emitting the pollutant at excessive levels that can cause neurotoxic and other health effects.

IV. CUMULATIVE IMPACTS: EXTRINSIC FACTORS

Certain extrinsic factors, like socioeconomic status and the social constructs of race, ethnicity, and gender, can also amplify a person's vulnerability to environmental hazards. In other words, it is not just that certain groups are disproportionately exposed to pollution (as described in breakout box II), but that, even faced with the same amount of pollution, certain populations may be more vulnerable and experience worse outcomes.

INDIVIDUAL-LEVEL FACTORS

Several systematic reviews have found that certain socio-demographic characteristics, such as lower educational attainment, income, and employment status, appear to increase vulnerability to the physical health impacts of air pollution.[92] In 2017, researchers published one of the first studies reporting a statistically significant association between ambient fine particulate matter ($PM_{2.5}$) exposure and adverse mental health symptoms.[93] The study, based on a nationally representative group of 4,008 elderly individuals, found that the association between exposure and moderate to severe anxiety symptoms was significantly enhanced among those with less than a high school education.[94]

Beyond air pollution, research has also suggested that children from families of lower SES are more vulnerable to the impacts of lead exposure.[95] For example, a study on early-childhood lead exposure in North Carolina found not only that higher blood lead levels between the ages of 9 and 36 months were associated with lower test scores in the fourth grade, but that this effect was more pronounced at the lower end of the distribution of test scores.[96] Lower test scores tended to come from children enrolled in the free/reduced lunch program, children whose parents were less educated, and children who were exposed to more lead, with Black children overrepresented in all three of these "riskier" groups.[97] The findings thus revealed that children experiencing "these cumulating deficits" would have an especial disadvantage that could explain the school achievement gap between wealthier white children and Black and lower SES children.[98]

NEIGHBORHOOD-LEVEL FACTORS

Research has highlighted the potential for neighborhood-level conditions to increase vulnerability as well. For example, a 2017 study in three U.S. cities found that the association between ozone pollution and pediatric respiratory disease was higher among children in low-SES environments than among children in high-SES environments.[99] Meanwhile, a 2017 systematic review synthesized studies published between 2005 and 2016, aiming to investigate how socioeconomic position affected the relationship between multiple air pollutants (ozone, particulate matter, sulfur dioxide, nitrogen dioxide) and cardiovascular health.[100] In broad terms, the review found that vulnerability varied by a person's education, income, and occupation as well as by an area's level of poverty, unemployment, and deprivation.[101] The effect was generally in the expected direction, meaning that fewer material resources were related to greater vulnerability.[102] In this vein, a study using Medicare patient data from 207 U.S. cities revealed that the association between long-term $PM_{2.5}$ exposure and mortality differed on the basis of community-level characteristics, with the effect being worse in cities with higher obesity rates, percentage of residents living in poverty, percentage of Black residents, and percentage of population without high school degrees.[103]

The previously cited national study on $PM_{2.5}$ and adverse mental health also investigated the role of neighborhood context. It found that the association between $PM_{2.5}$ exposure and moderate to severe depressive symptoms was significantly greater for those living in more impoverished census tracts—even after accounting for individual-level socioeconomic status.[104]

A local resident wheeling home a cart carrying cases of bottled water from the Newark Department of Health and Welfare in Newark, New Jersey, on August 15, 2019.

Despite the substantial body of research documenting environmental injustice and demonstrating a need for a cumulative impacts framework, EJ communities still often hear counterarguments from polluting industries and government agencies, who may acknowledge that they suffer from health disparities (concept I) but maintain that these health problems are a result of the communities' own life choices and behaviors rather than environmental policies and conditions. EJ communities are thus offered, at most, interventions like behavior-change programs, education, and individual services.[105] Such blame-shifting discourse is refuted by the overwhelming evidence of disparate exposures (concept II), as well as the evidence showing that social circumstances can and do in fact heighten vulnerability (concept IV). On this latter point, there is consensus that health-supporting behaviors cannot fully eliminate the increased risk of adverse health outcomes that will come with ongoing exposure to stressors.[106] The pathways through which extrinsic factors can amplify vulnerability are detailed in the breakout box below.

UNDERSTANDING VULNERABILITY AND IMPACTS ON HEALTH

Emerging scientific research is shedding light on how the extrinsic factors described earlier exacerbate vulnerability to environmental hazards and thus poor health.

STRESS RESPONSE AND ALLOSTATIC LOAD

One prominent explanation is that individuals in disadvantaged situations can face chronic stress, leading to accumulated wear and tear on the body known as allostatic load.[107] When stress chemicals are continually secreted, they can falter in their ability to protect the distressed person and instead begin to damage the brain and body.[108] Over time, this affects not only the neuroendocrine system (the system responsible for stress response in the first instance) but also the cardiovascular, metabolic, and immune systems as they try to compensate.[109] Initial evidence of this stress pathway was mixed, possibly due to the relatively few studies on the topic and the challenge of measuring something as complex as stress.[110] Nonetheless, a systematic review of the evidence concluded that there is a relationship between allostatic load and factors such as socioeconomic status (SES), social relationships, workplace, lifestyle, race/ethnicity, gender, and stress exposure.[111]

Research focusing specifically on children and adolescents provides further evidence.[112] For example, a study of African-American adolescents living in Michigan found that both individual and neighborhood-level factors reflecting socioeconomic disadvantage were associated with higher levels of cortisol, a key stress response hormone that regulates central nervous, metabolic, and immune systems; when levels are abnormal, adverse health outcomes can result.[113] A recent study of a racially diverse sample of kindergarten children in California over the course of a school year similarly found that the highest cortisol levels and greatest physical health problems among children were observed in families of lower SES and neighborhoods with less opportunity.[114] Moreover, the negative effects of family SES on children's cortisol levels and physical health were influenced by neighborhood attributes, such that higher-opportunity neighborhoods appeared to be a buffer against some of these effects.[115] Overall the researchers concluded that their study supported the existence of the stress–physiology pathway, whereby adverse conditions impair cortisol response, elevating the risk of physical health problems.[116]

The stress experienced by individuals in situations of social disadvantage may also have intergenerational impacts. Maternal cortisol is one of the pathways through which maternal emotional state and stress affect a fetus's developing brain; maternal cortisol concentrations influence fetal cortisol concentrations.[117] For example, a study in New Zealand found that women with lower SES had higher biological indicators of stress during pregnancy, and their babies were more biologically reactive to stress.[118] Further, women's experiences of racial/ethnic discrimination appeared related to their own stress levels, their self-rated health, and how their babies responded to stress.[119] This research provides evidence of the intergenerational impacts that SES and racial/ethnic discrimination may have on stress responses. When individuals (and their offspring) are then confronted with hazardous pollution, they are more vulnerable to the health impacts due to their altered stress responses. This is a key pathway by which social vulnerability contributes to cumulative impacts.

HEALTH CARE DISPARITIES

Additionally, factors like race/ethnicity and socioeconomic status may increase vulnerability to environmental hazards because, as evidence has long shown, individuals who are nonwhite or low-income or reside in certain geographic areas have less access to health care and lower-quality care.[120] Individual, provider, and community-level factors all contribute to disparities in access and quality of care.[121] These include not only a person's insurance status, access to material resources, and level of education—which tend to be correlated with race/ethnicity—but also implicit racial and other biases that affect how care providers interact with patients and how patients in turn respond.[122] Efforts to expand health insurance coverage, such as the Affordable Care Act and state Medicaid expansion, have reduced some disparities in insurance status and utilization of health care services, but they are insufficient by themselves to affect disparities in health outcomes.[123] In fact, a systematic review of 77 studies concluded that the effects of ACA-related Medicaid expansion on gaining health insurance have been comparable across racial/ethnic groups, suggesting that the disparities that previously existed still largely remain.[124]

One example of how disparities in health care magnify the impact of environmental exposures can be found in the exacerbation of asthma due to air pollution. Lack of adequate health care to manage asthma means that asthma exacerbations are more likely to result in emergency department visits, hospitalizations, and deaths.[125] One nationwide study of 5,535 children found that in 2008, children with uncontrolled asthma were seven times more likely to visit the emergency department than were children with well-controlled asthma, a finding researchers deemed disturbing given its suggestion that most emergency department visits could have been prevented by proper asthma management.[126]

Using Cumulative Impacts Analysis to Create Change—Case Studies in Chicago and Newark

We can use a cumulative impacts framework and cumulative impacts mapping tools to work with environmental justice communities to bring change.

Around 2017, NRDC and environmental justice groups in Chicago (the Southeast Side Coalition to Ban Petcoke, the Southeast Environmental Task Force, and the Little Village Environmental Justice Organization) and Newark, New Jersey (the Ironbound Community Corporation) decided to bring together their expertise to explore how a cumulative impacts framework could advance environmental justice. We aimed to work in close partnership to develop a method that could assess cumulative environmental burdens in those two cities and potentially be used in other places. Community–academic partnerships elsewhere had been working toward a similar goal, and proposals for draft tools and cumulative impacts policy had already been surfacing to varying extents in Illinois and New Jersey due to advocacy by EJ groups.[127] We sought to build on those efforts, adapt them as needed, and document the lessons learned for cumulative impacts–based advocacy.

METHOD AND APPROACH

We aimed to create a method that would be easily understood by nontechnical audiences, as well as be credible and persuasive for specific advocacy objectives when presented to policymakers. Moreover, we wanted the process to yield useful, actionable information while navigating around limitations and uncertainties of available data.

With these considerations in mind, we decided to use the indicators collected by the U.S. EPA's EJSCREEN as our principal source of environmental and population data. While we recognized the limitations in EJSCREEN described earlier, these were outweighed by the advantages of adhering to a set of indicators already vetted and endorsed by the U.S. EPA. The 2018 version of EJSCREEN (the most up-to-date version at the time) contains 6 socio-demographic indicators and 11 environmental indicators for each U.S. Census block group in the country (see Table 1).

To combine these indicators, we decided to adapt a method developed by researchers in California known as the Environmental Justice Screening Method.[128] Our approach is summarized here; for more detail, see the Technical Appendix. First, we ranked block groups within a chosen geographic area (e.g., a city or county) according to each of the 17 indicators. Next, for each block group, we combined its 11 rankings corresponding to the environmental indicators into a sub-score ranging from 1 to 5, and its 6 rankings corresponding to the socio-demographic indicators into another sub-score also ranging from 1 to 5. From there, we added the two sub-scores to get a final total score for each block group. This total score, ranging from 2 to 10, reflects how heavily burdened a given block group is, relative to other block groups within the area of interest; the higher the score, the greater the disproportionate cumulative burden. The result of this cumulative impacts analysis calls attention to areas that face a high combined burden from multiple environmental stressors and socio-demographic vulnerabilities, which, as we have seen, can have negative cumulative impacts on health and well-being.[129]

Though a cumulative impacts analysis such as the one we developed may yield results that are unsurprising to those affected by the problem, EJ communities and groups have found it valuable to their policy advocacy to have a data-driven visual that describes their lived experience of cumulative, disproportionate burdens.

Our initial discussions revealed that communities are eager to use cumulative impacts maps and analyses to inform land use and economic development policies, which historically have contributed to the burden and health inequities of EJ communities in important ways.[130] Having

the tools to provide a visual and quantifiable understanding of the combined impacts of land use and economic development policies on environmental and public health can help advocates push policymakers to pay attention to these accumulated burdens.

DAYLIGHTING THE PROBLEM

As applied to the city of Chicago, the analysis we conducted in 2018 and updated in 2019 highlighted communities in the west, southwest, and southeast as areas experiencing high cumulative burdens and potential vulnerability to environmental health impacts (see Map 1). The mayor at the time, Rahm Emanuel, was in the process of championing the Industrial Corridor Modernization Process (ICMP), which was presented as a beneficial public process "to refine land use policies for continued growth and private investment" in Chicago's industrial corridors.[131] However, EJ advocates noted from early on that the process effectively gentrified some corridors while distributing burdens to others. For example, as part of the ICMP, the City Council in 2017 not only rezoned the North Branch Corridor to prohibit many heavy industrial uses and enable high-end commercial and residential development, but also designated certain industrial corridors to be "receiving corridors" for the industry

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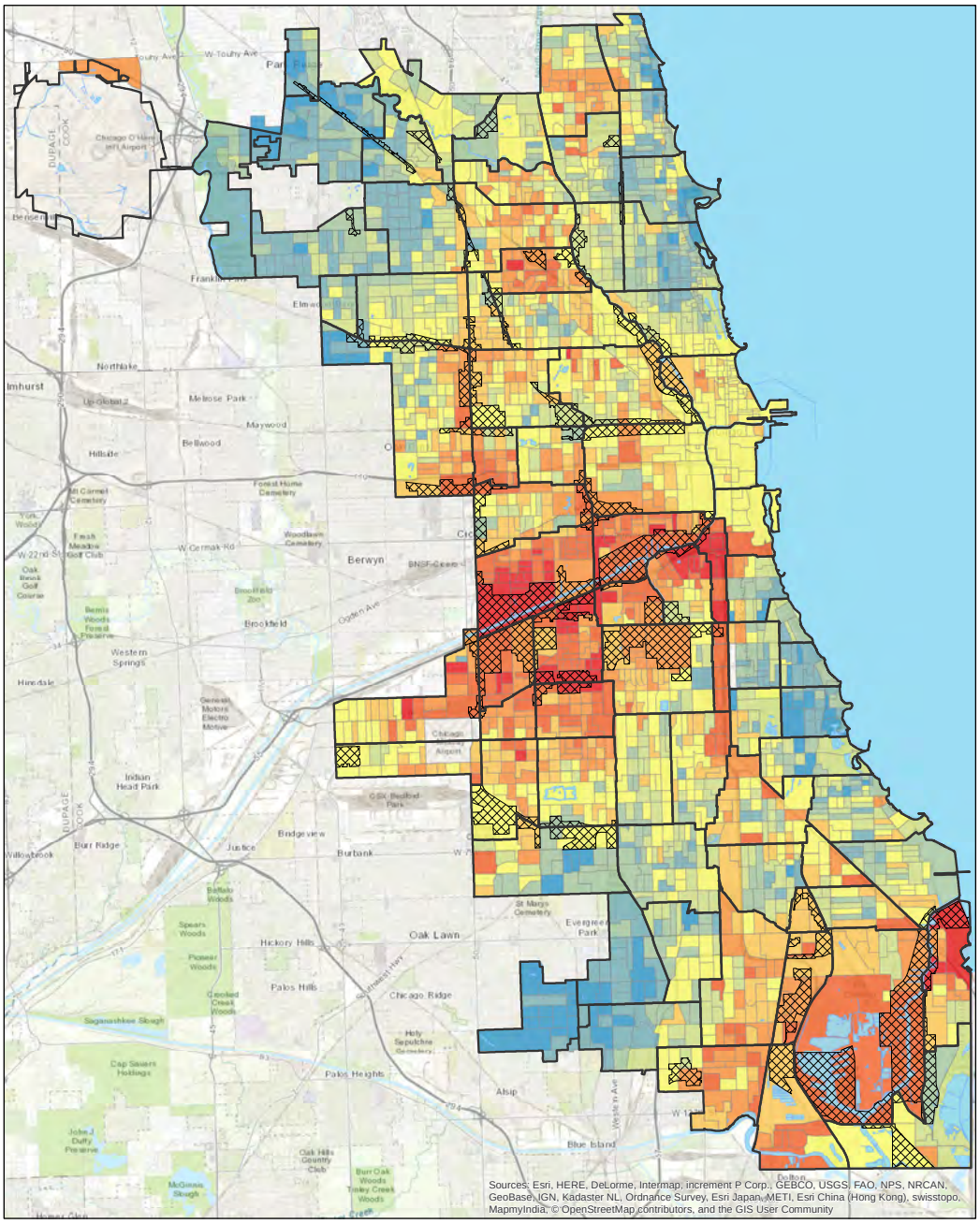
Little Village, Chicago, December 2019.

displaced by this gentrification.[132] These so-called receiving corridors, including Little Village and the Southeast Side, are predominantly located in or adjacent to low-income communities of color. EJ groups in Chicago were able to leverage our analysis and the corresponding cumulative impacts map of the city to argue for more careful and health-protective development of areas like the Little Village, Pilsen, and Southeast Side industrial corridors.

TABLE 1: INDICATORS FROM EJSCREEN 2018 INCORPORATED INTO CUMULATIVE IMPACTS ANALYSIS

INDICATORS	EJSCREEN'S SOURCE	SOURCE YEAR
ENVIRONMENTAL INDICATORS		
Particulate Matter 2.5 ($PM_{2.5}$)	U.S. EPA Office of Air and Radiation (OAR) modeled and monitoring data	2014
Ozone	U.S. EPA OAR modeled and monitoring data	2014
Diesel Particulate Matter	U.S. EPA National Air Toxics Assessment (NATA)	2011
Air Toxics Respiratory Hazard Index	U.S. EPA NATA	2011
Air Toxics Cancer Risk	U.S. EPA NATA	2011
Lead Paint	American Community Survey	2012–2016
Traffic Proximity	U.S. Department of Transportation	2014
Proximity to Superfund (National Priorities List) Sites	U.S. EPA Superfund Program	2018
Proximity to Risk Management Plan (RMP) Facilities	U.S. EPA RMP Database	2018
Proximity to Treatment Storage Disposal Facilities	U.S. EPA RCRAInfo Database and Biennial RCRA Report	2018
Wastewater Discharge	U.S. EPA Risk-Screening Environmental Indicators Model 2.3.5, Using Toxics Release Inventory 2015	2017
SOCIO-DEMOGRAPHIC INDICATORS		
Low-Income	American Community Survey	2012–2016
Minority[133]	American Community Survey	2012–2016
Less Than High School Education	American Community Survey	2012–2016
Linguistic Isolation	American Community Survey	2012–2016
Under Age 5	American Community Survey	2012–2016
Over Age 64	American Community Survey	2012–2016

MAP I: CHICAGO CUMULATIVE IMPACTS MAP



Legend

Cumulative Burden Score

- 2 - lowest burden
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 - highest burden

- Community Area
- Industrial Corridor
- Waterway

0 2.5 5 10 Miles

N

NRDC map version 3-28-2019. See accompanying methodology.

© Steve Geer/iStock

The coal-fired Crawford Generating Station in South Lawndale, Chicago. Demolition of the plant began in 2019. On April 11, 2020, the concrete smokestack was imploded, blanketing the nearby Little Village neighborhood with toxic dust.

We also presented the cumulative impacts framework and map to the Chicago Department of Public Health (CDPH) to urge for more tailored research on the health status of disproportionately burdened neighborhoods. In 2016, the city had launched its Healthy Chicago initiative to promote community health and well-being, but there was limited application of health data to environmental issues. By emphasizing disproportionately burdened neighborhoods, our analysis sought to focus attention on current inequities and counter the notion that communities must first prove that a specific hazard is causing a specific health outcome in order for action to be taken.[134] On the basis of our analysis and discussions with them, the CDPH agreed to include, for the first time, environmental stressors in its Chicago Health Atlas (chicagohealthatlas.org) and related data compilations, including the Healthy Chicago 2025 Data Compendium.[135] The exchange also helped inspire CDPH's creation of a new Air Quality and Health Index, released in July 2020, which combines indicators on air pollution, polluted sites, health factors, and social factors.[136] And it encouraged the adoption of environmental justice as a priority area in the upcoming Healthy Chicago 2025 community health improvement plan.

Meanwhile, in Newark, our city-level cumulative impacts analysis, conducted in 2018 and updated in 2019, highlighted the Ironbound neighborhood in eastern Newark as especially burdened when compared with the rest of the city (see Map 2). We used this analysis to call attention to disparities within Newark and emphasize the need to implement cumulative impacts policies.

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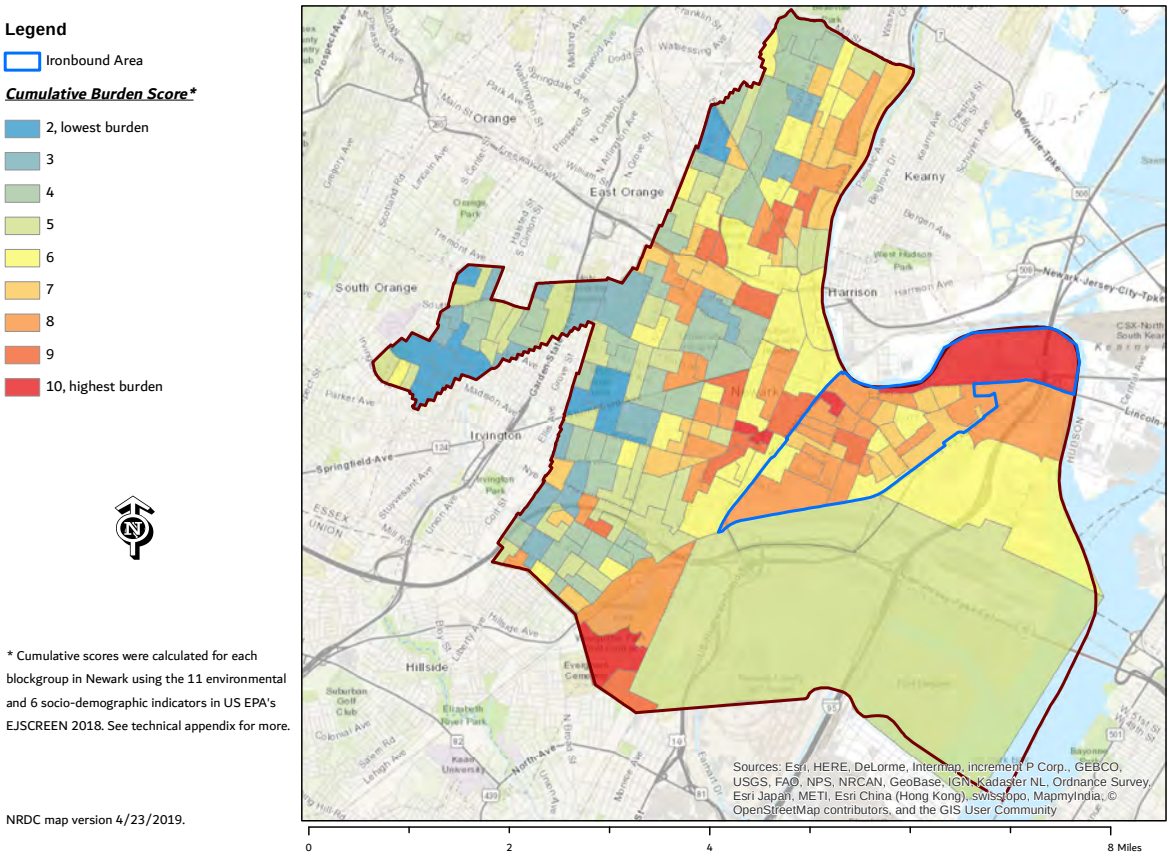
A pile of exhaust pipes and discarded steel parts in one of many dumping grounds on the South Side of Chicago, Illinois, shot on October 25, 2020.

MAP 2: NEWARK CUMULATIVE IMPACTS MAP

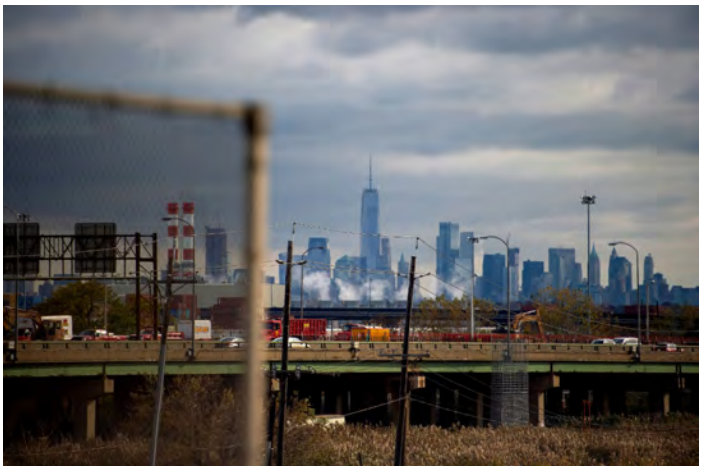


Community advocates in Newark, including the Ironbound Community Corporation, have long fought against the disproportionate siting of polluting facilities in low-income communities and communities of color, deriving from a legacy of permissive zoning, weak code enforcement, and race-based residential segregation.[137] In 2016, after efforts by EJ advocates, the city passed an Environmental Justice and Cumulative Impacts Ordinance, which amended its zoning regulations and required all industrial and commercial development applicants to submit an EJ checklist for consideration by the zoning board.[138] The ordinance also charged an Environmental Commission with the task of developing a Natural Resource Inventory for the city, which applicants were to use as a baseline guide for assessing cumulative impacts and preparing the EJ checklist.[139] At the time we conducted our cumulative impacts analysis for Newark, the Natural Resource Inventory was still in development and had not been officially adopted by the Environmental Commission. To help inform that process, we presented our analysis to the Environmental Commission as an example of a relatively simple method and data set that could be used.

The Newark analysis has been used by the Ironbound Community Corporation (ICC) in educating community youth about environmental justice. The map can also be used to debunk a common misperception observed by ICC that supposedly "the entire northern part [of the state] is a wasteland." It does so by demonstrating that there are still hot spots and disparities—areas of relative privilege and disadvantage—within minutes' driving distance of each other.

Environmental justice advocates have stressed that comparing marginalized neighborhoods only to each other falls into the trap of "playing oppression Olympics," and

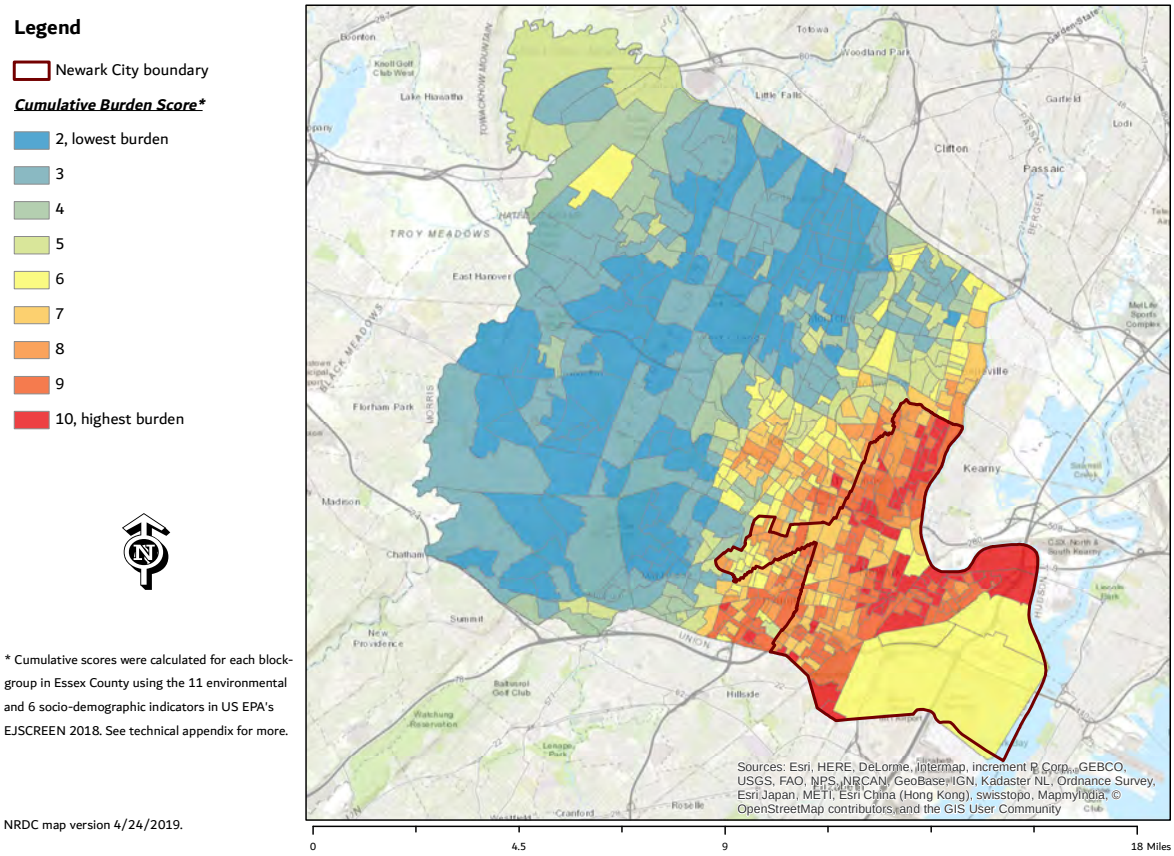
that the city of Newark as a whole could be considered marginalized; three out of every four Newark residents are people of color, and the median household income is approximately $35,000, much lower than the national average of $60,000.[140] For this reason, our assessment also incorporated a complementary, county-level cumulative impacts analysis for Essex County, New Jersey, where Newark is located. The resulting comparison shows that the city of Newark is disproportionately burdened, compared with the rest of Essex County (see Map 3). An added benefit of this analysis is that adjusting the area of comparison can be helpful depending on the level of policymaker and type of policy targeted. For example, many zoning and permitting decisions are made at the city level, but decisions about waste disposal and green space can be made at the county level.



© Photomuse/Kristin Reimer, for ICC and The New School

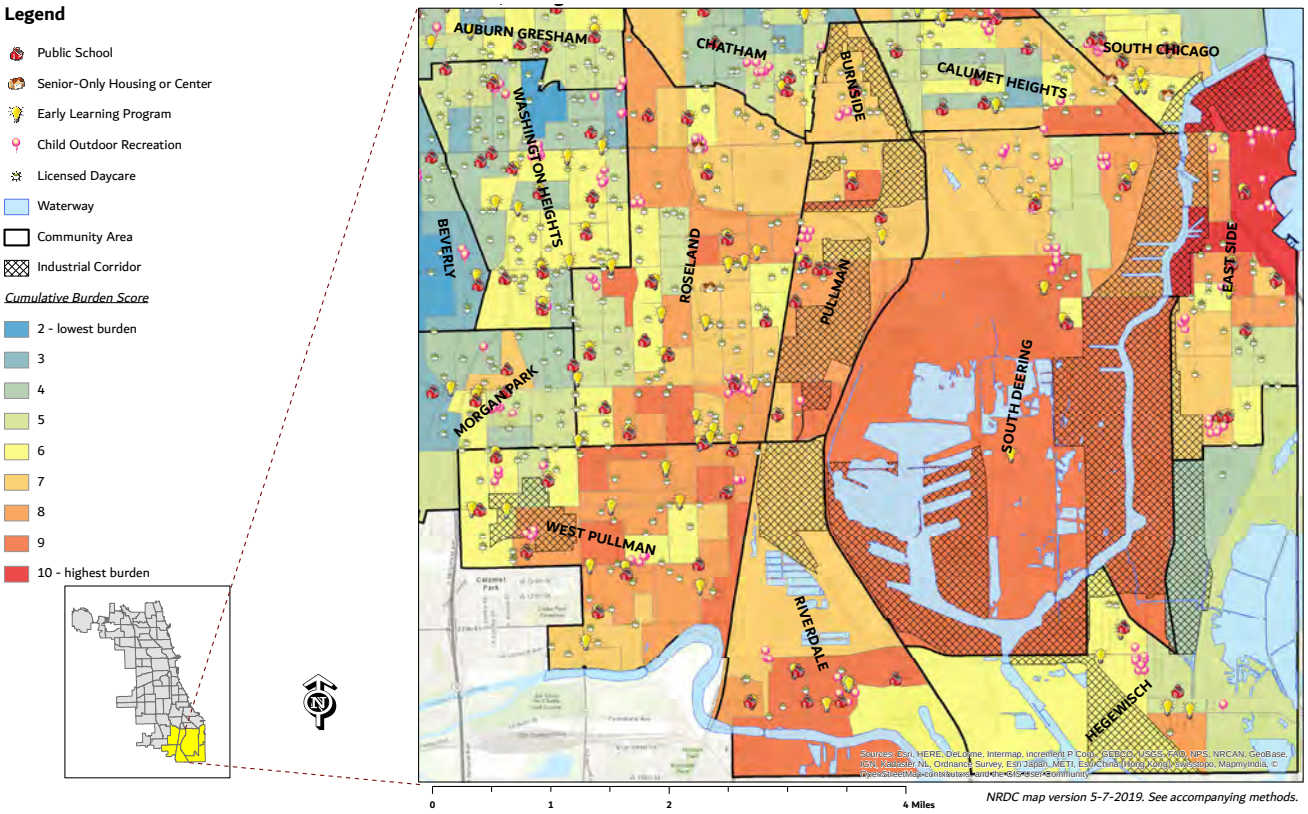
The New York City skyline as seen from the Ironbound neighborhood of Newark on November 3, 2018.

MAP 3: ESSEX COUNTY CUMULATIVE IMPACTS MAP



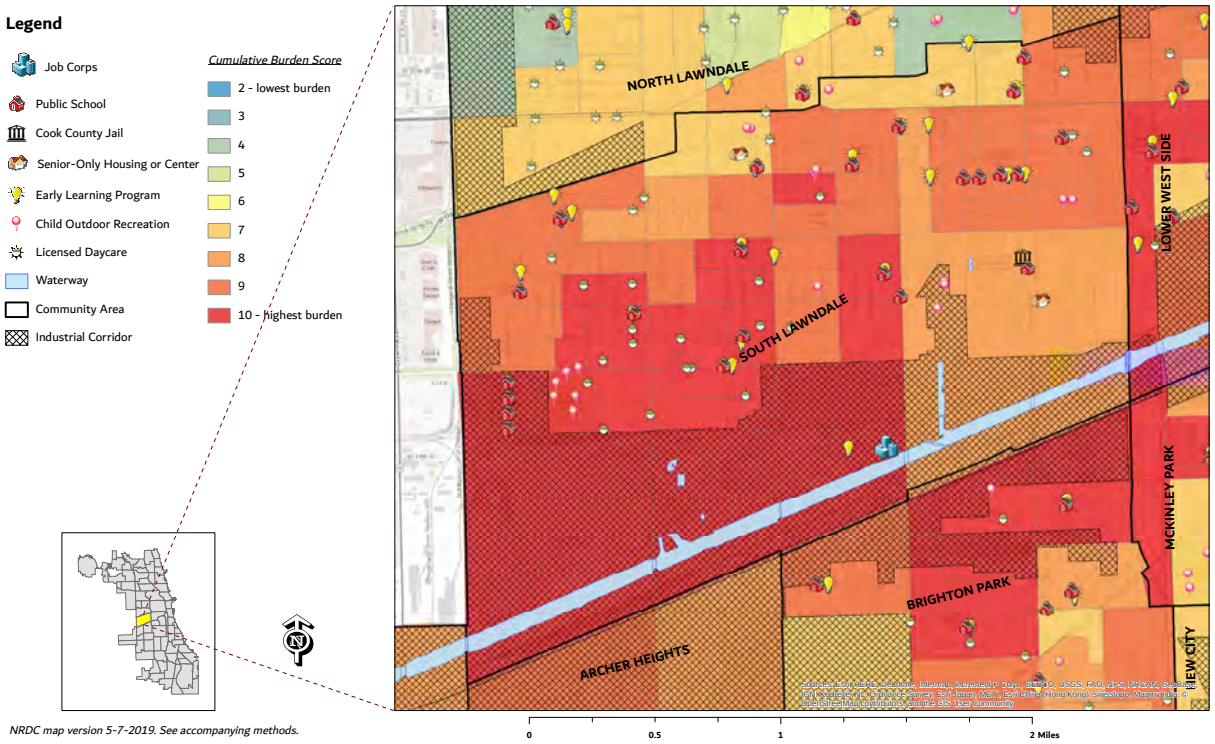
Community advocates in Chicago and Newark have heard the argument that areas plagued by cumulative polluting sources are not areas where people live. Thus, a subsequent step in our analysis involved the use of overlays to refute this argument. We took a more detailed look at both cities and overlaid the locations of sensitive sites like day care facilities, schools, and public housing on top of our cumulative burden map. The results helped demonstrate the real juxtaposition of pollution and population (see Maps 4, 5, and 6).

MAP 4: SOUTHEAST SIDE, CHICAGO, CUMULATIVE IMPACTS MAP WITH SENSITIVE SITES



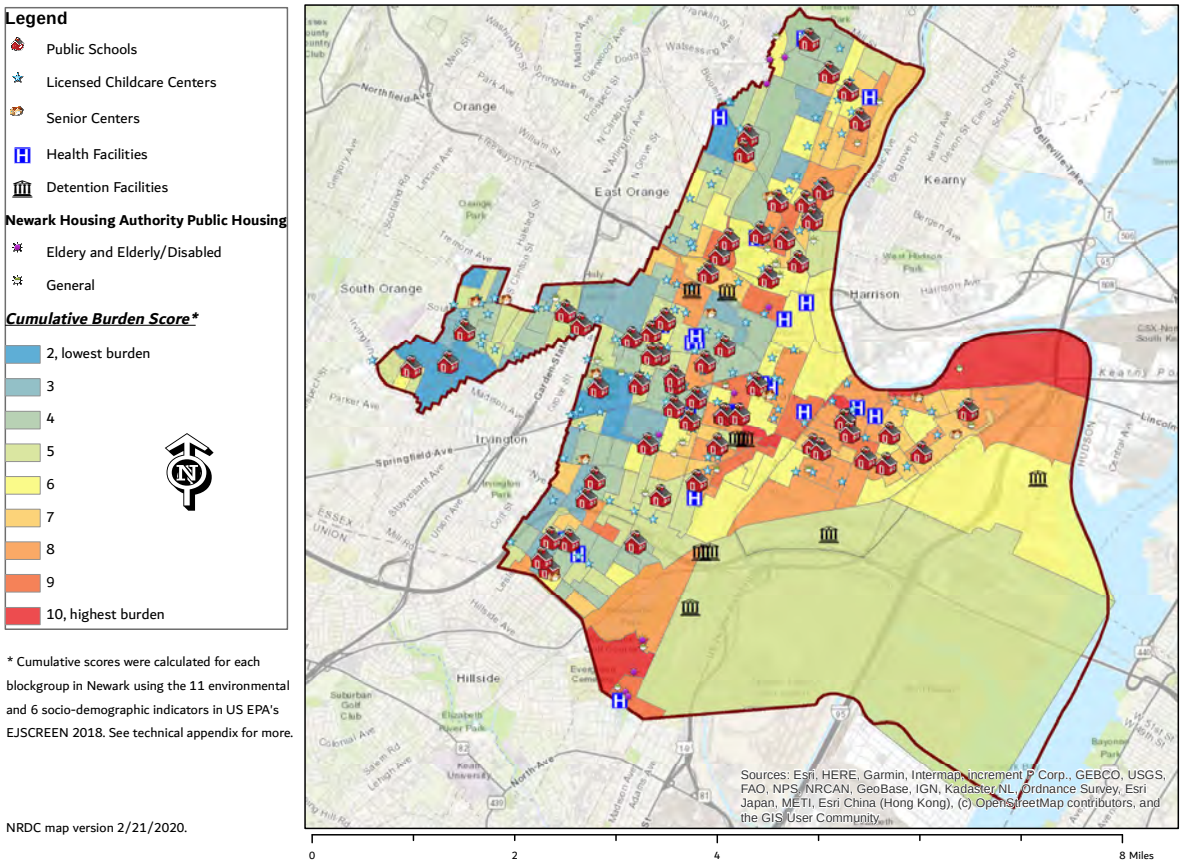
NRDC map version 5-7-2019. See accompanying methods.

MAP 5: SOUTH LAWNDALE, CHICAGO, CUMULATIVE IMPACTS MAP WITH SENSITIVE SITES



NRDC map version 5-7-2019. See accompanying methods.

MAP 6: NEWARK CUMULATIVE IMPACTS MAP WITH SENSITIVE SITES



* Cumulative scores were calculated for each blockgroup in Newark using the 11 environmental and 6 socio-demographic indicators in US EPA's EJSCREEN 2018. See technical appendix for more.

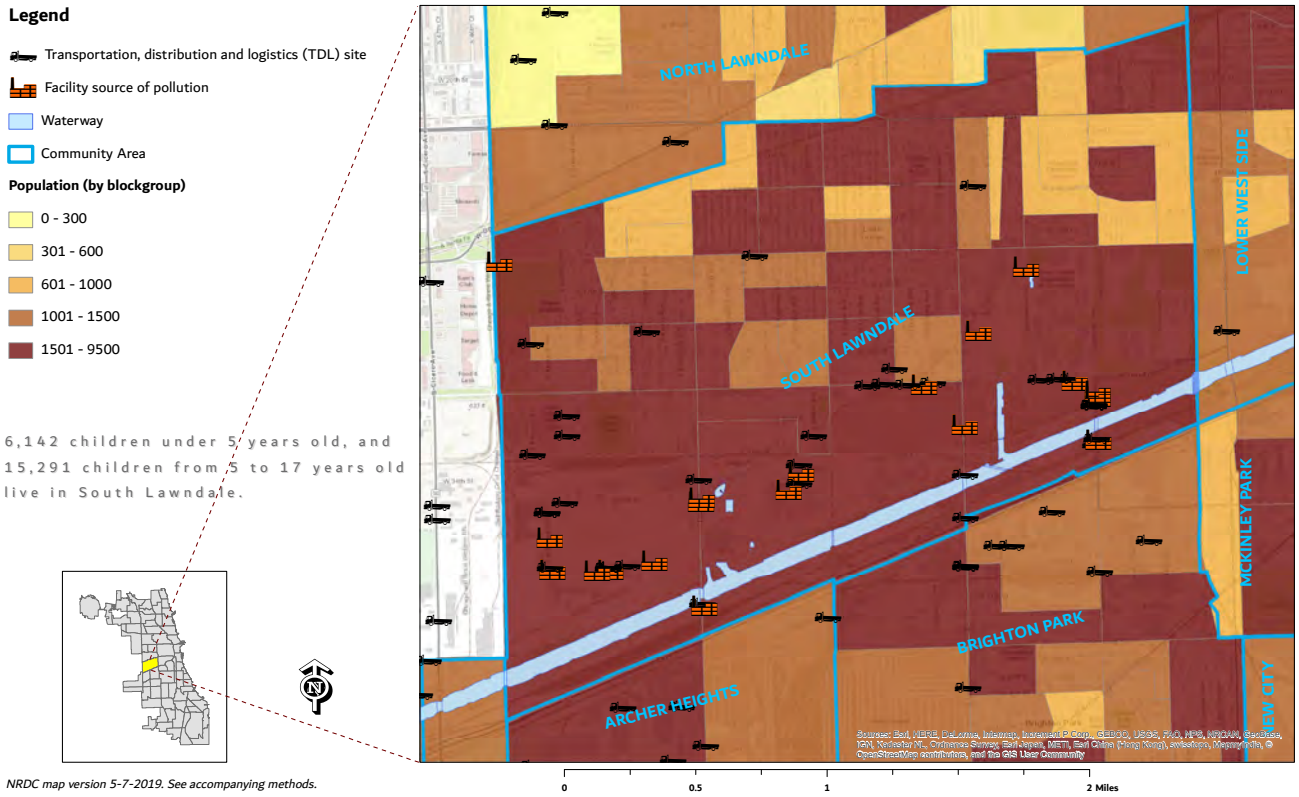
NRDC map version 2/21/2020.

Overlays can be helpful in other instances for including additional population or environmental information absent from official data sources, as well as ground-truthed or community-documented data that fill gaps in agency monitoring. For example, EJSCREEN's traffic indicator does not distinguish among types of vehicles, even though certain types, such as heavy-duty diesel trucks, contribute more pollution than others.[141] However, in Chicago, the Little Village Environmental Justice Organization has conducted truck counts and an inventory of transportation, distribution, and logistics sites, allowing us to create a more accurate picture of pollution burdens (see Map 7). In Newark, the Ironbound Community Corporation has similarly tracked numerous facilities and other pollution sources that do not appear in any U.S. EPA database. Through overlays, this community-based information helps supplement the cumulative impacts analysis, providing a more precise picture of the environmental burden for issues overlooked in official data.

As demonstrated by these case studies, the fact that some communities clearly show up as disproportionately burdened can stimulate discussions about which policies are responsible for that disparity and, conversely, the kinds of development that can most promote health and well-being. The maps help to describe the problem at hand so that effective policy solutions can be crafted.

Down Bottom Farms, part of the Ironbound Community Corporation's Urban Agriculture program, November 3, 2018.

MAP 7: SOUTH LAWNDALE, CHICAGO, POPULATION AND POLLUTION



NRDC map version 5-7-2019. See accompanying methods.

Developing and Implementing Solutions at the State and Federal Levels

As EJ leaders have long warned, the creation of tools to depict cumulative impacts should not overshadow the implementation of policies to create real change.

Cumulative impacts analysis is useful for understanding and demonstrating the burden facing many EJ communities, but that is only a first step. We need policies that act on this information. In municipalities and states across the country, EJ communities and advocates have been fighting for, and making some progress on, policies that advance environmental justice and address cumulative impacts.[142] One of the most significant policies proposed by EJ advocates to address cumulative impacts is a restriction on permitting new pollution sources or renewing permits for existing facilities in areas that are already overburdened. With this type of policy, advocates and policymakers can use a cumulative impacts analysis similar to the one described here, alongside methods that help address the limitations of such an analysis to identify areas as overburdened; such methods could include incorporating qualitative data, ground-truthing, and allowing a mechanism for communities to self-designate as overburdened. In the overburdened communities identified, rather than allowing more pollution, there should be efforts to reduce pollution and increase environmental goods, such as green space and green infrastructure.

Activists holding protest signs at the Youth Rally Against General Iron in the South Side of Chicago, Illinois, on October 25, 2020.

For more than a decade, the New Jersey Environmental Justice Alliance (NJEJA), Ironbound Community Corporation (ICC), and Clean Water Action, alongside other groups interested in EJ and environmental issues, have pushed for the adoption of such a statewide cumulative impacts policy in New Jersey. A 2013 NJEJA memorandum and subsequent NJEJA policy documents outlined a model statewide policy, including: (1) the identification of communities that are overburdened by pollution, have a significant percentage of low-income population, and/or have a significant percentage of persons of color; (2) the requirement that facilities applying for new permits or permit renewals in such communities demonstrate that they have considered all alternatives for minimizing/eliminating the pollution emitted by their operations; (3) the denial of new permits in these communities unless the facility results in no overall increase in pollution; and (4) the denial of permit renewals unless the applicant can show an overall decrease in emissions.[143]

Advocates for the adoption of a statewide cumulative impacts policy in New Jersey, including NJEJA, ICC, and Clean Water Action, achieved a landmark victory in the summer of 2020. Following 12 years of advocacy and negotiations, New Jersey lawmakers passed state bill S232/A2212, establishing a precedent-setting cumulative impacts law that requires the state Department of Environmental Protection (NJDEP) to deny or condition permits for certain types of facilities, if approval would contribute to disproportionately high "adverse cumulative environmental or public health stressors" in communities meeting certain socio-demographic criteria.[144] Excerpts from the law are contained in the breakout box below. There are some important differences between NJEJA's statewide model policy and the law as passed.[145] Still, pioneers of the policy, including Drs. Ana Baptista and Nicky Sheats, have described the law, respectively, as "a model for other states" and "a foundation from which New Jersey can address environmental justice."[146] Baptista, who is on the Board of Trustees of ICC and NJEJA, and Sheats, who serves on the Board of NJEJA, were part of a small group of veteran EJ advocates who were at the forefront of the fight for the state's cumulative impacts law. This group also included Melissa Miles of NJEJA, Maria Lopez-Nuñez of ICC, and Kim Gaddy of Clean Water Action.

At the federal level, there have been a few recent, significant steps forward in this direction, such as two proposed EJ bills in the House and Senate that would incorporate consideration of cumulative impacts into air and water permitting decisions.[147] As of the writing of this brief, however, neither of these bills had been signed into law.

EJ advocates have also been clear in noting that a problem as broad and deeply rooted as cumulative impacts cannot be solved by just a single policy. Alongside a more careful and just permitting framework, additional measures for tackling cumulative impacts should include:

- Land use and public health reforms to address the industrial facilities, diesel truck traffic, hazardous materials, noxious odors, and other environmental hazards that are located immediately adjacent to parks, schools, and residential neighborhoods;
- Targeted environmental monitoring, enforcement activities, and other types of regulatory attention in vulnerable areas;

Melissa Miles (center), Executive Director of NJ Environmental Justice Alliance, speaks alongside Maria Lopez-Nuñez (left), Deputy Director of Organizing and Advocacy at the Ironbound Community Corporation, during the signing ceremony for Senate Bill 232 in Newark, New Jersey, on September 18, 2020.

- Additional localized environmental and public health research, focusing on areas flagged as disproportionately burdened;
- Increased public health resources like access to screening and health services for impacted communities;
- Deployment of additional methods to characterize and understand cumulative impacts, such as biomonitoring, cumulative risk assessment, and health impacts assessments.[148]

One possibility for implementing all or a subset of these policies is through the creation of special zoning districts known as overlay zones, where reducing cumulative impacts and addressing environmental justice would be specific goals, and where a city could add regulations or incentives to guide development toward these goals.[149] Green zones are a particular form of overlay zone aimed not only at controlling pollution but also at encouraging economic development, aligning with the EJ movement's efforts to address economic justice.[150] Cities such as East Austin, Los Angeles, and Minneapolis have used overlay zones and green zones to reduce the concentration of industrial activity near residential areas, mitigate existing pollution burdens, enhance community participation, direct resources, and promote green business development in priority communities, among other goals.[151]

PROGRESS ON ENVIRONMENTAL JUSTICE: NEW JERSEY PASSES A LAW ON CUMULATIVE IMPACTS

NJ state bill S232/A2212 was signed into law on September 18, 2020, making New Jersey the first state in the nation to require denial of permits based on an analysis of cumulative impacts in environmental justice communities. The law applies to:

- **"Overburdened communities,"** defined as census block groups in which the latest U.S. Census data show "(1) at least 35% of the households qualify as low-income households [defined as earning less than twice the federal poverty level]; (2) at least 40% of the residents identify as minority or as members of a State recognized tribal community; or (3) at least 40% of the households have limited English proficiency."152
- **Permit applications for new facilities, expansion of facilities, or renewal of facilities for the following types of facilities:** (1) major sources of air pollution (as per the Clean Air Act); (2) resource recovery facilities or incinerators; (3) sludge processing facilities, combustors, or incinerators; (4) sewage treatment plants above a given capacity; (5) solid waste facilities or recycling facilities above a given throughput; (6) landfills; and (7) certain medical waste incinerators.

For a permit application for a covered facility located wholly or partially within an "overburdened community," the law establishes the following:

1. The permit applicant must prepare a detailed Environmental Justice Impact Statement (EJIS) that assesses both the "potential environmental and public health stressors" associated with the proposal and the "environmental or public health stressors already borne by the overburdened community as a result of existing conditions."
2. The permit applicant must submit the EJIS at least 60 days in advance of a public hearing. Specific notice requirements for the hearing are followed regarding mode of communication, timing, language, and content. Interested parties have an opportunity to submit written comments to the applicant.
3. The public hearing will be held in the overburdened community. The municipality will also be invited to participate. At the hearing, there will be an opportunity for meaningful public participation. Interested parties can submit written or oral comments. The applicant will transcribe the hearing, and DEP will consider the testimony presented and any comments received.
4. DEP will not issue a decision until at least 45 days after the public hearing. The DEP "shall deny a permit for a new facility" if it finds that it "would, together with other environmental or public health stressors affecting the overburdened community, cause or contribute to adverse cumulative environmental or public health stressors in the overburdened community that are higher than those borne by other communities within the State, county, or other geographic unit of analysis." (The specific rules are determined in rulemaking that will follow the law's adoption.)
5. For renewals and expansions, DEP "may…apply conditions" to mitigate impacts if it finds that the renewal or expansion "would, together with other environmental and public health stressors affecting the overburdened community, cause or contribute to the adverse cumulative environmental or public health stressors in the overburdened community that are higher than those borne by other communities within the State, county, or other geographic unit of analysis."
6. As part of the process, DEP can charge the applicant fees associated with the costs of providing technical assistance to overburdened communities.

Conclusion

Across the country, the proximity of pollution to neighborhoods where people live, work, and play is a public health threat. As these case studies demonstrate, a partnership combining community experience, knowledge, and advocacy with scientific support can be used to develop cumulative impacts analyses that highlight the environmental justice communities being hit the hardest because of especially high pollution burdens and social vulnerability. Moving from knowledge to action is the next crucial step, and action must come not only from environment and health agencies, but also from those responsible for zoning and planning. A multiagency response to address cumulative impacts, informed by community experience and knowledge, is both necessary and overdue.

Additional resources:

- American Public Health Association, *Policy Statement on "Advancing Environmental Justice to Achieve Health Equity,"* approved in November 2019. The statement describes the connection between environmental justice and public health and suggests actions that public health departments and professionals can take to confront cumulative impacts and promote environmental justice. https://www.apha.org/policies-and-advocacy/public-health-policy-statements/policy-database/2020/01/14/addressing-environmental-justice-to-achieve-health-equity
- Ana Baptista, *Local Policies for Environmental Justice: A National Scan*, Tishman Environment and Design Center, February 2019. The report details efforts by communities in more than 20 cities to transform zoning and local land use policies as a means to address cumulative impacts. https://www.nrdc.org/sites/default/files/local-policies-environmental-justice-national-scan-tishman-201902.pdf

Technical Appendix

This document describes the cumulative impacts analysis methodology and data sources used to produce the maps contained in the policy brief "Seeing the Whole: Using Cumulative Impacts Analysis to Advance Environmental Justice." We first describe the data sources and methodology used to conduct the cumulative impacts analysis, and then describe additional data sources used to produce the overlays that appear in the maps.

In 2017 NRDC began working with the Little Village Environmental Justice Organization, the Southeast Side Coalition to Ban Petcoke, and the Southeast Environmental Task Force to develop a cumulative impacts analysis methodology. The purpose was to analyze the cumulative burden of environmental hazards and socio-demographic characteristics that increase vulnerability and susceptibility to the impacts of those hazards. After conducting a scan of available spatial data and exploring various candidate methodologies, the group decided to adapt the Environmental Justice Screening Method (EJSM) developed by environmental scientist James Saad and colleagues and apply it to the data collected by the 2018 version of the U.S. Environmental Protection Agency's (EPA) environmental justice screening tool, EJSCREEN.[153] EJSM was chosen because it has been shown to be flexible, transparent, and relatively easy for lay audiences to understand. EJSCREEN 2018 was selected as the main source of socio-demographic and environmental information for the analysis because it is fairly comprehensive, current, and credible. Moreover, the data are available nationally (allowing the method to be applied elsewhere in the country) and at a relatively high spatial resolution (at the census block group level). The methodology was initially applied to Chicago, and then to Newark and Essex County, New Jersey.

DATA SOURCES

EJSCREEN 2018, the latest available version at the time of our analysis, compiles data from various government entities on 11 environmental indicators and 6 population indicators.[154] (More information about the data behind these indicators can be found on the EPA's website.[155]) Values for each of those 17 indicators are provided for each census block group in the country. The data file containing EJSCREEN 2018 results for all U.S. census block groups was downloaded from the EJSCREEN website in March 2019 for the Illinois analysis and in April 2019 for the New Jersey analysis.[156] At both times, the "last modified" date of the spreadsheet used, "EJSCREEN_2018_StatePctile.csv," was July 18, 2018.

We downloaded shapefiles for Illinois and New Jersey block groups based on 2014 census geographies from the U.S. Census Bureau website in March and April 2019, respectively.[157] Census geographies for 2014 were used because according to the EJSCREEN website (as accessed in spring of 2019), EJSCREEN 2018 incorporated indicators from the American Community Survey's five-year data for 2012–2016, "which is based on 2014 Census boundaries." A shapefile for Chicago's city boundary was downloaded from the City of Chicago data portal in March 2019.[158] A shapefile representing Newark's wards, dated 2012, was downloaded from the City of Newark data portal in April 2019.[159]

STEPS TO PREPARE THE DATA

FOR CHICAGO:

The Illinois census block group shapefile and Chicago city boundary shapefile were imported into ArcMap 10.6 and projected into the Illinois State Plane East projected coordinate system. A spatial join was performed to join the city boundary to Illinois block groups to derive the block groups located in Chicago. This generated 2,328 block groups, which were manually refined to 2,180 block groups based on zooming in and hand-excluding block groups that were mostly located outside the city boundary. In R, data from the full EJSCREEN 2018 data set were matched to the 2,180 Chicago block groups based on the census block group ID. Four block groups were further excluded because they were missing values for three environmental indicators in EJSCREEN (the three corresponding to the National Air Toxics Assessment). Thus, the final data set used for the Chicago cumulative impacts analysis consisted of 2,176 block groups and the 17 EJSCREEN indicators for them.

FOR NEWARK:

The New Jersey census block group shapefile and Newark ward shapefile were imported into ArcMap 10.6 and projected into the New Jersey State Plane projected coordinate system. Block groups that appeared to fall within Newark's wards were manually selected, yielding 204 Newark block groups. In R, data from the full EJSCREEN 2018 data set were matched to the Newark block groups. The final data set used for the Newark cumulative impacts analysis consisted of 204 block groups and the 17 EJSCREEN indicators for them.

FOR ESSEX COUNTY:

We were able to obtain block group IDs for block groups in Essex County directly from the American Community Survey (ACS). (We downloaded a data table for Essex County from the ACS for 2012–2016 five-year estimates of total population to get the block group IDs.) There were 671 block groups identified as belonging to Essex County. In R, data from the full EJSCREEN 2018 data set were matched to the Essex County block groups. The final data set used for the Essex County cumulative impacts analysis consisted of 671 block groups and the 17 EJSCREEN indicators for them.

ANALYSIS

Analysis was performed in R for each area of focus (Chicago, Newark, and Essex County). As an illustration, analysis for Chicago was conducted as follows: For each of the 17 indicators, each Chicago block group was assigned a quintile score from 1 to 5, corresponding to its value for that indicator. A score of 1 meant that the block group's value for that indicator fell into the bottom 20 percent of all Chicago block groups; a score of 5 meant that the value for that indicator was in the top 20 percent. For all EJSCREEN indicators, higher scores correspond to higher levels of pollution or socio-demographic vulnerability.

For each block group, we summed the quintile scores for the 11 environmental variables, which gave us a total that theoretically could range from 11 to 55.[160] Next we determined where each block group score stood in relation to all of the other Chicago block group scores and assigned a new quintile number to each block group. For instance, if a block group's total was in the bottom fifth of all Chicago block groups, it received a score of 1. This was its "environment quintile score."

We repeated the same process for the population variables. For each block group, we summed the quintile scores for the 6 socio-demographic variables, which yielded a total that could theoretically be anywhere from 6 to 30. We then assigned a new quintile score, from 1 to 5, to each block group based on how this total ranked within the totals for all of the other Chicago block groups. This was its "population quintile score."

The last step consisted of adding each block group's environment quintile score and population quintile score to get a final number, ranging from 2 to 10. For example, a block group that was in the highest quintile for both environmental and socio-demographic factors would have a final score of 10 (5+5). For both environmental and socio-demographic indicators, higher values denote greater pollution or vulnerability. Thus, the higher the block group's final score, the greater the cumulative burden. The final scores were joined back to the block groups and mapped in ArcMap.

The same methodology was followed using Newark and Essex County as areas of analysis.

ADDITIONAL DATA SOURCES FOR OVERLAYS SHOWN

- Chicago industrial corridors: shapefile obtained from City of Chicago data portal in May 2018.[161]
- Chicago community areas: shapefile obtained from City of Chicago data portal in March 2019.[162]
- Chicago waterways—shapefile obtained from City of Chicago data portal in March 2019.[163]
- Ironbound community boundary: created from manual selection of block groups, based on Google map of Ironbound community.
- Chicago public schools: addresses downloaded from Chicago Public Schools website in March 2019 (file appeared to have been last updated in October 2018).[164]
- Chicago senior-only housing and senior centers:
  - For senior centers, a list, dated March 7, 2019, was obtained from the City of Chicago data portal in March 2019.[165]
  - For senior-specific public housing, in March 2019 we accessed the Chicago Public Housing Authority's list of public housing and used its search engine to search for senior-specific housing.[166] (For the purpose of creating this layer for the maps shown, we included only the two senior public housing facilities located in the Southeast Side and South Lawndale.)
  - For other senior housing, in March 2019 we accessed the City of Chicago's Family & Support Services web page.[167] A list of assisted living, supportive living, and nursing homes was assembled. By definition, supportive living facilities house only older individuals, so these were all included. For assisted living and nursing homes, we called facilities to determine which ones were limited to seniors and included only the ones that were.
- Chicago early-learning programs (ELPs): addresses downloaded from the City of Chicago data portal in March 2018 (we checked in March 2019 to noted that there was no more recent version of the spreadsheet, which was dated December 2017).[168] These appear to be city-funded ELPs.
- Chicago child outdoor recreation sites: shapefile obtained from City of Chicago data portal in March 2019.[169] (This file was dated November 2016, last updated in May 2017.) We considered features described as playground parks, playgrounds, spray features, junior baseball/softball, and outdoor pools as child outdoor recreation sites.

- Chicago licensed day care facilities: addresses obtained through a search performed in March 2019 on the Illinois Department of Children & Family Services website.[170] A search for "Chicago" as city and "City of Chicago" as county generated 2,549 day care facilities.
- South Lawndale, Chicago, and surrounding community areas' transportation, distribution, and logistics (TDL) sites: sites obtained from the Little Village Environmental Justice Organization's data sets.
- Newark public schools: list obtained from Newark Public Schools website in February 2020.[171]
- Newark licensed child care centers: list obtained from the New Jersey Office of Information Technology's Open Data Center in April 2019.[172]
- Newark senior centers: addresses obtained from a senior resources web page and from the City of Newark's Division of Senior Services' list of senior centers in February 2019.[173]
- Newark health facilities: list of health facilities compiled from conducting Google searches, consulting community partners, and looking at city resources, including the City of Newark Department of Health and Community Wellness and Newark Community Health Centers, throughout 2018.[174]
- Newark detention facilities: list of detention facilities compiled from Google searches and from state and county websites, including the New Jersey Department of Corrections, throughout 2018.[175]
- Newark Housing Authority public housing: spreadsheet of all affordable housing for Essex County, dated 2015, downloaded from the New Jersey Department of Community Affairs website in June 2018.[176] We selected records corresponding to public housing under the Newark Housing Authority. Distinction between senior-specific and general public housing was made on the basis of a variable in the spreadsheet called "type" with values "family" and "age."

All spatial data files were imported into ArcMap and projected into the corresponding projected coordinate system. All locations/addresses were geocoded in ArcMap using the ArcGIS World Geocoding Service.

ENDNOTES

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125 Sara Grineski et al., "Children's Asthma Hospitalizations and Relative Risk Due to Nitrogen Dioxide (NO_2): Effect Modification by Race, Ethnicity, and Insurance Status," *Environmental Research* 110, no. 2 (February 2010): 178–88, https://doi.org/10.1016/j.envres.2009.10.012. Joyce Chang et al., "Repeated Respiratory Hospital Encounters Among Children With Asthma and Residential Proximity to Traffic," *Occupational and Environmental Medicine* 66, no. 2 (January 2009): 90–98, https://doi.org/10.1136/oem.2008.039412. Qi Zhang, Rajan Lamichhane, and Leigh Ann Diggs, "Disparities in Emergency Department Visits in American Children With Asthma: 2006–2010," *Journal of Asthma* 54, no. 7 (September 2017): 679–86, https://doi.org/10.1080/02770903.2016.1263315. Kohei Hasegawa et al., "Association of Insurance Status and Severity and Management in ED Patients With Asthma Exacerbation," *Western Journal of Emergency Medicine* 17, no. 1 (January 2016): 22–27, https://doi.org/10.5811/westjem.2015.11.28715. Gennaro D'Amato et al., "Asthma-Related Deaths," *Multidisciplinary Respiratory Medicine* 11, no. 1 (December 2016): 37, https://doi.org/10.1186/s40248-016-0073-0.

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127 James Sadd et al., "Playing It Safe: Assessing Cumulative Impact and Social Vulnerability Through an Environmental Justice Screening Method in the South Coast Air Basin, California," *International Journal of Environmental Research and Public Health* 8, no. 5 (May 2011): 1441–59, https://doi.org/10.3390/ijerph8051441. George Alexeeff et al., "A Screening Method for Assessing Cumulative Impacts," *International Journal of Environmental Research and Public Health* 9, no. 2 (February 2012): 648–59, https://doi.org/10.3390/ijerph9020648. Amy Schulz et al., "Race and the Distribution of Social and Physical Environmental Risk: A Case Example From the Detroit Metropolitan Area," *Du Bois Review: Social Science Research on Race* 13, no. 2 (October 2016): 285–304, https://doi.org/10.1017/S1742058X16000163.

128 The Environmental Justice Screening Method (EJSM) was developed by a group of California-based researchers who have been at the forefront of advancing cumulative impacts analysis. In the process, the researchers received extensive input not only from the state's agency scientists and other scientific colleagues, but also from community stakeholders working on environmental health and environmental justice. As a result, EJSM is a scientifically sound tool capable of providing regulatory guidance while also being transparent and easily understandable to diverse audiences. These qualities motivated us to choose the EJSM as a basis for our method over alternative, more complex methodologies. Sadd et al., "Playing It Safe: Assessing Cumulative Impact."

129 It is important to note that cumulative impacts analysis is different from typical scientific measurements, which yield specific estimates and measures of uncertainty, because here the "measurements" are relative and the uncertainty is not explicit. There is, of course, uncertainty in the underlying environmental and demographic indicators that we use. Our analysis is only as reliable as the data provided through EJSCREEN, and there are limitations to EJSCREEN, as described earlier. Despite these limitations, our cumulative impacts analysis provides a general sense of the relative burden experienced across city areas. Results should always be supplemented with additional research and local knowledge.

130 American Public Health Association, *Policy Statement on "Advancing Environmental Justice*."

131 City of Chicago, Department of Planning and Development, "Industrial Corridor Modernization Initiative," updated May 14, 2020, https://www.chicago.gov/city/en/depts/dcd/supp_info/repositioning-chicago-s-industrial-corridors-for-today-s-economy.html.

132 City of Chicago, Department of Planning and Development and Department of Transportation, *Mayor Emanuel's Industrial Corridor Modernization: North Branch Framework*, May 2017, https://www.chicago.gov/content/dam/city/depts/dcd/supp_info/industrial/NBIC_Adopted_Final_For-Web.pdf. Municipal Code of Chicago, § 16-8-020.

133 *Minority* is the term used by EJSCREEN to indicate the portion of the population that is nonwhite. We are not endorsing this terminology, but we do utilize it here to make it clear which EJSCREEN indicator we are referencing.

134 For a description and case study of how the dominant paradigm of "expert" data production and evidentiary requirements reinforces environmental racism and denies recourse to EJ communities, see Lauren Richter, "Constructing Insignificance: Critical Race Perspectives on Institutional Failure in Environmental Justice Communities," *Environmental Sociology* 4, no. 1 (January 2018): 107–21, https://doi.org/10.1080/23251042.2017.1410988. As described by Richter, this problem is particularly serious in the context of cumulative exposures and renders the harm caused by these exposures "scientifically and legally invisible."

135 Nikhil Prachand et al., *Healthy Chicago 2025 Data Compendium*, City of Chicago, Department of Public Health, October 2019, https://www.chicago.gov/content/dam/city/depts/cdph/CDPH/Healthy_Chicago_2025_Data-Compendium_10222019.pdf.

136 City of Chicago, *Air Quality and Health Report*, 2020, https://www.chicago.gov/content/dam/city/depts/cdph/statistics_and_reports/Air_Quality_Health_doc_FINALv4.pdf.

137 Ana Baptista, *Local Policies for Environmental Justice: A National Scan*, Tishman Environment and Design Center, February 2019, https://www.nrdc.org/sites/default/files/local-policies-environmental-justice-national-scan-tishman-201902.pdf.

138 City of Newark, New Jersey, "Environmental Justice and Cumulative Impact Ordinance," no. 16-0803, July 2016, https://www.njeja.org/wp-content/uploads/2019/10/Newark_EJ_CumulativeImpacts_ordinance.pdf.

139 Ibid.

140 U.S. Census Bureau, "QuickFacts: Newark City, New Jersey; United States," https://www.census.gov/quickfacts/fact/table/newarkcitynewjersey,US/PST045219 (accessed September 30, 2020).

141 Union of Concerned Scientists, "Cars, Trucks, Buses and Air Pollution," July 2008, updated July 2018, https://www.ucsusa.org/resources/cars-trucks-buses-and-air-pollution. U.S. Department of Transportation, Bureau of Transportation Statistics, "Estimated US Average Vehicle Emissions Rates per Vehicle by Vehicle Type Using Gasoline and Diesel," https://www.bts.gov/content/estimated-national-average-vehicle-emissions-rates-vehicle-vehicle-type-using-gasoline-and (accessed July 1, 2020).

142 A 2019 national landscape assessment commissioned by NRDC, LVEJO, SETF, and SSCBP and conducted by EJ expert and New School professor Ana Baptista describes several of these reforms. The policies, used to address cumulative impacts and environmental justice more broadly, are classified under six categories: (1) bans on specific types of polluting facilities, (2) general EJ policies, (3) targeting existing land uses, (4) proactive planning, (5) public health codes/policies, and (6) review processes. Baptista, *Local Policies for Environmental Justice.*

143 Nicky Sheats et al., "Cumulative Impacts and the Permitting Process," memorandum of the New Jersey Environmental Justice Alliance Cumulative Impacts Committee, June 2013, https://njeja.org/wp-content/uploads/2021/08/NJEJA-Statewide-Cumulative-Impacts-Policy_2019.pdf. New Jersey Environmental Justice Alliance, "Statewide Policy Platform: 2017–2018," 2018, http://www.njeja.org/wp-content/uploads/2018/02/NJEJA-Policy-Platform-Final.pdf.

144 The final text of the signed law is available at https://www.njleg.state.nj.us/2020/Bills/S0500/232_R2.htm (accessed October 9, 2020). See also New Jersey State Senate, "Committee Statement on the 'Environmental Justice and Cumulative Impacts Bill' (S232) Submitted to the 219th Legislature," June 25, 2020, https://www.njleg.state.nj.us/2020/Bills/S0500/232_S2.PDF. Clean Water Action, "NJ Assembly and Senate Just Passed National Precedent Setting Environmental Justice Bill This Afternoon," August 27, 2020, https://cleanwateraction.org/releases/nj-assembly-and-senate-just-passed-national-precedent-setting-environmental-justice-bill.

145 A detailed analysis of these policies, including their differences, is beyond the scope of this brief but will be covered in a forthcoming publication by Nicky Sheats et al.

146 Clean Water Action, "New Jersey Sets National Precedent With Environmental Justice Bill Signing Today," September 18, 2020, https://www.cleanwateraction.org/releases/new-jersey-sets-national-precedent-environmental-justice-bill-signing-today.

147 Environmental Justice Initiative of Chair Raúl M. Grijalva and Representative A. Donald McEachin, "Discussion Draft of 'Environmental Justice for All Act,'" February 26, 2020, https://www.popvox.com/madison/documents/environmental-justice-for-all-act. Office of U.S. Senator Cory Booker, "Booker Reintroduces Sweeping Environmental Justice Bill," July 24, 2019, https://www.booker.senate.gov/news/press/booker-reintroduces-sweeping-environmental-justice-bill.

148 On these additional methods for studying cumulative impacts, see Solomon et al., "Cumulative Environmental Impacts."

149 Baptista, *Local Policies for Environmental Justice.*

150 Ibid.

151 Ibid.

152 Note that these socio-demographic thresholds were negotiated between policymakers and advocates and chosen specifically for the New Jersey context; these thresholds may not be the most appropriate for other states seeking to implement a similar policy. Note also that as of the writing of this document, there is variation in the usage of the terms *overburdened community* and *environmental justice community* for purposes of policy. The New Jersey law refers to low-income communities and communities of color as "overburdened communities," whereas elsewhere (such as in the memorandum by the NJEJA Cumulative Impacts Committee cited above), these communities are called "environmental justice communities."

153 James Sadd et al., "Playing It Safe: Assessing Cumulative Impact and Social Vulnerability Through an Environmental Justice Screening Method in the South Coast Air Basin, California," *International Journal of Environmental Research and Public Health* 8, no. 5 (May 2011): 1441–59, https://doi.org/10.3390/ijerph8051441.

154 The environmental variables are: air toxics cancer risk, air toxics respiratory hazard, ozone, diesel particulate matter (PM), fine particulate matter ($PM_{2.5}$), traffic, potential lead paint exposure, proximity to Superfund sites, proximity to hazardous waste management facilities, proximity to facilities with potential chemical accidents, and toxic releases into waterways. The population indicators are the percentages of the population with the following characteristics: household income less than twice the poverty level, minority status, less than a high school education, linguistic isolation, under age 5, and over age 64.

155 U.S. Environmental Protection Agency (hereinafter EPA), "EJSCREEN: Environmental Justice Screening and Mapping Tool: Understanding EJSCREEN Results," https://www.epa.gov/ejscreen/understanding-ejscreen-results (accessed August 11, 2020).

156 EPA, "EJSCREEN: Environmental Justice Screening and Mapping Tool," https://www.epa.gov/ejscreen (accessed August 11, 2020).

157 U.S. Census Bureau, "TIGER/Line Shapefiles," https://www.census.gov/cgi-bin/geo/shapefiles/index.php (accessed August 11, 2020).

158 City of Chicago, "Data Portal," https://data.cityofchicago.org/ (accessed August 11, 2020).

159 City of Newark, "Open Data Portal," http://data.ci.newark.nj.us/ (accessed August 11, 2020).

160 An issue that arose here for a couple of the variables was that more than 20 percent of the block groups had the same maximum or minimum value. When this happened, we assigned all the block groups with the minimum (or maximum) value a score of 1 (or 5), then divided the rest of the block groups into quartiles and assigned them scores of 2, 3, 4, and 5 (or 4, 3, 2, and 1).

161 City of Chicago, "Data Portal."

162 Ibid.

163 Ibid.

164 Chicago Public Schools, "District Data," https://www.cps.edu/about/district-data/ (accessed August 11, 2020).

165 City of Chicago, "Data Portal."

166 Chicago Housing Authority, "Find Public Housing," https://www.thecha.org/residents/public-housing/find-public-housing (accessed August 11, 2020).

167 City of Chicago, "Family & Support Services," https://www.chicago.gov/city/en/depts/fss.html (accessed August 11, 2020).

168 City of Chicago, "Data Portal."

169 Ibid.

170 Illinois Department of Children and Family Services, "Day Care Provider Lookup," https://sunshine.dcfs.illinois.gov/Content/Licensing/Daycare/ProviderLookup.aspx (accessed August 11, 2020).

171 Newark Board of Education, "School Directory," https://www.nps.k12.nj.us/schools/ (accessed August 11, 2020).

172 State of New Jersey Office of Information Technology Open Data Center, "Licensed Child Care Center Explorer," https://data.nj.gov/childcare_explorer (accessed August 11, 2020).

173 Senior Center Resources for Seniors, "Senior Centers in Newark NJ," https://seniorcenter.us/senior-centers-city/newark_nj (accessed August 11, 2020). City of Newark, "Senior Services," https://www.newarknj.gov/card/newark-senior-services (accessed August 11, 2020).

174 City of Newark, "Department of Health and Community Wellness," https://www.newarknj.gov/departments/healthcommunitywellness (accessed August 11, 2020).

175 State of New Jersey, "Department of Corrections," https://www.state.nj.us/corrections/pages/index.shtml (accessed August 11, 2020).

176 State of New Jersey, Department of Community Affairs, "List of Affordable Developments by County," https://www.nj.gov/dca/divisions/codes/publications/developments.html (accessed August 11, 2020).