Recent Findings and Methodologies in Economics Research in Environmental Justice

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Abstract

This review synthesizes economics-oriented research in environmental justice with a focus on the last decade. We first categorize this literature into broad areas of inquiry and review main findings. Then, we review recent advances in data and methodologies that have allowed for new study designs and research questions. After identifying breakthroughs, we offer some guidance on how to continue to advance research in this area.

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1 Introduction

This paper is inspired by the recent growth in environmental and urban economics research that documents and quantifies disparate exposures to an array of environmental burdens, explores the mechanisms generating these disparities, and studies government interventions that address and interact with these patterns and mechanisms; or more succinctly, research in environmental justice. Our goal is to synthesize the past decade of economics-oriented research in environmental justice by reviewing papers from the fields of economics, environmental and ecological economics, sociology, public health, and general interest science. We reviewed over 100 papers published in the last decade and synthesize the body of work in two ways. In Section 2, we discuss the types of questions that this work generally seeks to answer. In Section 3, we present the key methodological decision points and debates in the recent work. In Section 4, we highlight on-going discussions and directions for future environmental justice research. While this review focuses on research done by economists or closely related fields, this focus does not reflect a prioritization of disciplines; rather, this paper is intended to be instructive for economics-oriented researchers seeking to contribute to a growing body of research questions in environmental justice.

This is not the first review of environmental justice literature and is very much related to previous reviews, notably by Banzhaf et al. (2019a) and Banzhaf et al. (2019b). This paper's contribution is to cover more recent work published since these reviews, focusing on topics that were not previously emphasized, including advances in methodological approaches and data availability. Agyeman et al. (2016) also review the history of the environmental justice movement, paying particular attention to trends and histories of activism and policy-making in this area. Mohai et al. (2009) review the key trends and methodological debates in environmental justice research at that time. While some of the key debates in Mohai et al. (2009), such as "race versus class" as the locus of the environmental injustice and the "chicken or the egg" problem of polluter siting versus residential sorting continue to be at play in the last decade of research, other debates such as whether the allocation of environmental burdens across communities should be based on "unit-hazard coincidence" (assigning population to hazards based on geographic coincidence defined by administrative boundaries) versus distance to pollution sources have transitioned to discussions of alternative pollution transport and dispersion models.

The political landscape has also evolved in the last decade, with increasing inclusion of environmental justice criteria in environmental policy at federal, state, and local levels. For example, the EPA now includes environmental justice (EJ) criteria in their regulatory impact assessments, federal agencies must consider EJ analyses in their proposed programs and policies via the National Environmental Policy Act, and the federal government now aims to advance environmental justice by delivering at least 40 percent of benefits from federal investments in clean energy and climate in socioeconomically disadvantaged communities with the Justice40 Initiative (Young et al., 2021). Given these trends, we find it a particularly prudent time to take stock of the recent literature and findings in environmental justice from the economics community.

2 Types of research questions addressed

2.1 Document and quantify

Many papers in this literature focus on documenting and quantifying differences in exposure or damages from environmental hazards across different communities. Table 1 includes a list of all 41 papers reviewed in this category, close to half of all reviewed papers. Documenting the exposure gap remains an important contribution for policy-making. When there are constraints on policy making, the relative size of the pollution gap across hazards and settings can inform where policymakers target regulation when working toward equity-related goals. Cost-benefit analyses used in regulatory proceedings also benefit from studies that provide monetary estimates of environmental damages, which many of these papers do.

Documenting a gap requires defining both the environmental outcome of interest and the sub populations for which the gap is measured. Studies that characterize disparities in concentrations and exposure (Colmer and Voorheis, 2020; Currie et al., 2020) calculate the differences in pollution concentrations (weighted or unweighted) across demographic groups. Others characterize disparities in damages by calculating the differences in hospitalizations, mortality, and morbidity by race or income groups (Gillingham and Huang, 2021). While the choice of outcome of interest may be driven by the research question, the set of outcomes studied are constrained by data availability. Section 3 discusses how expansions in measurement and data have expanded this set.

Computing a gap also requires choosing comparison groups. Existing studies have used different definitions depending on the question or institutional details of the setting. For example, Currie et al. (2020) and Gillingham and Huang (2021) compare exposure and health gaps between African American/Black and white populations. Other studies additionally consider other minority groups such as Hispanic/Latino or Asian American (Fowlie et al., 2012; Hausman and Stolper, 2021; Mansur and Sheriff, 2021; Shapiro and Walker, 2021). Other work compares exposure differences between low- and high-income groups or compares groups above and below the federal poverty line (Fowlie et al., 2012; Hausman and Stolper, 2021; Mansur and Sheriff, 2021; Shapiro and Walker, 2021). The choice of comparison groups dictates the types of conclusions these papers can make. For example, these studies have two main findings, (i) that African American/Black, Hispanic/Latino, and Asian American communities experience higher pollution exposure compared to predominantly white communities, and (ii) that low-income groups experience a higher pollution burden than high-income groups.

Studies have also leveraged specific policy or institutional details related to their setting to calculate pollution disparities or analyze the distributional consequences of different policies. Hoffman et al. (2020) and Nardone et al. (2020) compare differences in environmental risk by historical status as a redlined area. Other studies have compared groups depending on institutional definitions of vulnerability, for example using the EPA demographic index (Campa and Muehlenbachs, 2021) or the "disadvantaged community" definition used by the California EPA (Cushing et al., 2018; Hernandez-Cortes and Meng, 2023). The designation of a community as disadvantaged comes from a pollution index developed by the State of California which estimates relative pollution burdens across census tracts in California, the CalEnviroScreen (OEHHA, 2017). The publicly available scores facilitate researchers' ability to compare total pollution burdens across communities. The White House also recently published a similar tool, allowing practitioners to identify census block groups that are particularly polluted (White House, 2022).

Deciding how to make comparisons in this research is not trivial. For example, should one control for income in a comparison of exposures by race? Should groups be based on race, ethnicity, national origin, or linguistic isolation? The EPA's definition of environmental justice offers a helpful perspective:

> *Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. This goal will be achieved when everyone enjoys: The same degree of protection from environmental and health hazards, and equal access to the decision-making process to have a healthy environment in which to live, learn, and work.*

This definition underlines that environmental injustice exists wherever there are gaps in fair treatment and meaningful involvement across all people. Accordingly, well-done comparisons across many different demographic and socioeconomic characteristics can all contribute to our understating of environmental injustice. Though, the researcher needs to be fastidious in interpreting results across models, being cognizant of how seemingly small methodological decisions (e.g. conditioning on certain demographic characteristics or not) change the interpretation of their results.

Table 1: Environmental Justice Papers by Contribution Type

Contribution	**Papers**	**Count**
Document and Quantify	Abel and White (2011); Aizer et al. (2018); Aizer and Currie (2019); Ard (2015); Bento, Freedman, and Lang (2015); Bouvier (2014); Boyce, Zwickl, and Ash (2016); Clark, Millet, and Marshall (2014, 2017); Collins, Munoz, and JaJa (2016); Colmer et al. (2020); Currie et al. (2013); Currie, Greenstone, and Meckel (2017); Currie, Voorheis, and Walker (2020); De Silva (2016); Deryugina et al. (2019); Downey and Hawkins (2008); Fann et al. (2011); Gamper-Rabindran and Timmins (2011); Gillingham and Huang (2021); Hernandez-Cortes and Meng (2023); Hernandez-Cortes, Meng, and Weber (2023); Hipp and Lakon (2010); Ho (2022); Holland et al. (2019); Hsu et al. (2021); Isen, Rossin-Slater, and Walker (2017); Kravitz-Wirtz, Crowder, Hajat, and Sass (2016); Mikati et al. (2018); Morello-Frosch, Pastor, and Sadd (2001); Nardone et al. (2020); Pais, Crowder, and Downey (2014); Paolella et al. (2018); Prochaska et al. (2014); Sager and Singer (2022); Shadbegian and Gray (2012); Tessum et al. (2021); Voorheis (2017c); Walch (2020); X. Wang et al. (2021); Wolverton (2009)	41
Mechanisms	Abel and White (2015); Aizer and Currie (2019); Benatiya Andaloussi and Isaksen (2017); Anderson, Plantinga, and Wibbenmeyer (2020); Bakkensen and Ma (2020); Banzhaf, Ma, and Timmins (2019a); Christensen and Timmins (2022); Christensen, Sarmiento-Barbieri, and Timmins (2020); Collins, Munoz, and JaJa (2016); Currie et al. (2015); Cushing et al. (2015, 2018); Dauwalter and Harris (2021); Davis and Hausman (2021); De Silva (2016); Downey and Hawkins (2008); Fowlie, Holland, and Mansur (2012); Fowlie, Walker, and Wooley (2020); Gamper-Rabindran and Timmins (2011); Grainger (2012); Hausman and Stolper (2021); Heblich, Trew, and Zylberberg (2021); Hernandez-Cortes, Meng, and Weber (2023); Hoffman, Shandas, and Pendleton (2020); Keenan, Hill, and Gumber (2018); Konisky, Reenock, and Conley (2021); Melstrom and Mohammadi (2022); Morehouse and Rubin (2021); Nardone et al. (2020); Pais, Crowder, and Downey (2014); Shadbegian and Gray (2012); Shapiro and Walker (2021); Timmins and Vissing (2022); Voorheis (2017a,b); Walch (2020); W. Wang (2021); X. Wang et al. (2021); Wolverton (2009)	39

Welfare Impacts	Anthoff and Tol (2010); Bakkensen and Ma (2020); Bayer et al. (2016); Bouvier (2014); Campa and Muehlenbachs (2021); Colmer and Voorheis (2020); Cropper, Krupnick, and Raich (2016); Currie and Walker (2019); Currie et al. (2015); Depro, Timmins, and O'Neil (2015); Goulder et al. (2019); Grainger (2012); Haninger, Ma, and Timmins (2017); Hausman and Stolper (2021); Heblich, Trew, and Zylberberg (2021); Hsiang, Oliva, and Walker (2019); Maguire and Sheriff (2011); Mansur and Sheriff (2021); Melstrom and Mohammadi (2022); Sheriff and Maguire (2020); Timmins and Vissing (2022); Voorheis (2016); W. Wang (2021)	23
Government Intervention	Adams and Charnley (2018); Benatiya Andaloussi and Isaksen (2017); Bento, Freedman, and Lang (2015); Bin, Bishop, and Kousky (2017); Campa and Muehlenbachs (2021); Currie and Walker (2019); Cushing et al. (2018); Fowlie, Holland, and Mansur (2012); Fowlie, Walker, and Wooley (2020); Gamper-Rabindran and Timmins (2011); Grainger and Ruangmas (2018); Haninger, Ma, and Timmins (2017); Hernandez-Cortes and Meng (2023); Konisky, Reenock, and Conley (2021); Levy, Wilson, and Zwack (2007)	15
Climate Justice	Anderson, Plantinga, and Wibbenmeyer (2020); Auffhammer (2021); Bin, Bishop, and Kousky (2017); Borenstein and Bushnell (2022); Borenstein, Fowlie, and Sallee (2022); Dauwalter and Harris (2021); Davis and Hausman (2021); Deshmukh, Weber, Deschenes, Hernandez-Cortes, Kordell, Lee, Malloy, Mangin, Meng, Sum, et al. (2023b,a); Doremus, Jacqz, and Johnston (2022); Goulder et al. (2019); Hardy and Hauer (2018); Hoffman, Shandas, and Pendleton (2020); Holland et al. (2019); Hsu et al. (2021); Keenan, Hill, and Gumber (2018); Perry et al. (2022); Pizer and Sexton (2019)	18

Frontier Methods or Data	Adams and Charnley (2018); Anthoff and Tol (2010); Ard (2015); Baker et al. (2020); Bayer et al. (2016); Boyce, Zwickl, and Ash (2016); Christensen and Timmins (2022); Christensen, Sarmiento-Barbieri, and Timmins (2020); Colmer and Voorheis (2020); Colmer et al. (2020); Cropper, Krupnick, and Raich (2016); Currie, Voorheis, and Walker (2020); Depro, Timmins, and O'Neil (2015); Deryugina et al. (2019); Fann et al. (2011); Grainger and Ruangmas (2018); Hsiang, Oliva, and Walker (2019); Leelőssy et al. (2014); Levy et al. (2009); Mansur and Sheriff (2021); Paolella et al. (2018); Sadd et al. (2011); Sheriff and Maguire (2020); Su et al. (2009); Tessum et al. (2021); Voorheis (2016, 2017a,b)	28
Meta-analysis or Review	Agyeman et al. (2016); Baker et al. (2020); Banzhaf, Ma, and Timmins (2019a,b); Cushing et al. (2015); Maguire and Sheriff (2011); Pizer and Sexton (2019)	7

Notes: Categories are not mutually exclusive and reviewed papers are allowed up to two categorizations. Many papers can be seen as contributing to more than two categories, and selected categories represent the review authors' judgement of the two key contribution types. Papers in the Document and Quantify category document and/or study a disparity in an environmental related (dis)amenity, irrespective of findings and does not include disparities in prices or expenditures. Papers in the Government Intervention category take a broad stance on what constitutes a government intervention and include government policies and programs. The Welfare Impacts category includes papers that study or estimate willingness to pay and environmental justice related impacts to individual and/or social welfare.

2.2 Mechanisms

Making predictions is a key weakness in studies that only quantify the pollution exposure gap. And understanding the mechanisms that contribute to environmental injustice is necessary to move beyond program evaluation. Banzhaf, Ma, and Timmins (2019b) outline four general mechanisms, all of which also appear in Mohai, Pellow, and Roberts (2009)'s review. These mechanisms include: residential sorting, firm sorting, discriminatory policy and/or enforcement, and coordination between firm and household sorting. The mechanisms studied over the last decade follow a similar categorization. We list papers studying residential sorting and firm sorting in rows one and two of Table 2. We group papers studying discriminatory politics and enforcement as relating to procedural justice, listed in row three of Table 2. We add a fourth category of papers studying markets and market-based policy in row four. Individual welfare impacts are discussed in this section, though since papers in this area span multiple categories, they are listed in Table 1.

2.2.1 Residential sorting

Economic intuition tells us that households make residential location decisions by trading off their preference for better amenities with costly housing. Yet, formulating environmental injustice as the equilibrium result of standard economic models of residential sorting can greatly obscure the mechanisms generating the injustice, with recent empirical work demonstrating the ill-suitability of several of the standard assumptions included in these models. For example, a standard sorting model would ignore pure discrimination in the housing search process, and the results of Christensen and Timmins (2022) demonstrate the bias introduced by such an assumption. The authors combine a large-scale experiment in renters' housing search with a structural sorting model and identify race-based discrimination in rental housing markets, demonstrating that sorting models that exclude this form of discrimination would otherwise yield significantly biased estimates of willingness to pay. Christensen, Sarmiento-Barbieri, and Timmins (2020) find that renters with African American and Hispanic/Latino names are less likely than renters with white names to receive responses to rental inquiries for properties in low-exposure locations.

Several methodological developments over the last decade have improved the ability of sorting models to provide insights on environmental justice-related research questions. Bishop and Murphy (2011) and Bayer, McMillan, Murphy, and Timmins (2016) demonstrate the potential bias that occurs from ignoring the dynamic components of the sorting decision. Bishop and Murphy (2011) develop a simplified dynamic estimator to estimate willingness to pay to avoid violent crimes, finding that a myopic model underestimates willingness to pay. Bayer, McMillan, Murphy, and Timmins (2016) develop a dynamic structural model of neighborhood choice and apply it to estimate willingness to pay for environmental amenities for forward looking agents, finding that a static model underestimates willingness to pay to avoid pollution and crime, with the size of the bias varying by income level. Hausman and Stolper (2021) study the role of known and unknown information in the sorting decision, and show that sorting-induced environmental injustices are amplified when unobserved disamenities are correlated with observed disamenities. Complicating the role of information on EJ outcomes, X. Wang et al. (2021) find indirect evidence that information-based interventions in the form of disclosures can aggravate equity outcomes due to differential community effort. Depro, Timmins, and O'Neil (2015) study the contribution of household mobility to the pollution disparities, estimating differences in willingness to pay for clean air across race groups, and demonstrating how residential mobility contributes to differences in environmental health risks, which may work against policies intended to address environmental injustice. Gamper-Rabindran and Timmins (2011) find evidence of a related unintended consequence of an environmental clean-up, where the remediation of Superfund sites benefits the rich households that migrate to the cleaned-up areas rather than the households that were originally exposed to the contamination. Heblich, Trew, and Zylberberg (2021) study path dependence and persistence in pollution and neighborhood effects, finding that temporary industrial and coal pollution has long run implications on pollution and segregation, explaining up to 20 percent of neighborhood sorting 40 years later. Bakkensen and Ma (2020) use a boundary of discontinuity design to study sorting and flood risk, finding evidence that low-income minority residents are more likely to move to high-risk flood zones.

Advances in data access have allowed researchers to study longer term disparities in exposure across location decisions. Voorheis (2017a) uses new longitudinal data to study environmental gentrification, where amenity improvements induce cost of living price increases leading disadvantaged individuals to sort out newly improved regions, and finds that longer term environmental gentrification leads socioeconomically advantaged individuals in the sample to experience larger pollution exposure reductions than initially disadvantaged individuals. Pais, Crowder, and Downey (2014) study exposure and residential location over two decades, finding exposure differences are only partially explained by racial differences in suburban neighborhood attainment, socioeconomic status, and the frequency of inter-neighborhood moves.

Many of the sorting models in empirical work include amenities that are additively separable in the utility function, ignoring any potential cumulative impacts of pollution that may magnify exposures and vulnerabilities to environmental hazards. These effects have been studied in environmental and health-oriented research, including calculating population risk measures of cumulative pollution (Morello-Frosch, Pastor, and Sadd, 2001) and generating vulnerability indices that account for exposure to multiple sources of pollution and other risks (Su et al., 2009; Sadd et al., 2011). Hsiang, Oliva, and Walker (2019) discuss a related dimension, the differences between exposure and vulnerability, highlighting that differences in location-based exposure predicted by sorting models may tell an incomplete story of environmental justice due to differences in vulnerabilities to the environmental hazards across race and socioeconomic demographics. Future economics research in this area would do well to consider the non-additive and potentially interactive effects of environmental disamenities, as well as the differences and connections between exposure and vulnerabilities and their unique contributions to environmental injustice.

2.2.2 Welfare impacts

The aforementioned literature highlights that at least some component of choosing where to live involves trading off housing prices for amenities. If households are compensated for disamenities, then what are the welfare impacts of environmental injustice? Answering this question requires unbiased estimates of individuals' willingness to pay for environmental amenities, which is done in W. Wang (2021), Bento, Freedman, and Lang (2015), Cropper, Krupnick, and Raich (2016), and Depro, Timmins, and O'Neil (2015), and discussions of the connection between environmental inequalities and individual or social welfare are found in almost one fourth of the surveyed papers. Yet, many of the existing methodological approaches are unable to separately identify willingness to pay net of all other potential discriminatory forces impacting the household sorting decision. Further, Greenstone and Jack (2015) discuss four possible reasons why estimates of marginal willingness to pay among low-income individuals are seemingly low. Future research and continued innovation in modeling residential location decisions is needed to better connect environmental justice to individual welfare. We list the subset of papers in our review that discuss individual welfare impacts and/or estimation willingness to pay in Table 1.

2.2.3 Firm sorting

Other work studies how firm location decisions impact the distribution of environmental hazards. Morehouse and Rubin (2021) find that power plants strategically locate near borders, so that pollution disperses downwind of the local or state authority. Wolverton (2009) reviews the role of timing in the firm siting decisions – the difference in matching firms to communities at the time of making the location decision, versus the demographics of communities once located. While focusing on the latter informs which communities are expected to see pollution from firms, the former approach is more instructive for understanding how polluting firms decide where to locate (Abel and White, 2015; Collins, Munoz, and JaJa, 2016; Currie et al., 2015; De Silva, 2016; Mikati et al., 2018; Timmins and Vissing, 2022; W. Wang, 2021; X. Wang et al., 2021; Wolverton, 2009). Additionally, there are potential interactions between firm sorting and residential sorting. Heblich, Trew, and Zylberberg (2021) show that historical pollution and residential sorting with respect to firm locations can explain current segregation patterns. Ho (2022) studies the location of solid waste disposal, finding that NIMBY-motivated bans on waste disposal could lead to substitution of waste from facilities near white residents to facilities near Hispanic residents.

2.2.4 Procedural justice

As the EPA definition above discusses, environmental justice is not solely about fair treatment, but also meaningful involvement, which has been studied recently through the lens of procedural justice and makes up a small share of the work in our review. Procedural justice concerns the fairness of the processes that resolve disputes and allocation resources (Department of Justice, 2022). Bell and Carrick (2018) highlight that the decisions that change the environment are usually made by people who enjoy the benefits of the decisions rather than the burdens. Hamilton (1993) shows that communities that are better able to organize politically are less likely to see local firms expand hazardous waste processing. Gray and Shadbegian (2004) and Shadbegian and Gray (2012) study the determinants of regulatory stringency in communities near pollution facilities and find that collective action is an important determinant of stringency. Timmins and Vissing (2022) study outcomes from leases signed between shale operators and households in Texas, finding that race and English-speaking are correlated with lease terms and royalty compensation. Campa and Muehlenbachs (2021) study outcomes when companies negotiate with local communities as to whether to pay a monetary fine for breaking an environmental law or undertake a local environmental project. They find that richer communities are more likely to settle with in-kind transfers and that empirically, fewer in-kind settlements occur than would be optimal in an analogous theoretical model of welfare maximization. Fowlie, Walker, and Wooley (2020) study the connections between climate change policy, local air pollution policy, and environmental justice by evaluating recent legislative experiences, and find that a community driven process to address pollution hotspots is likely to be a “political prerequisite” for policy in EJ and climate, a finding that implicitly highlights the role of procedural justice in shaping historical outcomes.

2.3 Government intervention

Another body of work examines the impact of regulations and policy on disproportionate exposures and damages from environmental hazards. The papers that fall in the category are listed in Table 1.

2.3.1 Market-based

Within this literature, recent attention has been paid to whether market-based policies, such as emissions trading programs and pollution taxes, exacerbate inequities. In a market-based regulation, firms with lower abatement costs will reduce emissions relatively more than firms with higher abatement costs. Thus, households near and downwind of low abatement cost firms are expected to benefit more from the program compared to households living near and downwind of high abatement cost firms. Shapiro and Walker (2021) study offset trading in the Clean Air Act, a program which includes market-based elements but is distinct from cap-and-trade programs, and find little evidence that the location of emissions offset purchases and sales is correlated with larger Black or Hispanic population shares or lower mean income. Fowlie, Holland, and Mansur (2012) investigate the impact of Southern Cal-

Table 2: Papers Studying Mechanisms in Environmental Justice

Mechanism	**Papers**	**Count**
Residential Sorting	Abel and White (2015); Aizer and Currie (2019); Bakkensen and Ma (2020); Bayer et al. (2016); Christensen and Timmins (2022); Christensen, Sarmiento-Barbieri, and Timmins (2020); Depro, Timmins, and O'Neil (2015); Downey and Hawkins (2008); Gamper-Rabindran and Timmins (2011); Grainger (2012); Haninger, Ma, and Timmins (2017); Hausman and Stolper (2021); Heblich, Trew, and Zylberberg (2021); Keenan, Hill, and Gumber (2018); Melstrom and Mohammadi (2022); Pais, Crowder, and Downey (2014); Voorheis (2017b); W. Wang (2021)	18
Firm-Side Sorting	Collins, Munoz, and JaJa (2016); Currie et al. (2015); De Silva (2016); Morehouse and Rubin (2021); X. Wang et al. (2021); Wolverton (2009)	6
Procedural Justice	Adams and Charnley (2018); Campa and Muehlenbachs (2021); Fowlie, Walker, and Wooley (2020); Hoffman, Shandas, and Pendleton (2020); Morello-Frosch, Pastor, and Sadd (2001); Paolella et al. (2018); Sager and Singer (2022)	7
Markets and Market Based Policy	Benatiya Andaloussi and Isaksen (2017); Cushing et al. (2015, 2018); Dauwalter and Harris (2021); Davis and Hausman (2021); Fowlie, Holland, and Mansur (2012); Goulder et al. (2019); Grainger and Ruangmas (2018); Hernandez-Cortes and Meng (2023); Hernandez-Cortes, Meng, and Weber (2023); Mansur and Sheriff (2021); Shapiro and Walker (2021); Simeonova et al. (2019); Timmins and Vissing (2022); Pizer and Sexton (2019); Walch (2020)	16

ifornia's emissions trading program (RECLAIM) for local air pollution, assuming uniform pollution dispersal around point sources, and do not find evidence of disproportionate impact by demographics. Grainger and Ruangmas (2018) replicate the study relaxing the assumption of uniform pollution dispersion and do find evidence that high income areas benefited from emissions trading more than low-income areas, and predominantly Black communities benefited from emissions trading relative to Hispanic communities. The difference in findings highlights the importance of the chosen method of modeling pollution transport, a methodology further discussed in Section 3.

Market-based regulations to address global climate change have recently come under scrutiny, at least in part due to their impacts on co-pollutants emitted alongside greenhouse gases. While these policies regulate greenhouse gas emissions, they also impact the location and quantity of co-pollutants emitted alongside GHGs, which have human health effects for the exposed populations. Hernandez-Cortes and Meng (2023) and Walch (2020) study this question in the context of California's cap-and-trade program, all finding that pollution does not increase in vulnerable communities following the regulation, and Hernandez-Cortes and Meng (2023) find evidence of a gap narrowing. On the other hand, Cushing et al. (2018) study the same program in California and find descriptive evidence of increases in pollution exposure among heavily polluted communities following the program's implementation. Overall, research on emissions trading programs and EJ effects is beginning to establish that the anticipated EJ impacts from these types of policies are a priori ambiguous, depending critically on the empirical setting; namely, the spatial distribution of abatement costs and communities.

2.3.2 Non-market based

Among the literature studying non-market based regulations, an extensive body of work documents the welfare impacts of pollution decreases induced by the 1970 Clean Air Act (CAA) amendments.[1] The CAA amendments of 1970 and 1977 were based on a command and control approach for local air pollutants (Currie and Walker, 2019), requiring that coun-

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[1] These amendments established the maximum level of pollution concentrations of six pollutants: carbon monoxide, nitrogen dioxide, ozone, particulate matter, and sulfur dioxide.

ties that exceed emissions standards create their own air quality improvement plans. The CAA amendments of 1990 established similar standards for toxic emissions. Studies examining the effects of the CAA have found that improvements in air quality due to the CAA amendments caused significant health benefits (Aizer et al., 2018; Aizer and Currie, 2019; Colmer et al., 2020; Isen, Rossin-Slater, and Walker, 2017).

Currie, Voorheis, and Walker (2020) show that pollution concentrations throughout the United States have decreased in the last few decades, with concentrations in predominantly Black neighborhoods decreasing more than those in predominantly white neighborhoods. The authors examine whether the gaps closed due to the implementation of the CAA amendments, specifically, the revised PM2.5 standard in 2006. The authors find that the CAA accounts for over 60 percent of the relative improvement between Black-white pollution concentrations. The authors also find that this decline in the gap cannot be explained by changes in mobility, individual, or neighborhood characteristics, which allows them to attribute the change in the gap to the CAA Act PM2.5 standard. A recent working paper by Sager and Singer (2022) also shows that the 2005 PM2.5 CAA standards contributed to narrowing Urban-Rural and Black-white PM2.5 exposure disparities.

Other non-market based regulations involve the disclosure of information about pollution sources. For example, the information disclosure provided by the Toxic Release Inventory in 1990 provided information on existing pollution sources across communities in the United States. Although toxic emissions fell after the disclosure of the TRI (Wang et al., 2021, Environmental Protection Agency, 2016), studies have found that these reductions are not evenly distributed across communities. In particular, toxic emissions fell more in high-income counties compared to low-income counties (Kalnins and Dowell, 2017) and African American communities experienced a smaller decrease in toxic pollution compared to other communities (Ard, 2015). Releasing information about existing pollution sources might exacerbate pollution exposure depending on how and to what extent these releases re-sort individuals (Banzhaf and Walsh, 2008; Hausman and Stolper, 2021) and/or facilities (De Silva, 2016; Wolverton, 2009). A study by X. Wang et al. (2021) finds that TRI facilities located in communities with higher population density and higher education levels were more likely to relocate to lower income and lower educational attainment communities.

Cleanup programs such as the Brownfield Program and the Superfund Program are other examples of non-market based policies. Superfund sites are high risk areas that pose a significant threat for human and environmental health, while areas designated as Brownfields are currently low-risk areas that have been previously used for industrial or commercial purposes. Haninger, Ma, and Timmins (2017) examine whether the US EPA Brownfield grants program, designed to provide economic support to redevelop Brownfields, had positive impacts on property values. The Brownfields Program cleanups increased property values by 5–11.5 percent; however, the authors find that these impacts were highly localized near these areas. Moreover, Melstrom and Mohammadi (2022) find that Black residents are more likely to be displaced after a Brownfield cleanup, suggesting that the program contributed to environmental gentrification. W. Wang (2021) finds a similar result when looking at environmental improvements following the installment of abatement technologies in gas-fired power plants in Los Angeles following the California Electricity Crisis, finding that environmental improvements can benefit housing owners but have a negative impact on renters.

The EPA's Supplemental Environmental Projects constitutes another non-market based policy, and allows firms to address non-compliance with environmental regulation through environmental and community projects. Campa and Muehlenbachs (2021) find that these in-kind transfers can be beneficial for the violating firms, and that such projects are more likely to occur in communities that are high-income and predominantly white. Another non-market government intervention occurs in the siting and permitting of polluting facilities, and more broadly, land-use planning. Not much has been done in this area since Hamilton (1995), which studied how differences in the probability that residents would engage in collective action to oppose expansions of hazardous waste facilities impacted the locations of these expansions.

Finally, another non-market based approach for the EPA to regulate environmental injustice may come through new and evolving interpretations of the Agency's legal authority under Title VI of the Civil Rights Act of 1964 (Title VI). A recent report by the EPA notes that, as discussed in Executive Order 12898, "existing environmental and civil rights statues [Title VI] provide many opportunities to ensure that all communities live in a safe and healthful environment". The report also highlights that all EPA funding recipients are required to comply with Title VI (U.S. Environmental Protection Agency: Office of General Counsel, 2022). While developments on the legal authority of the EPA in the context of Title VI are on-going, recent updates indicate potential expansions in the EPA's legal tools to address environmental injustice.

2.4 Climate justice

2.4.1 Climate impacts

Recent research increasingly connects environmental injustice to climate induced environmental hazards. Urban "heat islands" have been found to disproportionately affect non-white and lower-income populations (Hsu et al., 2021). Heat-related disparities have also been linked to historical discrimination in housing markets through the practice of redlining. In an analysis of 108 American urban settings, Hoffman, Shandas, and Pendleton (2020) found that "94% of studied areas display consistent city-scale patterns of elevated land surface temperatures in formerly redlined areas", finding that the main associated mechanisms are disparities in canopy coverage, landscape features, and the types of construction in these areas.

Climate related natural disasters such as floods and wildfires have also been shown to disproportionately affect low-income and minority communities. Bakkensen and Ma (2020) find that housing prices lead low income and minority communities to be disproportionately likely to move into high-risk zones in south Florida. Keenan, Hill, and Gumber (2018) use Miami-Dade County, FL as a case study to descriptively study climate gentrification, finding that elevation levels are positively correlated with housing prices. Hardy and Hauer (2018) project sea-level risk in coastal Georgia out to 2050, finding disproportionate sea-level risk increases among women and Hispanic/Latino populations. There is also documented evidence of differential adaptive capacity and mitigation responses. Bin, Bishop, and Kousky (2017) find that while payouts in the National Flood Insurance Program tend to be progressive, both coverage and net premiums divided by coverage, are regressive. Anderson, Plantinga, and Wibbenmeyer (2020) show that fire control agencies increase the use of preventive measures in communities with higher income, more education, and a higher share of white population.

2.4.2 Climate policy costs and incidence

More recent policy discussions around the equity impacts of decarbonization policies have invigorated the debate around how regulating GHGs will impact equity outcomes. Existing studies show that increases in electricity bills associated with the energy transition to a decarbonized economy are likely to affect low-income groups. Pizer and Sexton (2019) provide an extensive summary of the existing evidence on the distributional impacts of energy taxes and discuss the main findings. They find that energy taxes tend to be regressive and much of the regressivity is driven by electricity consumption, given that households in the United States in the lowest decile spend a higher share of income on electricity than wealthier households. Other studies have found that these taxes are not necessarily regressive, as the distributional impacts also depend on the redistribution of the revenue generated by these policies (Chen, Goulder, and Hafstead, 2018). Doremus, Jacqz, and Johnston (2022) find that energy expenditures for low-income consumers are about half as responsive to extreme temperatures as all other households, indicating disparities in climate adaptation options available across income.

A report (Borenstein, Fowlie, and Sallee, 2022) on electricity rates in CA finds that half to two-thirds of electricity costs in the state are essentially a tax covering activities outside of the costs of supplying electricity (including climate mitigation and adaptation related activities), and these costs are distributed inequitably since electricity bills account for a larger share of income for low-income households. Other work finds that an increase in electrification and substitution from fossil fuels such as natural gas might affect low-income and minority consumers more due to the structure of capital cost recovery (Davis and Hausman, 2021). Dauwalter and Harris (2021) show that there are heterogeneous environmental benefits from rooftop solar installation, that these environmental benefits increase with income, and that minority households receive higher environmental benefits per capita.

Holland et al. (2016) study the environmental benefits of electric vehicles, including not only the climate related benefits, but the also the air quality costs from the electricity produced to fuel electric vehicles. They find highly heterogeneous environmental benefits to subsidizing electric vehicles across space, and Holland et al. (2020) find that electric vehicles only recently switched from being cleaner than the average gas powered vehicle, over the period 2010 to 2017. Holland et al. (2019) study the distributional consequences of electric vehicle adoption and find that on average (without census region fixed effects), Asian and Hispanic residents receive positive environmental benefits from electric vehicles, while white and Black residents see environmental costs. These findings underline that the future impacts from increasing electrification of the transportation sector are likely to be highly heterogeneous across space, and thus may come with mixed implications for environmental justice.

3 Study design and methodological considerations

The work reviewed in the previous section includes an array of methodological decisions at various stages, from formulating the study question to calculating the outcomes of interest. The differences in study designs and approaches prevent a quantitative meta-analysis of pollution inequities, but perhaps more importantly, highlight a need to carefully consider how and why these decisions are made. In many cases, decisions stem from data and methodological constraints. Recent advances in both dimensions provide an opportunity to relax some of these constraints. Below we discuss several methodological areas in which the research over the last decade has advanced: modeling of pollution transport, use of new data sources from satellites and crowd-sourced pollution monitors, and use of new administrative data sets to study long-run trends in exposure.

3.1 Pollution transport

Early literature in this field assigned pollution to people using the "unit-hazard coincidence" approach. This approach involves selecting predefined geographic units, determining which units contain environmental hazards, and comparing demographics of geographic units with and without those hazards. A key weakness of this approach is that it assigns environmental burdens equally to all people within the same unit, regardless of the size of the unit, people's distance to the hazard, transport of the hazard, and varying population vulnerabilities and defensive behaviors and investments. In 2006 Mohai and Saha describe unit-hazard coincidence as the "classic" and "most widely used" approach for assessing environmental disparities at the time. A related issue concerns to the "ecological fallacy", whereby an individual unit might have a different exposure than the assigned exposure after aggregating these units to some spatial scale. Banzhaf, Ma, and Timmins (2019a) discuss how the ecological fallacy creates bias when assigning individuals to hazards using grouped data.

Since then, increasingly sophisticated methods have been developed to model the transport of air pollutants, allowing for the assignment of people to air quality at finer spatial levels. Some new models embed the physical and chemical properties of pollutants into the transport models, though with different methodologies and assumptions. For example, dispersion models based on planetary boundary layers include Gaussian dispersion models such as AERMOD or ADMS, or Lagrangian dispersion models such as HYSPLIT or HyAD. Other pollution transport models consider the primary release of pollutants along with secondary chemical atmospheric reactions, examples of these models are WRF-Chem and GEOS-Chem. Models like AERMOD or HYSPLIT can be less computationally intensive than WRF/GEOS-Chem, though WRF/GEOS-chem model chemical reactions that are important for the formation of secondary PM2.5.

Reduced Complexity Models for air pollution modeling have surged in popularity, as they avoid the computational burdens required for full chemical transport models discussed above. Examples of these reduced complexity models are EASIUR, AP3 and InMAP (Gilmore et al., 2019). These models calculate total PM2.5 from precursors pollutants including primary $PM_{2.5}$, NO_x, SO_x, and NH_3, at different resolutions: EIASUR at a 36km × 36km pixel, AP3 at the county level, and InMAP at a varying grid of 1km × 1km in urban areas and 48km × 48km in rural areas). These models have improved researchers' overall access to more sophisticated pollution transport model though caveats and inconsistencies of the RCMs exist and have been documented (see Gilmore et al., 2019).

3.2 Satellite data

Recent advances in satellite data availability have also allowed for research at finer spatial scales and various time resolutions. Most of these satellite products measure Aerosol Optical Depth, which measures aerosol optical thickness based on how the atmosphere reflects the visible and infrared light. Di et al. (2016) use MODIS AOD data together with a neural network to predict daily PM2.5 concentrations in the United States at a 1km x 1km grid cell level resolution. Di et al. (2019) use machine learning algorithms such as random forests, gradient boosting and neural networks to estimate PM2.5 levels at a 1km x 1km resolution across the United States. Hammer et al. (2020) use a combination of satellite remote-sensing data with chemical transport modeling and geographically weighted regression to predict annual PM2.5 concentrations at a 1km x 1km resolution.

These satellite products have been validated using monitoring stations data; however, they can also underestimate total PM2.5 concentrations in some areas (Fowlie, Rubin, and Walker, 2019). One potential problem with these pollution products is that the construction and training of the data is based on the location and data availability of the existing pollution monitoring networks, which has been found to be endogenous to sociodemographics (Grainger and Schreiber, 2019; Mu, Rubin, and Zou, 2021; Zou, 2021). For example, Grainger and Schreiber (2019) find that regulators tend to avoid monitoring pollution in pollution hotspots, especially in poor areas. Although improvements in satellite data can provide opportunities for measuring pollution concentrations at spatially disaggregated areas, finding non-biased approaches to calibrating the data remains an important area for future research.

3.3 Crowd-source pollution monitoring

The recent deployment of “consumer” air quality monitors provides opportunities to observe air qualities at richer geographies though endogeneity concerns persist here as these areas select into finer measurement collection through consumer monitor adoption. Singer and Delp (2018) compare air quality measurements from these monitors, including – Air-Beam, AirVisual, Foobot, and Purple Air. They find that while the estimated mass concentrations for all four of these measurements were time correlated, all of the consumer and both research monitors studied substantially under-reported emissions for particles smaller than 0.3 μm diameter.

3.4 Short and long-run outcomes

Another decision point occurs in this literature when connecting a particular environmental burden to the policy-relevant outcome of interest. Example outcomes of interest include pollution concentration, population-weighted pollution concentration or exposure, or human health damages from pollutants. Differences in this choice reflect different research questions and will include/exclude different dimensions of environmental justice. For example, differential pollution concentrations across population groups may ignore differential abilities to adapt to pollution across these groups, which impact health outcomes. Studies focusing on characterizing disparities in concentrations and exposure (Colmer et al., 2020; Currie, Voorheis, and Walker, 2020) calculate the exposure gaps as the difference in pollution concentrations (weighted or unweighted) across demographic groups. Studies characterizing exposure gaps in damages calculate the differences in hospitalizations, mortality, and morbidity by race or income groups (Gillingham and Huang, 2021).

For some of the environmental hazards being studied, notably air pollution, human health and socioeconomic impacts are expected from long term exposure, rather than short term shocks (Isen, Rossin-Slater, and Walker, 2017, Aizer et al., 2018; Aizer and Currie, 2019). Further, people are mobile, and their location choices may change over time. In these cases, understanding disparities in human health impacts from environmental hazards necessitates tracking pollution exposure by people over time, incorporating changes in residential locations. Recently, the availability of long panel data has made such research designs possible.

In several first-of-their-kind studies,[2] Voorheis and co-authors use newly linked survey and administrative records to create long panel data that facilitate longitudinal studies of pollution exposure (Colmer and Voorheis, 2020; Voorheis, 2017a,b). Voorheis (2017a) con-

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[2] Other papers have also used administrative data to study longer term pollution exposure effects, though without a focus on distributional impacts by race and income, for example, Bishop, Ketcham, and Kuminoff (2018) and Deryugina et al. (2019).

Table 3: Pollution Transport Models and New Data Sources

Pollution measure	**Model type**	**Model name example**	**Papers example (*)**
Pollution transport models	Dispersion model based on planetary boundary layers	AERMOD	Sullivan (2017)
		HYSPLIT	Grainger and Ruangmas (2018); Hernandez-Cortes and Meng (2023); Morehouse and Rubin (2021)
	Reduced complexity air quality modeling	EASIUR	Heo and Strauss (2020)
		AP2/AP3/APEEP	Holland, Mansur, Muller, and Yates (2016); Chan et al. (2018)
		InMAP	Tessum et al. (2021); Auffhammer (2021); Hernandez-Cortes, Meng, and Weber (2023)
	Eulerian photochemical models	CAMx	Marshall, Swor, and Nguyen (2014)
		CAMQ	Bravo et al. (2016)
		WRF-Chem and GEOS-Chem	
	Toxics exposure	RSEI	Sheriff (2021)
Satellite data	AOD	MODIS	Zou (2021)
	Satellite data and machine learning/chemical transport	Neural Network (Di et al., 2016)	Fowlie, Rubin, and Walker (2019)
		Chemical transport modeling and geographic-weighted regression (Hammer et al., 2020)	Fowlie, Rubin, and Walker (2019); Currie, Voorheis, and Walker (2020)

Notes: (*) Papers listed are examples of papers that use these models for EJ related research, not intended as an exhaustive list.

nects these administrative records to satellite measurements of ground level concentrations of fine particulate matter to study longitudinal trends in pollution exposure from 2000 to 2014. The work confirms previous trends found in the literature – cross-sectional environmental inequality has been declining – but finds that this result masks longitudinal patterns. On average, pollution reductions over this period are larger among whiter and richer individuals than they are for minority and poorer individuals. Long panel data also allows for the study of intergenerational pollution exposure. Voorheis (2017b) uses administrative data to study the impact of pollution exposure at birth on outcomes as an adult, finding that pollution exposure at birth has significant effects on high school completion, college attendance, and incarceration. Colmer and Voorheis (2020) develop a data set that links parents and children, finding that regulation-induced air quality improvements in utero increase second generation college attendance, a result which appears to stem from parents' resources and investments rather than biological channels.

These longitudinal studies, made possible through the application of newly linked long panel data, provide novel insights into the intergenerational effects of pollution exposure, opening the door for further research into intergenerational consequences of environmental injustice.

4 Discussion

A key development in the last decade of work in this area regards the documentation of underlying selection and bias in off-the-shelf data sources. Pollution monitors, for example, can be strategically located or have systematically less coverage across minority or poor communities (Grainger and Ruangmas, 2018; Hausman and Stolper, 2021). Improvements in satellite data availability and the use of atmospheric transport models have allowed researchers to use finer-scale pollution exposure measures, without being limited to the administrative geographic units of strategically placed pollution monitors. Economists are well versed in the perils of selection in biasing estimation and need to continue to apply these fundamental tools to estimation in the environmental justice arena. Likewise, administrative agencies can play a role in refining state and federal reporting requirements to promote either more comprehensive, or when not possible, a randomized data collection process. Research has also demonstrated the pitfalls of aggregating sociodemographic characteristics to larger geographic boundaries (Baden, Noonan, and Turaga, 2007). And recent increases in data availability have allowed researchers to make use of finer scale pollution and demographic data, overcoming at least some of aggregation issues in earlier work. Further, the recent availability of longitudinal pollution and demographic data have allowed for burgeoning work in intergenerational pollution exposure.

Meanwhile, the literature continues to lack consensus on the objective function in environmental justice policy-making, likely in part due to the difficultly of connecting pollution exposure to individual measures of welfare. Studies have instead taken an array of approaches to defining environmental inequality and disparities in pollution exposure. Some calculate the average difference across minority groups or income levels (Currie, Voorheis, and Walker, 2020; Fowlie, Holland, and Mansur, 2012) while others have calculated the concentration distribution of pollution exposure across demographic groups using inequality indices like the Gini coefficient or the Atkinson index. Studies using inequality indexes estimate the extent to which existing pollution concentrations deviate from equality in pollution concentrations (Bouvier, 2014; Boyce, Zwickl, and Ash, 2016; Clark, Millet, and Marshall, 2014; Goodkind, Coggins, and Marshall, 2014; Holland et al., 2016). Notably, Clark, Millet, and Marshall (2014) find that the inequality in pollution exposure to NO_2 is larger than the income inequality in the United States, and Boyce, Zwickl, and Ash (2016) show that the Gini coefficient for toxic exposure in 2010 was higher than that of income. Moreover, analyzing inequality coefficients in pollution exposure can yield different policy implications than when looking at average pollution exposure across groups. Holland et al. (2016) find large differences in inequality of damages associated with different pollution sources – when comparing the Gini coefficients, damages from gasoline vehicles are more concentrated compared to damages of electric vehicles. Mansur and Sheriff (2021) use alternative methodologies derived from the income inequality literature to estimate the distributional impacts of a cap-and-trade program in Southern California. Using generalized Lorenz curves and equally distributed equivalents, the authors rank policies in terms of pollution distributions across groups, demonstrating a methodology that allows for a preference structure to be attributed to the decision maker, who can characterize a tradeoff across different policies.

Much of the recent literature studies environmental justice in the context of air pollution, with less research on other media (water pollution being one notable example). Several studies have found that the impacts of exposure to water pollution are large, particularly for infants (Currie et al., 2013; Currie, Greenstone, and Meckel, 2017; Flynn and Marcus, 2021). To our knowledge the impacts of water pollution on environmental justice remains a gap in the literature. Linking water pollution to affected communities is difficult as it requires modeling the catchment area of rivers, streams, and sources of drinking water. Keiser and Shapiro (2019) and Andarge (2020) use the National Hydrography Dataset, which delineates a network of all surface waters in the United States and describes the flow direction of rivers and streams, which allows the authors to characterize whether a location is upstream or downstream from rivers and streams. Hill and Ma (2021) create a novel dataset from several administrative data sources to study the impact of fracking on water quality. These empirical approaches offer guidance to future research studying disparities in water access and quality. Policy makers and state and federal agencies can also help here –expanding the data collection processes on air pollution to other media would offer a pathway for the next decade of research to study other environmental hazards.

Studies measuring pollution impacts to disadvantaged communities often associate pollution exposure based on individuals' place of residence. Depending on the occupation and commuting patterns for work and school, location of residence may be a poor indicator of total pollution exposure. Yet, filling in the research gap characterizing differences in exposure to pollution at home, school, and work, is stalled by data availability. As these differences can have important implications for anticipating the effects of place-based policy, the research community would do well to work with regulators on methods to fill in these gaps. The EPA has also developed methods for assessing environmental justice, publishing a Technical Guidance for Assessing Environmental Justice in Regulatory Analysis in 2016, which describes methodological practices to consider when assessing environmental justice concerns. Among other contributions, the guidance proposes a set of best practices, which relate to several topics discussed throughout this paper such as the selection of a comparison group, the selection of the geographic unit of analysis, the measurement of cumulative impacts, and other methodological decisions to examine environmental justice in EPA decisions.

5 Conclusion

The last 10 years have seen a marked increase in the documentation of many dimensions of environmental justice, as well as improvements in data collection and methodologies. Increasingly sophisticated pollution transport models have allowed for improvements in linking pollution sources to receptors. And the use of administrative records to observe location decisions over time as well as more sophisticated spatial equilibrium models have both been key advancements in connecting residential choices to pollution exposure. Yet, empirical researchers can only study what they observe, and much of the work in this review studies air pollution given the availability of data, with environmental justice research in water pollution, for example, notably lagging. Expanding pollution monitoring across space and media would be a straightforward way to make progress on EJ goals in the near term. Finally, a small but growing share of the recent literature connects disparities in pollution exposure to causal mechanisms. Analyzing the impacts of future policies on the environmental justice will require a continued focus on understanding where the injustice comes from.

References

CEQ Publishes Draft Climate and Economic Justice Screening Tool, Key Component in the Implementation of President Biden's Justice40 Initiative. 2022. URL `https://www.whitehouse.gov/ceq/news-updates/2022/02/18/ceq-publishes-draft-climate-and-economic-justice-screening-tool-key-component-in-the-implementation-of-president-bidens-justice40-initiative/`. Accessed March 20, 2022.

T. D. Abel and J. White. Skewed Riskscapes and Gentrified Inequities: Environmental Exposure Disparities in Seattle, Washington. *American Journal of Public Health*, 101(S1): S246–S254, 2011.

T. D. Abel and J. White. Gentrified sustainability: inequitable development and Seattle's skewed riskscape. *Interdisciplinary Environmental Review*, 16(2-4):124–157, 2015.

M. D. Adams and S. Charnley. Environmental justice and US Forest Service hazardous fuels reduction: A spatial method for impact assessment of federal resource management actions. *Applied Geography*, 90:257–271, 2018.

J. Agyeman, D. Schlosberg, L. Craven, and C. Matthews. Trends and Directions in Environmental Justice: From Inequity to Everyday Life, Community, and Just Sustainabilities. *Annual Review of Environment and Resources*, 41(1):321–340, 2016. doi: 10.1146/annurev-environ-110615-090052.

A. Aizer and J. Currie. Lead and Juvenile Delinquency: New Evidence from Linked Birth, School, and Juvenile Detention Records. *The Review of Economics and Statistics*, 101(4): 575–587, 2019. doi: 10.1162/rest_a_00814.

A. Aizer, J. Currie, P. Simon, and P. Vivier. Do Low Levels of Blood Lead Reduce Children's Future Test Scores? *American Economic Journal: Applied Economics*, 10(1):307–341, 2018. doi: 10.1257/app.20160404.

T. Andarge. The Effect of Incomplete Enforcement Information on Ambient Pollution Levels: Evidence from the Clean Water Act. Working Papers, 2020.

S. Anderson, A. Plantinga, and M. Wibbenmeyer. Inequality in Agency Responsiveness: Evidence from Salient Wildfire Events. page 36, 2020.

D. Anthoff and R. S. Tol. On international equity weights and national decision making on climate change. *Journal of Environmental Economics and Management*, 60(1):14–20, 2010.

K. Ard. Trends in Exposure to Industrial Air Toxins for Different Racial and Socioeconomic Groups: A Spatial and Temporal Examination of Environmental Inequality in the U.S. from 1995 to 2004. *Social Science Research*, 53(September):375–390, 2015. doi: 10.1016/j.ssresearch.2015.06.019.

M. Auffhammer. Distributional Impacts of Climate Change from California's Electricity Sector. Final project report, California Energy Commission, 2021.

B. M. Baden, D. S. Noonan, and R. M. R. Turaga. Scales of Justice: Is There a Geographic Bias in Environmental Equity Analysis? *Journal of Environmental Planning and Management*, 50(2):163–185, 2007. doi: 10.1080/09640560601156433.

K. R. Baker, M. Amend, S. Penn, J. Bankert, H. Simon, E. Chan, N. Fann, M. Zawacki, K. Davidson, and H. Roman. A database for evaluating the InMAP, APEEP, and EASIUR reduced complexity air-quality modeling tools. *Data in brief*, 28:104886, 2020.

L. A. Bakkensen and L. Ma. Sorting over Flood Risk and Implications for Policy Reform. *Journal of Environmental Economics and Management*, 104(November):102362, 2020. doi: 10.1016/j.jeem.2020.102362.

H. S. Banzhaf and R. P. Walsh. Do People Vote with Their Feet? An Empirical Test of Tiebout's Mechanism. *American Economic Review*, 98(3):843–863, 2008. doi: 10.1257/aer.98.3.843.

S. Banzhaf, L. Ma, and C. Timmins. Environmental Justice: The Economics of Race, Place, and Pollution. *Journal of Economic Perspectives*, 33(1):185–208, 2019a. doi: 10.1257/jep.33.1.185.

S. Banzhaf, L. Ma, and C. Timmins. Environmental Justice: Establishing Causal Relationships. *Annual Review of Resource Economics*, 11(1):377–398, 2019b. doi: 10.1146/annurev-resource-100518-094131.

P. Bayer, R. McMillan, A. Murphy, and C. Timmins. A Dynamic Model of Demand for Houses and Neighborhoods. *Econometrica*, 84(3):893–942, 2016. doi: 10.3982/ECTA10170.

D. Bell and J. Carrick. Procedural Environmental Justice. In R. Holifield, editor, *The Routledge Handbook of Environmental Justice*. Routledge, Taylor Francis Group, London; New York, 2018.

M. Benatiya Andaloussi and E. T. Isaksen. The environmental and distributional consequences of emissions markets: Evidence from the clean air interstate rule. *Elisabeth Thuestad, The Environmental and Distributional Consequences of Emissions Markets: Evidence from the Clean Air Interstate Rule (June 25, 2017)*, 2017.

A. Bento, M. Freedman, and C. Lang. Who Benefits from Environmental Regulation? Evidence from the Clean Air Act Amendments. *The Review of Economics and Statistics*, 97 (3):610–622, 2015. doi: 10.1162/REST_a_00493.

O. Bin, J. Bishop, and C. Kousky. Does the National Flood Insurance Program Have Redistributional Effects? *The B.E. Journal of Economic Analysis Policy*, 17(4), 2017. doi: 10.1515/bejeap-2016-0321.

K. C. Bishop and A. D. Murphy. Estimating the Willingness to Pay to Avoid Violent Crime: A Dynamic Approach. *American Economic Review*, 101(3):625–629, 2011. doi: 10.1257/aer.101.3.625.

K. C. Bishop, J. D. Ketcham, and N. V. Kuminoff. Hazed and confused: the effect of air pollution on dementia. 2018. doi: 10.3386/w24970.

S. Borenstein and J. B. Bushnell. Do Two Electricity Pricing Wrongs Make a Right? Cost Recovery, Externalities, and Efficiency. *American Economic Journal: Economic Policy*, 14(4):80–110, 2022. doi: 10.1257/pol.20190758.

S. Borenstein, M. Fowlie, and J. Sallee. Paying for Electricity in California: How Residential Rate Design Impacts Equity and Electrification. Energy Institute at Haas, University of California, 2022.

R. Bouvier. Distribution of Income and Toxic Emissions in Maine, United States: Inequality in Two Dimensions. *Ecological Economics*, 102:39–47, June 2014. doi: 10.1016/j.ecolecon.2014.03.005.

J. K. Boyce, K. Zwickl, and M. Ash. Measuring Environmental Inequality. *Ecological Economics*, 124:114–123, April 2016. doi: 10.1016/j.ecolecon.2016.01.014.

M. A. Bravo, R. Anthopolos, M. L. Bell, and M. L. Miranda. Racial Isolation and Exposure to Airborne Particulate Matter and Ozone in Understudied US Populations: Environmental Justice Applications of Downscaled Numerical Model Output. *Environment International*, 92–93:247–255, July 2016. doi: 10.1016/j.envint.2016.04.008.

California Office of Environmental Health Hazard Assessment (OEHHA). SB 535 Disadvantaged Communities, 2017. URL `https://oehha.ca.gov/calenviroscreen/sb535`.

P. Campa and L. Muehlenbachs. Addressing Environmental Justice through In-Kind Court Settlements. Discussion paper series, Center for Economic Policy Research, May 2021.

H. R. Chan, B. A. Chupp, M. L. Cropper, and N. Z. Muller. The Impact of Trading on the Costs and Benefits of the Acid Rain Program. *Journal of Environmental Economics and Management*, 88:180–209, March 2018. doi: 10.1016/j.jeem.2017.11.004.

Y. Chen, L. H. Goulder, and M. A. C. Hafstead. The Sensitivity of CO2 Emissions Under a Carbon Tax to Alternative Baseline Forecasts. *Climate Change Economics*, 09(01): 1840012, 2018. doi: 10.1142/S2010007818400122.

P. Christensen and C. Timmins. Sorting or Steering: The Effects of Housing Discrimination on Neighborhood Choice. *Journal of Political Economy*, 130(8):2110–2163, 2022. doi: 10.1086/720140.

P. Christensen, I. Sarmiento-Barbieri, and C. Timmins. Housing Discrimination and the Toxics Exposure Gap in the United States: Evidence from the Rental Market. March 2020. doi: 10.3386/w26805.

L. P. Clark, D. B. Millet, and J. D. Marshall. National Patterns in Environmental Injustice and Inequality: Outdoor NO2 Air Pollution in the United States. *PLoS One*, 9(4):e94431, 2014. doi: 10.1371/journal.pone.0094431.

L. P. Clark, D. B. Millet, and J. D. Marshall. Changes in transportation-related air pollution exposures by race-ethnicity and socioeconomic status: outdoor nitrogen dioxide in the United States in 2000 and 2010. *Environmental health perspectives*, 125(9):097012, 2017.

M. B. Collins, I. Munoz, and J. JaJa. Linking 'Toxic Outliers' to Environmental Justice Communities. *Environmental Research Letters*, 11(1):015004, 2016. doi: 10.1088/1748-9326/11/1/015004.

J. Colmer and J. Voorheis. The Grandkids Aren't Alright: The Intergenerational Effects of Prenatal Pollution Exposure. CES Working Paper CES 20-36, The United States Census Bureau, November 2020. URL `https://www.census.gov/library/working-papers/2020/adrm/CES-WP-20-36.html`.

J. Colmer, I. Hardman, J. Shimshack, and J. Voorheis. Disparities in PM2.5 Air Pollution in the United States. *Science*, 369(6503):575–578, 2020. doi: 10.1126/science.aaz9353.

M. Cropper, A. Krupnick, and W. Raich. Preferences for equality in environmental outcomes. (22644), 2016. doi: 10.3386/w22644.

J. Currie and R. Walker. What Do Economists Have to Say about the Clean Air Act 50 Years after the Establishment of the Environmental Protection Agency? *The Journal of Economic Perspectives*, 33(4):3–26, 2019.

J. Currie, J. S. Graff Zivin, K. Meckel, M. Neidell, and W. Schlenker. Something in the Water: Contaminated Drinking Water and Infant Health. *National Bureau of Economic Research*, (18876), March 2013. doi: 10.3386/w18876.

J. Currie, L. Davis, M. Greenstone, and R. Walker. Environmental Health Risks and Housing Values: Evidence from 1,600 Toxic Plant Openings and Closings. *The American Economic Review*, 105(2):678–709, 2015.

J. Currie, M. Greenstone, and K. Meckel. Hydraulic Fracturing and Infant Health: New Evidence from Pennsylvania. *Science Advances*, 3(12):e1603021, 2017. doi: 10.1126/sciadv.1603021.

J. Currie, J. Voorheis, and R. Walker. What Caused Racial Disparities in Particulate Exposure to Fall? New Evidence from the Clean Air Act and Satellite-Based Measures of Air Quality. *National Bureau of Economic Research*, (26659), January 2020. doi: 10.3386/w26659.

L. Cushing, R. Morello-Frosch, M. Wander, and M. Pastor. The haves, the have-nots, and the health of everyone: the relationship between social inequality and environmental quality. *Annual Review of Public Health*, 36:193–209, 2015.

L. Cushing, D. Blaustein-Rejto, M. Wander, M. Pastor, J. Sadd, A. Zhu, and R. Morello-Frosch. Carbon Trading, Co-Pollutants, and Environmental Equity: Evidence from California's Cap-and-Trade Program (2011–2015). *PLOS Medicine*, 15(7):e1002604, 2018. doi: 10.1371/journal.pmed.1002604.

T. Dauwalter and R. Harris. Distributional Benefits of Rooftop Solar Capacity. *Unpublished Manuscript*, November 2021.

L. Davis and C. Hausman. Who Will Pay for Legacy Utility Costs? *NBER Working Paper*, (28955), June 2021. doi: 10.3386/w28955.

D. De Silva. Entry and Exit Patterns of 'Toxic' Firms. *American Journal of Agricultural Economics*, 98(3):881–909, 2016.

Department of Justice. PROCEDURAL JUSTICE — COPS OFFICE, 2022. URL `https://cops.usdoj.gov/proceduraljustice`. Accessed January 26, 2022.

B. Depro, C. Timmins, and M. O'Neil. White Flight and Coming to the Nuisance: Can Residential Mobility Explain Environmental Injustice? *Journal of the Association of Environmental and Resource Economists*, 2(3):439–468, 2015. doi: 10.1086/682716.

T. Deryugina, G. Heutel, N. H. Miller, D. Molitor, and J. Reif. The mortality and medical costs of air pollution: Evidence from changes in wind direction. *American Economic Review*, 109(12):4178–4219, 2019.

R. Deshmukh, P. Weber, O. Deschenes, D. Hernandez-Cortes, T. Kordell, R. Lee, C. Malloy, T. Mangin, M. Meng, S. Sum, et al. Well setbacks limit california's oil supply with larger health benefits and employment losses than excise and carbon taxes. *Nature Energy*, pages 1–3, 2023a.

R. Deshmukh, P. Weber, O. Deschenes, D. Hernandez-Cortes, T. Kordell, R. Lee, C. Malloy, T. Mangin, M. Meng, S. Sum, et al. Equitable low-carbon transition pathways for california's oil extraction. *Nature Energy*, pages 1–13, 2023b.

Q. Di, I. Kloog, P. Koutrakis, A. Lyapustin, Y. Wang, and J. Schwartz. Assessing PM2.5 Exposures with High Spatiotemporal Resolution across the Continental United States. *Environmental Science & Technology*, 50(9):4712–4721, 2016. doi: 10.1021/acs.est.5b06121.

Q. Di, H. Amini, L. Shi, I. Kloog, R. Silvern, J. Kelly, M. B. Sabath, et al. An Ensemble-Based Model of PM2.5 Concentration across the Contiguous United States with High Spatiotemporal Resolution. *Environment International*, 130(September):104909, 2019. doi: 10.1016/j.envint.2019.104909.

J. M. Doremus, I. Jacqz, and S. Johnston. Sweating the Energy Bill: Extreme Weather, Poor Households, and the Energy Spending Gap. *Journal of Environmental Economics and Management*, 112(March):102609, 2022. doi: 10.1016/j.jeem.2022.102609.

L. Downey and B. Hawkins. Race, income, and environmental inequality in the United States. *Sociological Perspectives*, 51(4):759–781, 2008.

Environmental Protection Agency. Toxics Release Inventory (TRI) 2016 National Analysis. Executive Summary, 2016. URL `https://www.epa.gov/sites/production/files/2018-02/documents/tri_analytical_results_2016_final_version2_0.pdf`.

N. Fann, H. A. Roman, C. M. Fulcher, M. A. Gentile, B. J. Hubbell, K. Wesson, and J. I. Levy. Maximizing health benefits and minimizing inequality: incorporating local-scale data in the design and evaluation of air quality policies. *Risk Analysis: An International Journal*, 31(6):908–922, 2011.

P. Flynn and M. Marcus. A Watershed Moment: The Clean Water Act and Infant Health. *NBER, Working Paper Series*, (w29152), August 2021. doi: 10.3386/w29152.

M. Fowlie, S. P. Holland, and E. T. Mansur. What Do Emissions Markets Deliver and to Whom? Evidence from Southern California's NOx Trading Program. *The American Economic Review*, 102(2):965–993, 2012. doi: 10.1257/aer.102.2.965.

M. Fowlie, E. Rubin, and R. Walker. Bringing Satellite-Based Air Quality Estimates Down to Earth. *AEA Papers and Proceedings*, 109(May):283–288, 2019. doi: 10.1257/pandp.20191064.

M. Fowlie, R. Walker, and D. Wooley. Climate Policy, Environmental Justice, and Local Air Pollution. *Economic Studies*, October 2020. URL `https://www.brookings.edu/wp-content/uploads/2020/10/ES-10.14.20-Fowlie-Walker-Wooley.pdf`.

S. Gamper-Rabindran and C. Timmins. Hazardous Waste Cleanup, Neighborhood Gentrification, and Environmental Justice: Evidence from Restricted Access Census Block Data. *The American Economic Review*, 101(3):620–624, 2011. doi: 10.1257/aer.101.3.620.

K. Gillingham and P. Huang. Racial Disparities in the Health Effects from Air Pollution: Evidence from Ports. *NBER Working Paper Series*, 2021. URL `https://www.nber.org/papers/w29108`.

E. A. Gilmore, J. Heo, N. Z. Muller, C. W. Tessum, J. D. Hill, J. D. Marshall, and P. J. Adams. An Inter-Comparison of the Social Costs of Air Quality from Reduced-Complexity Models. *Environmental Research Letters*, 14(7):074016, 2019. doi: 10.1088/1748-9326/ab1ab5.

A. L. Goodkind, J. S. Coggins, and J. D. Marshall. A Spatial Model of Air Pollution: The Impact of the Concentration-Response Function. *Journal of the Association of Environmental and Resource Economists*, 1(4):451–479, 2014. doi: 10.1086/678985.

L. H. Goulder, M. A. Hafstead, G. Kim, and X. Long. Impacts of a carbon tax across US household income groups: What are the equity-efficiency trade-offs? *Journal of Public Economics*, 175:44–64, 2019.

C. Grainger and T. Ruangmas. Who Wins from Emissions Trading? Evidence from California. *Environmental and Resource Economics*, 71(3):703–727, 2018. doi: 10.1007/s10640-017-0180-1.

C. Grainger and A. Schreiber. Discrimination in Ambient Air Pollution Monitoring? *AEA Papers and Proceedings*, 109:277–282, 2019. doi: 10.1257/pandp.20191063.

C. A. Grainger. The Distributional Effects of Pollution Regulations: Do Renters Fully Pay for Cleaner Air? *Journal of Public Economics*, 96(9):840–852, 2012. doi: 10.1016/j.jpubeco.2012.06.006.

W. B. Gray and R. J. Shadbegian. 'Optimal' Pollution Abatement—Whose Benefits Matter, and How Much? *Journal of Environmental Economics and Management*, 47(3):510–534, 2004. doi: 10.1016/j.jeem.2003.01.001.

M. Greenstone and B. K. Jack. Envirodevonomics: A Research Agenda for an Emerging Field. *Journal of Economic Literature*, 53(1):5–42, 2015. doi: 10.1257/jel.53.1.5.

J. T. Hamilton. Politics and Social Costs: Estimating the Impact of Collective Action on Hazardous Waste Facilities. *The Rand Journal of Economics*, 24(1):101, 1993.

J. T. Hamilton. Testing for Environmental Racism: Prejudice, Profits, Political Power? *Journal of Policy Analysis and Management*, 14(1):107, 1995. doi: 10.2307/3325435.

M. S. Hammer, A. van Donkelaar, C. Li, A. Lyapustin, A. M. Sayer, N. C. Hsu, R. C. Levy, and et al. Global Estimates and Long-Term Trends of Fine Particulate Matter Concentrations (1998–2018). *Environmental Science & Technology*, 54(13):7879–7890, 2020. doi: 10.1021/acs.est.0c01764.

K. Haninger, L. Ma, and C. Timmins. The Value of Brownfield Remediation. *Journal of the Association of Environmental and Resource Economists*, 4(1):197–241, 2017. doi: 10.1086/689743.

R. D. Hardy and M. E. Hauer. Social Vulnerability Projections Improve Sea-Level Rise Risk Assessments. *Applied Geography*, 91:10–20, February 2018. doi: 10.1016/j.apgeog.2017.12.019.

C. Hausman and S. Stolper. Inequality, Information Failures, and Air Pollution. *Journal of Environmental Economics and Management*, 110:102552, October 2021. doi: 10.1016/j.jeem.2021.102552.

S. Heblich, A. Trew, and Y. Zylberberg. East-Side Story: Historical Pollution and Persistent Neighborhood Sorting. *Journal of Political Economy*, 129(5):1508–1552, 2021. doi: 10.1086/713101.

J. Heo and R. P. Strauss. Equity and the Environment: An Application of the Berliant–Strauss Vertical and Horizontal Equity Framework to Measuring the Distributional Effects of Air Quality Regulation. *International Journal of Economic Theory*, 16(1):82–94, 2020. doi: 10.1111/ijet.12255.

D. Hernandez-Cortes and K. C. Meng. Do Environmental Markets Cause Environmental Injustice? Evidence from California's Carbon Market. *Journal of Public Economics*, 217:104786, January 2023. doi: 10.1016/j.jpubeco.2022.104786.

D. Hernandez-Cortes, K. C. Meng, and P. Weber. Decomposing trends in us air pollution disparities from electricity. *Environmental and Energy Policy and the Economy*, 4:91–124, 2023. doi: 10.1086/722674. URL `https://doi.org/10.1086/722674`.

E. Hill and L. Ma. The Fracking Concern with Water Quality. *Science*, 373(6557):853–854, 2021. doi: 10.1126/science.abk3433.

J. R. Hipp and C. M. Lakon. Social disparities in health: disproportionate toxicity proximity in minority communities over a decade. *Health & place*, 16(4):674–683, 2010.

P. Ho. The Costs and Environmental Justice Concerns of NIMBY in Solid Waste Disposal. *Journal of the Association of Environmental and Resource Economists*, page 722613, November 2022. doi: 10.1086/722613.

J. S. Hoffman, V. Shandas, and N. Pendleton. The Effects of Historical Housing Policies on Resident Exposure to Intra-Urban Heat: A Study of 108 US Urban Areas. *Climate*, 8(1): 12, 2020. doi: 10.3390/cli8010012.

S. P. Holland, E. T. Mansur, N. Z. Muller, and A. J. Yates. Are There Environmental Benefits from Driving Electric Vehicles? The Importance of Local Factors. *American Economic Review*, 106(12):3700–3729, 2016. doi: 10.1257/aer.20150897.

S. P. Holland, E. T. Mansur, N. Z. Muller, and A. J. Yates. Distributional Effects of Air Pollution from Electric Vehicle Adoption. *Journal of the Association of Environmental and Resource Economists*, 6(S1):S65–94, 2019. doi: 10.1086/701188.

S. P. Holland, E. T. Mansur, N. Z. Muller, and A. J. Yates. Decompositions and Policy Consequences of an Extraordinary Decline in Air Pollution from Electricity Generation. *American Economic Journal: Economic Policy*, 12(4):244–274, 2020. doi: 10.1257/pol.20190390.

S. Hsiang, P. Oliva, and R. Walker. The Distribution of Environmental Damages. *Review of Environmental Economics and Policy*, 13(1):83–103, 2019. doi: 10.1093/reep/rey024.

A. Hsu, G. Sheriff, T. Chakraborty, and D. Manya. Disproportionate Exposure to Urban Heat Island Intensity across Major US Cities. *Nature Communications*, 12(1):1–11, 2021. doi: 10.1038/s41467-021-22799-5.

A. Isen, M. Rossin-Slater, and W. R. Walker. Every Breath You Take—Every Dollar You'll Make: The Long-Term Consequences of the Clean Air Act of 1970. *Journal of Political Economy*, 125(3):848–902, 2017. doi: 10.1086/691465.

A. Kalnins and G. Dowell. Community Characteristics and Changes in Toxic Chemical Releases: Does Information Disclosure Affect Environmental Injustice? *Journal of Business Ethics*, 145(2):277–292, 2017. doi: 10.1007/s10551-015-2836-5.

J. M. Keenan, T. Hill, and A. Gumber. Climate Gentrification: From Theory to Empiricism in Miami-Dade County, Florida. *Environmental Research Letters*, 13(5):054001, 2018. doi: 10.1088/1748-9326/aabb32.

D. A. Keiser and J. S. Shapiro. Consequences of the Clean Water Act and the Demand for Water Quality*. *The Quarterly Journal of Economics*, 134(1):349–396, 2019. doi: 10.1093/qje/qjy019.

D. M. Konisky, C. Reenock, and S. Conley. Environmental injustice in Clean Water Act enforcement: Racial and income disparities in inspection time. *Environmental Research Letters*, 16(8):084020, 2021.

N. Kravitz-Wirtz, K. Crowder, A. Hajat, and V. Sass. The long-term dynamics of racial/ethnic inequality in neighborhood air pollution exposure, 1990-2009. *Du Bois review: social science research on race*, 13(2):237–259, 2016.

Á. Leelőssy, F. Molnár, F. Izsák, Á. Havasi, I. Lagzi, and R. Mészáros. Dispersion modeling of air pollutants in the atmosphere: a review. *Open Geosciences*, 6(3):257–278, 2014.

J. I. Levy, A. M. Wilson, and L. M. Zwack. Quantifying the efficiency and equity implications of power plant air pollution control strategies in the United States. *Environmental Health Perspectives*, 115(5):743–750, 2007.

J. I. Levy, S. L. Greco, S. J. Melly, and N. Mukhi. Evaluating efficiency-equality tradeoffs for mobile source control strategies in an urban area. *Risk Analysis: An International Journal*, 29(1):34–47, 2009.

K. Maguire and G. Sheriff. Comparing distributions of environmental outcomes for regulatory environmental justice analysis. *International journal of environmental research and public health*, 8(5):1707–1726, 2011.

E. T. Mansur and G. Sheriff. On the Measurement of Environmental Inequality: Ranking Emissions Distributions Generated by Different Policy Instruments. *Journal of the Association of Environmental and Resource Economists*, 8(4):721–758, 2021. doi: 10.1086/713113.

J. D. Marshall, K. R. Swor, and N. P. Nguyen. Prioritizing Environmental Justice and Equality: Diesel Emissions in Southern California. *Environmental Science & Technology*, 48(7):4063–4068, 2014. doi: 10.1021/es405167f.

R. T. Melstrom and R. Mohammadi. Residential Mobility, Brownfield Remediation, and Environmental Gentrification in Chicago. *Land Economics*, 98(1):62–77, 2022. doi: 10.3368/le.98.1.060520-0077R1.

I. Mikati, A. F. Benson, T. J. Luben, J. D. Sacks, and J. Richmond-Bryant. Disparities in Distribution of Particulate Matter Emission Sources by Race and Poverty Status. *American Journal of Public Health*, 108(4):480–485, 2018. doi: 10.2105/AJPH.2017.304297.

P. Mohai and R. Saha. Reassessing Racial and Socioeconomic Disparities in Environmental Justice Research. *Demography*, 43(2):383–399, 2006. doi: 10.1353/dem.2006.0017.

P. Mohai, D. Pellow, and J. T. Roberts. Environmental Justice. *Annual Review of Environment and Resources*, 34(1):405–430, 2009. doi: 10.1146/annurev-environ-082508-094348.

J. M. Morehouse and E. Rubin. Downwind and Out: The Strategic. 43, 2021.

R. Morello-Frosch, M. Pastor, and J. Sadd. Environmental Justice and Southern California's 'Riskscape': The Distribution of Air Toxics Exposures and Health Risks among Diverse Communities. *Urban Affairs Review*, 36(4):551–578, 2001. doi: 10.1177/10780870122184993.

Y. Mu, E. A. Rubin, and E. Zou. What's missing in environmental (self-) monitoring: Evidence from strategic shutdowns of pollution monitors. (28735), 2021. doi: 10.3386/w28735.

A. Nardone, J. A. Casey, R. Morello-Frosch, M. Mujahid, J. R. Balmes, and N. Thakur. Associations between Historical Residential Redlining and Current Age-Adjusted Rates of Emergency Department Visits Due to Asthma across Eight Cities in California: An Ecological Study. *The Lancet Planetary Health*, 4(1):e24–31, 2020. doi: 10.1016/S2542-5196(19)30241-4.

J. Pais, K. Crowder, and L. Downey. Unequal Trajectories: Racial and Class Differences in Residential Exposure to Industrial Hazard. *Social Forces*, 92(3):1189–1215, 2014. doi: 10.1093/sf/sot099.

D. A. Paolella, C. W. Tessum, P. J. Adams, J. S. Apte, S. Chambliss, J. Hill, N. Z. Muller, and J. D. Marshall. Effect of model spatial resolution on estimates of fine particulate matter exposure and exposure disparities in the United States. *Environmental Science & Technology Letters*, 5(7):436–441, 2018.

F. Perry, C. Kredell, P. Marcia, and S. Leonard. Paying for Electricity in California: How Residential Rate Design Impacts Equity and Electrification. Technical report, Energy Institute at Haas, University of California, 2022.

W. A. Pizer and S. Sexton. The Distributional Impacts of Energy Taxes. *Review of Environmental Economics and Policy*, 13(1):104–123, 2019. doi: 10.1093/reep/rey021.

J. D. Prochaska, A. B. Nolen, H. Kelley, K. Sexton, S. H. Linder, and J. Sullivan. Social determinants of health in environmental justice communities: Examining cumulative risk in terms of environmental exposures and social determinants of health. *Human and Ecological Risk Assessment: An International Journal*, 20(4):980–994, 2014.

J. L. Sadd, M. Pastor, R. Morello-Frosch, J. Scoggins, and B. Jesdale. 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(5):1441–1459, 2011. doi: 10.3390/ijerph8051441.

L. Sager and G. Singer. Clean Identification? The Effects of the Clean Air Act on Air Pollution, Exposure Disparities and House Prices. Technical report, The Grantham Research Institute Working Papers, May 2022.

R. J. Shadbegian and W. B. Gray. Spatial Patterns in Regulatory Enforcement: Local Tests of Environmental Justice. In *The Political Economy of Environmental Justice*, chapter 9. Stanford University Press, 2012. doi: 10.11126/stanford/9780804780612.003.0009.

J. S. Shapiro and R. Walker. Where Is Pollution Moving? Environmental Markets and Environmental Justice. Technical report, NBER Working Papers, January 2021.

G. Sheriff. California's GHG Trading Program and the Equity of Air Toxic Releases. Working Paper, 2021.

G. Sheriff and K. B. Maguire. Health risk, inequality indexes, and environmental justice. *Risk Analysis*, 40(12):2661–2674, 2020.

E. Simeonova, J. Currie, P. Nilsson, and R. Walker. Congestion Pricing, Air Pollution, and Children's Health. *Journal of Human Resources*, pages 0218–9363R2, 2019.

B. C. Singer and W. W. Delp. Response of Consumer and Research Grade Indoor Air Quality Monitors to Residential Sources of Fine Particles. *Indoor Air*, 28(4):624–639, 2018. doi: 10.1111/ina.12463.

J. G. Su, R. Morello-Frosch, B. M. Jesdale, A. D. Kyle, B. Shamasunder, and M. Jerrett. An Index for Assessing Demographic Inequalities in Cumulative Environmental Hazards with Application to Los Angeles, California. *Environmental Science & Technology*, 43(20): 7626–7634, 2009. doi: 10.1021/es901041p.

D. Sullivan. Residential Sorting and the Incidence of Local Public Goods: Theory and Evidence from Air Pollution. Working papers, Resources for the Future, July 2017.

C. W. Tessum, D. A. Paolella, S. E. Chambliss, J. S. Apte, J. D. Hill, and J. D. Marshall. PM2.5 Polluters Disproportionately and Systemically Affect People of Color in the United States. *Science Advances*, 7(18), 2021. URL `https://advances.sciencemag.org/content/7/18/eabf4491`.

C. Timmins and A. Vissing. Environmental Justice and Coasian Bargaining: The Role of Race, Ethnicity, and Income in Lease Negotiations for Shale Gas. *Journal of Environmental Economics and Management*, 114:102657, July 2022. doi: 10.1016/j.jeem.2022.102657.

U.S. Environmental Protection Agency: Office of General Counsel. EPA Legal Tools to Advance Environmental Justice, May 2022.

US EPA, OEJECR. Title VI and Environmental Justice. Other Policies and Guidance. URL `https://www.epa.gov/environmentaljustice/title-vi-and-environmental-justice`.

J. Voorheis. Environmental justice viewed from outer space: how does growing income inequality affect the distribution of pollution exposure. *Washington, DC: Center for Administrative Records Research and Applications, US Census Bureau*, 2016.

J. Voorheis. Air Quality, Human Capital Formation and the Long-Term Effects of Environmental Inequality at Birth. CARRA Working Papers 79, Center for Administrative Records Research and Applications, May 2017a.

J. Voorheis. Longitudinal Environmental Inequality and Environmental Gentrification: Who Gains From Cleaner Air? Carra working papers, CARRA Working Papers, May 2017b. URL `https://ideas.repec.org/p/cen/cpaper/2017-04.html`.

J. Voorheis. The Long-Term Effects of Environmental Inequality At Birth. Carra working paper series, The United States Census Bureau, December 2017c. URL `https://www.census.gov/library/working-papers/2017/adrm/carra-wp-2017-05.html`.

R. Walch. The Effect of California's Carbon Cap and Trade Program on Co-Pollutants and Environmental Justice: Evidence from the Electricity Sector. 2020.

W. Wang. Environmental Gentrification. Technical report, HKUST CEP Working Papers, February 2021.

X. Wang, G. Deltas, M. Khanna, and X. Bi. Community Pressure and the Spatial Redistribution of Pollution: The Relocation of Toxic-Releasing Facilities. *Journal of the Association of Environmental and Resource Economists*, 8(3):577–616, 2021. doi: 10.1086/711656.

A. Wolverton. Effects of Socio-Economic and Input-Related Factors on Polluting Plants' Location Decisions. *The B.E. Journal of Economic Analysis Policy*, 9(1), 2009. doi: 10.2202/1935-1682.2083.

S. Young, B. Mallory, and G. McCarthy. The Path to Achieving Justice40, 2021. URL `https://www.whitehouse.gov/omb/briefing-room/2021/07/20/the-path-to-achieving-justice40/`.

E. Y. Zou. Unwatched Pollution: The Effect of Intermittent Monitoring on Air Quality. *American Economic Review*, 111(7):2101–2126, 2021. doi: 10.1257/aer.20181346.