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Environmental Justice and Regional Inequality in Southern California: Implications for Future Research

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Environmental justice offers researchers new insights into the juncture of social inequality and public health and provides a framework for policy discussions on the impact of discrimination on the environmental health of diverse communities in the United States. Yet, causally linking the presence of potentially hazardous facilities or environmental pollution with adverse health effects is difficult, particularly in situations in which diverse populations are exposed to complex chemical mixtures. A community–academic research collaborative in southern California sought to address some of these methodological challenges by conducting environmental justice research that makes use of recent advances in air emissions inventories and air exposure modeling data. Results from several of our studies indicate that communities of color bear a disproportionate burden in the location of treatment, storage, and disposal facilities and Toxic Release Inventory facilities. Longitudinal analysis further suggests that facility siting in communities of color, not market-based "minority move-in," accounts for these disparities. The collaborative also investigated the health risk implications of outdoor air toxics exposures from mobile and stationary sources and found that race plays an explanatory role in predicting cancer risk distributions among populations in the region, even after controlling for other socioeconomic and demographic indicators. Although it is unclear whether study results from southern California can be meaningfully generalized to other regions in the United States, they do have implications for approaching future research in the realm of environmental justice. The authors propose a political economy and social inequality framework to guide future research that could better elucidate the origins of environmental inequality and reasons for its persistence. ***Key words*****: air toxics; cancer; environmental justice; risk; social inequality; treatment, storage, and disposal facilities.** ***Environ Health Perspect*** **110(suppl 2):149–154 (2002).**
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Environmental justice, with its emphasis on public health, social inequality, and environmental degradation, provides a framework for public policy debates about the impact of discrimination on the environmental health of diverse communities in the United States. Indeed, activists, academics, and some decision makers argue that biases within environmental policy making and the regulatory process, combined with discriminatory market forces, result in disproportionate exposures to hazardous pollution among the poor and communities of color. The environmental justice framework also raises the challenging question of whether disparities in exposures to environmental hazards may play an important, yet poorly understood, role in the complex and persistent patterns of disparate health status among the poor and people of color in the United States (*1–13*).

In seeking to redress disparities in exposures to toxics, communities organizing for environmental justice offer environmental health researchers new insights into the junctures of social inequality and public health on one hand, and the political and economic forces that lead to environmental inequality on the other. Emerging research on the broad question of environmental justice attempts to elucidate how socioeconomic and institutional forces create "riskscapes" in which overlapping pollution plumes, emitted by various sources into our air, soil, food, and water, pose a range of health risks to diverse communities, all of which in turn determine inequalities in community susceptibility to environmental hazards. The environmental justice movement has also sparked contentious debates among researchers, policy makers, activists, and industry as to whether environmental discrimination actually exists and why, or whether it is simply the result of other structural forces (*14–24*). These debates have fueled a surge of academic and scientific inquiry into the question of environmental inequality in the United States over the last two decades.

Research on race and class differences in exposures to toxics varies widely, ranging from anecdotal and descriptive studies to rigorous statistical modeling that quantifies the extent to which race and/or class explain disparities in environmental hazards among diverse communities. Although by no means unequivocal, much of the evidence points to a pattern of disproportionate exposures to toxics and associated health risks among communities of color and the poor, with racial differences sometimes persisting across economic strata (*25,26*).

Nevertheless, causally linking the presence of environmental pollution with potentially adverse health effects is an ongoing challenge in the environmental health field, particularly in situations in which populations are chronically exposed to complex chemical mixtures (*3*). With few exceptions, researchers examining environmental inequalities have limited their inquiries to evaluating differences in the location of pollution sources between population groups, while placing less emphasis on evaluating the distribution of exposures or, more important, potential health risks. Of special concern has been the need to move beyond chemical-by-chemical or facility-by-facility analysis toward a cumulative exposure approach that accounts for the exposure realities of diverse populations and incorporates concepts of race and class into assessments of community susceptibility to environmental pollutants (*27*).

We review the evolution of a 3-year environmental justice research initiative in southern California carried out through an academic and community-based collaborative. Our methodological approach entails a regional focus, starting with the premise of previous environmental research that examines the racial distribution of facility siting. We then expand upon this locational approach to look at issues more closely related to health, such as outdoor concentrations of air toxics and associated cancer risks, and then to answer the complex question of temporal trends.

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Implications of the study results in southern California for policy making and developing a framework for future research are discussed in the conclusion.

Creating a Regional Collaborative for Environmental Health and Justice

In 1998, the authors, along with other community partners in southern California, formed an academic–community partnership to address environmental justice issues facing people of color and low-income communities in the Los Angeles Air Basin. (The lead author joined this community-academic collaborative in 1999.) In addition to training, organizing, and policy advocacy, a significant component of this collaborative supported research that would elucidate potential patterns of disproportionate exposures to environmental hazards among diverse communities in the region. Within the collaborative, potential research topics could be proposed by any partner—community or academic—and priorities and project development were decided in a way that was relevant to community organizing and environmental policy making. Although community partners had the most significant influence in the development of the collaborative research agenda, they prioritized basic environmental health research and risk assessment to address some of the persistent methodological challenges in the field of environmental justice research. We have worked toward this goal by making use of advances in air emissions inventories, such as the Toxic Release Inventory (TRI) and ambient air exposure modeling data (*28–30*). Until recently, there has been a paucity of research in which such environmental health and exposure information have been disaggregated by race and socioeconomic status (*31*).

We chose to focus our research efforts on southern California for several reasons: First, the region has a unique regulatory history in terms of its ongoing struggle to solve some of the worst air pollution problems in the country while still promoting economic growth. Second, southern California already comprises a majority of people of color and is rapidly becoming a bellwether of demographic and socioeconomic change for the state as well as the nation. Third, a regional focus in environmental justice research is crucial because industrial clusters, transportation planning, and economic development decisions are often regionally rooted. Thus, the equity question is how the social and environmental health effects of such industries are distributed within the regions that host them. Fourth, minority and low-income communities in the region have become increasingly concerned about whether they bear a disproportionate burden of exposures to air pollution and their associated environmental health risks. Thus, our collaborative is connected to community-based strategies for achieving environmental justice and rooted in a region where organizing on various environmental health issues is already happening. This also makes the results of our research directly relevant to ongoing policy efforts of the South Coast Air Quality Management District to address environmental inequality and to a new state legislative mandate, a law that directs California's Office of Planning and Research to coordinate the state's environmental justice initiatives with the federal government and across state agencies, including the California Environmental Protection Agency (*32*). Finally, the relevance of our work extends beyond southern California; understanding the patterns in this region may inform studies and policies elsewhere as local, state, and federal policy makers are compelled to consider the equity concerns of diverse communities impacted by environmental health risks from hazardous exposures.

In our research we sought to develop various indicators for assessing environmental inequalities: location of potentially hazardous stationary pollution sources such as TRI facilities and treatment, storage, and disposal facilities (TSDFs), and estimated cancer risks associated with outdoor air toxics exposures. We also sought to use the regulatory tools of risk assessment in a comparative framework to answer scientific and policy questions about what ambient concentrations of certain pollutants might in fact mean for distributions of potential health risks among diverse communities. In short, we wanted to address the ultimate question: Is there environmental inequality in southern California, and if so, who bears the burden? Our application of traditional regulatory risk assessment in a comparative framework provides a useful policy tool, particularly in situations in which epidemiologic data are not available and yet where time-sensitive decisions about disparate impact must be made, such as the judicial and administrative examination of Title VI complaints (42 U.S.C. §§ 2000d to 2000d-7) (*33–34*).

Evolution of Research Methodology and Results

Locational Studies

Following the lead of early watershed studies on environmental inequality (*25,35–37*), our first two studies in southern California examined the location of TSDFs in Los Angeles and TRI facilities in the entire region. The first study examining TSDFs found significant demographic differences between tracts with TSDFs versus tracts without (*38*). Those tracts hosting a TSDF or located within a 1-mile radius of a TSDF had significantly higher percentages of residents of color (particularly Latinos), lower per capita and household incomes, and a lower proportion of registered voters. Logistic regression results (Table 1) indicate that communities most impacted by TSDF location in Los Angeles County are working-class communities of color located in predominantly industrial areas. Following previous research (*38–40*), we found that the relationship between income and TSDF location is curvilinear, following an inverted U-shaped curve in which extremely poor tracts have fewer facilities because of less economic and industrial activity, whereas wealthier residents tend to live in tracts with fewer TSDFs, most likely because of their political power to resist pollution-generating activities. This result remained consistent even when the percentages of African American and Latino residents were evaluated as separate groupings (not shown).

Table 1. Logistic regression results for associaton between TSDF location and race/ethnicity, economic, and land use variables.

Independent variable	Parameter estimate (*t*-statistic)
Residents of color (%)	0.03 (6.32)***
Population density	0.00 (0.15)
Employment in manufacturing (%)	0.02 (2.22)**
Per capita income	0.03 (2.59)***
(Per capita income)^2	–0.00 (–2.45)***
Industrial land use (%)	0.03 (7.30)**

n = 1,636 tracts. R^2 = 0.17. ***p < 0.01. **p < 0.05.

Our second locational study broadened its regional scope by including the South Coast Air Quality Management District (which includes Ventura, Los Angeles, Orange, San Bernardino, and Riverside counties) and examining the distribution of facilities required to report air emissions to the TRI of the U.S. Environmental Protection Agency (U.S. EPA) (*40*). The study distinguished between all TRI facilities and those facilities releasing pollutants classified by the U.S. EPA as high priority for reduction and therefore included in the agency's 33/50 program. (The 33/50 program was designed to target 17 priority chemicals, most of them carcinogens, and set as its goal a 33% reduction in releases and transfers of these chemicals by 1992 and a 50% reduction by 1995 [using a 1988 baseline].) Study results indicated that compared with Anglo residents, Latinos have twice the likelihood of living in a tract with a TRI facility with 33/50 releases, followed closely by African Americans. Logistic regression

Table 2. Logistic regression results for associaton between TRI location and race/ethnicity, economic, and land use variables.

variable	Parameter estimate Independent (t-statistic)
Residents of color (%)	0.01 (5.34)***
Population density	–0.00 (0.12)
Employment in manufacturing (%)	0.10 (15.1)***
Per capita income	0.03 (3.50)***
(Per capita income)^2	–0.00 (–3.91)***
Industrial land use (%)	0.05 (10.7)**

n = 2,567 tracts. R^2 = 0.17. ***$p < 0.01$; **$p < 0.05$.

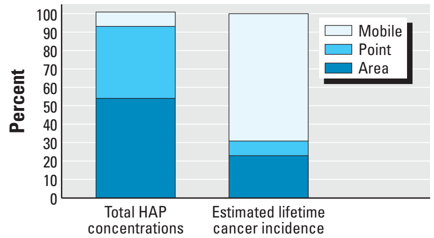

Figure 1. Emission source contributions to air toxics concentrations and estimated lifetime cancer incidence in the South Coast Air Basin. Mobile sources include onroad and offroad vehicles, area sources include small manufacturing and nonmanufacturing facilities, and point sources include large manufacturing facilities such as TRI sources.

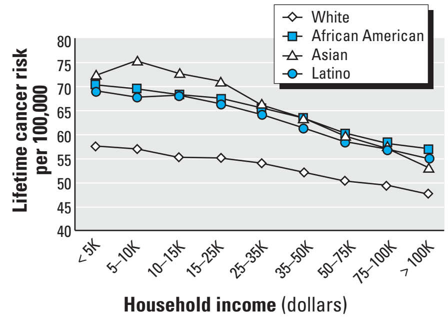

Figure 2. Estimated lifetime cancer risks from ambient air toxics exposures by race, ethnicity and income (South Coast Air Basin).

controlling for income, industrial land use, and population density found that the proportion of minority residents was significantly associated with proximity to a TRI facility (Table 2). A similar curvilinear relationship with income was also observed in this locational study.

Disparities in Outdoor Air Pollution Exposures and Estimated Cancer Risks

Although our preliminary studies focused on the location of potentially hazardous facilities, we sought to quantitatively assess the implications of outdoor air pollution exposures for potential disparities in estimated individual lifetime cancer risks among diverse communities (*27*). Making use of a recent modeling analysis undertaken by the U.S. EPA's Cumulative Exposure Project (*30,41–43*), our study combined estimated long-term annual average outdoor concentrations of 148 air toxics, or hazardous air pollutants (HAPs), listed under the 1990 Clean Air Act Amendments (*44*). We combined these data with demographic and land use information from the 1990 U.S. Census and the southern California Association of Governments. Our study examined a broader scope of air pollutants than previous environmental justice studies, incorporating outdoor HAP concentrations originating from mobile sources (e.g., cars), as well as pollutants from industrial manufacturing facilities, municipal waste combustors, small service industries, and other area emitters. By combining modeled concentration estimates with cancer toxicity information, we derived estimates of lifetime cancer risks and analyzed their distribution among populations in the region.

Estimated lifetime cancer risks associated with outdoor air toxics exposures in the South Coast Air Basin were found to be ubiquitously high, often exceeding the Clean Air Act Goal of one in one million by between one and three orders of magnitude. [In 1990, Congress established a health-based goal for the Clean Air Act: to reduce lifetime cancer risks from major sources of hazardous air pollutants to one in one million. The Act required that over time, U.S. EPA regulations for major sources should "provide an ample margin of safety to protect public health" (*45*).] Figure 1 presents source contributions to total air toxics concentrations and total estimated excess lifetime cancer incidence with the effects of background concentrations removed. Background concentrations are attributable to long-range transport, resuspension of historical emissions, and natural sources derived from measurements taken at clean air locations remote from known emissions sources (*30*).

Interestingly, area and point emissions account for over 90% of total estimated HAP concentrations, but mobile sources are the largest driver of estimated excess cancer incidence, accounting for 70% of the estimated excess cancer incidence associated with outdoor HAP concentrations from these three source categories. This difference is consistent with another exposure study conducted recently in southern California (*46*) and underscores the importance of distinguishing between exposures versus health risks when assessing emission source contributions to pollution problems. Although, on average, point sources do not appear to contribute substantially to modeled concentrations and predicted cancer risks, there are several tracts in the South Coast Basin where point source contributions to both concentration and risk estimates are dominant.

Figure 2 shows how the racial/ethnic disparities in estimated cancer risks persist across household income strata. The y-axis shows a population-weighted individual excess cancer risk estimate for each racial and economic category and the x-axis displays nine annual household income categories ranging from less than $5,000 to more than $100,000. As indicated in the figure legend, each line in the graph represents one of four racial/ethnic groups that include Anglos, African Americans, Asians, and Latinos. Asians, African Americans, and Latinos have the highest population cancer risk estimates, with risks nearly 50% higher than that for for Anglos. Although risk levels tend to decline for all groups as household income increases, the gap between residents of color and Anglos is fairly consistent across income strata. These preliminary results are likely to be influenced by demographic differences in where population groups reside. Whereas African Americans, Latinos, and Asians are concentrated mainly in the urban core where pollution levels and risks tend to be higher, Anglos are more dispersed, with significant numbers living in less-urban areas where risks are lower. Table 3 presents the multivariate regression models of the association between lifetime cancer risk and race/ethnicity, land use, and economic variables, including the percentage of home ownership, the percentage of industrial, commercial, and transportation land use, median housing value, median household income, and median household income squared. Model 1 uses the percentage of residents of color and model 2 shows a breakdown of the racial/ethnic groups. Multivariate regression results indicate that even after controlling for well-known causes of pollution such as population density, income, land use, and a proxy for assets (home ownership) (*47*), race was consistently shown to be positively associated with higher cancer risks. Note that median household income is entered as a quadratic variable. The curvilinear relationship between income and lifetime cancer risk is consistent with the locational studies, following the inverted U-shaped curve in which extremely poor tracts may have lower cancer risks due to low levels of economic and industrial activities, whereas wealthier residents tend to live in tracts with lower cancer risk levels.

Demographic Transition and the Siting of Environmental Hazards

Although these studies suggest that environmental hazards disparately impact communities of color in southern California, the cross-sectional nature of these results precludes the possibility of assessing the causal sequence of facility siting, that is, whether facilities were sited in communities of color or whether minority residents moved into neighborhoods after facility siting decreased property values and neighborhood desirability. Our subsequent study sought to examine this siting versus minority-move-in hypothesis, which entailed compiling longitudinal data on the siting and location of TSDFs from 1970 to 1990 (*23*). Preliminary results indicate that the proportion of minority residents living within a 1-mile radius of a TSDF increased from 9% in 1970 to over 20% in 1990, whereas the increase for White residents was less, from 5% to nearly 8%. Tracts receiving TSDFs between 1960 and 1990 had a higher proportion of residents of color, were poorer and more blue-collar, had lower initial home values and rents, and had significantly fewer homeowners. Moreover, multivariate analysis showed that there was little evidence of so-called minority move-in into areas where TSDFs had been previously sited.

Finally, we sought to examine whether neighborhoods that had undergone drastic demographic transitions in their ethnic and racial composition were more vulnerable to TSDF siting, possibly due to weak social and political networks that could undermine a community's capacity to influence siting decisions. A tract-level variable of ethnic churning was constructed to measure this phenomenon by taking the absolute sum of racial demographic change between 1970 and 1990. Figure 3 maps this ethnic-churning variable in Los Angeles overlaid onto the siting of TSDFs during the 1970s and 1980s. The apparent visual correlation between high demographic transition and TSDF siting was tested with simultaneous modeling using a two-stage least-squares regression. Results revealed that this type of demographic transition significantly predicted the siting of a TSDF even after controlling for economic and other demographic indicators (not shown). Thus, in historically or uniformly ethnic areas, siting seems less likely to occur than in locations where the proportion of residents of color is high but split and changing between African American and Latino groups.

Table 3. Regression results on associaton between cancer risks associated with air toxics and race/ethnicity, economic, and land use variables.

Independent variable	Model 1[a] parameter estimate (*t*-statistic)	Model 2[b] parameter estimate (*t*-statistic)
Residents of color (%)	0.17 (7.03)***	
Population density	0.18 (22.92)***	0.18 (22.67)***
Home ownership (%)	–0.02 (–0.46)	–0.02 (–0.56)
Median housing value	0.09 (5.08)***	0.08 (4.56)***
Median household income	0.26 (4.67)***	0.22 (4.10)***
(Median household income)^2	–0.0007 (–5.48)***	–0.0007 (–4.85)***
Transportation land use (%)	0.53 (6.19)***	0.53 (6.24)***
Industrial land use%	0.27 (5.57)***	0.28 (5.71)***
Commercial land use (%)	0.30 (6.34)***	0.29 (6.05)***
African American (%)		0.17 (5.40)***
Latino (%)		0.13 (4.79)***
Asian (%)		0.28 (5.75)***

***$p < 0.01$. [a]n = 2,495 tracts; R^2 = 0.41; F statistic = 188.3. [b]n = 2,495 tracts; R^2 = 0.41; F statistic = 155.4.

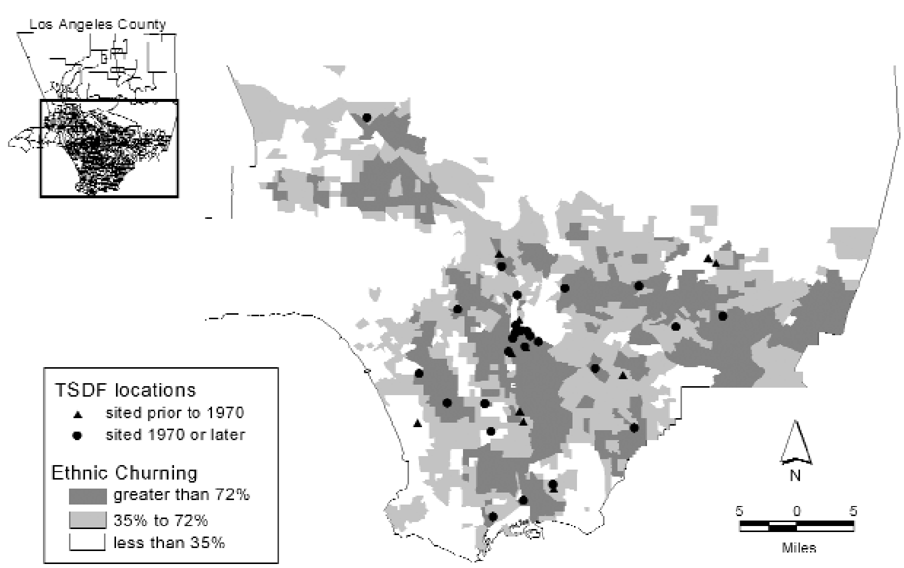

Figure 3. High capacity hazardous waste TSDFs and ethnic churning, 1970–1990, southern Los Angeles County, California. Data from 1970, 1980, and 1990 Census. Each category contains one-third of all Los Angeles County census tracts.

Policy Implications of Research Results

Our studies examining environmental inequality in southern California have consistently revealed a disproportionate burden borne by communities of color, particularly African Americans and Latinos, in the location of TRI and TSD facilities and lifetime cancer risks associated with outdoor air toxics exposures (*27,38,40*). A longitudinal study further suggests that the disproportionate location of TSD facilities in Los Angeles County has been the result of the siting of facilities predominantly in communities of color and not simply a market-induced move-in of poor residents of color to lower-rent areas already affected by environmental hazards (*23*). Moreover, communities undergoing rapid demographic transition seem more vulnerable to the placement of TSDFs. This measurement of ethnic churning merits further inquiry, as it may be a crude indicator of a community's capacity to mobilize social networks and politically resist or influence siting decisions.

Although three of our studies were locational, focusing on the siting of potentially hazardous facilities, we were also able to examine the health risk implications of outdoor air toxics exposures attributable to mobile and nonmobile sources. These latter results suggest that air toxics concentrations and their associated health risks originate mostly from smaller area and mobile sources, raising new challenges for policy makers and environmental justice advocates alike in terms of developing regulatory and pollution prevention strategies for these emission sources. Unlike large industrial and waste facilities that traditionally have been the focus of organizing, research, and regulatory attention, mobile and area sources are smaller, more widely dispersed, and diverse in terms of their emissions and production characteristics, making a uniform regulatory approach and community organizing strategy more difficult. Regulatory oversight of small manufacturing and service operations has been minimal because these facilities tend to be the most difficult to control from a technological perspective compared with large point sources that have been the focus of command and control efforts. Indeed, dispersed, small-scale production often turns industry into a moving target, as smaller firms avoid community scrutiny and regulatory responsibility for the social costs and environmental health impacts of production. Small factories are often undercapitalized, short-term operations that do not have the technology or know-how to safely produce, store, and transport toxic inputs and wastes (*48*). Finally, the proliferation of mobile sources may be eroding the previous gains made from stricter emissions standards. Thus, future emissions reduction efforts must better address mobile and area sources with a particular emphasis on how regional economic development, changing land use patterns, suburbanization, and the development of major transportation corridors impact pollution streams and the distribution of health risks among communities of color and the poor.

Equally important, these study results reinforce the need to take a more holistic approach to environmental equity research. As better data become available, future studies should move away from locational and pollutant-by-pollutant analysis and toward a cumulative exposure approach (across pollutants and emission sources) that better answers the question of what disparities in exposure mean for potential inequities in health risks. Of course, the use of risk assessment, even within an equity analysis framework, remains controversial among the public and policy makers alike (*49,50*). We sought to improve the use of risk assessment by using it comparatively to assess the distribution of cancer risk due to outdoor air toxic exposures among diverse communities.

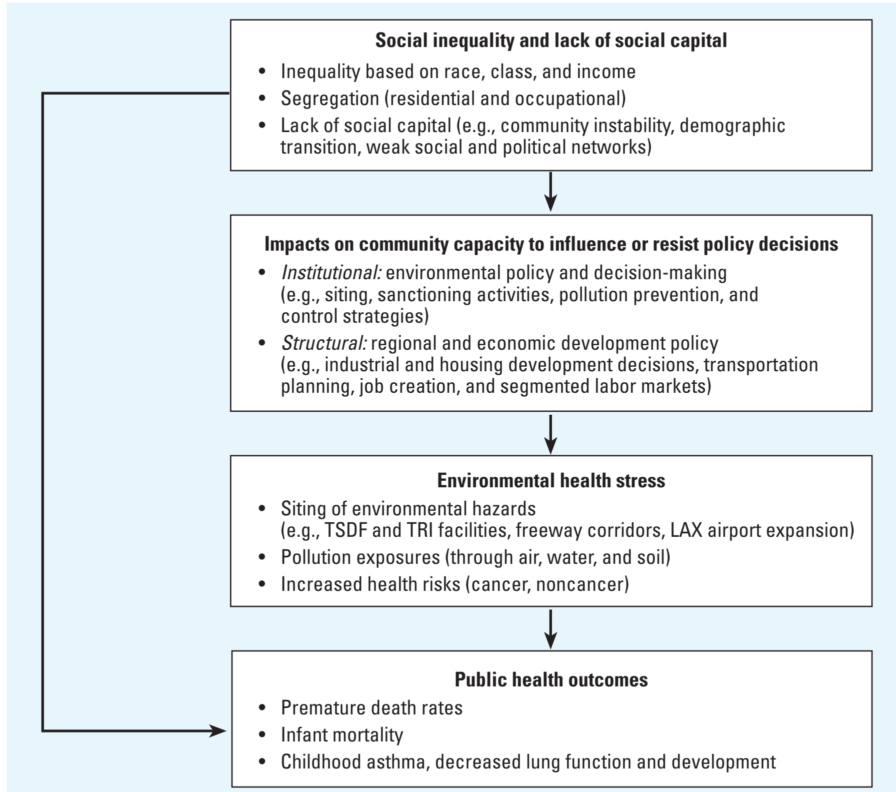

Figure 4. Political economy of environmental inequality.

Conclusion: A Framework for Future Research

Although risk assessment and statistical analysis can show how inequities in environmental health risks are spread among diverse communities, they shed little light on their origins or the reasons for their persistence. These larger questions necessarily lead us in a new direction in our research to address two overarching issues: *a*) using a social inequality framework (based on race, class and income) to facilitate the integration of knowledge from the fields of economics and sociology in a way that enables researchers to better understand the complex dynamics of environmental inequality (*51,52*); and *b*) examining the political and economic forces that lead to environmental inequality, which requires consideration of how institutional discrimination (such as occupational and residential segregation) interacts with larger structural forces, including disparities in patterns of economic and regional development. Figure 4 proposes such a social inequality framework that could be used to develop future research questions. Patterns of social inequality, segregation, and lack of social capital [such as social networks, cohesion, and a community's ability to mobilize politically (*53–55*)] impact a community's capacity to influence or resist environmental policy-making and regulatory enforcement activities (*56*). Similarly, social inequality diminishes a community's ability to shape regional and economic development activities in systematic ways that would benefit (or at minimum not harm) its residents (*57*). The interaction of these institutional and structural processes ultimately places additional environmental stress on communities of color through the placement of potentially hazardous facilities, transportation corridors, and pollutant exposures through various media. Ultimately, the adverse effects of these intersecting processes can be assessed through specific public health outcomes.

Research examining the socioeconomic factors that create environmental inequalities can move policy discussions on environmental justice beyond simply tinkering with the regulatory process and toward addressing how social inequalities and discrimination directly and indirectly impact the environmental health of communities of color and the poor. Preliminary research in this area suggests that disparities in political power and residential segregation affect not only the net costs and benefits of environmentally degrading activities but also the overall magnitude of environmental degradation (e.g., air pollution) and health risks (e.g., individual estimated lifetime cancer risk) (*52,58*). Community participation is key to developing long-term regulatory, enforcement, and regional development initiatives that are politically and economically sustainable and that protect public health. The challenge for policy makers and researchers alike is to reorient future inquiry to examine how indicators of inequality and political empowerment can promote environmental protection and environmental justice for everyone.

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