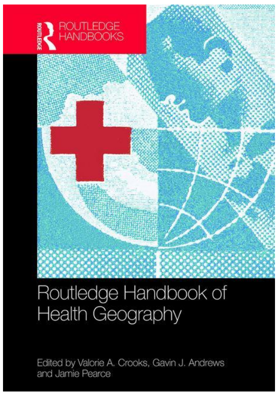

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ENVIRONMENTAL HEALTH INEQUITIES

From global to local contexts

Eric Crighton, Holly Gordon and Caroline Barakat-Haddad

There is general consensus that the burdens of pollution and other environmental hazards are not distributed evenly across communities and nations and that this explains an important part of the health disparities that exist between different populations around the world (WHO, 2010; Prochaska et al., 2014). Importantly, how hazards like industrial pollution, automobile emissions and agricultural pesticides are distributed, and the burden they place on health, is often determined not by chance, but rather by environmental, economic and social practices, as well as policies and laws that discriminate based on race, class, culture, age or gender. Thus, many environmental health *inequalities* also represent *inequities* in that they are unfair, unjust and avoidable (WHO, 2010).

This chapter examines the concept and theoretical underpinnings of environmental health inequity, beginning with its roots in the environmental-justice and civil-rights movements and continuing to its contribution to the discipline of health geography today, while illustrating the multiplicity, scope and scale of the phenomena through an examination of international examples.

Background

The concept of environmental health inequity is rooted in environmental justice, a social movement and research stream focused on documenting and redressing disproportionate environmental burdens faced by socioeconomically or demographically disadvantaged groups. Environmental justice was first described in terms of race (i.e., environmental racism) in studies examining community racial and socioeconomic characteristics and the location of hazardous-waste sites in the United States (Boyd, 2015). In 1979, an African-American community in Houston, Texas, filed the first lawsuit to challenge the local siting of a hazardous-waste landfill. Public interest in environmental justice grew in the 1980s, with high-profile events such as the Love Canal disaster in Niagara Falls, New York. Hundreds of homes were evacuated after a protracted battle between the government and a community built in close proximity to a toxic-waste dump, eventually leading to the evacuation of hundreds of homes (Edelstein, 2004). In 1982, more than 500 people were arrested in Warren County, North Carolina, while protesting to stop the siting of a landfill for polychlorinated biphenyl (PCB)–contaminated soil in a predominately poor, African-American community (Boyd, 2015). Prompted by the events of Warren County, the US government conducted a study comparing racial and socioeconomic characteristics and the location of hazardous-waste sites. Findings showed a disproportionate number of hazardous sites located in or near African-American communities (Lee, 2010).

These are among the many events that fed a growing awareness about environmental hazards in marginalized, low-income and racial-minority communities and a groundswell of related activism and research in the United States and internationally, on issues including air quality, toxic-waste disposal, workplace hazards and disproportionate exposure to lead (Lee, 2010).

The concept of environmental health inequity has emerged as an important theme within the disciplines of health geography and environmental health. There is a significant and growing body of evidence showing that poor and disadvantaged communities are more likely to live near sources of pollution, such as industries, refineries and highways, and as a consequence are more likely to suffer from associated adverse health effects (Masuda et al., 2008; WHO, 2010). These communities are also more likely to feature poor-quality housing, noise and odors and to have fewer environmental amenities, such as green spaces, close by (Boyd, 2015). Confirming the previous findings, Tooke, Klinkenberg and Coops (2010) have shown that in Canadian urban settings, the proportion of green space and tree canopy cover, both of which are associated with positive mental and physical health outcomes, is positively associated with neighborhood income (Tooke, Klinkenberg and Coops, 2010). Research has also shown that these inequities exist across age and gender. For example, it has been reported that, because of prolonged shortages of fuel, low-income Armenian women were commonly burning municipal waste for cooking and heating, resulting in disproportionate gender-related exposure to hazardous substances such as dioxins and heavy metals (WHO, 2010). These inequities are reproduced across geographic scales. For example, a study in Toronto, Canada, examining neighborhood levels of nitrogen dioxide, a hazardous air pollutant, showed the neighborhoods marked by low income, low education and lone-parent families were more likely to experience high ambient exposures (Buzzelli and Jerrett, 2007). At the macro scale, using World Health Organization data and a broad definition of "environmental risks" that included occupational hazards, Benetti (2007) assessed deaths attributable to environmental risk factors by nation and found that deaths attributable to environmental risk factors were substantially greater in less-developed countries (25%) as compared to more-developed countries (17%).

According to Bolte et al. (2012), there are two dimensions to environmental health inequity. The first dimension is known as distributional or geographic inequity, which refers to the spatial distribution and resulting disparities of environmental risks across socioeconomic and racial groups. This includes places where people live, work, learn and recreate. The second dimension is known as procedural inequity, which refers to opportunities, or a lack thereof, to influence decisions about pollution and development that may create environmental risks. Low socioeconomic and marginalized groups are often characterized by both geographic and procedural inequities (Kruize et al., 2014) that result in health disparities across a range of geographic contexts. How this occurs has been conceptualized by numerous authors (e.g., WHO, 2010; Morello-Frosch and Lopez, 2006; Gee and Payne-Sturges, 2004; Sexton, 2000). Morello-Frosch and Lopez (2006), for example, present an ecosocial framework outlining how the connections between spatial forms of social inequality (e.g., racial segregation), structural mechanisms of discrimination (e.g., political disenfranchisement, economic exclusion, uneven government investment patterns) and community-level conditions (e.g., land use, traffic density, civic engagement, neighborhood quality) disproportionately expose low socioeconomic and marginalized communities to environmental hazards. Individual-level stressors such as poverty, poor diet and lack of health behaviors, as well as inadequate access to health care, act to amplify *vulnerability* to the toxic effects of those environmental hazards that create health disparities. Gee and Payne-Sturges (2004), in their exposure-disease-stress framework, highlight the importance of psychosocial impacts of environmental exposures on health, as well as the role that individual-level stress may play in increasing vulnerability and environmental health inequities. This relationship has been demonstrated by health geographers in numerous studies in diverse contexts of both real and perceived environmental exposures (e.g., Crighton et al., 2003a; b; Wakefield and Elliott, 2000).

In examining place-specific health disparities, health geographers have long focused on the contribution of environmental determinants of health within the context of broad socioeconomic, health-care and individual factors. In doing so, the research has revealed evidence of significant health inequalities across a range of geographic contexts associated with the inequitable distribution of environmental hazards. In the following pages, we present a series of illustrative examples of environmental health inequity that span global to local scales in order to elucidate the nature, diversity and ubiquity of the problem. At the global scale, we examine international trade in toxic electronic waste (e-waste) and large-scale environmental disasters, namely the Aral Sea disaster, and, at the local scale, we examine urban air pollution as well as environmental exposures in Indigenous communities.

International trade in hazardous e-waste

The export of e-waste from high-income countries to low-income countries represents a significant and growing international environmental-health-inequity issue that has received considerable attention (Heacock, Kelly and Suk, 2016). E-waste, which includes obsolete and discarded computers, phones, televisions and numerous other electronic products, represents a large and fast-growing component of the global municipal solid-waste stream (Widmer et al., 2005). E-waste contains numerous valuable materials, including copper, silicon, iron and gold, but also many highly toxic substances, such as cadmium (Cd), mercury (Hg), chromium (Cr), lead (Pb), and polybrominated diphenyl ethers (PBDEs) (Xu et al., 2012). The hazardous nature of the waste, combined with strict environmental and health-and-safety regulations in high-income countries, makes it cheaper to export e-waste for recycling to low-income countries, where regulations are either weak or unenforced (Wu et al., 2015). This trade is often done in violation of international law (Widmer et al., 2005).

The environment and health impacts associated with the trade in e-waste are significant. This is demonstrated in a study by Xu et al. (2012) that examined the impacts of e-waste recycling on birth outcomes in Guiyu, China, where it is estimated that nearly 6,000 family workshops informally recycle approximately 1.6 million tons of e-waste per year using antiquated and uncontrolled methods. Comparing Guiyu to a non-recycling control site revealed significantly higher concentrations of cadmium, chromium, nickel and PBDEs in umbilical cord blood of neonates in Guiyu. Lead, a major component of e-waste and highly detrimental to neurodevelopment, was also found to be significantly higher in Guiyu. With regard to birth outcomes, the study revealed significantly higher rates of stillbirths, low birth weights and lower Apgar scores (a standard measure of the physical condition of a newborn) in Guiyu compared to the control site (Xu et al., 2012).

Unfortunately, the situation seen in Guiyu is not unique. A study examining the environmental impacts of e-waste recycling in Taizhou City, China, revealed that the improper disassembly of polychlorinated biphenyl (PCB)–containing equipment has led to PCB contamination at levels estimated to pose serious cancer risks to children and adults (Wu et al., 2015). In Ghana, the Agbogbloshie recycling site receives up to 215,000 tons of e-waste annually from Western Europe. Here, open burning is used to remove plastic insulation from copper cables, a practice that heavily pollutes the air, soil and water and exposes workers and local communities to increased health risks (Amankwaa, 2013). The international trade of e-waste and other hazardous waste from more-developed to less-developed nations is not a new phenomenon, and, given the fast pace of technological developments and speed at which electronics become obsolete, the trade in e-waste is expected to increase in the future (Widmer et al., 2005).

The Aral Sea disaster

There is overwhelming evidence of environmental health inequity in the context of both natural and unnatural environmental disasters (Bullard, 2007). Natural disasters such as Hurricane Katrina in the United States in 2005 demonstrated clearly that many low-income and black communities were particularly vulnerable to the storm and its impacts but also received the lowest priority in terms of disaster response, allocation of post-disaster assistance, and reconstruction assistance (Bullard, 2007). This inequity is also seen in the context of unnatural environmental disasters. The Aral Sea disaster is an important example of this due to its scale, the severity of the health impacts and also the lack of attention it has received internationally. The history of the disaster dates back to the 1950s, when the Soviet government in Moscow imposed unsustainable, industrial cotton-farming methods on the Soviet republics of Kazakhstan and Uzbekistan. Doing so involved diverting massive quantities of water for irrigation away from the Aral Sea, once the fourth-largest freshwater lake in the world (Micklin, 2007). The Aral Sea supported a rich natural ecosystem and a minority population of more than five million people. The region quickly became one of the world's largest cotton producers; however, the local population received few of the economic benefits, and the environmental impacts have been enormous (Small, van der Meer and Upshur, 2001). The sea steadily receded, such that today it covers less than one-fifth of its original area, and towns like Muynak, once a major fishing port and tourist destination, is more than 100 kilometers from the waters of the now biologically dead sea. Salinization of agricultural land resulting from over-irrigation, as well as the wind transport of salts from the exposed seabed, has severely impacted ground and surface water quality and reduced agricultural productivity (Micklin, 2007). Concomitantly, decades of chemical-dependent agricultural practices have resulted in high levels of toxic pesticides in the local environment and the population living there (Crighton et al., 2011). As a consequence of these environmental impacts, the people living in this area have experienced significant health declines and face some of the highest rates of anemia and certain cancers, respiratory illnesses and birth defects in the world (Crighton et al., 2011).

Although local residents and scientists have long claimed that the environmental problems have been significantly affecting their health, limited empirical evidence of the relationships, combined with a general disinterest in the disaster internationally, have been cited as barriers to action (Small, van der Meer and Upshur, 2001). Of the research that has been done, most is focused on agricultural chemicals and their impact on the most vulnerable in the population: children. Results have demonstrated high levels of organochlorine pesticides, dioxins, heavy metals and other toxic pollutants in the environment, in local food products and in the population itself (i.e., in umbilical cord blood, urine, hair, breast milk) (Crighton et al., 2011). It has also been shown that body burdens of toxic substances are significantly higher among individuals living in the most environmentally affected areas (i.e., cotton-growing areas and regions closer to the sea) and compared to reference populations in Europe (Crighton et al., 2011).

Health geographers have made an important contribution to our understanding of this disaster and the effects it has had on the population's health. For example, Bennion et al. (2007), in a study examining the relationship between airborne dust and lung function and respiratory symptoms in children in the region, demonstrated significantly higher rates of poor respiratory health closer to the former seashore. Although no association with dust deposition was found, the authors indicate that other environmental factors are likely responsible. In a study examining the psychosocial impacts associated with the disaster, Crighton et al. (2003a; b) identified high levels of emotional distress and poor self-rated health. Psychosocial impacts were found to be significantly associated with levels of environmental concern, having young children, being an ethnic minority and being female.

Urban air pollution

The aforementioned environmental health inequities occurring at global scales are similarly seen at smaller scales, with air pollution–related inequities being perhaps the best documented example of this. Health geographers have long focused on neighborhood relationships between socioeconomic status and air pollution from sources including industry and transportation networks (Buzzelli, 2008). For example, a recent study examined the relationship between ambient nitrous dioxide (NO_2) exposures and measures of material deprivation (e.g., low income, unemployment, low education) and social deprivation (e.g., living alone, linguistic isolation) in the context of Canada's three largest cities (Pinault et al., 2016). This study found that indicators of both social and material deprivation were associated with living in close proximity to a major roadway and experiencing higher concentrations of ambient NO_2 air pollution. In Europe, similar findings have been reported. For example, a Swedish study by Chaix et al. (2006) examined the relationship between local-scale data on outdoor NO_2, residential and school locations and household incomes of approximately 30,000 children living in Malmö. Results indicated that exposure to NO_2 at the school of attendance and place of residence typically increased as the socioeconomic status of the neighborhood of residence decreased. Although health outcomes were not examined in either of these studies, NO_2 exposure is a well-established risk factor for asthma and other respiratory conditions, especially among children.

Some of the strongest evidence of air pollution–related health inequity has been found in the United States. In the city of Atlanta, O'Lenick et al. (2017) examined the modifying effect of neighborhood-level socioeconomic status on the relationship between air pollution (NO_2, O_3 and $PM_{2.5}$) and pediatric asthma morbidity. Here, the authors observed significantly stronger air pollution–pediatric asthma associations in *deprivation areas* compared with *non-deprivation areas* and concluded that neighborhood level socioeconomic status is a factor contributing to children's vulnerability to air pollution–related asthma morbidity. Using an ecological level, spatial study design in New York City, Corburn, Osleeb and Porter (2006) identified neighborhood *hot spots* of childhood asthma hospitalizations and analyzed the effects of neighborhood characteristics related to air quality (i.e., presence of polluting land uses, industries and major roadways) and sociodemographic conditions (e.g., income, education, unemployment). Here, neighborhood housing characteristics were also examined, as poor quality housing is likely to increase exposures to indoor air pollutants such as rodent and cockroach allergens, molds and dust mites, which are known to trigger asthma. Results demonstrated an association between neighborhood asthma hospitalization rates, low average household income, high percentage of minorities and multiple environmental pollution burdens.

Canada's Indigenous communities

Environmental health inequities among Indigenous communities are frequently recognized as particularly significant when compared to non-Indigenous communities in contexts including Chile (Romero, Méndez and Smith, 2012), the United States (Hoover et al., 2012) and Canada (Dhillon and Young, 2010). Notably, Dhillon and Young (2010) argue that cases of environmental inequity are so prevalent in Canadian Indigenous communities that it is more appropriately labeled environmental racism. An example of this is seen in the Grassy Narrows (Ojibwa) First Nation in Ontario. Between 1962 and 1970, the Dryden paper mill dumped an estimated 10 metric tons of methylmercury into the English-Wabigoon River upstream from the community, contaminating local lakes and tributaries and all fish species (Kinghorn, Solomon and Chan, 2007). The impacts on the community included the loss of cultural practices and opportunities to transmit traditional ecological knowledge, the two most important sources of employment (commercial fishing and guiding) and confidence in the safety of the food and water (Kinghorn, Solomon and Chan, 2007). Widespread mercury exposure has also resulted in significant and long-term health impacts including a significant outbreak of Minamata disease, though the provincial government disputes this (Harada et al., 2005). While mercury levels have since decreased, river sediments and some common fish species are still contaminated above safe limits and serious health problems persist (Kinghorn, Solomon and Chan, 2007).

The Aamjiwnaang First Nation in Sarnia, Ontario, faces similar inequities. Labeled Chemical Valley, Sarnia hosts approximately 40% of Canada's chemical industries, including chemical plants, petroleum refineries, plastics recyclers and Canada's largest hazardous-waste dump. Approximately 60% of the air pollutants released by these factories occurs within five kilometers of the Aamjiwnaang Reserve, one of the closest residential areas (MacDonald and Rang, 2007). Talfourd Creek runs through the Reserve and is contaminated with substances including nickel, cadmium, arsenic and lead (Wiebe, 2016). For this community, major accidental chemical releases of benzene, toluene and other highly toxic substances and resultant evacuations are recurrent events (Wiebe, 2016). Community-based studies have identified a broad range of health issues, from headaches, asthma and skin rashes to elevated cancer rates and reproductive concerns (MacDonald and Rang, 2007). A study examining temporal changes in the sex ratio in the community concluded that male births declined continuously from 1990 to 2003, to a ratio of two females born for every one male (Mackenzie, Lockridge and Keith, 2005). The authors indicate that exposure to endocrine-disrupting industrial chemicals during the preconception and prenatal periods is a possible cause.

Even Indigenous communities living in some of the most remote areas of the Arctic are disproportionately exposed to contaminants such as mercury, pesticides, heavy metals and radionuclides. Transported thousands of kilometers by wind and ocean currents from industries in the South, these contaminants are known to accumulate in fish and marine mammals that are hunted for food (Furgal, Powell and Myers, 2005). These *country foods* are socially and culturally vital to Inuit and northern peoples and have traditionally provided an essential source of nutrients for local diets (Richmond and Ross, 2009). Problematically, country-food consumption results in northern communities commonly exceeding tolerable daily intakes and safe blood levels of numerous toxic substances including PCBs, chlordane, toxaphene and mercury (Van Oostdam et al., 2005). Poor economic circumstances coupled with remote locations means that choosing store-bought alternatives is not an option for many communities (Richmond and Ross, 2009).

Conclusion

This chapter examined the concept of environmental health inequity using a series of global and local examples to demonstrate the contextual and geographic scope of the phenomena. While these examples are highly divergent, they are similar in that each highlights how vulnerable populations are being unfairly, unjustly and avoidably affected by environmental hazards as a result of their race, class, culture, age or gender. Health geographers and environmental-health researchers have made significant contributions to identifying and enhancing public awareness and understanding many of the environmental health inequities that exist within and across communities around the world today, as well as examining the processes that create these inequities.

Despite this achievement and the considerable growth in research interest in environmental-health-inequity issues, many research gaps remain. In a systematic review of Canadian environmental-health research, Masuda et al. (2008), identify some of these gaps. The authors call for research that (a) uses broader definitions of "health" that include non-physical health outcomes (i.e., psychosocial health); (b) integrates theoretical concepts such as therapeutic landscapes, developed by geographers, to consider positive dimensions of environment and health – not just negative dimensions; and (c) takes a multiscalar approach, recognizing that contaminates often move across locales. A WHO review (2010) identified the need for environmental-health-equity research that takes age, gender and migration into account, considers the cumulative effects of multiple environmental exposures, and examines the interaction between social and economic factors and environmental exposures.

Research that addresses these gaps is critical for informing the development of effective policies and programs that do not simply reduce exposures, but also address conditions that create health inequities. While programs aimed at reducing the overall release of hazardous pollutants into the environment are important, they alone will not reduce environmental health inequities, since low socioeconomic and marginalized groups will continue to be disproportionately exposed to toxic contaminants and be more vulnerable to their effects. Thus, the development of policies targeting environmental health inequities requires highly interdisciplinary and broad-based efforts that account for the sociopolitical and economic structures that create inequities in the first place. It also requires addressing the social, economic, health-care and behavioral determinants of health that make low-socioeconomic and marginalized groups more vulnerable to environmental hazards. Health geographers have an important role to play in these efforts.

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