Applied Geography 95 (2018) 54–60

Contents lists available at ScienceDirect

Applied Geography

journal homepage: www.elsevier.com/locate/apgeog

The environment and environmental justice: Linking the biophysical and the social using watershed boundaries

Dustin T. Hill*, Mary B. Collins, Elizabeth S. Vidon

Department of Environmental Studies, State University of New York College of Environmental Science and Forestry, 107 Marshall Hall, Syracuse, NY, 13210, USA

ARTICLE INFO

Keywords:
Toxics release inventory
Disproportionality
Erie/Niagara
ArcGIS
Unit-hazard coincidence
Water pollution

ABSTRACT

Point source pollution from industrial activity is a significant environmental problem that unequally impacts people. In addition to disparate impacts on people, the environment is also unequally impacted. Environmental justice is one body of scholarship that studies this problem but almost exclusively from the social side. The question we are striving to answer is how the use of watershed boundaries in place of traditional political boundaries affects environmental justice analyses. Do the same patterns of racial and class inequality hold true when the biophysical boundaries are used? In addition, this analysis looks closely at one watershed to understand where point source pollution output occurs relative to racial and class distribution. The hypothesis is that watersheds of higher minority population and higher poverty will face greater environmental burden in the form of impacted waterways and that these impacted environs will face high concentrations of continuing pollution production. We found that traditional environmental justice patterns hold true with stability for racial inequality. The results suggest that analysis of biophysical conditions and population distribution together is a valuable way to assess environmental impacts while taking into account social and biological forces.

1. Introduction

The Buffalo River in New York is amongst the worst in the Great Lakes region for contaminated sediment. While it remains a severely impacted waterway, there are currently efforts underway for its remediation. In addition to the river's long industrial pollution history, other environmental factors have been considered during remediation including care of wetlands and how changes in land use interact with current remediation plans. The area of concern is six miles of river from the mouth into the city and industrialized portion going through communities of high poverty and lower economic status (Jedlicka, Wooster, & Winkler, 2010; Krieg, 2007).

Like most environmental problems, some parts of the Buffalo River are more easily remediated than others (Tauxe, 2011); some people are more impacted by proximate water quality than others (Moran, 2010), and, as we will show, some sources contribute more than what might be considered acceptable, although patterns do mirror known scholarly findings (Collins, Munoz, & JaJa, 2016; Freudenburg, 2005). Our effort herein is to test the notion that a systems-based understanding of the pollution, remediation, and local characteristics of the Erie/Niagara watershed may serve environmental managers well and may lead to greater gains in desired environmental outcomes. As such, we employ synthesis methods to combine the biophysical and social characteristics with the goal of not only providing insight into the case we present here, but also as a potential framework for environmental managers to consider in their own work.

Our effort proceeds as follows: first we examine relevant literature at the intersection of water issues, unequal impacts (relying heavily on existing environmental justice scholarship), and methodological decisions related to how places are defined. Regarding place definition, to our knowledge most researchers rely on the use of *firm boundaries* (i.e. those defined by county lines, census tract definitions). As part of the spatially focused and systems-based aim of our work, we explore how changing this definition from human-defined boundaries to watersheds may affect relevant patterns. Our substantive effort is watershed-based study in Western New York, combining geospatial analysis linking environmental justice populations to issues of water quality. We also provide a brief discussion and concluding remarks.

1.1. Environmental justice & defining boundaries

A mature body of scholarship reinforces what researchers began to document decades ago—people of color and those living in poverty are more likely to face environmental contamination issues in their communities (Mohai, Pellow, & Roberts, 2009). This field of study is most commonly referred to as environmental justice (EJ). As a field of study,

* Corresponding author.
E-mail address: dthill@syr.edu (D.T. Hill).

https://doi.org/10.1016/j.apgeog.2018.04.007
Received 25 April 2017; Received in revised form 20 April 2018; Accepted 22 April 2018

EJ is typically interested in inquiry related to the right of communities and individuals to have "equal protection [under] environmental and public health laws and regulations" in the places "where we live, work, play, [and] go to school" (Mohai et al., 2009, p. 407). EJ scholarship has observed that unfair siting practices put unequal environmental burden on communities of color (Pulido, 2000), segregated communities by race and class (Chavis & Lee, 1987), and that such communities face increased environmental risk and health related problems (Cushing, MOrello-Frosch, Wander, & Pastor, 2015).

Most efforts to establish environmental inequality have relied on defining a community or group of communities using municipal/political or other firm boundaries (i.e. US Census geometry, county, state) to establish patterns of injustice. In the beginnings of EJ research, determining units of analysis was important because different firm boundaries such as those using zip codes or county census tracts yielded different results (Anderton et al., 1994; Chavis & Lee, 1987). There has been much research and discussion about the best ways to examine issues of environmental quality and EJ in academic research. A seminal report by the United Church of Christ (UCC) that found unequal siting of toxic waste facilities across the U.S. (Chavis & Lee, 1987; see also the corroborating report; Bullard, Mohai, Saha, & Wright, 2008) was met by controversy after another study by different researchers (Anderton et al., 1994) did not find the same result. The main difference was that the UCC study used zip codes rather than census tracts as a proxy for neighborhood. In the case of the follow-up study, the census tract boundary was problematic because census boundaries can sometimes geospatially separate different regions that otherwise should be connected, like dividing a city or neighborhood (Mohai et al., 2009). More recently, distance based models are growing in their use and application (Mohai et al., 2009).

We use what Mohai and Saha (2006) call the *unit-hazard coincidence* method. Most geospatial studies use this model, despite known edge effects (see: Mohai et al., 2009 for complete description). We chose this method because the definitional units are biophysically-based (watersheds) and we hypothesize that the environmental factors related to pollution impact will be better represented. Such efforts are rare, but evidence does exist that they are potentially fruitful (see Sanchez et al., 2013 for a census tract and stream length overlay procedure). Despite recognition that humans and nature are "inevitably intertwined … in all social and ecological projects" (Braun, 2002, p. 10), meaningfully operational testing of this idea in an integrated research framework is very challenging. For example, although EJ scholarship is inherently connected to environmental degradation, and efforts at managing environmental degradation are inherently connected to social forces, the way the study area is defined does not usually reflect such a tight coupling.

1.2. Watershed boundaries for environmental justice research

Part of our charge herein is to explore whether biophysical boundaries, such as those defined by watershed units, could help to incorporate relevant environmental factors (i.e. flows of contaminants, relevant management units) to add to understanding of the human-natural system. One situation where such an understanding might play a role is in unfair siting practices, a body of research that relies heavily on firm boundaries, usually defined politically, rather than biophysically. For example, researchers have shown that new facilities are often sited in communities where there are already several polluters present (Pastor, Sadd, & Hipp, 2001). Overwhelmingly, these communities are characterized as having a higher proportion of non-white members and class differences (Mohai et al., 2009; Pastor et al., 2001). Our thought is that the explicit incorporation of environmentally relevant boundaries might help managers make counterpart resistance arguments based on the fact that groups of polluters may put undue strain on regional ecosystem services and the environment as well as the proximate human community (Allan, Mcintyre, Smith, Halpern, & Boyer, 2012; Carpenter et al., 2015). We argue that using biophysical boundaries to examine social actions, like industrial pollution, and environmental impacts at the biophysical interface is one way to operationalize the coupling of social and environmental systems in an integrated framework and, hopefully, generate management options (Sanchez et al., 2013).

There are a few who, albeit indirectly, call for such integration. As it specifically relates to the hydro-social cycle, Perrault (2014) states that: "water as a natural resource can only be understood relative to the social relations of production and consumption" (Perrault, 2014, p. 235). We acknowledge that although Perreault's charge could be operationalized in a variety of ways, traditional firm boundaries are unlikely to follow natural geologic or other biological and environmental processes. Additionally, biophysical boundaries (such as those that define watersheds) may be of greater use to environmental managers and expand on the important work that has come before. For example, traditional firm boundaries are linked to political realties including: historic issues of race and class, segregation, predatory siting, and white flight (Mohai et al., 2009; Pulido, 2000), and bio-physical boundaries are not completely absent from the socio-environmental studies (see: Armstrong, Stedman, Bishop, & Sullivan, 2012; Brinckman & Munsell, 2012; Nowak, Bowen, & Cabot, 2006, for integrated woodshed and lake studies). In addition, Nowak et al. (2006) state that "instead of selecting existing political [firm] boundaries … it appears more appropriate to select scales of social organization congruent with the scales of the biophysical degradation processes" (Nowak et al., 2006, p. 155). Our focus is on such a call and its value in improving management of natural resources. Other related scholars have looked at landowner perception in headwater regions to understand human-environment impacts in watershed areas (Armstrong et al., 2012) and others have looked at ecosystem services and how humans rely on them more heavily in certain geographically-based locations (Carpenter et al., 2015). One study that combined evaluation of stream metrics with environmental justice indicators looked at a watershed region in Michigan and proposed a model for understanding stream health and demographic patterns along with land use choices (Sanchez et al., 2013). The authors found that for the basin examined, stream health and anthropogenic activities were highly linked and that socio-economic inequality was measurable and more significant in some stream areas than others (Sanchez et al., 2013).

1.3. Watersheds as units of management

We also think that a change in boundary definitions may be warranted (especially in the case of management-related applications), because current regulation related to both the Clean Water Act and the Clean Air Act relies upon biophysical boundaries. Water and air quality assessment conducted by the Environmental Protection Agency (EPA) is collected at the watershed- or airshed-level, to determine which regions are in attainment and which are not—therefore incorporating measurements of inequality into biophysically defined spaces may be more readily useful for managers. In addition, the unit of management for water resources is the watershed (see Galaz, 2007 for a discussion of integrated water resources management). These findings indicate that using biophysical units of analysis coupled with core concepts of unequal pollution generation (Collins et al., 2016) and impacts (Mohai et al., 2009) could expand understanding of anthropogenic factors and biophysical characteristics interacting to cause known problems. Thus, because physical geography is so critical to spatial definition in examinations of social actions and environmental impacts, we propose adding the watershed boundary to the already extant firm boundary designations. To date, we are unaware of other studies that perform a traditional EJ analysis where the unit of analysis is a watershed boundary. Towards this end, we ask the following central question: *Do environmental justice patterns hold when the study area unit of analysis is defined by watershed boundaries, rather than traditional firm boundaries?*