



Critical review

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Giorgia Scognamiglio*

BRIDGING THEORETICAL ADVANCEMENTS AND EMPIRICAL PRACTICES IN ENVIRONMENTAL JUSTICE RESEARCH: TOWARDS A MIXED-METHODS APPROACH

Abstract

This critical review explores the evolution of environmental justice research, highlighting the transition from a primary focus on the distribution of environmental “goods” and “bads” to a multidimensional approach that includes recognition, participation, and socio-historical analysis. The review evaluates empirical studies, categorizing them into quantitative and qualitative methods, and assesses their strengths and limitations. While quantitative research has been instrumental in mapping spatial inequalities, it often fails to capture the socio-historical and structural processes that shape environmental injustices. On the other hand, while qualitative methods have added depth by capturing lived experiences and complex socio-political dynamics, they often lack the ability to address spatial patterns systematically. The separation of these approaches has limited the field’s ability to fully understand environmental justice. To bridge these gaps, the contribution proposes a framework for a new generation of environmental justice (EJ) scholars, advocating for mixed-methods research and the adoption of a critical geographical perspective. This integrated approach aims to offer a comprehensive understanding of environmental justice, encompassing distribution, recognition, participation, and other possible dimensions, thereby enhancing both academic insight and practical policy impact.

Keywords: environmental justice; mixed-methods; critical geography.

* Department of Methods and Models for Territory, Economics and Finance, Sapienza University of Rome, Italy.

1 Introduction

The growing interest in environmental issues in recent years has led to the need to examine environmental inequalities. Environmental justice (EJ) has emerged as a critical framework for understanding the unequal distribution of environmental “bads” (e.g., pollution, hazardous sites) across different populations, often focusing on marginalized communities that disproportionately bear the impacts of environmental hazards. It fundamentally redefined the scope of environmentalism, asserting that the environment encompasses everything: where we live, work, play, as well as the broader physical and natural world (Novotny, 2000). This perspective, underscoring the interconnectedness of social dynamics and ecological conditions, has increasingly attracted a wide range of scholars in various disciplines, including human and economic geography, sociology, economics, political ecology, and public health.

The early focus of environmental justice research was on documenting spatial inequalities, particularly within the United States. However, over the past few decades, the field has evolved significantly, expanding beyond merely identifying the locations of injustices and affected populations, to address the underlying socio-historical, political, and structural factors that shape these environmental injustices. Despite theoretical advancements, gaps remain in the application of broader conceptual frameworks to empirical research. Many studies, especially those employing quantitative methods, have primarily focused on mapping and statistical analysis, while failing to capture the socio-historical context underlying environmental injustices. Conversely, qualitative research has explored lived experiences and social dynamics but is often criticised for lacking methodological rigor and the ability to systematically address spatial patterns. The ongoing separation of these two approaches has limited the ability of the field to fully address the multidimensional nature of environmental justice.

This critical review seeks to connect the theoretical advancements in EJ theory with the current state of empirical research, assessing the strengths and limitations of both quantitative and qualitative approaches. However, it does not offer specific solutions for the inherent limitations of each individual methodology, which require separate, detailed discussions. Instead, it proposes a framework for a new generation of environmental justice scholars who use mixed or multimethods and adopt a critical geographical perspective. This framework aims to address existing gaps, ultimately providing a more comprehensive understanding of multidimensional environmental justice, encompassing issues of distribution, recognition, and participation, among other potential dimensions.

The literature search was conducted using databases such as Google Scholar, Scopus, and PubMed, ensuring a broad range of scholarly articles. Peer-reviewed journals such as *Environmental Justice*, *Local Environment*, *Geoforum*, *Environment and Planning E*, and *Antipode* were reviewed, and previous literature reviews were consulted (e.g., Agyeman et al., 2016; Banzhaf et al., 2019; Reed & George, 2011). In order to limit the scope to the most widely accessible research, this review drew predominantly from the English-language literature. Nevertheless, a significant body of research exists in other languages, particularly Spanish and Portuguese, and especially from Latin America, where environmental justice issues are deeply relevant.

The search terms included “environmental justice,” “environmental inequality,” “distributive justice,” “recognition justice,” “procedural justice,” “qualitative,” “quantitative,” “mixed-method,” “multimethod,” and “geography”. Empirical research from 2000 to 2024 was selected, and articles were filtered by reviewing titles and

abstracts. Selected articles were then categorized based on methodology (quantitative, qualitative, mixed), analysis techniques, type of environmental outcome considered (e.g., waste sites, industrial facilities, green spaces, etc.), type of disadvantage/vulnerability (e.g., race, income, gender, etc.), and dimensions of environmental justice analyzed (distributive, procedural, recognition, and others). Approximately, 100 articles were included in the final review as well as a few books and book chapters. More details on the number of articles, the journals consulted, the geographical focus, and the concentration of articles over time can be found in the Appendix.

Far from being exhaustive, this review offers a focused overview identifying the main gaps and opportunities in current research on environmental justice. The paper is structured as follows. Section 2 sets up the discussion providing a brief overview of the theoretical evolution of environmental justice, while Section 3 explores the state of the current empirical research and identifies limitations and gaps. Section 4 proposes a new framework that bridges the conceptual and empirical approaches, drawing on critical geography and mixed methods.

2 Theoretical evolution: from distributional to multidimensional environmental justice

Environmental justice research has traditionally focused on the unequal distribution of environmental “bads” (e.g., pollution, hazardous sites) and “goods” (e.g., green spaces) across different demographic groups and communities (Reed & George, 2011; Schlosberg, 2007). This distributional approach, rooted in traditional geographical analysis, has been crucial in uncovering patterns of environmental racism and inequality, especially in the US (Walker, 2009). Numerous studies from various disciplines have shown that ethnic minorities and economically disadvantaged populations are disproportionately affected by environmental hazards such as industrial pollution and toxic waste (Bullard, 1990; Chakraborty et al., 2011).

However, while these distributional inequalities are significant, many scholars have argued that overemphasis on this aspect alone risks oversimplifying the complex and deeply embedded socio-historical, political, and structural processes that contribute to environmental injustice (Foster, 1998; Holifield, 2001; Pulido, 1996). Pulido (2000) and Holifield (2001), for instance, underscored the need for a socio-historical approach to analyse how institutional racism and white privilege shape environmental inequities over time, creating clean suburbs and polluted zones. Schlosberg (2004; 2007) encouraged the use of additional notions of justice, including “recognition” (i.e. whether certain communities are recognized in decision-making processes and how certain places are devalued or stigmatized), and “participation” (i.e. how decisions about exposure to hazards or access to resources are made and whether communities meaningfully participate). Within this framework, Walker and Bulkeley (2006) developed the theory of the plural “geographies of environmental justice,” calling for a multidimensional approach that incorporates different aspects of justice. Additionally, it became increasingly clear that environmental justice issues do not conform to a strictly US-centric definition but vary significantly in different spatial and social contexts, necessitating a broader lens for analysis (Holifield et al., 2009).

The concept of “sacrifice zones” also emerged in environmental justice theory (Juskus, 2023), illustrating how specific areas are designated for environmental burden

of pollution, chemical exposure, and toxic waste, sacrificing the well-being of marginalized communities in favor of economic or political gains (Bullard, 2011; Lerner, 2010). Armiero (2021) coined the term “Wasteocene” to describe an era where the economic and socio-political systems do not just generate physical waste but “wasting relationships” which deem certain geographies - often inhabited by less privileged populations – as “disposable,” turning them into sacrifice zones. The EJ framework has been further developed to include intersectional approaches, accounting for multiple axes of difference such as race, gender, age, and so on (Buckingham & Kulcur, 2009; Buckingham-Hatfield et al., 2005; Goodling, 2020). At the same time, Global EJ and Critical EJ have emerged as theoretical expansions, addressing global power imbalances and recognizing non-human entities within justice considerations (Pellow, 2017; Zeitoun, 2013).

These conceptual advancements in EJ research have underscored the importance of qualitative methodologies that are better suited for exploring the complex geographic processes that generate patterns of inequality (Holifield, 2001). According to some literature reviews (Agyeman et al., 2016; Das, 2021) this shift from quantitative to qualitative studies has characterized the second (e.g., Faber and McCarthy, 2003; Pellow & Park, 2003; Pulido 2000) and third generation of EJ scholars (e.g., Pellow, 2007; Schlosberg, 2007; Tschakert, 2009), although much of EJ research still seem to rely on quantitative methods.

3 Empirical evidence in environmental justice research: where do we stand?

3.1 Quantitative approaches in environmental justice research: mapping the *where* and *who*

Much empirical research on environmental justice has used quantitative methods, employing spatial analysis and geographic information systems (GIS) to map the unequal distribution of environmental “bads” or “goods” across different demographic groups. Quantitative studies have often analyzed large datasets to measure the relationships between environmental hazards and social factors, providing clear evidence of disparities. However, critical methodological choices influence findings and interpretations of such analyses, including geographic scale, the selection of exposed subpopulations, the environmental and social variables to be examined, and the statistical methods used (Chakraborty et al., 2011; Most et al., 2004).

One of the most critical aspects is determining the appropriate geographic scale. Different scales, from regional to municipal to census tracts, can yield varying results (cf. Modifiable Areal Unit Problem - MAUP). For example, municipal-level analysis tends to capture inequalities more precisely than larger scales, while smaller scales, such as census tracts or neighborhoods, allow the detection of more granular disparities but may underestimate exposure if the units are too narrow (Baden et al., 2007; Chakraborty et al., 2011). This was evident in studies like Bowen et al. (1995), where a county-level analysis in Ohio linked environmental hazards to race, but smaller-scale analysis found income to be a more relevant factor. Similarly, initial signs of environmental justice in Brazilian cities were found to affect non-white, lower-income groups, but finer-scale analysis indicated similar risks for higher-income white

residents (Carvalho et al., 2022). This issue, along with the ecological fallacies that arise when inferring individual behavior from group-level data (Banzhaf et al., 2019), complicates efforts to draw accurate conclusions about environmental injustices. Given the impact of scale, Agyeman et al. (2016) suggested to carefully select and justify the geographic units of analysis, ideally using a mix of scales to capture both macro and micro-level disparities.

Beyond scale, decisions about the exposed populations can also influence the results. Researchers use GIS to identify areas potentially exposed to environmental “bads” or “goods” and compare these to less-exposed or non-exposed groups (Chakraborty et al., 2011; Maantay, 2002). Two common methods are unit-hazard coincidence, which compares the characteristics of populations within specific geographic units near environmental hazards to those in areas without them, and distance-based analyses, which create buffers around hazards to identify impact areas (Chakraborty et al., 2011; Mohai & Saha, 2006). While unit-hazard coincidence is simple and intuitive, it may inaccurately locate residential populations near hazards by assuming that exposure is confined to predefined boundaries. Distance-based analyses address some of these limitations by considering proximity more directly, but they may still not fully capture the true distribution of risk due to complex dispersion patterns. Some researchers have improved these methods by incorporating distance-decay functions, wind directions, and toxicity-weighted emissions (Chakraborty & Maantay, 2011; Fisher et al., 2006), though they are often limited by incomplete data and imperfect modeling assumptions (Mohai et al., 2009). Despite these efforts, proximity measurements remain widely used. For assessing distributive injustice without focusing on health, buffer analyses that accounts for different types of hazards, such as assigning scores (Bernardini Papalia & Scognamiglio, 2023) offer a compromise to consider concerns beyond health such as noise, odors, traffic, visual blight, property values, and social stigma associated with hazardous facilities (Mohai et al., 2009).

The selection of environmental and population variables adds further complexity. Studies have analyzed a broad range of environmental bads, including air pollution (e.g., Germani et al., 2014; Schoolman & Ma, 2012; Xu et al., 2019; Zhang, Li, & Khanna, 2021), industrial facilities and sites (e.g., Basu & Chakraborty, 2016; Collins et al., 2016; Cushing et al., 2021; Gemmiti et al., 2022; Pasetto et al., 2022, 2023), hazardous waste sites (e.g., Basu & Chakraborty, 2016; Mohai & Saha, 2007; Bernardini Papalia & Scognamiglio, 2023), natural disasters (Chakraborty et al., 2019; Maldonado et al., 2016; Montgomery & Chakraborty, 2015), renewable energy and new technologies (Levenda et al., 2021, Tyree & Greenleaf, 2009), and climate change (e.g., White-Newsome et al., 2009). Measurements often focus on the number of hazardous sites rather than specific factors (e.g., size, typology, quantity of pollutants, regulatory regime etc.) mainly due to data limitations (Rosignoli, 2020). Recently, the scope of EJ studies has expanded to include not only environmental hazards, but also benefits and resources such as national parks (Laird et al., 2000), natural resources (Mutz et al., 2002; Schroeder, 2000), access to green spaces and outdoor opportunities (Certomà & Martellozzo, 2019; Suárez et al., 2020).

When it comes to characterizing populations, researchers have not agreed on a universal set of metrics. The variables used are context-specific and strongly dependent on data availability, and the rationale behind them is not always clearly articulated (Althor & Witt, 2020). Race and ethnicity have been central to US EJ research, largely because of the longstanding focus on environmental racism (Brulle & Pellow, 2006). By contrast, European studies tend to focus on social categories (Köckler et al., 2017; Laurent, 2011). Socioeconomic status is one of the most commonly used variables,

particularly in the UK. It is measured through various indicators such as income, poverty rates, and deprivation indices, often depending on the definition of poverty/deprivation and the metrics used to measure it in each country. However, these broad and sometimes contentious measures can oversimplify complex social realities, which is why researchers prefer to use multiple indicators such as education, occupation and housing conditions (e.g., Collins et al., 2015; Chakraborty, 2024; Mennis, 2002; Mohai & Saha, 2006). Despite its relevance, gender has received relatively limited attention (e.g., Cannon, 2021; Germani et al., 2014). The same applies to age and disability (Chakraborty, 2020, 2022). Only a few studies have examined a broad set of social factors and intersectionality, considering multiple axes of differences (e.g., Cannon, 2021; Chakraborty, 2020; Chakraborty et al., 2016). I have not found studies that have collected data on contextual factors, such as social capital, amenities, institutional quality, crime, and political engagement, which could contribute to making communities more disadvantaged, more vulnerable, and less resilient.

In terms of statistical methods, the diversity and complexity of EJ research has led to the use of a wide range of analytical techniques, reflecting differences in study design and data availability. Multivariate regression is the most common method for measuring the relationship between environmental hazards and social factors (e.g., Fricker & Hengartner, 2001; Pastor et al. 2004). Univariate and bivariate methods such as linear regression, correlation, and t-test are used as well, but few studies rely entirely on them (e.g., Ash & Boyce, 2013; Chakraborty, 2024; Koester & Davis, 2018). Recently, spatial regression models have been used to account for spatial effects and autocorrelations (e.g., Grineski & Collins, 2008; Mennis & Heckert, 2017; Pastor et al., 2005). Geographically Weighted Regression (GWR) has also been applied in studies to capture local variations in environmental injustice patterns that global models like Ordinary Least Squares (OLS) and Spatial Autoregressive (SAR) may overlook (Chakraborty et al., 2022; Grineski, Collins & Olvera, 2015; Mennis & Jordan, 2005). Spatial Quantile Regression (SQR) is a newer approach, examining the uneven distribution of hazards across all values, not just the mean. Though not yet widely used, studies such as Lome-Hurtado et al. (2020) demonstrate its potential to reveal how the relationship between vulnerable groups and pollution intensifies as concentrations increase. Very few studies have directly compared these methods (e.g., Schoolman & Ma, 2012), making it unclear how the use of different methods can affect the results.

The inconsistency in the combination of variables and model types across studies complicates any attempt to compare findings as different approaches often yield varying insights into environmental injustice. This lack of standardization makes it challenging to draw definitive conclusions or to synthesize results from the literature. Furthermore, quantitative studies often lack the ability to explain why these spatial patterns exist and fully capture the political, economic, and social forces that shape them (Chowkwanyun, 2023). Although some researchers recognize the influence of power dynamics and systemic inequalities, incorporating these concepts into quantitative research is often challenging or beyond the scope of the studies (Collins et al., 2016).

3.2 Qualitative approaches in environmental justice research: understanding the *why* and *how*

While much research continues to follow quantitative methodologies, quantitative research no longer completely dominates academic discourse on the subject. The

predominant focus on quantitative approaches has been challenged by scholars who have recognized their limitations and the need for more qualitative research (Pulido, 1996; Weinberg, 1998). While quantitative methods are effective in mapping the spatial patterns of environmental injustice, they struggle in exploring more than distributive justice. In contrast, qualitative studies move beyond simply documenting the distribution of environmental hazards, addressing a wide range of topics, including historical processes and socio-ecological relationships (e.g., Flanquart, Hellequin & Vallet, 2013; Pellow, 2004; Privitera et al., 2023; Williams & Mawdsley, 2006), embodied geographies (e.g., Gay-Antaki, 2023; Iengo, 2022), procedural justice, recognition and marginalization (e.g., Bell, 2008; Deacon & Baxter, 2013; Gibson-Wood & Wakefield, 2013; Tschakert, 2009; Wan, 2014), alternative imaginations of places (e.g., Houston, 2013) as well as resistance and activism (e.g., Armiero & D'Alisa, 2012; Davies, 2006; Di Chiro, 2008). Although questions of environmental injustice have long been recognized as inherently spatial, relatively few geographers have explored the complex dynamics contributing to environmental inequalities (e.g., Davies, 2006; Deacon & Baxter, 2013; Gay-Antaki, 2023; Houston, 2013; Ma et al., 2017; Tschakert, 2009).

Many environmental justice researchers are positioning their work within broader cross-disciplinary discussions, employing a wider range of methodologies, such as interviews (e.g., Gibson-Wood & Wakefield, 2013; Iengo & Armiero, 2017), participant observation (e.g., Pellow, 2004), surveys (e.g., Flanquart et al., 2013; Wan, 2014), document analyses (e.g., Cutts et al., 2016; Schönach, 2016), toxic autobiographies (e.g., Armiero et al., 2019; Praseetha, 2015) and community-based participatory research (e.g., Tschakert, 2009; Sadd et al., 2014). These approaches, as noted by Chowkwanyun (2023), facilitate dialogue between researchers and communities, and give voice to those who are often marginalized in the environmental decision-making process.

However, qualitative EJ studies often lack clear explanations for why specific methods are chosen and how they are applied (Das, 2015; 2021). Despite being invaluable for shedding light on history, socio-ecological relationships, lived experiences and multiple dimensions of justice, they often do not provide empirical evidence on where and to whom environmental hazards are disproportionately allocated, neglecting the analysis of space, spatiality and distributional issues, with a few exceptions (e.g., Tschakert, 2009).

EJ studies that have adopted both qualitative and quantitative methods remain limited (e.g., Collins et al., 2016; Lei et al., 2023; Ma et al., 2017; Mitchell & Rabassa, 2024). For instance, Collins et al. (2016) integrated quantitative exposure analysis with a conceptual approach to explore societal power dynamics. Mitchell and Rabassa (2024) combined spatial regression for analyzing poverty and environmental risk with qualitative methods like site visits and semi-structured interviews to show the impact of household participation in decision-making on outcomes.

Noteworthy is the recently emerged approach of “statistical political ecology” (Temper et al., 2015; 2020), which integrates quantitative methods into political ecology to examine socio-environmental conflicts. By employing large-scale datasets, often co-produced with activists, such as the Environmental Justice Atlas (EJAtlas), it identifies patterns across thousands of cases globally, providing an empirical basis to analyze power dynamics, resistance strategies, and outcomes (e.g., Martínez-Alier et al., 2016; Pérez-Rincón, 2019; Scheidel et al., 2020). By quantifying these trends, this approach provides empirical support for insights that have traditionally been explored qualitatively in political ecology, helping to explain why specific environmental

outcomes and resistance forms emerge in particular contexts (Martinez-Alier et al., 2021).

4 Toward a new generation of environmental justice scholars: bridging methods and expanding geographical insights

Environmental justice theory has evolved significantly, moving from focusing solely on distribution to embracing multiple dimensions of justice, such as recognition and participation (Schlosberg, 2007; Walker, 2009). This shift offers critical opportunities to address not only “where” injustices occur and “who” are the affected populations, but also “why” and “how” these injustices are created and perpetuated. However, these theoretical advancements have not been adequately addressed in empirical research, creating a bias between theory and practice (Sze & London, 2008; Schlosberg, 2007; Walker & Bulkeley 2006).

Quantitative methods have been instrumental in illustrating how environmental “goods” and “bads” are distributed, but they often fail to address deeper socio-historical processes. Conversely, qualitative methods offer depth and context, but frequently lack spatial analysis, thereby providing an incomplete understanding of environmental injustice. This division between the two approaches constrains our ability to understand the complexity of socio-environmental relationships. Other factors also contribute to the gaps in EJ research. First, the lack of interdisciplinary integration has prevented the incorporation of broader pluralistic justice frameworks. Second, operationalizing multidimensional environmental justice in a way that can be systematically measured or studied remains a challenge. As a result, scholars tend to rely on more traditional, quantifiable aspects of justice, such as distribution, while neglecting other crucial dimensions, such as socio-historical processes and lived experiences. Third, addressing these broader aspects requires a critical approach that challenges dominant narratives and digs deeper into structural issues.

A critical geographical approach has the potential to connect the multiple dimensions of environmental justice, bridging the gap between theory and practice in EJ research. I agree with Walker (2009) on the urgent need for a “new, imaginative, methodologically diverse, and theoretically pluralized” approach in geographical scholarship to advance the field. Drawing on critical geography theories, there are three key reasons why geographers should expand their engagement with environmental justice:

1. Space is not neutral; it is socially produced, and shaped by economic forces, social relations and power dynamics (Lefebvre, 1991; Massey, 2004; Smith, 2008; Soja, 2013). The disproportionate location of environmental hazards is thus not random, but results from social and political processes that make certain places “disposable” and expendable. The concept of “sacrifice zones” (Bullard, 2011; Lerner, 2010) is, therefore, a geographic notion about the production of space that encapsulates significant political, social, and historical connotations. Understanding environmental injustices as ongoing socio-historical processes, rather than isolated events, is crucial for moving beyond mere distributional metrics (Pulido, 1996).
2. According to Soja’s (1980) concept of the “socio-spatial dialectic,” space and society are in constant interplay, with each shaping the other. This dynamic

means that environmental injustices can perpetuate urban, social and economic inequalities. For instance, when places become stigmatized as “disposable,” they are more likely to be targeted for further environmental burdens, which perpetuates marginalization and hinders opportunities for development (Pellow, 2004; Walker, 2009). Space also operates on multiple levels, including political, institutional, and cultural, and at various scales, from local to national and from the body to the community (Walker, 2009). These intersecting spatialities imply that environmental injustice occurs through complex, multi-scalar processes that cannot be understood through a simplistic distributional lens.

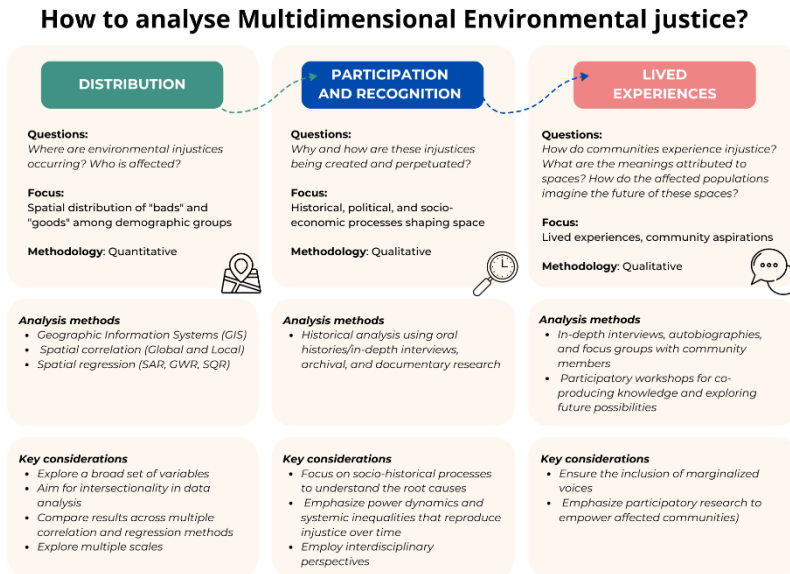
3. As Walker (2009) points out, simply documenting the unequal distribution of environmental goods and bads does not prove injustice, as environmental features are inherently uneven; what matters is the fairness of the processes by which these distributions occur and the opportunities available for communities to avoid or mitigate risks. Therefore, a meaningful assessment of environmental injustice must therefore include a deeper examination of the processes of exclusion and systemic power imbalances, ensuring that justice is understood as more than just distribution.

It is critical that the multidimensional nature of environmental justice be emphasized without discarding the traditional distributional focus. As noted by Young (1990), justice is inherently a balance between distribution, recognition, and participation (among potential others, I would add), and all elements must be addressed together as they are deeply interconnected, co-occurring, and mutually reinforcing.

To advance the field, a fourth-generation of environmental justice scholars should adopt mixed and multimethod approaches (Anguera et al., 2018; Hunter & Brewer, 2015), that combine quantitative and qualitative techniques. Such an approach connects the traditional focus on distribution with the newer, multifaceted geographies of justice, providing a fuller understanding of how injustices are produced, experienced, and addressed. Mixed and multimethod approaches can mitigate the limitations inherent in relying solely on either quantitative or qualitative methods, enhancing rigor and effectively addressing both the subjective and objective dimensions of research questions (Hawthorne, 2016). Spatial and statistical analysis can reveal where marginalized communities are disproportionately exposed to environmental hazards, while qualitative methods can shed light on the socio-historical processes and lived experiences underlying these injustices. Geography, with its focus on spatiality and intricate social and economic issues, is particularly well-positioned to facilitate this integration (Hawthorne, 2016).

The proposed framework for this approach is illustrated in Table 1, which details the different dimensions of justice and the methodologies that would be suitable to explore them, showing how quantitative and qualitative methods can be utilized in tandem to capture both the spatial distribution (“where” and “who”) and the socio-historical processes (“why” and “how”) that underlie environmental injustices.

Figure 1. Environmental justice research framework: toward a fourth generation of EJ scholars



Source: author’s elaboration

5 Conclusions

This critical review highlighted significant gaps and shortcomings in the existing literature on environmental justice, particularly regarding methodologies employed in both quantitative and qualitative studies.

The theoretical evolution of environmental justice – from focusing solely on distributional inequalities to a more complex, multidimensional understanding of justice – has yet to be adequately translated into empirical research, creating a persistent gap between theory and practice.

Quantitative research has been crucial in providing a clear, data-driven picture of how environmental “goods” and “bads” are distributed, with methodological innovations contributing to an ever richer understanding (e.g., Chakraborty et al., 2022; Rüttenauer & Best, 2021; Mennis & Heckert, 2017). Despite its strengths, quantitative studies often face several challenges, such as selecting the appropriate geographic scale, metrics, and statistical models, which often lead to disparate and contradictory conclusions and interpretations. The focus on methodological rigor has gone hand-in-hand with weak theoretical foundations (Pellow, 2000) and the inability to capture the socio-historical processes that shape these environmental injustices, resulting in a partial understanding of the complexities involved in EJ.

On the other hand, qualitative research has provided essential insights into lived experiences and structural forces shaping environmental injustices, offering a broader theoretical scope for understanding EJ (e.g., Armiero et al., 2019; Gay-Antaki, 2023; Gibson-Wood & Wakefield, 2013). However, EJ qualitative studies often lack

transparency, struggle with methodological rigor, and fail to adequately address spatial dimensions, thereby providing an incomplete understanding of environmental injustice.

The persistent separation between quantitative and qualitative research has limited the capacity of EJ studies to fully explore the intricate socio-environmental relationships involved, thus urging a more integrated approach that combines the strengths of both methodologies. Ultimately, overcoming the bias between conceptual and empirical approaches in EJ research requires embracing interdisciplinary integration and critical perspectives that challenge existing power structures and advocate systemic change.

This review also highlighted the missed opportunity for geography as a discipline to fully engage with the complexities of environmental justice (Walker, 2009; Walker & Bulkeley, 2006). The inherent spatial nature of environmental inequalities presents a unique opportunity for geographers to advance empirical research integrating the various dimensions of justice: distribution, participation, recognition and others. Critical geography, grounded in theories of spatial production, socio-spatial dialectics, and multiple spatialities, is well-positioned to examine how social and political processes shape places creating “sacrifice zones” where environmental burdens are disproportionately placed, and how certain places in turn shape social, political and economic dynamics.

The gaps identified in this review highlight the urgent need for a fourth-generation environmental justice scholars. This new generation should adopt a multidimensional framework and a mixed-method approach. This means integrating quantitative methods to analyze the “where” and “who” with qualitative approaches to explore the “why” and “how” of environmental injustices. Specifically, quantitative methods can be employed to analyze the distributional aspects, while qualitative methods can delve into the socio-historical contexts and lived experiences that shape these injustices. Such an integrated approach will not only bridge the gap between theory and practice, but also provide a more comprehensive understanding of how environmental injustices are produced, experienced and perpetuated. This will not only advance academic understanding but also have practical implications, informing policy and advocacy efforts aimed at fostering a more just and equitable society.

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A Appendix A Summary of reviewed literature

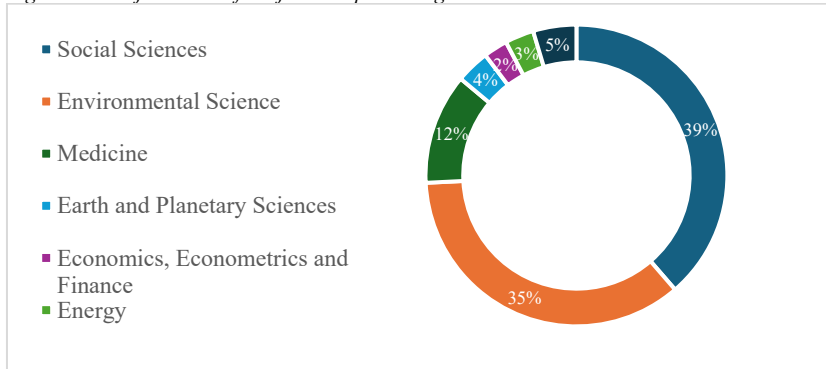
The journals included in this review are primarily published in the U.S. and U.K (both 42.3%), reflecting their significant contributions to environmental justice scholarship. Notably, a considerable body of work from the Netherlands (11.0%) also emerges. The remaining articles are published in Switzerland and India (Table A1). The journals in which the articles included in the review appear are mainly in the fields of “Social sciences” (38.7%) and “Environmental sciences” (35.6%) (Figure A1).

Table A1. List of journals of the articles included in the review: geographic area of publication and number of articles from each source

Journals	Count	Geographic area
American behavioural scientist	1	US
American journal of public health	2	US
Annals of the Association of American Geographers	4	US
Annual Review of Environment and Resources	2	US
Annual Review of Public Health	2	US
Antipode	6	UK
Applied Geography	1	Netherlands
Capitalism Nature Socialism	1	UK
Computers, Environment and Urban Systems	1	UK
Demography	2	US
Ecological Economics	4	Netherlands
Environmental and Ecological Statistics	1	Netherlands
Environment and Planning E: Nature and Space	2	US
Environmental Health Perspectives	2	US
Environmental Humanities	3	US
Environmental Justice	8	US
Environmental Management	1	US
Environmental Politics	2	UK
Environmental Research	2	UK
Environmental Research Letters	5	UK
Environmental Science & Policy	1	Netherlands
Epidemiologia e Prevenzione	1	Italy
Étude, a Multidisciplinary Research Journal	1	India
Exposure and health	1	Netherlands
Frontiers in Climate	1	Switzerland
Geoforum	3	UK
Geografiska Annaler: Series B, Human Geography	1	UK
GeoJournal	1	Netherlands
Geotema	1	Italy
Global Environmental Change	1	UK

Health & Place	1	UK
Health education & behavior	1	UK
Health, Risk & Society	1	UK
International Journal of Environmental Research and Public Health	2	Switzerland
Journal of Economic Perspectives	1	US
Journal of Environmental Planning and Management	2	UK
Journal of Environmental economics and management	1	US
Journal of Environmental Studies and Sciences	1	US
Journal of Political Ecology	2	US
Journal of Urban Affairs	1	UK
Landscape and Urban Planning	1	Netherlands
Local Environment	3	UK
Oxford Development Studies	1	UK
Pennsylvania Geographer	1	US
Population and Environment	2	Netherlands
Progress in Human Geography	1	UK
Qualitative Research Journal	1	UK
Qualitative sociology	1	US
Social Problems	1	US
Social Science Quarterly	2	UK
Sociology Compass	1	US
The Extractive Industries and Society	2	UK
The Geographical Journal	1	UK
The Journal of Peasant Studies	1	UK
The Professional Geographer	3	US
Urban geography	1	UK
<i>Total count</i>	<i>100</i>	

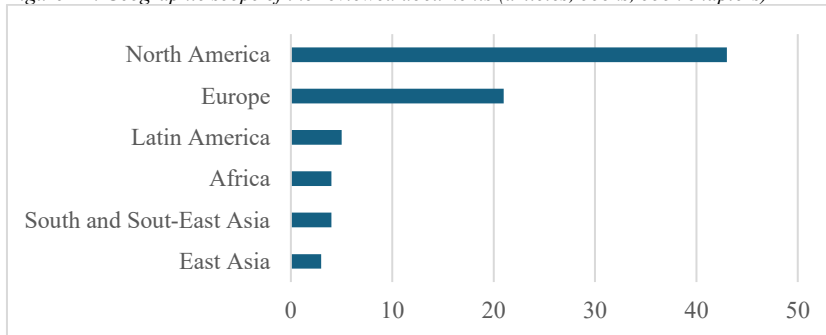
Figure A1. Subject areas of the journals publishing the articles included in the review



Source: author's elaboration

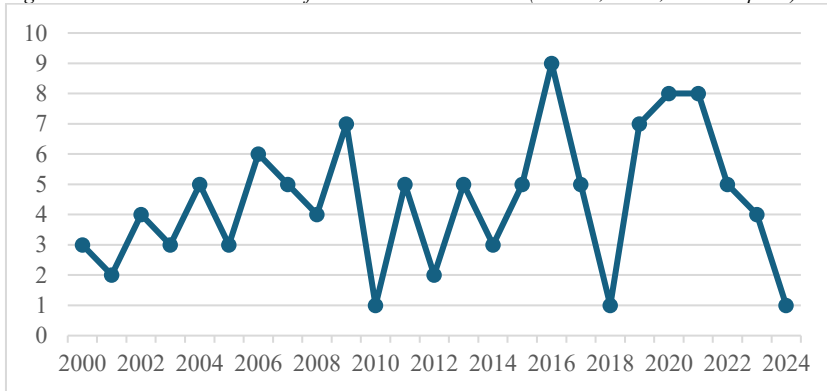
In addition to the 100 articles included, 7 books and 6 book chapters were also included in the review. The geographical scope of the reviewed documents themselves is diverse (Figure A2). The literature reviewed included case studies and analyses from regions around the world, including Europe, Latin America, Asia, and Africa. In Europe, the countries included are Italy, United Kingdom, Finland, Ireland, France, and Germany.

Figure A2. Geographic scope of the reviewed documents (articles, books, book chapters)



Source: author's elaboration

The review included articles published between 2000 and 2024, with a larger number of articles published in 2009, 2016 and 2021 (Figure A3).

Figure A3. Concentration in time of the reviewed documents (articles, books, book chapters)

Source: author's elaboration