

ADVANCED REVIEW

A critical review of disproportionality in loss and damage from climate change

Kelly Dorkenoo¹  | Murray Scown^{1,2}  | Emily Boyd¹ 

¹Lund University Centre for Sustainability Studies, Faculty of Social Sciences, Lund University, Lund, Sweden

²Copernicus Institute of Sustainable Development, Utrecht University, Utrecht, Netherlands

Correspondence

Kelly Dorkenoo, Lund University Centre for Sustainability Studies, Faculty of Social Sciences, Lund University, Lund, Sweden.

Email: kelly.dorkenoo@lucsus.lu.se

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Abstract

The notion of disproportionate impacts of climate change on certain groups and regions has long been a part of policy debates and scientific inquiry, and was instrumental to the emergence of the “Loss and Damage” (L&D) policy agenda in international negotiations on climate change. Yet, ‘disproportionality’ remains relatively undefined and implicit in science on loss and damage from climate change. A coherent theoretical basis of disproportionality is needed for advancing science and policy on loss and damage. It is necessary to ask: What is disproportionate, to whom, and in relation to what? We critically examine the uses of disproportionality in loss and damage scholarship by analyzing how disproportionality is treated in the literature conceptually, methodologically, and empirically. We review publications against a set of criteria derived from seminal work on disproportionality in other fields, mainly environmental justice and disaster studies that have analyzed environment–society interactions. We find disproportionality to be dynamic and multidimensional, spanning the themes of risks, impacts, and burdens. Our results show that while the concept is often used in loss and damage scholarship, its use relies on unarticulated notions of justice and often lacks conceptual, methodological and empirical grounding. Disproportionality also appears as a boundary concept, enabling critical and multiscale explorations of historical processes that shape the uneven impacts of climate change, alongside social justice and normative claims for desired futures. This emerging area of science offers an opportunity to critically re-evaluate the conceptualization of the relationship between climate-change-related impacts, development, and inequality.

This article is categorized under:

Climate, Nature, and Ethics > Climate Change and Global Justice

Climate and Development > Social Justice and the Politics of Development

KEYWORDS

climate change, climate justice, development, inequality, loss and damage

1 | INTRODUCTION

The notion of disproportionate impacts of climate change on certain groups and regions has long been part of science and policy debates. In its fifth assessment report, the Intergovernmental Panel on Climate Change (IPCC) states that “the socially and economically disadvantaged and the marginalised are disproportionately affected by the impacts of climate change and extreme events” (Olsson et al., 2014, p. 802). ‘Disproportionality’ is a central and contentious element of international negotiations on climate change. It was instrumental to the emergence of Loss and Damage (L&D)¹ as a concept and political debate in global policy processes, and the Warsaw International Mechanism for Loss and Damage (WIM), which aims to address losses and damages associated with the impacts of climate change. Within the realm of climate policy, L&D mostly refers to discussions on the negative manifestations of climate impacts that occur despite (failed or insufficient) adaptation to climate change (UNFCCC, 2012; Warner & der Geest, 2013). More broadly, in science, loss and damage (l&d distinct from L&D in policy) refers to harm to individuals, societies, or the environment resulting from observed climate-related impacts and projected risks (IPCC, 2018). Along with the creation of the WIM, the inclusion of L&D in the Paris Agreement in 2015 is the outcome of decades of advocacy by negotiators and national civil society representatives, particularly small island developing states, that identify as being disproportionately impacted by climate change while having contributed minimally to it (Roberts & Huq, 2015).

Claims of disproportionality are used in scholarship on loss and damage from climate change, but the concept remains largely implicit and underexplored. In both L&D and science on loss and damage, discussions on disproportionality have mostly revolved around the classic divide between Global North and Global South, along the lines of historical responsibility and current and future financial resources. However, disproportionality does not only happen at the scale of nations, nor does it manifest exclusively in monetary terms. Equally, impact does not equate to loss and damage, nor vice versa; and a loss for someone is not necessarily a loss for others. Against this background, a coherent theoretical basis of disproportionality becomes necessary for advancing science and policy on loss and damage from climate change.

In its most basic definition, disproportionality, or disproportionate, describes something that is “too large or too small when compared with something else” (Oxford University Press, 2021). More broadly, it can also refer to a sense of unfairness or injustice (Pomerleau, n.d.). Scientifically and philosophically, the concept has been thoroughly developed in a number of fields, most notably environmental and climate justice (Been, 1994; Perhac, 1999), risk and vulnerability studies, and political economy (Freudenburg, 2006; Freudenburg et al., 2009; Nowak et al., 2006; Wisner et al., 2004), with particular attention to disproportionate impacts from environmental hazards or changes on certain places and groups.

Departing from insights from seminal work in these other fields, we identify key analytical themes and criteria relevant to an analysis of disproportionality in the context of loss and damage from climate change. We take stock of the emerging strands of loss and damage scholarship, and systematically assess their use of disproportionality by asking how the concept is treated, conceptualized, and operationalized. We critically review the use of disproportionality in loss and damage scholarship against key themes and criteria, examining how scholars engage with the concept conceptually, methodologically, empirically. In doing so, we evaluate the conceptual and methodological relevance of disproportionality, and identify critical knowledge gaps in an emerging area of science. Providing the first comprehensive review of disproportionality in the literature of loss and damage from climate change, we make a key contribution to advancing science and policy debates on climate-society interactions.

2 | THE ROLE OF DISPROPORTIONALITY IN THE EMERGENCE OF LOSS AND DAMAGE AND WHY IT MATTERS

The first reference to loss and damage in global policy discussions appeared in 1991, in a proposal from the Alliance of Small Island States (AOSIS) to develop a fund and insurance mechanism against loss and damage from climate-related impacts of sea-level rise (Roberts & Huq, 2015). Since then, advocacy efforts to develop an L&D policy agenda have continued, centering on disproportionality in impacts, capacities, and responsibilities, as illustrated in the description of the so-called Least Developed Countries Group: “made up of the 47 poorest countries in the world, which contribute the least to climate change, yet disproportionately suffer from its ever-increasing impacts.” (Wangdi, 2021). Through almost 30 years of significant climate advocacy efforts, L&D was integrated into the Paris Agreement in 2015, becoming a third pillar in climate change negotiations alongside mitigation and adaptation.

Despite not being formally defined, L&D as a concept has been used to emphasize that it is no longer sufficient to talk about impacts of climate change in the neutral sense, as “consequences or outcomes” that “can be adverse or beneficial” (IPCC, 2018, p. 551). Instead, it underscored that these (unavoidable) impacts translate into losses and damages that are temporary or permanent, affecting the environment, people, and societies negatively. In doing so, L&D has also shone a light on the deep inequalities embedded in the distribution of these impacts (between developed and developing countries) and, in particular, the presence of disproportionality.

Scientific scholarship on loss and damage (see footnote 1) from climate change emerged and evolved alongside, but has become increasingly distinguished from, L&D as a term and debate in the context of global international policy processes (IPCC, 2018). This scholarship is advancing, articulated through a growth of diverging perspectives and strands of research (Boyd et al., 2017; McNamara & Jackson, 2019). Increasingly, losses and damages (intangible/tangible, economic/non-economic, human and natural) are being conceptualized as adverse consequences of climate impacts when adaptation does not happen, or fails, and even as resulting from a longer chain of failures to mitigate, adapt, and sustainably develop globally (Boda et al., 2020); and with this come questions of inequality and disproportionality.

Disproportionality as a concept is not novel. It appeared long ago and in a broad array of disciplines, including economics (Marx), medicine, psychology, and sociology (Nowak et al., 2006). Scholars have used it to emphasize outliers and capture the effect or impact of one factor on another, or on the system in which it operates. For instance, disproportionate impacts of environmental hazards on certain groups have been at the core of environmental justice scholarship and movements in the United States (Lee, 2021). Disproportionality in impacts of climate change is also documented in the scientific work of the IPCC Working Group II (impacts, adaptation, and vulnerabilities), which has informed much of the advocacy and debates on L&D in international negotiations on climate change. Disproportionality as a concept is closely linked to questions of justice and equity; for some, it is what makes climate change a social justice issue (Bullard et al., 2016). However, the concept of disproportionality in loss and damage scholarship remains largely implicit, and scholars rarely engage conceptually, or critically, with the term.

The conceptualization of disproportionality has concrete implications for scholarship and policy on climate change; it influences how the problem is framed, represented, addressed, and who gets to participate in producing that knowledge in the first place (Barnett, 2020; Gaillard, 2019; Vanhala et al., 2020). It is critical to render more explicit the assumptions about what qualifies as disproportionate.

3 | A FRAMEWORK FOR THE DISPROPORTIONALITY CONCEPT

To analyze disproportionality in loss and damage literature, we begin by reviewing its use in other scholarship and identify key elements important to disproportionality. At its core, research on loss and damage from climate change focuses on interactions between the environment (in particular, the climate) and human society, and, more broadly,

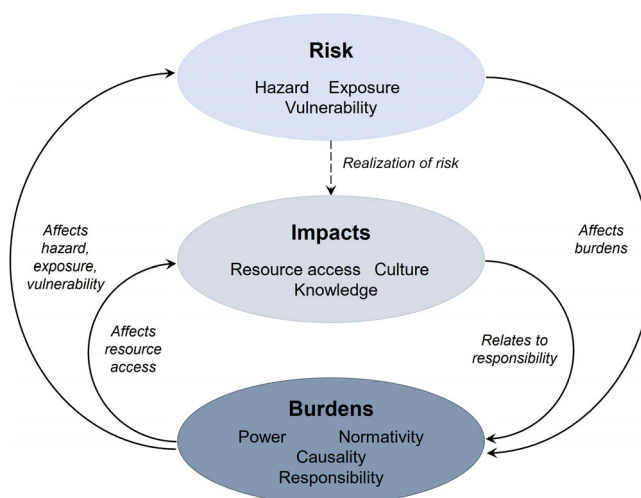


FIGURE 1 Three themes through which we analyze disproportionality in loss and damage scholarship: risk, impacts, and burdens. The themes are interconnected and not mutually exclusive, and issues of governance span all three

between development and inequality (Boyd et al., 2021). It is around this relationship that we anchor our analytical framework. We take the conceptualization of disproportionality in risk science as a point of departure, and supplement it with concepts from other fields, including environmental justice and political economy, to develop a comprehensive analytical framework that we then apply to loss and damage scholarship. We identify three overarching analytical themes for disproportionality in the literature: risk, impacts, and burdens (Figure 1). These three core analytical themes are interconnected; their respective dimensions affect and relate to one another; thus, divisions created in this framework are used only to guide our review process. Similarly, issues of governance span all three themes.

3.1 | Disproportionality in risk

The conceptualization of disproportionality in *risk* centers on the relationship between hazards, exposure, and vulnerability; in particular, the role of environmental conditions and governance in influencing how people and places are exposed, and vulnerable to, climate hazards. It emphasizes the importance of jointly examining environmental and social factors of exposure and vulnerability, and, in particular their interconnections with political-economic factors (Freudenburg et al., 2008; Nowak et al., 2006).

Risk generally represents the “potential for adverse consequences” to human or ecological systems (Reisinger et al., 2020, p. 5). The risks of climate-related impacts are influenced by exposure and vulnerability, in particular, the physical and environmental conditions of a place, and the social, economic, and political processes, such as the type of governance and development pursued. Climate, topography, landforms, and geomorphology are factors that mediate environmental hazards. Exposure to cyclones varies for people settled along coasts or inland, as well as for places in tropical, compared to temperate, latitudes. In relation to climate change, populations living in tropical deltas have been identified as disproportionately exposed to climate hazards (e.g., cyclones, storm surge, and flooding), due to low elevation and geomorphic factors such as low sedimentation (Edmonds et al., 2020).

Geographic patterns of exposure to climate-related hazards are not random. Movements of people, livelihood patterns, and modifications of the natural environment through human activity are influenced by governance, and socio-economic development processes (Wisner et al., 2004). Disproportionality can result from political-economic factors; for instance, the prioritization of certain economic benefits through infrastructure development, which increase the degree of exposure or vulnerability to climate hazards, particularly extreme weather events (Freudenburg et al., 2009). Similarly, sedimentation processes in deltas can be affected by human activities such as the development of renewable energy infrastructures (i.e., hydropower dams) (Dunn et al., 2019), ultimately impairing deltas' ability to maintain their elevation above sea level, thus increasing exposure of their inhabitants to flooding and salinization.

3.2 | Disproportionality in impacts

Impacts can be thought of as the consequences associated with realized risks, thus as distinct from risk (IPCC, 2018). The type and consequences of impacts from hazards on people and places differ. For example, scholars have highlighted the need to better account for the differentiated experiences of indigenous, ethnic, gender, and sexual minorities in disasters (Bolin & Kurtz, 2018; Fordham, 1998; Gaillard et al., 2017; Jackson, 2021; True, 2016). When disproportionality in impacts occurs, it is often mediated by socio-economic processes. Characteristics of individuals or groups (e.g., gender, ethnicity, sexuality, health, or economic status) influence their capacity to cope, adapt, or recover from the impacts of hazards such as climate-related events (Adger, 1999; Cutter et al., 2003; Wisner et al., 2004). Structural drivers of socio-political and economic nature condition access to resources that are necessary to deal with the impacts of hazards, and lead to differentiated experiences of similar levels of physical change (K. Thomas et al., 2019).² Resource access, for instance, can be defined along the lines of race, caste, gender, and economic status (K. Thomas et al., 2019). The way these categories interact to create social difference (discrimination, disadvantage, or privilege) is often analyzed through the concept of intersectionality, which originates in feminist scholarship (Perkins, 2018). Patterns of resource access and exclusion can be assessed at an individual or collective level, at the scale of communities, regions, or nations (Adger, 1999).

Beyond resource access, identity, culture, and knowledge are central to understanding differentiated experiences and degrees of harm from impacts (K. Thomas et al., 2019). Climate change can reinforce or challenge social categorizations defined by power-structures, and their effects at different scales (Kaijser & Kronsell, 2014). An individual or a

group's situatedness, as Kaijser & Kronsell (2014, p. 422) explain, can be the source of specific (but not fixed) knowledge derived from “material and ideational” experiences. Cultural aspects, such as values and beliefs, can affect how people experience environmental change and exposure to climate hazards (Adger et al., 2009; McNeeley & Lazrus, 2014). Specific knowledge acquired by a group or individual can be differentially impacted by climate-related hazards, for instance, by altering or removing people from ancestral lands and sites central to their knowledge system (Adger et al., 2011).

3.3 | Disproportionality in burdens

In environmental justice scholarship, beyond impacts, *burdens* and responsibilities are key elements of disproportionality. Burdens can, for example, be environmental, economic, or health-related, whereas responsibilities can refer to duty of care, liability or accountability (Cutter, 1995; Juhola, 2019). By locating disproportionality within power struggles, as a matter of distribution of burdens and responsibilities, and emphasizing root causes, insights from environmental justice contribute to counter the apolitical framing generally associated with vulnerability in risk science (Ford et al., 2018). In doing so, an environmental justice framing enables greater consideration of cross-scale interactions and normative aspects.

The distribution of burdens associated with risks and impacts is uneven and power-laden (S. Eriksen et al., 2015). It is related to issues of causality, responsibility, and normativity. Those who hold greater power (social, economic, political) have the ability to influence structural drivers of the unequal distribution of environmental burdens and benefits, often by marginalizing some groups in society. Spaces of marginalization can be geographical, social, economic, and political (Wisner et al., 2004), and, as illustrated in the context of disasters, those affected tend to be “disproportionately drawn from the segments of society, which are chronically marginalised in daily life” (Gaillard, 2010, p. 222).

By questioning the standard against which we measure disproportionality, an environmental justice perspective also allows us to explore normative considerations, specifically: what alternative distribution of burdens and responsibilities would be desirable and in which context. An area where climate change and vulnerability scholarship often comes short is its failure “to assess the effects of environmental and social change against a standard of culturally relevant wellbeing or flourishing, rather than mere physical survival” (K. Thomas et al., 2019, p. 10).

4 | METHODOLOGY

We adopt the format of a systematic critical review. Criticality is here understood as a mode of inquiry that seeks to highlight the gaps and shortcomings of a specific body of knowledge (Grant & Booth, 2009). Our aim is to identify

TABLE 1 Step-by-step overview of review process (adapted from Berrang-Ford, 2015; Enríquez-de-Salamanca et al., 2017; Woroniecki et al., 2019)

Steps	Procedure	Results
1. Data gathering	Searches in Scopus and Web of Science	1561 potentially relevant papers (with duplicates)
2. Data screening	Articles are screened according to scope (title and abstract) and access	468 articles remaining
3. Data cleaning	Articles from both databases are merged, duplicates are removed. Articles are downloaded and screened a second time. Results are compared with set from previous literature review	205 articles including 1 found through comparison with set from Boda et al. (2020)
4. Article classification	Articles are classified according to different strands in the literature	Six strands are identified
5. Analysis part I	Analysis of treatment of disproportionality in the literature using Nvivo (text search function)	99 articles deal with disproportionality; 63 articles conceptualize or operationalize disproportionality (36 articles mention it anecdotally—excluded)
6. Analysis part II	Analysis of disproportionality in literature through analytical framework	63 articles are analyzed

where knowledge on disproportionality in loss and damage comes from, characterize this knowledge, and, finally, identify its limitations in relation to conceptualizations of disproportionality in other research fields while highlighting its implications for science and practice. Our step-by-step approach is summarized in Table 1.

To do so, we investigate how loss and damage scholarship relates to, conceptualizes and operationalizes disproportionality through the following questions:

- i. *Treatment of disproportionality.* What proportion of loss and damage literature addresses disproportionality, and in which strands of the literature? How is disproportionality treated: is it mentioned, conceptualized or operationalized?
- ii. *Conceptualization and/or operationalization of disproportionality.* How is disproportionality conceptualized or operationalized? What methods do the articles adopt, and how do their analyses treat scale?

4.1 | Data sources and document selection

The focus is on understanding the conceptual and theoretical uses of disproportionality in the context of loss and damage research. Thus, we search for evidence and/or treatment of disproportionality in scientific literature only, limiting our sources to peer-reviewed journal publications (book chapters were excluded, to reduce duplication of content) in English and French. We look at scholarship centered on losses and damages from the impacts of climate change, as it has emerged alongside the concept of L&D in international negotiations on climate change.

To reflect our scope and aim, searches were conducted in two databases, Web of Science and Scopus, with the terms: (1) “loss and damage” AND “climate change,” (2) “compensation” AND “climate change.” These terms were selected because they represent the different ways that loss and damage is conceptualized in policy and science, and represented in the literature; for instance, in policy, loss and damage is most often associated with compensation. The time span for the searches was 2009–2020, and the final sample of 205 articles was determined in 2013–2020. The cut-off date for the search was December 14, 2020.

4.2 | Strands of loss and damage research

To reflect the broad approaches to loss and damage scholarship and provide greater nuance to our analysis, we began by clustering different strands of research within the 205 articles on loss and damage. Using keywords, journal name, and previous reviews on loss and damage scholarship (Boda et al., 2021; Boyd et al., 2017; McNamara & Jackson, 2019), six different strands were identified: justice, ethics and law; risk and vulnerability; loss and grief; development; climate policy; and other. The 205 articles were classified according to these six strands; each article was classified into one strand only (See Supporting information). When one article overlapped two categories, critical appraisal was used to determine the most relevant strand.

4.3 | Treatment of disproportionality

We then searched the articles for mentions of disproportionality, noting both implicit and explicit uses of the concept, using the word search function in Nvivo 12, including exact matches, stemmed words and synonyms. To delimit our search scope, we searched for “disproportionality or inequality”, two terms broadly representing the dictionary definition of disproportionality (Pomerleau, n.d.; Oxford University Press, 2021); this included stemmed words and synonyms such as “inequities” and “unfair.” Through this search, we further narrowed our set of articles from 205 to 99. These 99 articles represent all the loss and damage literature we could find that engages in some way with the concept of disproportionality.

Finally, we performed a manual analysis of each occurrence of the terms within their context (in the 99 articles) to determine whether it was anecdotal, conceptualized, or operationalized:

- *Anecdotal reference:* mentioned but not used in any meaningful way in analysis or argument.
- *Conceptualized:* embedded in a broader conceptual framework and discussion on the topic.

- *Operationalized*: researched or empirically demonstrated through methodological choices.

Out of the 99 articles, 63 conceptualized and/or operationalized disproportionality, and 36 contained anecdotal references to it.

4.4 | Conceptualization and/or operationalization of disproportionality

To review knowledge on disproportionality in loss and damage literature, we analyzed and coded the remaining 63 articles in Nvivo according to the three themes in the analytical framework (Figure 1), and the associated dimensions of each theme (Table 2). In addition, to analyze how disproportionality is operationalized, we examined the methods and scale of analysis across all themes. To support the analysis, the codes selected for each dimension were purposefully kept broad and overarching (i.e., “socio-economic and political characteristics” instead of income, ethnicity, caste, gender, sexuality) to support the analysis.

5 | RESULTS: UNDERSTANDING DISPROPORTIONALITY IN LOSS AND DAMAGE

5.1 | Treatment of disproportionality

Approximately half of the 205 loss and damage articles reviewed engage with the concept of disproportionality, representing the final set of 99 articles that were analyzed in detail. Out of all research strands, “justice, ethics, and law” is most focused on disproportionality, mentioned by 69% of articles within this strand, followed by the “loss and grief”

TABLE 2 Overview of themes, dimensions and codes associated with the analytical framework used in the Nvivo analysis

Analytical theme	Dimensions	Associated codes
Risk	Hazard; exposure; vulnerability	Climate hazards; environmental conditions; governance; scale; methods
Impacts	Resource access; culture; knowledge	Socio-economic and political characteristics; Identity and culture; knowledge; impacts; scale; methods; governance
Burdens	Power; causality; responsibility; normativity	Power; causality; responsibility; normativity; scale; methods; governance

TABLE 3 Different attention paid to disproportionality across the six strands of loss and damage research reviewed

Research strand (n)	% of all articles within each strand mentioning disproportionality	% of the 99 articles mentioning disproportionality coming from each strand
Justice, ethics, and law (70)	69% (48/70)	48% (48/99)
Loss and grief (22)	55% (12/22)	12% (12/99)
Development (16)	44% (7/16)	7% (7/99)
Risk and vulnerability (57)	35% (20/57)	20% (20/99)
Other (12)	33% (4/12)	4% (4/99)
Climate policy (28)	29% (8/28)	8% (8/99)
Total (205)	48% (99/205)	

Note: Numbers of articles in each strand are shown (total, and number that mention disproportionality), and percentages are shown relative to the total 99 articles in the final analysis set, and to the size of each strand.

(55%) and “development” (44%) strands (Table 3). About a third or fewer articles within the remaining strands engage with the concept. Our results show that most of our knowledge on disproportionality in loss and damage is coming from the “justice, ethics and law” (48%) and “risk and vulnerability” (20%) strands of the literature. Very few of the 99 articles addressing disproportionality came from other strands (Table 3).

About a third of the articles (33%) treat disproportionality only anecdotally, 46% conceptualize it, and 21% operationalize the concept. The degree to which disproportionality is conceptualized and operationalized varies across the research strands (Figure 2). Disproportionality is most often operationalized in strands of literature on “risk and vulnerability” (45%) and “development” (43%), whereas it is predominantly conceptual in “loss and grief” (67%) and “justice, ethics, and law” (54%) (Figure 2).

5.2 | Conceptualization and operationalization of disproportionality

5.2.1 | Disproportionality in risk in the loss and damage literature

Disproportionality in risk in the loss and damage literature predominantly appears in discussions of changes in the magnitude, frequency and combination of hazards, and the presence of “hotspots,” where conditions of exposure and vulnerability are particularly challenging. Disproportionate risk is most often operationalized at national and regional scales, and via the use of modeling tools.

The literature highlights changes in events and phenomena such as ocean heatwaves (Licker et al., 2019), cyclone induced storm surges that cause saline intrusion (Rabbani et al., 2013), sea-level rise exacerbating coastal erosion (Monnereau & Abraham, 2013), harvest losses caused by changes in precipitation patterns (Lassa et al., 2016). Emphasis on combinations of events is also present, with some literature focused on regions experiencing combined slow onset and extreme weather events (Noy, 2017; Rabbani et al., 2013), or repetitive, cyclical exposure to drought and floods (Chandra et al., 2017). The magnitude of risk is also discussed; for some regions (e.g., small island nations), cyclical dynamics over time and spatial concentration of hazards (through compounded risk) can pose an existential threat in all aspects of life (A. Thomas et al., 2020).

Disproportionality in risk is also expressed through the degree of unpredictability and uncertainty characterizing the relationship between the hazard on a global level and its manifestation at localized levels. Verchick (2018, pp. 2, 8) warns of potential “outsize” or “big ticket” impact in specific geographic regions, resulting from a surge effect of

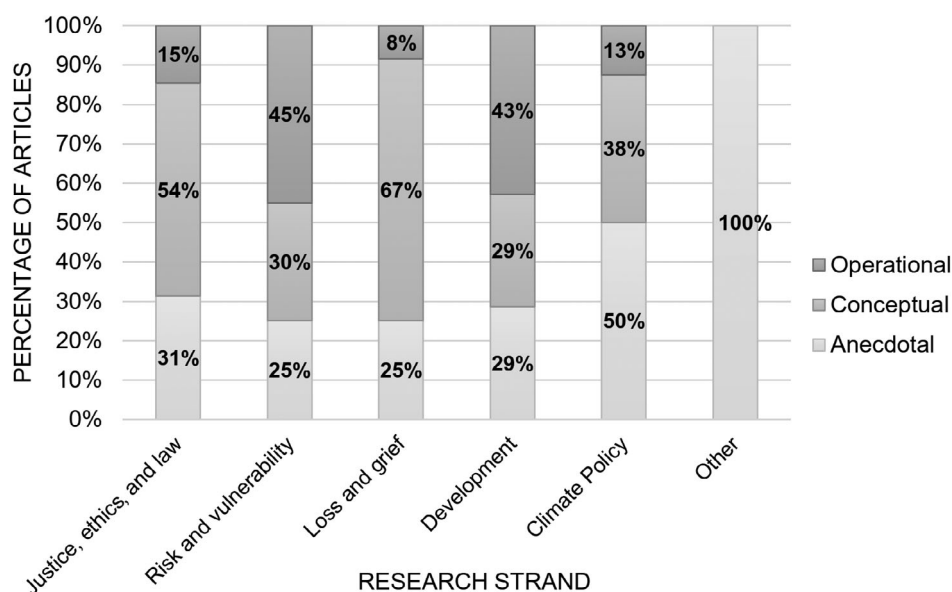


FIGURE 2 Degree to which disproportionality is treated anecdotally, conceptualized, or operationalized across six identified research strands. The figure shows proportions of articles per strand, out of those articles that engage with the concept in any way (see Table 3 middle column)

climatic hazards induced by the difference between a global temperature of 1.5 and 2°C. Chandra et al. (2017, p. 47), referring to previous studies, give an example of how disproportionate risk from temperature change can unfold locally, noting that a “1°C increase in growing season/night-time temperature can cause a corresponding loss of rice yield and biomass by 10 percent in Philippines.”

Regional and local environmental conditions shape exposure to climate hazards, and lead some regions to being identified as potential hotspots. This is the case for small islands, with their low land elevation, remoteness, insularity, and small land area (Monnereau & Abraham, 2013; Noy, 2017). Coastal areas and their associated livelihood activities also feature prominently, due to their high socio-economic importance and simultaneous exposure to multiple hazards, such as salinity intrusion, flooding, cyclones, and erosion exacerbated by sea-level rise (Ignacio et al., 2015; Licker et al., 2019; Rabbani et al., 2013). Similarly, mountain areas with risk of cascading impacts appear as potential hotspots (Huggel et al., 2020; Motschmann et al., 2020).

Disproportionate risk to societies from climate change is often associated with a degree of vulnerability related to level of development, and governance aspects; authors identify low-income countries as particularly vulnerable (Page & Heyward, 2017; Pretis et al., 2018). These countries are generally perceived as more exposed, due to the greater dependence of their economies on natural capital (Burkett, 2014). Socio-economic processes, such as population growth and movement, as well as urbanization, can affect exposure (Noy, 2017); governance influences populations' exposure by, for instance, determining what locations are considered unsafe and enforcing (or not) zoning regulations (Huggel et al., 2020). However, limits to what governance can achieve appear, particularly in islands states, where, without a reduction of global emissions, displacement increasingly becomes inevitable (Wewerinke-Singh & Van Geelen, 2018).

Disproportionality in risk is investigated spatially and temporally, often through models attempting to take into account historical elements and cross-scale interactions; these aim to determine current and projected changes, and their potential to create differentiated losses and damages, over time and across regions. For example, interactions between global and local drivers of climate risks are examined using a causation chain method to identify risks of “cascading impacts” (Huggel et al., 2020). Historical analysis in empirical case studies is also quite prevalent as a way to review the socio-economic processes underpinning current exposure, vulnerability, and experiences of climate-related hazards and their impacts (Ayeb-Karlsson, 2020a; Motschmann et al., 2020). Licker et al. (2019, p. 12) adopts a regional approach, and highlights the temporal aspect of climate-related risks by highlighting of the potential effect of “lags in the carbon cycle,” where impacts related to historical emissions have yet to appear; in some regions, effects are expected in the next 20–30 years.

5.2.2 | Disproportionality in impacts in the loss and damage literature

Disproportionality in impacts in loss and damage literature is largely seen as linked to, or resulting from, poverty. Beyond poverty, authors identify several social “categories,” particularly gender, age, and indigeneity, that can interact with climate (and non-climate-related) events to create disproportionate impacts. In this view, pre-existing conditions determine capacity to respond, and climate change comes as an add-on, reinforcing or exacerbating existing patterns of inequality that affect certain groups (Gach, 2019; Huggel et al., 2020; Williams, 2019) by conditioning access to social capital, assets and resources (e.g., insurance), and threatening livelihoods (Bahinipati & Patnaik, 2020; Ghahramani et al., 2020; Motschmann et al., 2020).

Poverty is, however, often largely undefined, and equated to vulnerability, wherein “the poor,” “low-income populations,” or “the most vulnerable” are identified as disproportionately affected (Elliott, 2018; Nordlander et al., 2020; Noy, 2017; Page & Heyward, 2017; Pretis et al., 2018; Roberts & Andrei, 2015). When specified, the role of poverty is analyzed in relation to livelihoods and capabilities, whereby direct socio-economic dependence on environmental resources can induce disproportionate impacts (Licker et al., 2019). Rabbani et al. (2013) empirically demonstrate how poorer rice-farming households are disproportionately affected by storm-induced salinity intrusion, losing a greater percentage of their income. Disproportionate impacts also manifest through aspects other than income, and failure to recognize that those who live in lower-income nations and/or in conditions of subsistence “meet a large portion of their needs non-economically” can create epistemological injustice (Tschakert et al., 2019, p. 69). This is particularly relevant for indigenous groups, who are disproportionately represented in the world's poor, and extreme poor (Comberti et al., 2019). Lyster (2017) points to the temporal dimension associated with poverty and its disproportionate effects through the so-called “vulnerability trap,” and describes how those living in poverty rapidly exhaust their limited resources in attempting to recover from climate-related impacts, undermining households' overall sustainability and

wellbeing over time by fundamentally destroying their capabilities. These effects also manifest through migration and mobility patterns. In agrarian contexts, the impacts of climate events can lead to women being subjected to forced migration, or being “left behind” by spouses in search of work opportunities to cope with losses (Chandra et al., 2017; Mair, 2014, p. 208). Conversely, being left behind can lead to further immobility in the context of climate-induced displacement (Ayeb-Karlsson, 2020a).

Disproportionality in losses and damages from climate-related impacts are particularly likely for those whose wellbeing (physical, social, and cultural) is closely related to the environment (Roberts & Andrei, 2015, p. 262), and “whose cultural identities are tied to vulnerable biophysical processes and places” (Sonja & Harald, 2018, p. 4). Existential threats to some places can violate rights to culture and (epistemic) self-determination, especially for groups whose losses are not recognized (Ourbak & Magnan, 2018; Werkheiser, 2017). This is particularly pertinent for populations in small island nations, who, although their homelands and nationalities are in peril, are not entitled to another territory (Adelman, 2016), and for indigenous people, who make up the most of cultural diversity in the world (Comberti et al., 2019).

Disproportionate effects also depend on how people and governments respond to climate-related impacts. Relocation (as a solution to exposure) can lead to profound losses, such as loss of sense of place, spirituality, knowledge, and cultural heritage, or even the disappearance of entire cultures (Adelman, 2016; Burkett, 2014; Monnereau & Abraham, 2013). McNamara et al. (2021) find that displacement due to climate events can disproportionately affect women, children, and the elderly, through loss of livelihoods and socio-cultural activities; additionally, fear of relocation can last a lifetime, with severe consequences on mental health. Loss of socio-cultural systems, or cultural erosion, also takes place as a slow and pervasive process that alters communities’ capacities to adapt and (culturally) persist, for example, by reducing their ability to be self-sufficient and secure food through traditional methods (Werkheiser, 2017).

The role of knowledge in the creation of disproportionality in impacts is also prominent, often interlinked to methods and scale, and through recognition; certain processes render some impacts and associated losses invisible. The exclusion of non-economic losses and damages in many models systematically discounts certain groups’ experiences, and obscures disproportionality. As Sonja and Harald (2018, pp. 6) highlight, the “loss of land from sea-level rise is entirely different for an indigenous community than for someone who purchased oceanfront property as a financial investment”. Certain social groups “far from centres of power” can suffer a loss of epistemic self-determination, wherein the “human side of socio-ecological systems becomes much less localised, and intervening in global institutions sometimes requires relying on analyses made by distant others and presented fully formed.” (Werkheiser, 2017, p. 163).

Disproportionality in impacts, and losses and damages, is examined through a variety of methods and at different scales. Models often rely on global data sets of losses and damages, such as Desinventar, or census data at the national scale (Ignacio et al., 2015; Lassa et al., 2016). However, models in this literature are limited, and potentially obscure disproportionality due to their inability to capture differences in people’s experiences, even within a same community or location (Ohdedar, 2016; Sonja & Harald, 2018). To alleviate this problem, some studies rely on a mixed-methods approach, using existing quantitative data and projections from climate science (often from IPCC), and qualitative data obtained through interviews and focus group discussions in the regions studied (Chandra et al., 2017; Monnereau & Abraham, 2013; Motschmann et al., 2020; Rabbani et al., 2013). Ethnographic storytelling and in depth-interviews are also used to explore individuals’ differentiated experiences, especially un-measured and often non-economic forms of loss and damage (Ayeb-Karlsson, 2020a).

5.2.3 | Disproportionality in burdens in the loss and damage literature

Disproportionality in burdens in the loss and damage literature is most often discussed as an injustice resulting from power imbalances, whereby those who are least responsible for climate change (currently and historically), are disproportionately burdened by it (Adelman, 2016; Allan & Hadden, 2017; Boran, 2017; Burkett, 2016; A. Thomas et al., 2020; Williams, 2019).

Processes of marginalization and exclusion influenced by power struggles, and their role on disproportionality are particularly prominent in the loss and damage literature (Dehm, 2020; Toussaint & Martínez Blanco, 2020; Werkheiser, 2017). Such processes influence the distribution of burdens and consequently responsibilities, in addition to the different dimensions of climate risk (hazard, exposure, vulnerability). Authors refer to the role and type of development pursued as a root cause of climate-related hazards themselves, and hence of increased exposure globally. For

Comberti et al. (2019), it is the domination of “modern western knowledge systems” over other systems of knowledge that determine the path of development pursued globally. This highly unequal form of development, heavily reliant on greenhouse gas emissions and the exploitation of the atmosphere, has disproportionately benefitted industrialized countries. This inequality is illustrated by the concept of climate debt (Ciplet, 2017).

Globally, and at the level of nations, disproportionality in burdens and responsibilities is discussed in terms of development, mitigation, and adaptation processes. As Eckersley (2015, p. 487) states, climate change puts some countries in a “tragic dilemma” by forcing them to either give up on the same opportunities for development (as industrialized countries have had), or risk suffering a disproportionate burden from the consequences of climate change. Current policy and legal frameworks do not allow for a fair distribution of the cost burden (Arevalo Garcia, 2020). Those who have contributed the least to the problem may also have least capacity to face it (A. Thomas et al., 2020). A lack of mitigation by some can increase the adaptation burden for others (Sonja & Harald, 2018). Despite their minimal contribution to climate change, small and low-income nations will have to reallocate resources “away from economic development and poverty alleviation” to address these costs (Monnereau & Abraham, 2013, p. 417). Currently favored instruments in loss and damage policy (e.g., insurance) deflect attention from historical responsibility (Nordlander et al., 2020). By deferring the problem indefinitely and “responsibilizing” those who are impacted, current global governance processes create a form of slow violence or incremental violence that takes place across temporal scales and goes unnoticed (Dehm, 2020).

At the subnational level, marginalization processes can render segments of a population more exposed to climate-related hazards by determining where they settle. For instance, indigenous groups and other people living in informal settlements tend to inhabit marginal or low-elevation lands that are disaster-prone (Bahinipati & Patnaik, 2020; Comberti et al., 2019). In contexts with deeply unequal power relations, adaptation by some can also lead to losses and damages for others (Roberts & Pelling, 2019), whereby “the rich and powerful move to avoid loss and dispossess poorer people in the process” (Elliott, 2018, p. 309). The processes are structurally influenced, driven by relationships of power that are rooted in colonial practices of domination and dispossession, and operate at different scales (Ghahramani et al., 2020; Williams, 2019).

The effects of marginalization also extend to the realms of representation and procedure in the context of international negotiations. For instance, indigenous people are represented by the very nation states that have long marginalized and discriminated against them. Despite significant diversity, they are unitarily recognized as a homogenized group, further undermining their “individual identity and nationhood”; these overlapping and interacting spaces of marginalization increase their risk of incurring loss and damage (Comberti et al., 2019, pp. 16–17). Disproportionately impacted groups tend to also have lower procedural justice (Lyster, 2019), as exemplified by the long-standing criticism of climate change negotiations where procedural inequities in size of delegations, as well as uneven access to scientific and legal expertise, are common (Newell & Taylor, 2020).

Alternatives to the current distribution of burdens and responsibilities are discussed through normative frames, such as justice, rights and international law. Some authors advocate for a (human) rights-based approach, to counter disproportionalities in losses and damages resulting from a changing climate, which are framed as a violation of rights (to culture, land, self-determination, food, health), in particular in the context of loss of territory, and displacement (Adelman, 2016; Roberts & Andrei, 2015; Toussaint & Martínez Blanco, 2020). Normative claims are often rooted in varying theories of social justice, with a majority of authors referring to the need to protect the worst impacted and most vulnerable, through capability—and human-rights-based approaches and international law (Bahinipati & Patnaik, 2020; Cao et al., 2016; Lyster, 2017; Page & Heyward, 2017; Toussaint & Martínez Blanco, 2020). A strong emphasis on distributive and compensatory forms of justice is found in scholars' examination of varied principles of attribution, compensation and reparation (Arevalo Garcia, 2020; Dehm, 2020; Huggel et al., 2016; Mair, 2014; Mayer, 2017; Wallimann-Helmer, 2015; Williams, 2019). Procedural justice is also discussed to some extent in the context of negotiations (Comberti et al., 2019). Others adopt a climate-justice framing favoring transformational approaches that aim to address the root causes of vulnerability and reshape unequal power relationships (Ciplet, 2017; Roberts & Pelling, 2019; Wrathall et al., 2015).

Disproportionality in burdens is largely examined at the global scale between nations, with insufficient consideration for other spatial and temporal dynamics, such as intergenerational and interspecies justice (A. Thomas et al., 2020). Models are predominantly used to determine causality and attribute responsibility for the problem. Conceptually, the choice of aggregation (spatial and temporal) plays a central role, as it can influence what constitutes responsibility (Williams, 2019). For instance, inequalities in responsibility can also appear within countries, with certain groups (i.e., wealthy and middle classes) being able to “hide behind the poor” (Ohdedar, 2016, p. 14). Mera

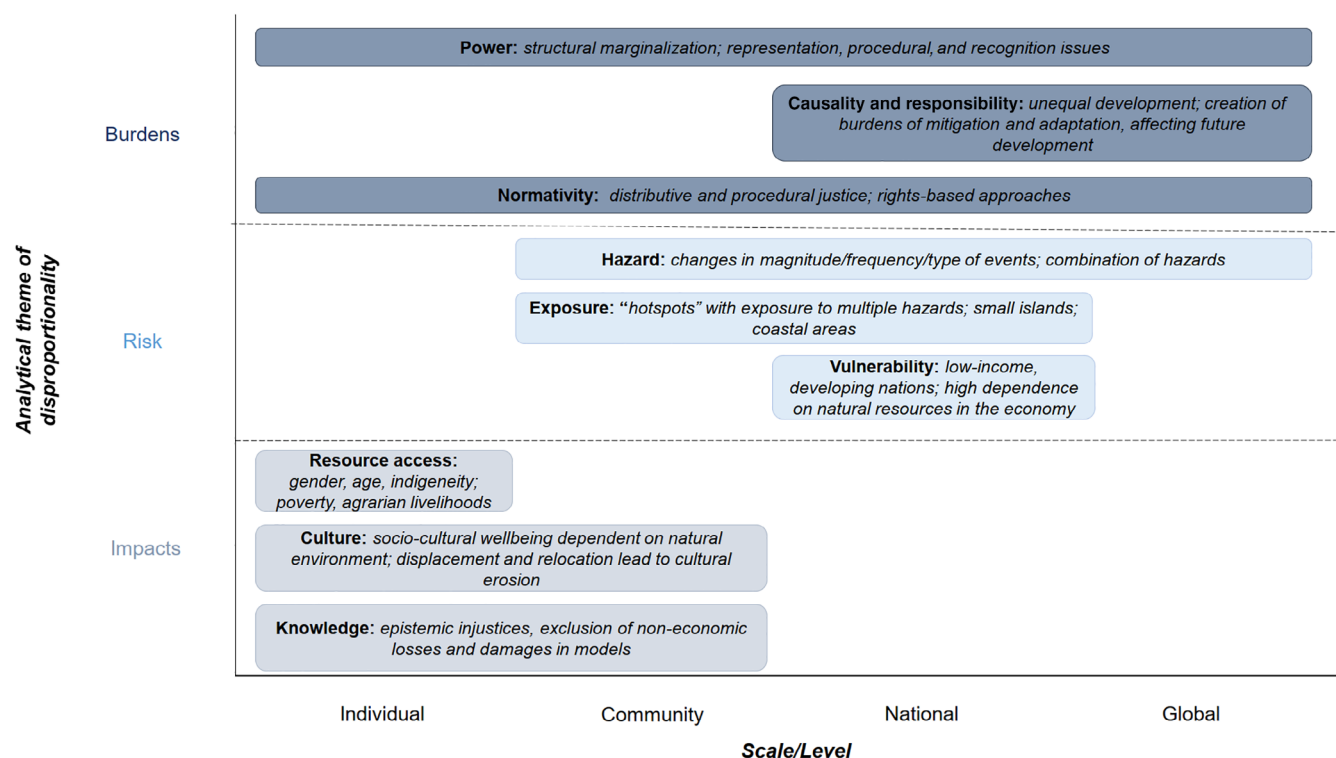


FIGURE 3 Disproportionality as it is conceptualized and operationalized in loss and damage literature, through the themes of risks, impacts, and burdens and responsibilities, and across scales/levels

et al. (2015, p. 428) find that the method of probabilistic event attribution, “can serve as a tool for addressing climate justice concerns of populations within developed nations who are disproportionately exposed to climate risks.” However, data availability issues can obscure disproportionality between countries, since those that tend to be more vulnerable to climate impacts also have the lowest “attributability” (Jézéquel et al., 2019).

6 | TOWARDS A SCIENTIFIC UNDERSTANDING OF DISPROPORTIONALITY IN LOSS AND DAMAGE FROM CLIMATE CHANGE

6.1 | Emerging features and challenges

This study demonstrates three key findings. First, disproportionality emerges as multidimensional; the concept is malleable, in that it is found to transverse conceptual areas, from risk and impacts to burdens. Second, disproportionality in loss and damage is most distinct in literature focused on impacts and at the local and individual level (Figure 3). Third, despite disproportionality's centrality to policy and scientific debates, it remains unelaborated in much loss and damage scholarship: largely implicit, used partially or anecdotally, and insufficiently explored, theoretically and methodologically.

Disproportionality emerges through time and across multiple dimensions such as risk, responsibility, and in the shift from impacts to loss, mediated by the socio-cultural dimensions of the human–nature relationship. Disproportionality is most distinct at the level of impacts, at lower scales of analysis, specifically in people's differentiated experiences of climate impacts, when scholars ask what is lost or damaged, to whom, and in relation to what. Disproportionality appears as a useful boundary concept that highlights the dynamic nature of loss and damage resulting from a changing climate, by helping to uncover the incremental changes that accumulate and create disproportionate risks, burdens, and losses and damages. In doing so, it enables critical and multiscale explorations of historical processes shaping the uneven impacts of climate change, as well as social justice and normative claims for recovery trajectories. However, this potential can only be realized if a number of key conceptual and methodological challenges are addressed.

We found that disproportionality is largely undefined and implicit in loss and damage scholarship; studies mostly portray partial understandings of the concept, often using it anecdotally. Much of the evidence remains focused on the national scale, and is explained through categories inherited from policy terminology, wherein “low-income,” “poor,” or “developing” equates to vulnerable and disproportionately impacted. In addition, methodological approaches are often not able to capture the multidimensional nature of disproportionality in loss and damage, thus potentially furthering existing inequities in knowledge, and epistemic injustices.

Poverty influences but does not equate to vulnerability, and vulnerability alone cannot fully explain the occurrence of disproportionality in loss and damage. Categorizations such as “the poor” and “the vulnerable” recall previous academic debates on essentialism and “responsibilizing” the poor for being poor or vulnerable, and risk insufficiently accounting for the agency and resourcefulness of the people affected. These broad categorizations can obscure disproportionalities at different spatial and temporal scales, rendering certain groups invisible (Tschakert et al., 2019). Except for a few studies (Ayeb-Karlsson, 2020b; Chandra et al., 2017), we find limited engagement in the literature with intersectional approaches or earlier work on interactive and multiplicative effects in environmental justice scholarship (Mohai et al., 2009).

Disproportionality research requires methods and approaches that can capture its multiple dimensions and their causal relationships across scales. Some attempts to capture the dimensions of risk, impacts and responsibility have been made, using, for instance, the causation chain method (Huggel et al., 2020). Similarly, efforts have been made to examine impacts, losses and causality across scales, with the use of extensive research designs (Carrico et al., 2020; Marshall et al., 2019). Disproportionality in the distribution of (environmentally related) benefits and burdens can be empirically investigated and analyzed at one or multiple scales (Holifield, 2001), often longitudinally, to discern cumulative effects (Howell & Elliott, 2019; Mohai et al., 2009). With some exceptions (Bahinipati & Patnaik, 2020; Chandra et al., 2017; Huggel et al., 2020), longitudinal and cross-scale studies remain largely absent in loss and damage literature. Questions of scale matter conceptually and methodologically, often in relation to representation and recognition for justice. The need for greater consideration of the importance of scale was already argued a decade ago, in relation to climate justice, with a call to extend theories of recognition and capabilities to communities (Schlosberg, 2012). Greater inter- and trans-disciplinary research, fostered through collaboration, would be a fruitful avenue to further science on disproportionality in environment–society interactions (Nowak et al., 2006).

6.2 | A disproportionality in loss and damage research agenda: knowledge gaps and future studies

By critically examining the use of disproportionality through the themes of risk, impacts, and burdens, we highlight a number of knowledge gaps relating to development, climate risk, and responsibility. We suggest three key areas for future research on disproportionality in loss and damage studies: compound events and their implications, the role of development and political economy, and grounded understandings of normative principles and responsibility.

In relation to disproportionality in risk, our understanding of extreme or compound events and their implications remains limited, leading to a potential underestimation of future climate risk that can exacerbate impacts. Uncertainty and multiplicity of hazards are prominent features in the literature, in particular, the presence of compound events, which can be defined as a “combination of processes (climate drivers and hazards) leading to a significant impact” (Zscheischler et al., 2018, p. 469). Despite emerging contributions from physical geography in loss and damage scholarship more broadly (Ozer et al., 2017), we note the limited amount of contributions from environmental and ecological sciences on impacts on ecosystems, which would provide important insights for research on disproportionality in loss and damage.

The lack of critical examination of governance, the type of development, and political economic context and their influence is a broader knowledge gap in loss and damage scholarship (McNamara & Jackson, 2019), which also appears in relation to disproportionality. Development appears in the literature as a uniform indicator of propensity to incur disproportionate losses and damages. The fact that it is only partially explored through a focus on risk and poverty represents a missed opportunity to critically examine its role, and the relationship between material affluence and vulnerability, as done in risk research (C. Eriksen et al., 2020; Klinenberg, 2015; Thomalla et al., 2018). Existing attempts to address this gap theoretically and empirically through theories of sustainable development could provide a basis for further work in disproportionality research (Bahinipati & Patnaik, 2020; Boda et al., 2021).

Disproportionality research calls for a critical examination of the deeply rooted structural inequalities that lead to skewed distribution of burdens at a global scale. Development and political economic processes shape, and are shaped by, a changing climate, from global to local (Barnett, 2020; Ciplet, 2017). Further exploration of these interactions in the context of loss, and their role in creating disproportionality, would provide greater nuance to current binary categorizations (i.e., developed vs. developing). A focus on loss, however, also calls for more context-specific and qualitative approaches that can capture what people value and, hence, is at risk of being lost (Barnett et al., 2016). Grounded research on the interactions between development and disproportionality offers an opportunity to explore culturally relevant standards of wellbeing (K. Thomas et al., 2019, p. 10), and engage with recent efforts to bring different epistemologies into knowledge-making on experiences of extreme events and wellbeing (Gaillard, 2019; D. Johnson et al., 2021).

Disproportionality as a concept originates from—and is rooted in—questions of justice and responsibility. However, in loss and damage scholarship, these remains mostly conceptual, often lacking in empirical grounding. As a lens, disproportionality makes it necessary to investigate what justice and responsibility mean for those affected, conceptually and empirically. To address disproportionality, loss and damage scholarship promotes various normative principles that could be contextualized in a radical environmental justice framework, as proposed by Svarstad and Benjaminsen (2020), as well as transformational and rights-based approaches. These principles and approaches highlight the centrality of power as influencing both the causes and the outcomes of a changing climate. At present, responsibility is mostly framed through causality, and as a matter of contribution, obscuring and potentially mixing responsibility for causing the problem with responsibility to address it. Moving forward, further grounded understandings of the different types of responsibility, across scales, in the context of disproportionality are needed (Caney, 2014; Juhola, 2019).

7 | ADDRESSING DISPROPORTIONALITY IN LOSS AND DAMAGE FROM CLIMATE CHANGE: IMPLICATIONS FOR POLICY AND PRACTICE

A disproportionality research agenda for loss and damage scholarship presents an opportunity for both policy and research. Disproportionality analyses span multiple dimensions, and can contribute to a broader understanding of what it means to suffer disproportionate losses and damages, who is affected and why, and at what scale. The shifts from impacts to losses and damages, and from inequality to disproportionality, embodies a broader push towards justice as a normative framing in climate change and Loss and Damage (L&D) discussions (Gach, 2019). Through a disproportionality lens, limits become much less prominent, and questions of normativity take center stage. Despite attempts to integrate justice considerations into risk frameworks (Schinko et al., 2019), these continue to fall short, as they struggle to account for non-economic forms of losses and damages, and tend to rely on top-down approaches to determine who is at risk and an insufficiently grounded understanding of desired futures (L. Johnson & Wrathall, 2017; Serdeczny et al., 2018).

Our results reflect the growing disconnect between loss and damage, as defined in the realm of policy, and the science attempting to capture the reality of loss on the ground. Loss and damage research focuses heavily on questions of justice, ethics and law, which closely relate to disproportionality, while, in L&D policy processes, risk framings dominate (UNFCCC Secretariat, 2021). Risk science approaches are useful for comprehending the potential for impacts but tend to prescribe methods and measures (e.g., insurance, probabilistic attribution method) which are often ill-equipped to capture and address disproportionality and actually-realized loss and damage (Hulme, 2014; Nordlander et al., 2020).

Disproportionality research on loss and damage aligns with the objectives of L&D policy processes, in particular the mandate of the WIM, which prioritizes measures to address loss and damage in regions that are “particularly vulnerable to the adverse effects of climate change” (UNFCCC Secretariat, 2021). L&D debates take place in the context of a world heading for a 3°C global average temperature increase, where neither mitigation nor adaptation are on track to achieve globally agreed objectives (Berrang-Ford et al., 2021; United Nations Environment Programme, 2020). Yet, in international negotiations on climate change, the L&D policy agenda is often overlooked, marked by a widening divide between developed and developing nations, with some calling the negotiations “no longer fit for purpose” (Huq, 2019). A disproportionality framing challenges the outlook on causality through a more critical exploration of historical responsibility, and aims to identify those who suffer disproportionate losses and damages from climate impacts. In doing so, it helps to illuminate the role of power across scales, and challenges the idea of “trickle down” in the distribution of financing and resources. Instead, disproportionality emphasizes an understanding of the means and need to enable support beyond the level of nations, down to most-affected groups and individuals.

Finally, research on disproportionality in loss and damage can offer new insights for alliances for social justice—in policy processes and practice—at different scales. Disproportionality was a core element of social and environmental justice movements in the 1980s in the United States, which evolved alongside scholarship providing scientific evidence of the disproportionate burden borne by some groups in society (Lee, 2021). Disproportionality research in the realm of climate change could make constructive contributions to advocacy by civil society organizations to counter hegemonic narratives and push for greater recognition of experiences of loss and damage (Ciplet, 2017; Ciplet & Roberts, 2017; Climate Action Network Pacific et al., 2021).

8 | CONCLUSION

Our results demonstrate that disproportionality is core, but largely implicit to, loss and damage scholarship and debates. We have taken a first step towards a coherent theoretical and methodological basis for disproportionality research, which is central to advancing loss and damage research, policy, and practice.

In the literature, disproportionality emerged as a multidimensional, malleable concept, bridging the social–environmental and past–future interfaces, and contributing to our understanding of loss and damage across scales. We highlighted a number of knowledge gaps, as well as opportunities for further research on disproportionality in relation to compound events and climate risks, the role of development and political economy context, and grounded understandings of normative principles and responsibility; we also examined the relevance of disproportionality research for policy and practice. The intent was not to propose yet another scholarly concept, but rather to suggest a more meaningful and rigorous engagement with the emerging body of knowledge on the topic, by learning from long-standing research in other fields, such as environmental justice, political economy, and disaster risk.

Scholarship on loss and damage occupies a unique space in climate change research, policy and practice; it can foreground a research agenda on the everyday reality of a changing climate. Greater scholarly attention to the roots and premises of the concept of disproportionality offers opportunities to advance science at the interface of climate, development and justice. By broadening the scope of what constitutes disproportionate loss and damage, and to whom, a comprehensive approach to disproportionality research can open up avenues and widen spaces of participation, to further an understanding of disproportionate effects at different scales, and explore pathways for discussions of justice and desired futures. This review opens and begins to unpack the “black box” of disproportionality. It is an invitation to engage in interdisciplinary scholarship on loss and damage emerging from climate–society interactions in more profound ways moving forward.

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CONFLICT OF INTEREST

The authors have declared no conflicts of interest for this article.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

AUTHOR CONTRIBUTIONS

Kelly Dorkenoo: Conceptualization (lead); data curation (lead); formal analysis (lead); methodology (lead); writing – original draft (lead); writing – review and editing (lead). **Murray Scown:** Conceptualization (supporting); formal analysis (supporting); methodology (supporting); supervision (equal); writing – review and editing (supporting). **Emily Boyd:** Conceptualization (supporting); methodology (supporting); supervision (equal); writing – review and editing (supporting).

ORCID

Kelly Dorkenoo  <https://orcid.org/0000-0002-5526-8560>

Murray Scown  <https://orcid.org/0000-0003-0663-7937>

Emily Boyd  <https://orcid.org/0000-0002-1643-9718>

ENDNOTES

- ¹ Throughout this article, we refer to “Loss and Damage” (capitalized letters) or L&D as the term and political debate in global policy processes, and scholarship or research on “loss and damage” (lowercase letters) as the body of knowledge on the losses and damages to individuals, societies, or environment resulting from climate-related impacts.
- ² K. Thomas et al. (2019) provide a comprehensive review of knowledge about differential vulnerability to climate change in the social sciences by examining the role of social aspects through four themes: resource access, governance, culture, and knowledge.

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FURTHER READING

- Iwama, A. Y., Araos, F., Anbleyth-Evans, J., Marchezini, V., Ruiz-Luna, A., Ther-Ríos, F., Bacigalupe, G., & Perkins, P. E. (2021). Multiple knowledge systems and participatory actions in slow-onset effects of climate change: Insights and perspectives in Latin America and the Caribbean. *Current Opinion in Environmental Sustainability*, 50, 31–42. <https://doi.org/10.1016/j.cosust.2021.01.010>
- Martyr-Koller, R., Thomas, A., Schleussner, C.-F., Nauels, A., & Lissner, T. (2021). Loss and damage implications of sea-level rise on Small Island developing states. *Current Opinion in Environmental Sustainability*, 50, 245–259. <https://doi.org/10.1016/j.cosust.2021.05.001>
- Mechler, R., Singh, C., Ebi, K., Djalante, R., Thomas, A., James, R., Tschakert, P., Wewerinke-Singh, M., Schinko, T., Ley, D., Nalau, J., Bouwer, L. M., Huggel, C., Huq, S., Linnerooth-Bayer, J., Surminski, S., Pinho, P., Jones, R., Boyd, E., & Revi, A. (2020). Loss and damage and limits to adaptation: Recent IPCC insights and implications for climate science and policy. *Sustainability Science*, 15, 1245–1251. <https://doi.org/10.1007/s11625-020-00807-9>
- Nightingale, A. J., Eriksen, S., Taylor, M., Forsyth, T., Pelling, M., Newsham, A., Boyd, E., Brown, K., Harvey, B., Jones, L., Kerr, R. B., Mehta, L., Naess, L. O., Ockwell, D., Scoones, I., Tanner, T., & Whitfield, S. (2020). Beyond technical fixes: Climate solutions and the great derangement. *Climate and Development*, 12(4), 343–352. <https://doi.org/10.1080/17565529.2019.1624495>
- Thomas, A., Serdeczny, O., & Pringle, P. (2020). Loss and damage research for the global stocktake. *Nature Climate Change*, 10, e700. <https://doi.org/10.1038/s41558-020-0807-z>
- Tschakert, P., Barnett, J., Ellis, N., Lawrence, C., Tuana, N., New, M., Elrick-Barr, C., Pandit, R., & Pannell, D. (2017). Climate change and loss, as if people mattered: Values, places, and experiences. *WIREs Climate Change*, 8(5), e476. <https://doi.org/10.1002/wcc.476>

REFERENCES

- Adelman, S. (2016). Climate justice, loss and damage and compensation for small island developing states. *Journal of Human Rights and the Environment*, 7(1), 32–53. <https://doi.org/10.4337/jhre.2016.01.02>
- Adger, W. N. (1999). Social vulnerability to climate change and extremes in coastal Vietnam. *World Development*, 27(2), 249–269. [https://doi.org/10.1016/S0305-750X\(98\)00136-3](https://doi.org/10.1016/S0305-750X(98)00136-3)
- Adger, W. N., Barnett, J., Chapin, F. S., & Ellemor, H. (2011). This must be the place: Underrepresentation of identity and meaning in climate change decision-making. *Global Environmental Politics*, 11(2), 1–25. https://doi.org/10.1162/GLEP_a_00051
- Adger, W. N., Dessai, S., Goulden, M., Hulme, M., Lorenzoni, I., Nelson, D. R., Naess, L. O., Wolf, J., & Wreford, A. (2009). Are there social limits to adaptation to climate change? *Climatic Change*, 93(3–4), 335–354. <https://doi.org/10.1007/s10584-008-9520-z>
- Allan, J. I., & Hadden, J. (2017). Exploring the framing power of NGOs in global climate politics. *Environmental Politics*, 26(4), 600–620. <https://doi.org/10.1080/09644016.2017.1319017>
- Arevalo Garcia, G. J. (2020). Challenges of compensation and reparation for loss and damage related to the adverse effects of climate change. *Mexican Law Review*, 13(1), 183–199. <https://doi.org/10.22201/ijj.24485306e.2020.1.14813>
- Ayeb-Karlsson, S. (2020a). ‘When we were children we had dreams, then we came to Dhaka to survive’: Urban stories connecting loss of wellbeing, displacement and (im)mobility. *Climate and Development*, 13(4), 348–359. <https://doi.org/10.1080/17565529.2020.1777078>
- Ayeb-Karlsson, S. (2020b). ‘I do not like her going to the shelter’: Stories on gendered disaster (im)mobility and wellbeing loss in coastal Bangladesh. *International Journal of Disaster Risk Reduction*, 50, e101904. <https://doi.org/10.1016/j.ijdr.2020.101904>
- Bahinipati, C. S., & Patnaik, U. (2020). Does development reduce damage risk from climate extremes? Empirical evidence for floods in India. *Water Policy*, 22, 748–767. <https://doi.org/10.2166/wp.2020.059>
- Barnett, J. (2020). Global environmental change II: Political economies of vulnerability to climate change. *Progress in Human Geography*, 44(6), 1172–1184. <https://doi.org/10.1177/0309132519898254>
- Barnett, J., Tschakert, P., Head, L., & Adger, W. N. (2016). A science of loss. *Nature Climate Change*, 6(11), 976–978. <https://doi.org/10.1038/nclimate3140>
- Been, V. (1994). Locally undesirable land uses in minority neighborhoods: Disproportionate siting or market dynamics? *The Yale Law Journal*, 103(6), 1383–1422. <https://doi.org/10.2307/797089>

- Berrang-Ford, L. (2015). Systematic review approaches for climate change adaptation research. *Regional Environmental Change*, 15, 755–769. <https://doi.org/10.1007/s10113-014-0708-7>
- Berrang-Ford, L., Siders, A. R., Lesnikowski, A., Fischer, A. P., Callaghan, M. W., Haddaway, N. R., Mach, K. J., Araos, M., Shah, M. A. R., Wannewitz, M., Doshi, D., Leiter, T., Matavel, C., Musah-Surugu, J. I., Wong-Parodi, G., Antwi-Agyei, P., Ajibade, I., Chauhan, N., Kakenmaster, W., ... Abu, T. Z. (2021). A systematic global stocktake of evidence on human adaptation to climate change. *Nature Climate Change*, 11(11), 989–1000. <https://doi.org/10.1038/s41558-021-01170-y>
- Boda, C. S., Faran, T., Scown, M., Dorkenoo, K., Chaffin, B. C., Nastar, M., & Boyd, E. (2021). Loss and damage from climate change and implicit assumptions of sustainable development. *Climatic Change*, 164(1–2), e13. <https://doi.org/10.1007/s10584-021-02970-z>
- Boda, C. S., Scown, M., Faran, T., Nastar, M., Dorkenoo, K., Chaffin, B., & Boyd, E. (2020). Framing loss and damage from climate change as the failure of sustainable development. *Climate and Development*, 13(8), 667–684. <https://doi.org/10.1080/17565529.2020.1851640>
- Bolin, B., & Kurtz, L. C. (2018). Race, class, ethnicity, and disaster vulnerability. In H. Rodríguez, W. Donner, & J. E. Trainor (Eds.), *Handbook of disaster research* (pp. 181–203). Springer International Publishing. https://doi.org/10.1007/978-3-319-63254-4_10
- Boran, I. (2017). Two concepts of wrongful harm: A conceptual map for the Warsaw International Mechanism for Loss and Damage. *Ethics, Policy & Environment*, 20(2), 195–207. <https://doi.org/10.1080/21550085.2017.1342953>
- Boyd, E., Chaffin, B. C., Dorkenoo, K., Jackson, G., Harrington, L., N'Guetta, A., Johansson, E. L., Nordlander, L., Paolo De Rosa, S., Raju, E., Scown, M., Soo, J., & Stuart-Smith, R. (2021). Loss and damage from climate change: A new climate justice agenda. *One Earth*, 4(10), 1365–1370. <https://doi.org/10.1016/j.oneear.2021.09.015>
- Boyd, E., James, R. A., Jones, R. G., Young, H. R., & Otto, F. E. L. (2017). A typology of loss and damage perspectives. *Nature Climate Change*, 7(10), 723–729. <https://doi.org/10.1038/nclimate3389>
- Bullard, R. D., Gardezi, M., Chennault, C., & Dankbar, H. (2016). Climate change and environmental justice: A conversation with Dr. Robert Bullard. *Journal of Critical Thought and Praxis*, 5(2), e3. <https://doi.org/10.31274/jctp-180810-61>
- Burkett, M. (2014). Loss and damage. *Climate Law*, 4(1–2), 119–130. <https://doi.org/10.1163/18786561-00402010>
- Burkett, M. (2016). Reading between the red lines: Loss and Damage and the Paris Outcome. *Climate Law*, 6(1–2), 118–129. <https://doi.org/10.1163/18786561-00601008>
- Caney, S. (2014). Two kinds of climate justice: Avoiding harm and sharing burdens. *Journal of Political Philosophy*, 22(2), 125–149. <https://doi.org/10.1111/jopp.12030>
- Cao, M., Wang, Q., & Cheng, Y. (2016). Remedies for loss and damage caused by climate change from the dimension of climate justice. *Chinese Journal of Population Resources and Environment*, 14(4), 253–261. <https://doi.org/10.1080/10042857.2016.1258795>
- Carrico, A. R., Donato, K. M., Best, K. B., & Gilligan, J. (2020). Extreme weather and marriage among girls and women in Bangladesh. *Global Environmental Change*, 65, Article e102160. <https://doi.org/10.1016/j.gloenvcha.2020.102160>
- Chandra, A., McNamara, K. E., Dargusch, P., Caspe, A. M., & Dalabajan, D. (2017). Gendered vulnerabilities of smallholder farmers to climate change in conflict-prone areas: A case study from Mindanao, Philippines. *Journal of Rural Studies*, 50, 45–59. <https://doi.org/10.1016/j.jrurstud.2016.12.011>
- Ciplet, D. (2017). Subverting the status quo? Climate debt, vulnerability and counter-hegemonic frame integration in United Nations climate politics – A framework for analysis. *Review of International Political Economy*, 24(6), 1052–1075. <https://doi.org/10.1080/09692290.2017.1392336>
- Ciplet, D., & Roberts, J. T. (2017). Climate change and the transition to neoliberal environmental governance. *Global Environmental Change*, 46, 148–156. <https://doi.org/10.1016/j.gloenvcha.2017.09.003>
- Climate Action Network Pacific, ICCCAD, Practical Action, Prakriti Resources Centre, Stamp out Poverty, & UUSC. (2021). *How the theme of adaptation and resilience marginalizes loss and damage and why we must focus on addressing loss and damage*. <http://www.icccad.net/publications/policy-brief/how-the-theme-of-adaptation-and-resilience-marginalizes-loss-and-damage-and-why-we-must-focus-on-addressing-loss-and-damage/>
- Comberti, C., Thornton, T. F., Korodimou, M., Shea, M., & Riamit, K. O. (2019). Adaptation and resilience at the margins: Addressing indigenous peoples' marginalization at international climate negotiations. *Environment: Science and Policy for Sustainable Development*, 61(2), 14–30. <https://doi.org/10.1080/00139157.2019.1564213>
- Cutter, S. L. (1995). Race, class and environmental justice. *Progress in Human Geography*, 19(1), 111–122. <https://doi.org/10.1177/030913259501900111>
- Cutter, S. L., Boruff, B. J., & Shirley, W. L. (2003). Social vulnerability to environmental hazards. *Social Science Quarterly*, 84(2), 242–261. <https://doi.org/10.1111/1540-6237.8402002>
- Dehm, J. (2020). Climate change, 'slow violence' and the indefinite deferral of responsibility for 'loss and damage'. *Griffith Law Review*, 29(2), 220–252. <https://doi.org/10.1080/10383441.2020.1790101>
- Dunn, F. E., Darby, S. E., Nicholls, R. J., Cohen, S., Zarfl, C., & Fekete, B. M. (2019). Projections of declining fluvial sediment delivery to major deltas worldwide in response to climate change and anthropogenic stress. *Environmental Research Letters*, 14(8), Article e084034. <https://doi.org/10.1088/1748-9326/ab304e>
- Eckersley, R. (2015). The common but differentiated responsibilities of states to assist and receive 'climate refugees'. *European Journal of Political Theory*, 14(4), 481–500. <https://doi.org/10.1177/1474885115584830>
- Edmonds, D. A., Caldwell, R. L., Brondizio, E. S., & Siani, S. M. O. (2020). Coastal flooding will disproportionately impact people on river deltas. *Nature Communications*, 11(1), e4741. <https://doi.org/10.1038/s41467-020-18531-4>
- Elliott, R. (2018). The sociology of climate change as a sociology of loss. *European Journal of Sociology*, 59(3), 301–337. <https://doi.org/10.1017/S0003975618000152>

- Enríquez-de-Salamanca, Á., Díaz-Sierra, R., Martín-Aranda, R. M., & Santos, M. J. (2017). Environmental impacts of climate change adaptation. *Environmental Impact Assessment Review*, 64, 87–96. <https://doi.org/10.1016/j.eiar.2017.03.005>
- Eriksen, C., Simon, G. L., Roth, F., Lakhina, S. J., Wisner, B., Adler, C., Thomalla, F., Scolobig, A., Brady, K., Bründl, M., Neisser, F., Grenfell, M., Maduz, L., & Prior, T. (2020). Rethinking the interplay between affluence and vulnerability to aid climate change adaptive capacity. *Climatic Change*, 162(1), 25–39. <https://doi.org/10.1007/s10584-020-02819-x>
- Eriksen, S., Nightingale, A. J., & Eakin, H. (2015). Reframing adaptation: The political nature of climate change adaptation. *Global Environmental Change*, 35, 523–533. <https://doi.org/10.1016/j.gloenvcha.2015.09.014>
- Ford, J. D., Pearce, T., McDowell, G., Berrang-Ford, L., Sayles, J. S., & Belfer, E. (2018). Vulnerability and its discontents: The past, present, and future of climate change vulnerability research. *Climatic Change*, 151(2), 189–203. <https://doi.org/10.1007/s10584-018-2304-1>
- Fordham, M. H. (1998). Making women visible in disasters: Problematising the private domain. *Disasters*, 22(2), 126–143. <https://doi.org/10.1111/1467-7717.00081>
- Freudenburg, W. R. (2006). Environmental degradation, disproportionality, and the double diversion: Reaching out, reaching ahead, and reaching beyond. *Rural Sociology*, 71(1), 3–32. <https://doi.org/10.1526/00360110677789792>
- Freudenburg, W. R., Gramling, R., Laska, S., & Erikson, K. T. (2008). Organizing hazards, engineering disasters? Improving the recognition of political-economic factors in the creation of disasters. *Social Forces*, 87(2), 1015–1038. <https://doi.org/10.1353/sof.0.0126>
- Freudenburg, W. R., Gramling, R., Laska, S., & Erikson, K. T. (2009). Disproportionality and disaster: Hurricane Katrina and the Mississippi River-Gulf Outlet. *Social Science Quarterly*, 90(3), 497–515.
- Gach, E. (2019). Normative shifts in the global conception of climate change: The growth of climate justice. *Social Sciences*, 8(1), 24. <https://doi.org/10.3390/socsci8010024>
- Gaillard, J. C. (2010). Vulnerability, capacity and resilience: Perspectives for climate and development policy. *Journal of International Development*, 22(2), 218–232. <https://doi.org/10.1002/jid.1675>
- Gaillard, J. C. (2019). Disaster studies inside out. *Disasters*, 43(Suppl. 1), S7–S17. <https://doi.org/10.1111/disa.12323>
- Gaillard, J. C., Gorman-Murray, A., & Fordham, M. (2017). Sexual and gender minorities in disaster. *Gender, Place & Culture*, 24(1), 18–26. <https://doi.org/10.1080/0966369X.2016.1263438>
- Ghahramani, L., McArdle, K., & Fatorić, S. (2020). Minority community resilience and cultural heritage preservation: A case study of the Gullah Geechee community. *Sustainability*, 12(6), e2266. <https://doi.org/10.3390/su12062266>
- Grant, M. J., & Booth, A. (2009). A typology of reviews: An analysis of 14 review types and associated methodologies. *Health Information & Libraries Journal*, 26(2), 91–108. <https://doi.org/10.1111/j.1471-1842.2009.00848.x>
- Holifield, R. (2001). Defining environmental justice and environmental racism. *Urban Geography*, 22(1), 78–90. <https://doi.org/10.2747/0272-3638.22.1.78>
- Howell, J., & Elliott, J. R. (2019). Damages done: The longitudinal impacts of natural hazards on wealth inequality in the United States. *Social Problems*, 66(3), 448–467. <https://doi.org/10.1093/socpro/spy016>
- Huggel, C., Carey, M., Emmer, A., Frey, H., Walker-Crawford, N., & Wallimann-Helmer, I. (2020). Anthropogenic climate change and glacier lake outburst flood risk: Local and global drivers and responsibilities for the case of lake Palcacocha, Peru. *Natural Hazards and Earth System Sciences*, 20(8), 2175–2193. <https://doi.org/10.5194/nhess-20-2175-2020>
- Huggel, C., Wallimann-Helmer, I., Stone, D., & Cramer, W. (2016). Reconciling justice and attribution research to advance climate policy. *Nature Climate Change*, 6(10), 901–908. <https://doi.org/10.1038/nclimate3104>
- Hulme, M. (2014). Attributing weather extremes to ‘climate change’: A review. *Progress in Physical Geography: Earth and Environment*, 38(4), 499–511. <https://doi.org/10.1177/0309133314538644>
- Huq, S. (2019, December 17). For the vulnerable, UN climate talks are no longer fit for purpose. *Climate Home News*. <https://www.climatechangenews.com/2019/12/17/vulnerable-un-climate-talks-no-longer-fit-purpose/>
- Ignacio, A. F., Cruz, G. T., Nardi, F., & Henry, S. (2015). Assessing the effectiveness of a social vulnerability index in predicting heterogeneity in the impacts of natural hazards: Case study of the Tropical Storm Washi flood in the Philippines. *Vienna Yearbook of Population Research*, 13, 91–129. <https://doi.org/10.1553/populationyearbook2015s091>
- IPCC (2018). Annex I: Glossary. In J. B. R. Matthews, V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufouma-Okia, C. Pean, S. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, & T. Waterfield (Eds.), *Global warming of 1.5°C. An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*. https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_AnnexI_Glossary.pdf
- Jackson, G. (2021). Perceptions of disaster temporalities in two Indigenous societies from the Southwest Pacific. *International Journal of Disaster Risk Reduction*, 57, e102221. <https://doi.org/10.1016/j.ijdr.2021.102221>
- Jézéquel, A., Yiou, P., & Vanderlinden, J.-P. (2019). Comparing scientists and delegates perspectives on the use of extreme event attribution for loss and damage. *Weather and Climate Extremes*, 26, 100231. <https://doi.org/10.1016/j.wace.2019.100231>
- Johnson, D., Parsons, M., & Fisher, K. (2021). Engaging indigenous perspectives on health, wellbeing and climate change. A new research agenda for holistic climate action in Aotearoa and beyond. *Local Environment*, 26(4), 477–503. <https://doi.org/10.1080/13549839.2021.1901266>
- Johnson, L., & Wrathall, D. J. (2017). The limits of risk science—(E)Letters. Response to article ‘Identifying the policy space for climate loss and damage’ by Mechler and Schinko. <https://science-sciencemag-org.ludwig.lub.lu.se/content/354/6310/290/tab-e-letters>
- Juhola, S. K. (2019). Responsibility for climate change adaptation. *WIREs Climate Change*, 10, e608. <https://doi.org/10.1002/wcc.608>

- Kaijser, A., & Kronsell, A. (2014). Climate change through the lens of intersectionality. *Environmental Politics*, 23(3), 417–433. <https://doi.org/10.1080/09644016.2013.835203>
- Klinenberg, E. (2015). *Heat wave: A social autopsy of disaster in Chicago*. University of Chicago Press.
- Lassa, J. A., Lai, A. Y.-H., & Goh, T. (2016). Climate extremes: An observation and projection of its impacts on food production in ASEAN. *Natural Hazards*, 84(Suppl. 1), 19–33. <https://doi.org/10.1007/s11069-015-2081-3>
- Lee, C. (2021). Confronting disproportionate impacts and systemic racism in environmental policy. *The Environmental Law Reporter*, 51(3), 10207–10225.
- Licker, R., Ekwurzel, B., Doney, S. C., Cooley, S. R., Lima, I. D., Heede, R., & Frumhoff, P. C. (2019). Attributing ocean acidification to major carbon producers. *Environmental Research Letters*, 14(12), 124060. <https://doi.org/10.1088/1748-9326/ab5abc>
- Lyster, R. (2017). Climate justice, adaptation and the Paris Agreement: A recipe for disasters? *Environmental Politics*, 26(3), 438–458. <https://doi.org/10.1080/09644016.2017.1287626>
- Lyster, R. (2019). The idea of (climate) justice, neoliberalism and the Talanoa Dialogue. *Journal of Human Rights and the Environment*, 10(1), 35–61. <https://doi.org/10.4337/jhre.2019.01.03>
- Mair, C. (2014). Climate change: The greatest challenge for the future and a major cross-sectoral area of intervention. *International Community Law Review*, 16(2), 177–213. <https://doi.org/10.1163/18719732-12341276>
- Marshall, N., Adger, W. N., Benham, C., Brown, K., Curnock, M. I., Gurney, G. G., Marshall, P., Pert, P. L., & Thiault, L. (2019). Reef grief: Investigating the relationship between place meanings and place change on the Great Barrier Reef, Australia. *Sustainability Science*, 14(3), 579–587. <https://doi.org/10.1007/s11625-019-00666-z>
- Mayer, B. (2017). Climate change reparations and the law and practice of state responsibility. *Asian Journal of International Law*, 7(1), 185–216.
- McNamara, K. E., & Jackson, G. (2019). Loss and damage: A review of the literature and directions for future research. *WIREs Climate Change*, 10, e564. <https://doi.org/10.1002/wcc.564>
- McNamara, K. E., Westoby, R., & Chandra, A. (2021). Exploring climate-driven non-economic loss and damage in the Pacific Islands. *Current Opinion in Environmental Sustainability*, 50, 1–11. <https://doi.org/10.1016/j.cosust.2020.07.004>
- McNeeley, S. M., & Lazrus, H. (2014). The cultural theory of risk for climate change adaptation. *Weather, Climate, and Society*, 6(4), 506–519. <https://doi.org/10.1175/WCAS-D-13-00027.1>
- Mera, R., Massey, N., Rupp, D. E., Mote, P., Allen, M., & Frumhoff, P. C. (2015). Climate change, climate justice and the application of probabilistic event attribution to summer heat extremes in the California Central Valley. *Climatic Change*, 133(3), 427–438. <https://doi.org/10.1007/s10584-015-1474-3>
- Mohai, P., Pellow, D., & Roberts, J. T. (2009). Environmental justice. *Annual Review of Environment and Resources*, 34(1), 405–430. <https://doi.org/10.1146/annurev-enviro-082508-094348>
- Monnereau, I., & Abraham, S. (2013). Limits to autonomous adaptation in response to coastal erosion in Kosrae, Micronesia. *International Journal of Global Warming*, 5(4), 416–432. <https://doi.org/10.1504/IJGW.2013.057283>
- Motschmann, A., Huggel, C., Carey, M., Moulton, H., Walker-Crawford, N., & Muñoz, R. (2020). Losses and damages connected to glacier retreat in the Cordillera Blanca, Peru. *Climatic Change*, 162, 837–858. <https://doi.org/10.1007/s10584-020-02770-x>
- Newell, P., & Taylor, O. (2020). Fiddling while the planet burns? COP25 in perspective. *Globalizations*, 17(4), 580–592. <https://doi.org/10.1080/14747731.2020.1726127>
- Nordlander, L., Pill, M., & Romera, B. M. (2020). Insurance schemes for loss and damage: Fools' gold? *Climate Policy*, 20(6), 704–714. <https://doi.org/10.1080/14693062.2019.1671163>
- Nowak, P., Bowen, S., & Cabot, P. E. (2006). Disproportionality as a framework for linking social and biophysical systems. *Society & Natural Resources*, 19(2), 153–173. <https://doi.org/10.1080/08941920500394816>
- Noy, I. (2017). To leave or not to leave? Climate change, exit, and voice on a Pacific island. *CESifo Economic Studies*, 63(4), 403–420. <https://doi.org/10.1093/cesifo/ifx004>
- Ohdedar, B. (2016). Loss and damage from the impacts of climate change: A framework for implementation. *Nordic Journal of International Law*, 85(1), 1–36.
- Olsson, L., Opondo, M., Tschakert, P., Agrawal, A., Eriksen, S. H., Ma, S., Perch, L. N., & Zakieldein, S. A. (2014). Livelihoods and poverty. In C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, & L. L. White (Eds.), *Climate change 2014: Impacts, adaptation, and vulnerability. Part A: Global and sectoral aspects. Contribution of working group II to the fifth assessment report of the intergovernmental panel on climate change* (pp. 793–832). Cambridge University Press.
- Ourbak, T., & Magnan, A. K. (2018). The Paris Agreement and climate change negotiations: Small islands, big players. *Regional Environmental Change*, 18(8), 2201–2207. <https://doi.org/10.1007/s10113-017-1247-9>
- Oxford University Press. (2021). Disproportionate. In *Oxford advanced learner's dictionary*. OxfordLearnersDictionaries.Com. <https://www.oxfordlearnersdictionaries.com/definition/english/disproportionate>
- Ozer, A., Ozer, P., & Ginesu, S. (2017). Physical geography and the risks of loss and damage related to climate change: An introduction. *Geo-Eco-Trop*, 41(3), 313–315.
- Page, E. A., & Heyward, C. (2017). Compensating for climate change loss and damage. *Political Studies*, 65(2), 356–372. <https://doi.org/10.1177/0032321716647401>
- Perhac, R. M. (1999). Environmental justice: The issue of disproportionality. *Environmental Ethics*, 21(1), 81–92. <https://doi.org/10.5840/enviroethics199921143>

- Perkins, P. E. (2018). Climate justice, gender and intersectionality. In T. Jafry, M. Mikulewicz, & K. Helwig (Eds.), *Routledge handbook of climate justice* (1st ed., pp. 349–358). Routledge. <https://doi.org/10.4324/9781315537689-26>
- Pomerleau, W. P. (n.d.). Western theories of justice. *Internet encyclopedia of philosophy*. Retrieved 14 June 2021, from <https://iep.utm.edu/justwest/>
- Pretis, F., Schwarz, M., Tang, K., Haustein, K., & Allen, M. R. (2018). Uncertain impacts on economic growth when stabilizing global temperatures at 1.5°C or 2°C warming. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 376, Article e20160460. <https://doi.org/10.1098/rsta.2016.0460>
- Rabbani, G., Rahman, A., & Mainuddin, K. (2013). Salinity-induced loss and damage to farming households in coastal Bangladesh. *International Journal of Global Warming*, 5(4), 400–415. <https://doi.org/10.1504/IJGW.2013.057284>
- Reisinger, A., Howden, M., Vera, C., Garschagen, M., Hurlbert, M., Kreibich, S., Mach, K. J., Mintenbeck, K., O'Neill, B., Pathak, M., Pedace, R., Pörtner, H.-O., Poloczanska, E., Corradi, M. R., Sillmann, J., Van Aalst, M., Viner, D., Jones, R., Ruane, A. C., & Ranasinghe, R. (2020). *The concept of risk in the IPCC sixth assessment report: A summary of cross-working group discussions*. Intergovernmental Panel on Climate Change.
- Roberts, E., & Andrei, S. (2015). The rising tide: Migration as a response to loss and damage from sea level rise in vulnerable communities. *International Journal of Global Warming*, 8(2), 258–273. <https://doi.org/10.1504/IJGW.2015.071965>
- Roberts, E., & Huq, S. (2015). Coming full circle: The history of loss and damage under the UNFCCC. *International Journal of Global Warming*, 8(2), 141–157. <https://doi.org/10.1504/IJGW.2015.071964>
- Roberts, E., & Pelling, M. (2019). Loss and damage: An opportunity for transformation? *Climate Policy*, 20(6), 758–771. <https://doi.org/10.1080/14693062.2019.1680336>
- Schinko, T., Mechler, R., & Hochrainer-Stigler, S. (2019). The risk and policy space for loss and damage: Integrating notions of distributive and compensatory justice with comprehensive climate risk management. In R. Mechler, L. M. Bouwer, T. Schinko, S. Surminski, & J. Linnerooth-Bayer (Eds.), *Loss and damage from climate change* (pp. 83–110). Springer International Publishing. https://doi.org/10.1007/978-3-319-72026-5_4
- Schlosberg, D. (2012). Climate justice and capabilities: A framework for adaptation policy. *Ethics & International Affairs*, 26(4), 445–461. <https://doi.org/10.1017/S0892679412000615>
- Serdeczny, O. M., Bauer, S., & Huq, S. (2018). Non-economic losses from climate change: Opportunities for policy-oriented research. *Climate and Development*, 10(2), 97–101. <https://doi.org/10.1080/17565529.2017.1372268>
- Sonja, K., & Harald, W. (2018). Building equity in: Strategies for integrating equity into modelling for a 1.5°C world. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 376, e20160461. <https://doi.org/10.1098/rsta.2016.0461>
- Svarstad, H., & Benjaminsen, T. A. (2020). Reading radical environmental justice through a political ecology lens. *Geoforum*, 108, 1–11. <https://doi.org/10.1016/j.geoforum.2019.11.007>
- Thomalla, F., Boyland, M., Johnson, K., Ensor, J., Tuhkanen, H., Gerger Swartling, Å., Han, G., Forrester, J., & Wahl, D. (2018). Transforming development and disaster risk. *Sustainability*, 10(5), e1458. <https://doi.org/10.3390/su10051458>
- Thomas, A., Baptiste, A., Martyr-Koller, R., Pringle, P., & Rhiney, K. (2020). Climate change and small island developing states. *Annual Review of Environment and Resources*, 45, 1–27.
- Thomas, K., Hardy, R. D., Lazrus, H., Mendez, M., Orlove, B., Rivera-Collazo, I., Roberts, J. T., Rockman, M., Warner, B. P., & Winthrop, R. (2019). Explaining differential vulnerability to climate change: A social science review. *WIREs Climate Change*, 10, e565. <https://doi.org/10.1002/wcc.565>
- Toussaint, P., & Martínez Blanco, A. (2020). A human rights-based approach to loss and damage under the climate change regime. *Climate Policy*, 20(6), 743–757. <https://doi.org/10.1080/14693062.2019.1630354>
- True, J. (2016). Gendered violence in natural disasters: Learning from New Orleans, Haiti and Christchurch. *Aotearoa New Zealand Social Work*, 25(2), 78–89. <https://doi.org/10.11157/anzswj-vol25iss2id83>
- Tschakert, P., Ellis, N. R., Anderson, C., Kelly, A., & Obeng, J. (2019). One thousand ways to experience loss: A systematic analysis of climate-related intangible harm from around the world. *Global Environmental Change*, 55, 58–72. <https://doi.org/10.1016/j.gloenvcha.2018.11.006>
- UNFCCC. (2012). *A literature review on the topics in the context of thematic area 2 of the work programme on loss and damage: A range of approaches to address loss and damage associated with the adverse effects of climate change*. <https://unfccc.int/resource/docs/2012/sbi/eng/inf14.pdf>
- UNFCCC Secretariat. (2021). *Report of the Executive Committee of the Warsaw International Mechanism for Loss and Damage associated with climate change impacts – FCCC/SB/2020/3* (p. 28).
- United Nations Environment Programme. (2020). *The emissions gap report 2020*. <https://www.unep.org/emissions-gap-report-2020>
- Vanhala, L., Robertson, M., & Calliari, E. (2020). The knowledge politics of climate change loss and damage across scales of governance. *Environmental Politics*, 30(1–2), 141–160. <https://doi.org/10.1080/09644016.2020.1840227>
- Verchick, R. R. M. (2018). Can ‘loss and damage’ carry the load? *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 376, e20170070. <https://doi.org/10.1098/rsta.2017.0070>
- Wallimann-Helmer, I. (2015). Justice for climate loss and damage. *Climatic Change*, 133(3), 469–480. <https://doi.org/10.1007/s10584-015-1483-2>
- Wangdi, S. P. (2021). *Home page—From the LDC Chair*. LDC Climate Change. Retrieved 14 June, 2021, from <http://www.ldc-climate.org/>
- Warner, K., & der Geest, K. V. (2013). Loss and damage from climate change: Local-level evidence from nine vulnerable countries. *International Journal of Global Warming*, 5(4), 367. <https://doi.org/10.1504/IJGW.2013.057289>

- Werkheiser, I. (2017). Loss of epistemic self-determination in the Anthropocene. *Ethics, Policy & Environment*, 20(2), 156–167. <https://doi.org/10.1080/21550085.2017.1342966>
- Wewerinke-Singh, M., & Van Geelen, T. (2018). Protection of climate displaced persons under international law: A case study from Mataso Island, Vanuatu. *Melbourne Journal of International Law*, 19(12), e3325937. <https://doi.org/10.2139/ssrn.3325937>
- Williams, E. (2019). Attributing blame?—Climate accountability and the uneven landscape of impacts, emissions, and finances. *Climatic Change*, 161, 273–290. <https://doi.org/10.1007/s10584-019-02620-5>
- Wisner, B., Blaikie, P., Cannon, T., & David, I. (2004). *At risk: Natural hazards, people's vulnerability, and disasters* (Electronic resources; 2nd ed.). Routledge. <https://doi.org/10.4324/9780203714775>
- Woroniecki, S., Krüger, R., Rau, A.-L., Preuss, M. S., Baumgartner, N., Riggers, S., Niessen, L., Holländer, L., Beyers, F., Rathgens, J., Wagner, K. C., Habigt, L., Krause, T., Wamsler, C., von Wehrden, H., & Abson, D. (2019). The framing of power in climate change adaptation research. *WIREs Climate Change*, 10(6), e617. <https://doi.org/10.1002/wcc.617>
- Wrathall, D. J., Smith, A. O., Fekete, A., Gencer, E., Reyes, M. L., & Sakdapolrak, P. (2015). Problematising loss and damage. *International Journal of Global Warming*, 8(2), 274. <https://doi.org/10.1504/IJGW.2015.071962>
- Zscheischler, J., Westra, S., van den Hurk, B. J. J. M., Seneviratne, S. I., Ward, P. J., Pitman, A., AghaKouchak, A., Bresch, D. N., Leonard, M., Wahl, T., & Zhang, X. (2018). Future climate risk from compound events. *Nature Climate Change*, 8(6), 469–477. <https://doi.org/10.1038/s41558-018-0156-3>

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