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Challenges and Opportunities for Integrating Intersectionality Into Social Vulnerability Assessment for Flood Risk Analysis

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ABSTRACT

Adaptation to flood events has emerged as a vital concern for our societies. However, both individual and collective adaptation heavily depend on levels of vulnerability across various strata at both the individual and collective levels. The impacts of flood events, along with individual preparedness and coping strategies, are distributed unequally across societies globally. This primer tackles the challenge of integrating an intersectional perspective into social vulnerability assessment in flood risk analysis and management. Social vulnerability is a central question within the decision-making process of flood risk management, which helps public administration select appropriate risk reduction measures for national, regional, and local areas. Despite a wealth of literature examining individual vulnerability, adaptive capacity to floods, and the associated inequalities, current research often adopts a one-dimensional view of individuals, overlooking the complexities of intersecting forms of structural discrimination. We explore the implications of adopting this intersectional approach to social vulnerability in flood risk management, how such a perspective can be achieved, and how it might help mitigate social inequalities.

This article is categorized under:

Engineering Water > Planning Water

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1 | Introduction

Flooding can substantially affect daily lives. Numerous past flood events worldwide demonstrate that the occurrence, impact, and recovery from these events vary widely (WMO 2021; Hamidifar and Nones 2023). Different regions are more prone to flooding, yet their individual and collective capacities to cope with and recover from such events vary considerably (Sayers et al. 2018; Bertola et al. 2023; Selsor et al. 2023; Pinchoff et al. 2024). Some regions, in particular, often experience a greater number of fatalities and long-term negative socioeconomic impacts on individuals and communities (Burby et al. 2003; Ward and Shively 2017; Lindersson et al. 2023). At the same time, these regions are often less prepared for flood events and possess fewer resources to cope with and recover from such disasters (Cutter et al. 2010, 2014; Tselios and Tompkins 2019). Globally, these inequalities manifest not only between the Global North and South (IPCC 2022) but also within countries (Collins et al. 2018;

Chakraborty et al. 2019; Tate et al. 2021), between rural and urban regions, and within a community (Peacock et al. 2014; Kammerbauer and Wamsler 2017; Emrich et al. 2020).

The unequal distribution of social vulnerability and the ability to cope with and adapt to floods are expected to worsen in the future due to the negative impacts of climate change (Sayers et al. 2024). A key challenge is that the effects of a warmer climate intensify these vulnerabilities thereby deepening existing inequalities (Friedrich 2023; Mikulewicz et al. 2023). These inequalities are also rooted in historical social exclusions and ongoing discrimination shaped by past and present policy decisions (Forsyth 2014; Friedrich 2023). Although actors at the global, national, and local levels aim to reduce these spatial inequalities, their efforts often produce only modest or no measurable improvements. A core issue is that vulnerability is frequently viewed as a uniform characteristic of individuals and communities, without fully considering the complexities of institutional discrimination (Forsyth 2014; Friedrich 2023). Vulnerability indices, such as hazard-of-place model indices, incorporate various variables, such as income, gender, ethnicity, age, health, and education to assess the vulnerability of a specific geographical area (Cutter et al. 2003). However, these variables are often examined in isolation or incorporated in assessments with overly simplistic perspective, which often can create misleading policy recommendations (Sultana 2010; Hinkel 2011; Nelson et al. 2015; Rufat et al. 2019; Babcicky et al. 2021; Seebauer et al. 2024).

For example, social vulnerability indices often fail to capture differences within each indicator, such as ethnic disparities within the migration category (Rubio et al. 2020). In such cases, high-income migrants (e.g., expats) may be assigned the same vulnerability value as low-income migrants. Scholars have noted that the challenge of assessing vulnerability via single indicator is compounded when other indicators, such as language, citizenship, or lack of social and cultural capital. These indicators are frequently excluded from social vulnerability assessments in flood risk analysis and decision-making, which undermines the ability to answer who receives which risk-reduction strategies and when those strategies are implemented (Bourdieu 1986; Roy et al. 2020, 2022). Furthermore, because these indicators are socially constructed, they can change over time—a dynamic that is often overlooked in assessments (Hankivsky 2014; Hankivsky et al. 2014).

This reductionist focus on vulnerability overlooks important complexities (Collins and Bilge 2020): Intersecting forms of discrimination and power asymmetries are frequently omitted from vulnerability assessments (Ahmed 2017; Amorim-Maia et al. 2022). For example, gender is one vital category, alongside other inequalities, such as age, language, citizenship, and income/class (Johnson et al. 2020). Adopting an intersectional perspective entail examining how different indicators such as gender, ethnicity, or class, overlap. This approach reorients judgments about social vulnerability (who is, and who is not, socially vulnerable) by requiring that different indicators be understood and interpreted within a complex and non-linear assessment, rather than aggregated mathematically, as it is often the case in "classical" social vulnerability analysis in flood risk research (Martin-Gutierrez et al. 2025).

These indicators can interact to create individual privilege or disadvantage at the individual level, because discrimination in one area often frequently overlaps with other forms of inequality (Johnson et al. 2020; Amorim-Maia et al. 2022). Across academic discourses, scholarly literature, and policy documents, there is a growing call to incorporate an intersectional perspective into climate change adaptation (e.g., Owusu et al. 2019; Amorim-Maia et al. 2022): "(...) intersectionality is a core conceptual lens to understand how various forms of social inequalities and vulnerability interconnect and overlap with each other" (Amorim-Maia et al. 2022, 3). Of course, this depends on the political and cultural context of each community, for example, gender or sexual orientation in certain countries.

Nevertheless, key questions persist: how can the complexity of intersectionality be embedded within existing social vulnerability assessments at a global scale? And how might a shift toward an intersectionality transform and strengthen decision-making processes in flood risk management?

2 | Why Intersectionality Matters in Flood Risk Analysis

The concept of intersectionality was introduced and supported by Black feminist critiques of antidiscrimination discourse and feminist theories (Crenshaw 1989, 2017). Additionally, theoretical discourses and debates from indigenous feminist groups to the LGBTQIA+ community have contributed to advancing the intersectionality discourse (Hankivsky 2014; Hankivsky et al. 2014). A core argument of intersectionality is that feminist theories often focused primarily on white women, thereby overlooking the multiple, intersecting indicators of discrimination faced by women of color (e.g., ethnicity, income, gender; Crenshaw 1989). Intersectionality seeks not only to address discrete forms of discrimination (e.g., ethnicity); it examines the broader spectrum of power asymmetries and structural inequalities that shape society (Chu and Cannon 2021; Rice et al. 2023). By incorporating indicators such as exclusion from political processes and exposure to environmental inequalities, this approach offers a more comprehensive understanding of vulnerability and discrimination.

An example of this is the U.S. redlining housing policy of the 1930s, which systematically entrenched housing discrimination against marginalized communities of Americans. Today, these same communities remain disproportionally vulnerable to flood impacts—a risk likely to intensify with climate change (Herreros-Cantos et al. 2020; Linscott et al. 2022; Sauer et al. 2023). Consequently, these individuals face a compounded disadvantage and suffer from a double penalty: those already facing systemic discrimination are increasingly likely to suffer from the severe consequences from future climate related hydro-metrological events. Another example is homelessness (Vickery 2018). Homeless individuals are particularly vulnerable to flood impacts (Wisner 1998), as they often live outdoors, are excluded from early warning systems, and receive limited public support. However, people experiencing homelessness are not a homogeneous group; they experience intersecting forms of discriminations, related to citizenship status, mental health

challenges (e.g., posttraumatic stress disorder [PTSD]), gender, and physical disabilities (Vickery 2018).

Nevertheless, a key question remains: how might an intersectional perspective reshape "traditional" social vulnerability assessments in flood risk analysis? Adopting such a perspective would also alter decision-making processes in flood risk management, as vulnerable regions can no longer be treated as monolithic geographical units. Yet political support to mitigate inequalities rooted in intersectional discrimination is often limited. In particular, flood risk management often relies on hydrological models and social vulnerability index assessments that preclude a holistic understanding of the different dynamic developments and their impacts (Nielsen et al. 2023; Scolio et al. 2025; Tate et al. 2025; Asl et al. 2026). For example, flood risk management plans frequently lack a holistic perspective on vulnerability and its intersecting discriminations. Furthermore, flood risk management is not necessarily "neutral" (Calderón-Argelich et al. 2023), raising critical issues regarding the prioritization and distribution of limited public and private resources (Thaler and Priest 2014; Emrich et al. 2020; Han et al. 2024). It is imperative to establish priority recipients of support and to specify the level and type of assistance public administration should provide to individuals and communities.

Prioritizing public support is particularly challenging as determining the order of aid is inherently complex. A common approach is to prioritize the most vulnerable individuals or communities (Kaufmann et al. 2018; Thaler et al. 2018). However, this Rawlsian perspective on justice is difficult to implement, as identifying the "most vulnerable" is not always straightforward. Scholars such as Thaler et al. (2018), Ciullo et al. (2020), and Jafino et al. (2022) have grappled with this question, noting that various indicators exist to assess vulnerability. These challenges are compounded by the fact that vulnerability is often linked to intersecting forms of discrimination, which are frequently overlooked in assessments.

The problem extends beyond determining who should receive support first; it also involves defining what types and levels of support should be provided. A central concern is that political responses may be too slow, resulting in high-risk areas receiving the same level of support as low-risk areas (Ciullo et al. 2020; Thaler 2021). Moreover, certain types of support can unintentionally lead to individual or collective maladaptation (Schipper 2020) or even exacerbate vulnerability (Siders 2019). A classic example is planned relocation in disaster risk reduction, which has often been implemented for low-income communities under the justification of low cost–benefit ratios (Siders 2019). An intersectional approach can deepen our understanding of layered discrimination and unequal power dynamics (Nygren and Wayessa 2018; Walker et al. 2019; Nielsen et al. 2023; Manatsa et al. 2025). The key challenge, however, is how to effectively assess and operationalize intersectionality within flood risk management. Most studies have focused on conceptual development and qualitative studies, with less attention to quantitative studies.

3 | Novel Challenges in the Social Vulnerability Assessment and How They Might Be Solved

Social vulnerability is a key component of flood risk analysis and thus of flood risk management. Social vulnerability assessment helps to determine who needs support, what forms of support different actors can provide, when support should be implemented and how such interventions can reduce social inequality within communities and regions. Approaches are diverse: quantitative methods include the hazard-of-place model (Cutter et al. 2003), which applies spatiotemporal assessments and commonly uses census data to create maps on multiple scales (Seebauer et al. 2024). While this model analyses individual characteristics, such as socioeconomic, psychological, or other social indicators (Babcicky et al. 2021), it has limitations in capturing the multidimensional, intersecting social discriminations that shape vulnerability at individual and/or community levels. In contrast, qualitative frameworks, like the Pressure-and-Release (PAR) framework, emphasize the social construction of vulnerability and integrate politico-economic perspectives to explain why some individuals and/or communities are more vulnerable than others (Wisner et al. 2004; Rauken and Kelman 2010; Hülssiep et al. 2021).

The hazards-of-place model evaluates social vulnerability via various indicators (weighted or not) within specific geographic boundaries, such as census blocks, cities, or regions (Seebauer et al. 2024). Social vulnerability is typically represented as maps created for a single point in time (Cutter et al. 2003), with historical change rarely examined. Traditional indicators include age, gender, education level, income, racial or ethnic minority status, and employment status. Less commonly used indicators include health-related issues, social networks, or home ownership (Seebauer et al. 2024). These indicators are generally derived from previous surveys (Cutter et al. 2003) and are often weighted equally, without accounting for intersecting discriminations and power asymmetries.

Surveys often focus on selected individual socioeconomic indicators, frequently using measures similar to those in the hazards-of-place model, such as education and income (Seebauer et al. 2024). However, studies such as Babcicky et al. (2021) and Babcicky and Seebauer (2021) have broadened these variables to better capture social vulnerability, by incorporating psychological and social indicators such as stress, health impacts, social norms, social capital, and fear, among others. Surveys may also assess adaptive behaviors (Cutter et al. 2010). However, research on social vulnerability assessments often relies on broad, aggregated categories such as "Black communities," rather than examining how specific forms of structural discrimination, such as citizenship status, influence the vulnerability of these communities (Rubio et al. 2020). A more nuanced perspective can be a powerful tool for a more in-depth understanding of why a person may be vulnerable or living near hazardous areas. Rubio et al.'s (2020) intracategorical framework demonstrates that using multiple categories, such as ancestry or ethnic origin groups, reveals that social vulnerability is far from homogeneous. This approach offers a richer, more comprehensive understanding of vulnerability, and yields better insights into spatial inequalities.

Another promising area for integrating an intersectional perspective into flood-related social vulnerability assessment is health studies. First, health studies have a long tradition of incorporating intersectionality into decision-making processes. Second, various studies employ diverse methods to analyze

intersectionality, including linear models linked to identity, multilevel analysis, ANOVA-based methods, and subgroup analysis, such as ethnicity in combination with sexual identity or three-way causal mediation decomposition (Evans et al. 2018; Bostwick et al. 2019; Philipps et al. 2020; Guan et al. 2021). While these studies represent significant progress toward integrating intersectionality into quantitative frameworks, they also require a certain degree of simplification, such as the inclusion of power asymmetries in assessments. In this context, qualitative frameworks such as the Pressure-and-Release (PAR) framework can offer valuable insights.

The PAR framework considers "root causes, dynamic pressures, and unsafe conditions" (Wisner et al. 2004, 51) that influence social vulnerability. For instance, root causes encompass structural conditions that can either increase or decrease an individual's vulnerability. These conditions, such as patriarchy, lack of resources, and social or political power asymmetries, are crucial factors that affect individual or collective vulnerability, as well as the capacity to respond to current and future disasters (Wisner et al. 2004). Other elements, such as dynamic pressures (which address the challenges of discrimination) and unsafe conditions (which focus on the limited availability of and access to information and resources), play a significant role in understanding how intersecting forms of discrimination impact both individual and collective vulnerability (Wisner et al. 2004).

4 | Integration of Intersectionality in the Social Vulnerability Assessment

Flood risk management includes a wide range of strategies and actions to cope with and adapt to current and future flood events. The selection of adaptation strategies to reduce the impact of these floods should incorporate an intersectional perspective on vulnerability. However, many strategies and actions overlook this, as policymakers across the globe often prioritize rapid "build-back" strategies, which inadvertently often increase the vulnerability and exposure of individuals and communities—the so-called levee effect—following risk reduction measures (Di Baldssarre et al. 2015; Hutton et al. 2019; Slavikova et al. 2021). This strong emphasis on recovery speed often neglects the underlying vulnerabilities that contributed to the disasters. It also fails to account for spatial inequalities, issues of maladaptation, path dependencies, and the specific needs of vulnerable individuals and communities (Schipper 2020; Thaler et al. 2023). This oversight is especially problematic for vulnerable communities facing multiple intersecting forms of discrimination.

Flood risk management strategies and actions often account for different forms of discrimination, leading to neglect of the unique needs of affected communities. Intersectionality is not merely a complex, abstract concept; it also raises practice-oriented questions about how to integrate it meaningfully into assessments, including which indicators are relevant for an intersecting social vulnerability assessment. Health-related studies, for example, often consider gender, nationality, education, income, age, as well as geographical location (Evans et al. 2018). Nevertheless, vital challenges stem from data availability and quality, and from the reoccurring absences of spatio-temporal linkages among variables. Lessons from health research suggest that quantitative assessment of intersectionality typically relies on a limited set of indicators, which inevitably reduces complexity.

Recognition of these needs and interests is typically absent in land-use planning and related decision-making processes, largely because flood management strategies are usually set through top-down decision-making processes (Chu and Michael 2019; Paauw et al. 2025; Wiering et al. 2025). As a result, public administrations and other actors may select measures that are inappropriate or even detrimental to individuals and communities. For example, cost–benefit assessments primarily focus on physical or financial losses, often neglecting social or psychological indicators like gender, self-efficacy or stress among others (Babcicky et al. 2021) or intersecting discriminations. Consequently, communities or individuals with lower potential property damage may be excluded from public risk reduction measures (Johnson et al. 2007; Johnson and Penning-Rowsell 2010; Siders 2019).

Moreover, the selection of flood risk management strategies and actions often creates path dependency, which can exacerbate spatial inequalities and increase social vulnerability. Path dependency also heightens the risk of maladaptation, disproportionately affecting socially vulnerable communities (Barnett et al. 2015; Duvat et al. 2021). This dynamic—common in flood risk management (Seebauer et al. 2023)—reflects resistance to changing established practices, even when those practices have become increasingly maladaptive (Barnett et al. 2015).

There are various methods for assessing potential adaptation strategies, such as adaptation pathways or exploratory scenario analyses (Haasnoot et al. 2013; Wise et al. 2014; Werners et al. 2021). Adaptation pathways, for example, offer different risk reduction measures, either as single actions or bundled strategies, for future scenarios. These pathways typically include robust quantitative information, such as climate scenarios or cost–benefit analyses (Haasnoot et al. 2013). The overarching goal of adaptation pathways is to identify and implement the most effective and efficient risk reduction measures while also avoiding potential lock-in situations (Haasnoot et al. 2013; Wise et al. 2014; Werners et al. 2021).

Integrating intersectionality into the decision-making process for adaptation pathways is essential, as long-term vulnerabilities may stem from past flood risk management decisions (Wisner et al. 2004; Duvat et al. 2021). Thus, adaptation pathways should be both forward-looking and backward-looking. A retrospective assessment helps analyze and understand the root causes of individual and community vulnerabilities, ensuring that future decisions in flood risk management do not reinforce or exacerbate existing vulnerabilities (Thaler et al. 2023).

5 | Conclusion

Intersectionality can inform flood risk management. Predominantly top-down flood risk management often creates path dependency within communities (Hanger-Kopp et al. 2022), entrenching or aggravating existing inequalities. As a result, public administrations may adopt risk reduction

strategies that overwhelm vulnerable communities or produce disproportionately negative consequences. A common example is the planned relocation of low-income communities, justified on the grounds that technical mitigation measures (e.g., dikes or dams) lack sufficient public benefit to justify the investment (Siders 2019), even though relocation can intensify inequalities. While intersectionality has largely served as a powerful conceptual lens in flood risk management research (Vickery 2018; Walker et al. 2019; Kuran et al. 2020; Ayanlade et al. 2023), it often lacks operationalization for informing and guiding decision makers. Health research has moved further in operationalizing intersectionality through quantitative indicators for large-scale, geographic, spatio-temporal assessments of social vulnerability (Evans et al. 2018; Evans 2019; Philipps et al. 2020; Guan et al. 2021). Advancing flood risk management requires integrating intersectionality into risk assessments to provide a more nuanced understanding of vulnerability. So far, traditional flood risk assessments have often categorized people as vulnerable based on a single indicator (e.g., age, gender, income, ethnicity) without linking these different indicators. Intersectionality emphasizes a multidimensional perspective on social vulnerability and enables the assessment of multiple, intersecting forms of discrimination experienced by individuals and communities. The outcome would be more targeted, context-specific support that addresses the diverse needs and interests of individuals and communities, rather than providing one-size-fits-all solutions for an entire nation. At the same time, this approach would reduce the potential for flood risk management strategies and actions to exacerbate social inequalities.

Moreover, applying intersectionality in flood risk management would introduce greater nuance in participation and engagement processes. A clearer understanding of who is vulnerable—and of their specific needs—would prompt a redesign of "traditional" participation formats in flood risk management, enabling more diverse actions to integrate marginalized voices into decision-making and ensuring and fostering more inclusive governance. At the same time, integrating intersectionality into flood risk assessment requires rethinking current used methods. Flood risk management should follow a trajectory similar to health studies, particularly by developing quantitative intersectional vulnerability indicators that support more detailed mapping and more accurate representations. However, it is crucial to avoid excessive complexity in quantitative assessments, which can render results difficult to interpret and validate and may be impossible to replicate due to data limitations.

Author Contributions

Thomas Thaler: conceptualization (equal), funding acquisition (lead), project administration (lead), visualization (equal), writing – original draft (equal), writing – review and editing (equal). **Katharina Gugerell:** conceptualization (equal), visualization (equal), writing – original draft (equal), writing – review and editing (equal).

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

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

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