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Exploring implementation of disaster risk management strategies by public housing authorities: A national survey

Amber S. Khan[1*], **Rebecca J. Walter**[2], **Sara Hamideh**[3], **Andrew Aurand**[4], **Jamie Vickery**[1], **Nicole A. Errett**[1]

1 Department of Environmental and Occupational Health Sciences, University of Washington, Seattle, Washington, Unites States of America, **2** Runstad Department of Real Estate, University of Washington, Seattle, Washington, United States of America, **3** School of Marine and Atmospheric Sciences, Stony Brook University, Stony Brook, New York, United States of America, **4** National Low Income Housing Coalition, Washington District of Columbia, United States of America

* akhan92@uw.edu

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Abstract

The United States is experiencing an affordable housing crisis. Simultaneously, disasters are increasing in frequency and intensity partly due to anthropogenic climate change. Disasters exacerbate adverse impacts on extremely low-income renters living in federally-subsidized housing units managed by Public Housing Authorities (PHAs). To date, there is an overall lack of knowledge around what disaster risk management (DRM) strategies are being implemented by PHAs, as well as factors that influence PHA DRM implementation. A national survey was administered to PHAs to assess their implementation of DRM strategies. Survey results, along with secondary data, were analyzed using descriptive statistics. Fisher's exact test of independence was used to calculate the association between each binary DRM strategy variable ("Yes" versus "No") and each PHA characteristic. Findings suggest that PHA Moving To Work (MTW) status, PHA size, urban classification, state-level political affiliation, and perceived hazard risk influence PHA DRM implementation.

Introduction

The United States (US) is experiencing a housing crisis due to a lack of affordable housing stock, disproportionately impacting renters, particularly low-income renters [1]. Simultaneously, anthropogenic climate change is contributing to a rapid increase in the frequency and intensity of disasters [2–4]. Disasters have been shown to have profound economic consequences by severely impacting housing market stocks [5] and damaging large amounts of housing [6,7], further intensifying social inequities [8]. This can lead to disproportionate displacement of marginalized populations [9,10], result in environmental health concerns around housing (e.g., mold, airborne

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toxicants) [11,12], and subsequently cause and exacerbate adverse mental and physical health outcomes [13].

This convergence of housing insecurity and heightened hazard risk reveals pressing housing and environmental justice concerns and highlights the uneven distribution of climate vulnerability across race, class, and housing tenure status. Although the detrimental impacts of disasters are often discussed as if they are attributed to a hazard itself, it is the societal structures in place, such as policies and social stratifications of wealth and race, that contribute to shaping population impacts [14]. As such, disasters are, in fact, not "natural" and impact communities unequally due to poor urban planning, increasing socioeconomic disparities between groups, lack of equitable policies, and structural racism [15]. The monetary and social disparities between whites and people of color have been caused and compounded by historically racist policies (e.g., residential segregation through redlining, discriminatory mortgage lending practices) and disinvestment in communities of color, contributing greatly to housing insecurity and its subsequent health disparities across racial and socioeconomic lines [16,17].

Health and economic impacts of disasters are especially pronounced among renters, who are more often low-income and racial minorities when compared to higher income, white homeowners [18,19]. Renters have also been shown to experience disparate challenges in obtaining post-disaster assistance, which can often result in housing displacement [18,20,21]. Renters living in federally-subsidized housing units, overseen by the US Department of Housing and Urban Development (HUD), may be especially vulnerable to disaster impacts given their intersectional lived experiences of low-income economic status, race, disability status, and age [22]. Aligned with the International Panel on Climate Change's AR5 climate risk framework [23], these renters are uniquely at high risk due to their specific vulnerabilities, exposure through poor housing, and hazard susceptibility of the geographic location of their housing. Federally-subsidized housing units account for roughly 10% of the national rental housing stock and serve as a critical resource for the lowest-income renters in the country (i.e., households with incomes 30% of the Area Median Income (AMI) or less) [24]. A 2023 report by the National Low Income Housing Coalition (NLIHC) found that 24% of federally-subsidized homes are located in US census tracts with the highest risk of adverse impacts from disasters and within eight states, over half of federally-subsidized homes are within high-risk census tracts [24]. In addition, renters living in federally-subsidized housing are significantly less prepared for disasters than homeowners and unsubsidized renters [22], are at higher risk of post-disaster housing displacement than private market renters [20], and lack control over reconstruction and recovery decisions of their housing units [25]. For example, after Hurricane Katrina hit New Orleans, many public housing residents were displaced after the demolition of their rental units by the federal government [26].

Public housing authorities (PHAs), who are quasi-governmental entities responsible for managing and overseeing federally-subsidized housing units at varying and overlapping jurisdictional levels (e.g., county, city, multiple jurisdictions), face significant challenges as disasters escalate in frequency and intensity and as affordable

housing shortages persist across the US. Traditionally, PHAs played a primary role as affordable housing providers for HUD-subsidized housing units. However, this role has vastly changed as federal housing policy has shifted from the production and management of affordable housing to more neoliberal policies centered on demand-side rental assistance, through strategies such as housing vouchers [27]. This has been accompanied by an overall decline in federal funding for public housing development, resulting in largely under-resourced and underfunded PHAs [28].

While HUD recommendations on disaster readiness, response, and recovery exist [29], PHAs lack mandates from HUD or the Federal Emergency Management Agency (FEMA) around managing disaster risk. Concurrently, there are no protections or policies in place to preserve federally-subsidized units after disasters, with some being torn down post-disaster [30]. For example, in the years following Hurricane Katrina, New Orleans public housing units were reduced by 70% as part of a privatization effort by HUD and some were replaced with units subsidized by the Low-Income Housing Tax Credit, despite local resistance against the efforts [31].

Although PHAs hold a tremendous amount of responsibility overseeing federally-subsidized housing units, little is known about the disaster preparedness, response, and recovery strategies they are currently engaged in, hereon referred to as disaster risk management (DRM). Such strategies may include having plans, partnerships, and DRM-specific roles in place, as well as having appropriate resources to engage in DRM. While some studies have explored the impacts of disasters on residents living in federally-subsidized housing units [25,32,33], few studies have assessed PHA implementation of organizational-level DRM strategies, and how implementation differs by community- and organizational-level factors, highlighting a critical gap in the environmental justice literature.

This work contributes to environmental justice theory by examining how institutional governance structures, specifically PHAs, engage in DRM and therefore shape disaster risk and housing insecurity for low-income renters. While past research has emphasized the racialized and class-based dimensions of environmental exposures [34], less attention has been given to how public institutions tasked with managing vulnerability approach protecting and mitigating harm through disaster planning and policy decisions. By exploring housing governance as an environmental justice principle, this study extends theoretical understanding of how environmental injustice is produced through both exposure to hazards and institutionally-led DRM strategies.

Research objective and questions

As housing need among renters grows due to more frequent disasters and federal funding limitations continue to exist [35], PHAs will continue to struggle with meeting affordable housing needs of current and prospective residents. Building on previous environmental and housing justice literature [36], this study contributes to scholarship by examining if and how institutional actors responsible for low-income housing are engaging in DRM. Specifically, investing in DRM strategies is an essential and overdue need for PHAs, yet the scope of current PHA engagement in DRM is largely unknown. By centering PHAs, this research highlights a critical but underexplored governance scale in the production of housing precarity amid climate change. This study provides an overview of current PHA DRM strategy implementation in the US, and addresses the following research questions:

Research question 1 How does implementation of PHA DRM strategies vary by community- and organizational-level characteristics, including PHA size, Moving To Work status, urban classification status, and political affiliation of state governors?

Research question 2 How does implementation of PHA DRM strategies vary by a PHA's perceived hazard risk?

Six DRM strategies were identified from previous research on organizational DRM [37] and data was collected through an online survey. These DRM strategies include having dedicated DRM funding in place, implementation of disaster plans, having adequate staff and technical capacity to engage in DRM, having adequate financial resources to engage in DRM, having a DRM role or department in place, and having partnerships in place to support DRM engagement. A description of each of these DRM strategies is provided below, along with relevant literature. In addition, secondary data on four

community- and organizational-level characteristics of interest was collected. These community- and organizational-level characteristics include PHA size, Moving to Work (MTW) status, urban classification, and political affiliation of state governors. Data on one additional organizational-level characteristic, perceived hazard risk, was collected through the online survey. A description of these five community- and organizational-level characteristics, along with relevant literature, is also provided below.

Disaster risk management strategies

(1) Dedicated DRM funding

Organizational financial preparedness can help to alleviate the detrimental and unexpected short-term expenses that arise post-disaster [38]. For example, past research has shown that government agencies that have experienced a past disaster are more likely to set aside funds for future disasters, which improves their ability to engage in effective DRM [39]. Specifically for low-income communities, who are at higher risk of detrimental post-disaster impacts [5], setting aside dedicated funds may help reduce the risk of residents falling into poverty if housing is lost or damaged. To date, it is currently unknown if PHAs are setting aside dedicated funds to engage in DRM.

(2) Disaster plan implementation

It has been well-established in the planning literature that investing time and resources into disaster planning is a viable strategy for improving post-disaster outcomes [40,41]. Yet, incorporation of PHAs in disaster planning among state and local governments is largely lacking. A recent analysis of state-level emergency operation and disaster plans found that PHAs are rarely included or considered in plans [42]. A case study conducted in Utah County confirmed this lack of PHA inclusion in planning at a more local scale [43]. Authors conducted semi-structured interviews with local emergency management, city planning, and housing officials, finding an overall lack of pre-disaster plans for public housing recovery [43]. In addition, while it is recommended by HUD for every PHA to implement a disaster plan [29], it is currently unknown if PHAs are currently implementing their own organizational disaster plans.

(3) Adequate staff/technical capacity

The importance of administrative capacity in disaster planning has been emphasized in numerous studies [44–46]. For example, researchers conducted semi-structured interviews with seven local health departments, identifying that funding for specific programs and adequate staffing are essential needs for their staff to engage communities in disaster preparedness [47]. While PHAs lack staff and technical capacity [48], it is largely unknown if this lack of capacity impacts implementation of DRM strategies. Identifying administrative capacity needs can help to inform future DRM resource allocation.

(4) Adequate financial resources

At the same time, a lack of financial resources at the organizational level has consistently been shown to be a limiting factor in implementing DRM strategies [49,50], as well as a barrier for implementation of effective affordable housing policy for PHAs in general [51]. A qualitative study using interviews with community-based homeless organizations in Los Angeles found that financial resources and staff time were significant barriers to organizational engagement in disaster preparedness [52]. To date, no research has investigated if PHAs have adequate financial resources for engaging in DRM.

(5) DRM role and/or department

At the organizational level, creating specific PHA roles or departments centered on DRM may be a viable DRM strategy, as previous studies have highlighted the importance of risk managers in managing organizational risks [49]. One study conducted interviews with fifteen organizations and disseminated a survey to organizations in Memphis and found

that hiring of a risk manager results in adoption of risk-reducing measures [53], suggesting that having a DRM role or department in place may reduce the impacts of disasters on organizations. In a PHA context, the presence or utility of a DRM-specific role or department remains to be investigated.

(6) Partnerships

Numerous studies have demonstrated that establishing collaborative, interdisciplinary relationships before disasters results in a more successful disaster response [46,54,55]. In a Georgia case study that utilized interviews with businesses, local government, and academics, Buehler et al. found that strong partnerships between public health and business leadership led to expanded shared learning opportunities, ultimately improving emergency response [56]. While research on cross-sectoral and interdisciplinary DRM partnerships has been conducted in fields such as public health [47,56], a deeper study of DRM partnerships remains absent in the field of affordable housing, among PHAs specifically.

Community- and organizational-level characteristics

(1) PHA size

Numerous studies have demonstrated that organizational size is a predictor of DRM [57–61], as larger organizations are more likely to have formalized DRM initiatives [62] and more resources to invest in DRM strategies [58]. PHAs vary widely in the number of units they administer and their jurisdiction sizes, some being at the county- or city-level, while others serve large rural areas. There are roughly 4,000 PHAs in the U.S., and majority of these are small (69.3% of PHAs are responsible for overseeing fewer than 250 units total) and medium-sized (21.3% of PHAs are responsible for overseeing 250–1,249 units total), but large PHAs are responsible for the majority of federal housing assistance (6.4% of PHAs are responsible for overseeing 1,250–10,000 + units total) [63,64]. Using administrative data and interviews with executive directors of small PHAs in Illinois, researchers found that smaller PHAs (i.e., serving less than 1,000 units) are less likely to be designated as “high-performing,” based on HUD’s Public Housing Assessment System [48]. To date, there remains a gap in understanding how implementation of DRM strategies varies by PHA size. Given previous research in other sectors, it is plausible that PHA size may be associated with implementation of DRM strategies as larger PHAs may be better resourced.

(2) Moving To Work (MTW) status

In the past 25 years, federal initiatives have greatly expanded the scope of local PHA action, which has both created conflicting goals for PHAs and promised them more flexibility for adopting new strategies at the local level [27,65]. For example, the MTW program is a HUD-led demonstration program that provides some PHAs with opportunities to design and test innovative, locally-guided strategies to use federal funding more efficiently and provide exemptions from existing rules around using funding [66]. Other than providing more flexibility for use of funds, the MTW program can foster expanded partnerships with organizations to provide more affordable housing and fund hybrid social service programs to improve self-sufficiency among residents [65]. While programs such as MTW have potential to influence PHA planning decisions [67] by allowing more resources to be allocated towards DRM, it remains to be investigated if and how MTW PHAs may differ from non-MTW PHAs in their ability to implement DRM strategies.

(3) Urban classification

Disasters have been shown to impact metropolitan and rural areas disparately, which may be due to an overall lack of human capacity and financial resources in rural communities [68], which is especially exacerbated post-disaster [69]. A 2023 report from the NLIHC found that 30% of federally-assisted homes in rural areas are in census tracts with greatest risk hazard, compared to 23% of federally-assisted homes in urban or metropolitan areas, highlighting the higher risk that

rural residents living in units managed by PHAs face [24]. At the same time, rural communities may be more self-reliant and have stronger social networks and a sense of community that can enhance resilience to disasters [70]. Little research exists on the unique experiences of metropolitan, micropolitan, and rural PHAs [48]. Given the differences between urban classification status of PHAs, it remains to be investigated if implementation of DRM strategies differs among them.

(4) Political affiliation of state governors

Research suggests that the political affiliation of state governors may influence decision-making around DRM [71–75]. For example, the COVID-19 pandemic highlighted stark differences between policy implementation by Republican and Democratic state governors [71]. In general, Republican governors were much slower than Democratic governors to adopt policies that encouraged social distancing and stay-at-home orders, ultimately leading to adverse public health impacts [71]. These differences in approaches to decision-making may be due to the more conservative leanings of Republican politicians, who often desire a limitation of governmental intervention on a day-to-day basis [75]. The association between the political affiliation of state governors and implementation of DRM strategies at PHAs has yet to be investigated.

(5) Perceived hazard risk

Past research has demonstrated that public agencies are more likely to engage in preparedness activities if they perceive a high level of hazard risk [58,60,76]. While there are discrepancies around the definition of "perceived hazard risk" across studies, a general consensus is that if hazard risk is recognized at the managerial level, it is more likely to be prioritized across organizations [77,78]. The association between perceived hazard risk and organizational engagement in preparedness has been conducted at specific types of agencies, such as public transportation providers [77], yet a gap remains on studying this association specifically at PHAs.

Materials and methods

We developed and distributed a survey tool to 3,362 PHA executive directors across the US. Survey results were analyzed, along with secondary data, to understand how implementation of six DRM strategies vary by five community- and organizational-level characteristics (i.e., PHA size, MTW status, urban classification status, political affiliation of state governors) and perceived hazard risk. The University of Washington Human Subjects Division determined this study to be human subjects research that qualifies for exempt status on September 13, 2023.

Data collection

A survey tool (S1 Data) was developed and informed by findings from previous literature and semi-structured interviews previously conducted with key informants by the research team [37]. Fig 1 provides an overview of the survey sampling process.

Survey recipients were identified from a comprehensive list of PHA executive directors, which is maintained by HUD on ArcGIS' Open Data website [79]. At the time of survey dissemination, the PHA executive director contact information had last been updated on March 6, 2023.An initial email was first sent out on October 16, 2023 to prospective recipients through a University of Washington study email address in order to collect bounceback emails. For bouncebacks received, one investigator (AK) consulted the PHA's website to identify an alternative executive director email address. If an alternative email was identified, the contact sheet was corrected, and if not, the PHA was removed from the contact sheet.

The survey was administered via REDCap software and distributed electronically by email on October 24, 2023. Informed consent was collected at the start of the survey through REDCap. Previous work by Dillman has demonstrated that repeated, appropriate contact with survey recipients can substantially increase survey response rate, specifically five varied points of contact regarding the survey [80,81]. Thus, five survey reminders were sent out about 1 week apart

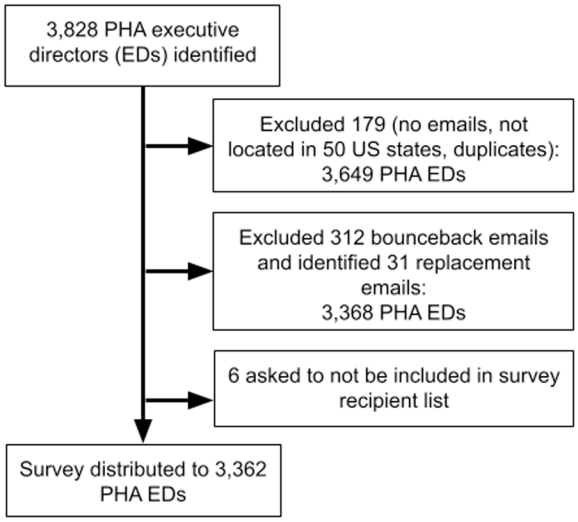

Fig 1. Survey sampling process.

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on alternating weekdays. The survey was officially closed on November 23, 2023 and was sent to a final count of 3,362 survey recipients. Survey questions that measured PHA DRM implementation include:

- **Dedicated funding:** Does your PHA currently have dedicated funding set aside for disasters?
- **Plans:** Does your PHA currently have emergency/disaster plans in place?
- **Staff/technical capacity:** Does your PHA have adequate staff and/or technical capacity to engage in DRM?
- **Financial resources:** Does your PHA have adequate financial resources available to engage in DRM?
- **DRM department/role**: Does your PHA have a DRM department and/or role?
- **Partnerships:** Does your PHA have partnerships that support DRM?

Publicly-available secondary data was utilized for four community- and organizational-level characteristics in the analysis. A fifth organizational-level characteristic "perceived hazard risk" was collected through the survey tool. These five community- and organizational-level characteristics are provided in Table 1, along with data types, values, definitions, and sources.

Data Analysis

Descriptive statistics, specifically Fisher's exact test of independence, were used to calculate the association between each binary DRM strategy variable ("Yes" versus "No") and each PHA characteristic outlined in Table 1. Fisher's exact test is used to determine if there is a statistically significant difference in the proportions of categories in two variables and can be used for small sample sizes (<5), allowing for flexible use across the dataset. This specific statistical approach was used, rather than regression, due to small sample sizes for the 'PHA size' and 'Moving to Work' variables and collinearity between DRM strategy variables. For example, 'PHA size' and 'OMB urban classification' variables are highly correlated due to rural PHAs being a much smaller size than urban PHAs. This introduced bias in the models and it was determined that a descriptive statistical approach was the most appropriate for this analysis. The "Do Not Know" answers for each DRM strategy variable were dropped at the survey question level, as inclusion did not specifically address implementation

Table 1. Community- and organizational-level characteristics, types, values, definitions, and data sources used in analysis.

Community- or Organizational-Level Characteristic	Data Type	Data Values	Definition	Data Source
PHA Size	Categorical	Extra Large (5,000+) Large (1,000–4,999) Medium High (300–999) Medium Low (100–299) Small (50–99) Very Small (0–49)	Combined Size Category based on unit count of Low Rent and Section 8 units	HUD PHA ArcGIS Open Data website[a]
Office of Management and Budget (OMB) Urban Classification	Categorical	Metropolitan Statistical Areas (MSAs) Micropolitan Statistical Areas (μSAs) Rural Areas	MSAs consist of the county or counties (or equivalent entities) associated with at least one urban area of at least 50,000 population.[b] μSAs consist of the county or counties (or equivalent entities) associated with at least one urban area of at least 10,000 but less than 50,000 population.b Rural areas consist of any areas that are not defined as MSAs or μSAs.[c]	HUD PHA ArcGIS Open Data website[a]
Moving to Work (MTW) Status	Categorical	MTW Status No MTW Status	PHAs with Standard Agreements for MTW status designated prior to 2021 (i.e., Initial Agencies) were included. All other PHAs were grouped into the "No MTW status" including PHAs selected for MTW expansion, since full MTW authority was not granted to these agencies. There was a total of 36 MTW agencies.	HUD MTW Agency website[d]
Political Affiliation of State Governors	Categorical	Republican Democrat	State governor affiliation in October 2023 (at time of survey distribution)	Ballotpedia, Partisan composition of governors[e]
Perceived Hazard Risk	Categorical	Yes No	The survey question that measured perceived hazard risk was "Is your PHA at risk of experiencing impacts from disasters/hazards?"	Survey tool (S1 Data)

[a][82]

[b][83]

[c][84]

[d][66]

[e][85]

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of DRM strategies. However, collection of "Do Not Know" data was important to measure because it provides an overview of knowledge of DRM strategy implementation by PHA representatives. "Do Not Know" response counts per DRM strategy are provided in S1 Table. All data cleaning and descriptive statistics were performed in R Studio Version 4.1 [86].

Results

A total of 559 PHA representatives responded to the survey out of 3,362 recipients, resulting in an overall 16.6% response rate. At least one PHA from every state, except for Hawai'i, responded to the survey and were represented in the sample. Table 2 presents the overall count and percentages of survey respondents, organized by five community- and organizational-level characteristics (i.e., PHA size, MTW status, urban classification, political affiliation of state governors, perceived hazard risk).

These results indicate that almost half of survey respondents represent PHAs of medium low and medium high size, while only 5.4% represent extra large PHAs. More than half of survey respondents represented PHAs in metropolitan areas. While only 2% of respondents represented PHAs with MTW status, this is expected as there are only 36 MTW agencies who were sent the survey (see Table 2). Political affiliation of state governors was distributed equally among PHA survey respondents. Over half of respondents reported that they perceived hazard risk at their PHAs. The sample of survey respondents was representative of survey non-respondents, as demonstrated in Table 2.

Table 2. Percentages of responses from survey respondents, survey non-respondents, and overall survey recipients, organized by community- and organizational-level characteristics.

	Survey respondents (n = 559)	Survey non-respondents (n = 2803)	Overall (n = 3362)
PHA Size			
Extra Large (5,000+)	*5.4%*	*3.0%*	*3.4%*
Large (1,000–4,999)	*20.2*	*14.5*	*15.4*
Medium High (300–999)	*24.2*	*23.2*	*23.3*
Medium Low (100–299)	*23.8*	*25.8*	*25.5*
Small (50–99)	*13.1*	*14.4*	*14.2*
Very Small (0–49)	*13.4*	*19.2*	*18.2*
MTW Status			
MTW Status	*2.1*	*0.9*	*1.1*
No MTW Status	*97.9*	*99.1*	*98.9*
OMB Urban Classification			
Rural	*24.5*	*26.1*	*25.8*
Micropolitan	*18.8*	*21.2*	*20.8*
Metropolitan	*56.7*	*52.7*	*53.4*
Political Affiliation			
Republican	*49.7*	*48.7*	*48.9*
Democratic	*50.3*	*51.3*	*51.1*
Perceived Hazard Risk[a]			
Yes	*56.0*[b]	*N/A*	*N/A*
No	*44.0*[b]	*N/A*	*N/A*

[a]Overall n is smaller (n = 482) for "Perceived Hazard Risk" due to 77 "Do Not Know" responses from survey respondents.

[b]Percentages are calculated to be out of 482 for "Perceived Hazard Risk"

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Overall, the most commonly implemented PHA DRM strategies were having partnerships in place that support DRM (66%) and having PHA disaster plans in place (88%). The DRM strategies that were reported to be implemented the least were having dedicated disaster funding set aside for DRM (18%) and having a specific DRM department and/or role in place (21%). Thirty-two percent of respondents reported having adequate staff and/or technical capacity to engage in DRM, while 37% had adequate financial resources to engage in DRM. Table 3 describes the proportion of PHAs by each disaster risk management strategy: Dedicated disaster funding; Disaster plan(s) in place; Adequate staff and/or technical capacity; Adequate financial resources; DRM department and/or role; and Partnerships. For in-depth tables that include an overview of "No" responses per DRM strategy, refer to S2 Table.

Dedicated disaster funding

Overall, only 18% of respondents said that they currently have dedicated funding set aside for disasters. A higher proportion of extra large (4%) and large PHA respondents (5%) reported having dedicated disaster funding, while only one very small PHA said that they have dedicated disaster funding in place (0.5%). There was a statistically significant association between PHA size and dedicated disaster funding ($p = 0.05$), and between MTW status and dedicated disaster funding ($p = 0.005$). However, no statistically significant associations between dedicated disaster funding and urban classification, political affiliation, and perceived hazard risk were identified ($p \leq 0.05$).

Table 3. Status of six PHA DRM strategies by PHA size, MTW status, OMB urban classification, Political affiliation, and Perceived hazard risk.

	Dedicated disaster funding (n = 196[a]) n (%)	*p*-value	Disaster plan(s) in place (n = 207[a]) n (%)	*p*-value	Adequate staff and/or technical capacity (n = 429) n (%)	*p*-value	Adequate financial resources (n = 401) n (%)	*p*-value	DRM department and/or role (n = 464) n (%)	*p*-value	Partnerships (n = 436) n (%)	*p*-value
Total "Yes" responses	35 (*17.9%*)		182 (*87.9%*)		137 (*31.9%*)		149 (*37.2%*)		99 (*21.3%*)		288 (*66.1%*)	
PHA Size		**0.05***		0.74		0.22		0.52		**6.8e-05*****		**1.5e-04*****
Extra Large (5,000+)	8 (*4.1*)		20 (*9.7*)		8 (*1.9*)		8 (*2.0*)		14 (*3.0*)		23 (*5.3*)	
Large (1,000–4,999)	9 (*4.6*)		47 (*22.7*)		29 (*6.8*)		28 (*7.0*)		25 (*5.4*)		73 (*16.7*)	
Medium High (300–999)	6 (*3.1*)		59 (*28.5*)		43 (*10.0*)		37 (*9.2*)		29 (*6.2*)		80 (*18.3*)	
Medium Low (100–299)	7 (*3.6*)		29 (*14.0*)		26 (*6.1*)		38 (*9.5*)		20 (*4.3*)		58 (*13.3*)	
Small (50–99)	4 (*2.0*)		15 (*7.2*)		19 (*4.4*)		16 (*4.0*)		8 (*1.7*)		34 (*7.8*)	
Very Small (0–49)	1 (*0.51*)		12 (*5.8*)		12 (*2.8*)		22 (*5.5*)		3 (*0.65*)		20 (*4.6*)	
MTW Status		**0.005*****		1.0		0.34		0.18		**7.7e-04*****		0.76
MTW Status	6 (*3.1*)		11 (*5.3*)		5 (*1.2*)		6 (*1.5*)		8 (*1.7*)		8 (*1.8*)	
No MTW Status	29 (*14.8*)		171 (*82.6*)		132 (*30.8*)		143 (*35.7*)		91 (*19.6*)		280 (*64.2*)	
OMB Urban Classification		0.40		0.22		0.51		0.88		**6.9e-04*****		**3.2e-05*****
Rural	3 (*1.5*)		20 (*9.7*)		27 (*6.3*)		33 (*8.2*)		12 (*2.6*)		45 (*10.3*)	
Micropolitan	4 (*2.0*)		31 (*15.0*)		26 (*6.1*)		27 (*6.7*)		14 (*3.0*)		51 (*11.7*)	
Metropolitan	28 (*14.3*)		131 (*63.3*)		84 (*19.6*)		89 (*22.2*)		73 (*15.7*)		192 (*44.0*)	
Political Affiliation		0.85		0.53		1.0		0.53		0.37		**0.01*****
Republican	16 (*8.2*)		87 (*42.0*)		67 (*15.6*)		77 (*19.2*)		46 (*9.9*)		137 (*31.4*)	
Democratic	19 (*9.7*)		95 (*45.9*)		70 (*16.3*)		72 (*18.0*)		53 (*11.4*)		151 (*34.6*)	
Perceived Hazard Risk		1.0		0.81		0.60		0.35		**5.9e-04*****		**4.2e-07*****
Yes	27 (*13.8*)		137 (*66.2*)		80 (*18.6*)		78 (*19.4*)		70 (*15.1*)		194 (*44.5*)	
No	8 (*4.1*)		45 (*21.7*)		57 (*13.3*)		71 (*17.7*)		29 (*6.2*)		94 (*21.6*)	

*Significant at $p < 0.1$; ***Significant at $p < 0.05$

[a]"n" for "Dedicated disaster funding" and "Disaster plan(s) in place" is smaller due to formatting of parent-child questions in the survey. See S1 Data for the survey tool.

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Disaster plan(s) in place

The majority of PHAs reported currently having disaster plan(s) in place (88%). Eleven of twelve MTW PHAs respondents said that they have disaster plans in place (5%), while metropolitan PHAs had the highest response to implementing disaster plans (63%) compared to micropolitan (15%) and rural PHAs (10%). In addition, a higher proportion of PHAs

with perceived hazard risk responded that they have implemented plans (66%) than PHAs without perceived hazard risk (22%). Overall, there were no statistically significant associations between having PHA disaster plans in place and any of the community- and organizational-level characteristics ($p \leq 0.05$).

Adequate PHA staff and/or technical capacity

Most respondents said that they do not have adequate PHA staff and/or technical capacity to engage in DRM (68%). A higher proportion of medium-high sized PHA respondents reported having adequate PHA staff and/or technical capacity (10%), while extra large sized PHA respondents had the lowest proportion (2%). Five out of eleven respondents with a MTW PHA reported adequate PHA staff and/or technical capacity to engage in DRM (1.2%). There were no statistically significant associations between adequate PHA staff and/or technical capacity and any of the community- and organizational-level characteristics ($p \leq 0.05$).

Adequate financial resources

Thirty-seven percent of respondents said that they have adequate PHA financial resources to engage in DRM strategies. Notably, about half of very small PHA respondents (5.5%), as well as six out of ten PHAs with MTW status (1.5%), said that they have adequate financial resources for engaging in DRM. Among 223 PHAs with perceived hazard risk (56%), about one-third of them reported that they have adequate financial resources available to engage in DRM (19%). There were no statistically significant associations between having adequate financial resources to engage with DRM and any of the community- and organizational-level characteristics ($p \leq 0.05$).

DRM Department and/or role

Twenty-one percent of respondents said that their PHA has a DRM department and/or role in place. Lower proportions of respondents from small (1.7%) and very small PHAs (0.65%) reported having a DRM department and/or role. Eight of twelve respondents with MTW status (1.7%) answered “Yes” to having a DRM department and/or role at their PHA. A higher proportion of respondents with perceived hazard risk reported having a DRM department and/or role in place (15%) compared to those with no perceived hazard risk (6%). Having a DRM department and/or role in place was statistically significantly associated with all community- and organizational-level characteristics, except for political affiliation ($p \leq 0.05$).

Partnerships

Overall, 66% of respondents reported that they have PHA partnerships in place that support DRM. Within every PHA size category except “Very Small”, more respondents reported having partnerships in place that support DRM than not having such partnerships in place. Similarly, more metropolitan (44%) and micropolitan (12%) respondents reported having partnerships in place that support DRM than not having such partnerships in place. Having partnerships in place that support DRM was statistically significantly associated with all community- and organizational-level characteristics, except for MTW status ($p \leq 0.05$).

Discussion

Disasters resulting from climate-sensitive hazards and the affordable housing crisis are concurrently intensifying in the US [1,2], making it essential to engage PHAs in DRM strategies so that they can better support the housing needs of low-income residents. Using a national-level online survey distributed to PHAs, this study provides a cross-sectional assessment of implementation of six DRM strategies at PHAs. The most frequently implemented DRM strategies at PHAs were having partnerships in place that support DRM and having PHA disaster plans in place. The least frequently implemented DRM strategies at PHAs were having dedicated disaster funding set aside for DRM and having a specific

DRM department and/or role in place. The quality of PHA disaster plans in place remains to be investigated, given the low proportion of PHAs who reported adequate staff/technical capacity and specific DRM departments/roles in place. This study also expands understanding of the association between implementation of DRM strategies and community- and organizational-level characteristics, including PHA size, MTW status, urban classification status, political affiliation of state governors, and perceived hazard risk.

Findings from this study suggest that PHAs who have more resources and flexibility in funds, such as through the MTW program, are more likely to participate in implementation of DRM strategies. Past research has demonstrated that MTW provides PHAs with an avenue to gain flexibility in funding structures, allowing PHAs to customize their programs based on local priorities [65,87]. A recent qualitative study that used interviews with PHA, federal and state government, and non-profit professionals found that MTW allowed PHAs to generate cash flow and not be tied to HUD requirements, thereby allowing them to better implement DRM strategies, such as purchasing generators or communication systems for their units [37]. Our findings expand on current literature and suggest that PHAs with MTW status may be more equipped to implement DRM strategies, highlighting the utility of flexible spending programs as a potential policy tool for PHAs to better engage in implementation of DRM strategies. However, the benefits of MTW with regard to DRM may not necessarily outweigh MTW's opportunity costs of providing fewer Housing Choice Vouchers or making critical capital repairs to public housing [88]. Advocates also argue that there are potentially adverse impacts of MTW features in some cases, such as work requirements and higher rents [35]. Further research is necessary to understand the full scope of MTW utilization as a flexible funding mechanism for PHAs, including in DRM.

At the same time, our findings indicate that PHA size is significantly associated with implementation of numerous DRM strategies. These findings complement previous literature on large organizational size as a determinant of disaster preparedness, as larger organizations often possess more resources, resulting in more technical capacity and knowledge among staff [58,62]. Rural PHAs, who are often smaller in size, face unique challenges because they are often under-resourced, their staff lack technical training [48], and rural areas receive less federal disaster aid compared to urban areas [89]. Future research should explore how smaller and rural housing authorities can better collaborate and consolidate resources, and if and how that ultimately improves preparedness, response, and recovery for future disasters.

Currently, no HUD mandates or requirements exist for PHAs to implement DRM strategies, and dedicated DRM resources from HUD are lacking. In absence of mandates, HUD has compiled a PHA disaster readiness, response, and recovery guidebook [29], which clarifies the roles of PHAs in disasters. Yet without appropriate funding and resource provision, qualitative research has shown that PHAs struggle to meet the recommended guidelines [37]. While HUD published a 2021 Climate Action Plan [90] and a 2024 Climate Adaptation Plan [91] for guiding HUD to take appropriate adaptation measures to reduce climate risk and identify measures to help their communities build resilience, both documents fail to address PHA roles around climate change adaptation and resilience. Given this gap of PHA inclusion in climate change and disaster planning, HUD should prioritize providing DRM-focused technical assistance and staff training to PHAs to better help them prepare for disasters and adapt to climate change. Recently, HUD has created and shared a hazard-specific webinar series [92] and fact sheets [93] on PHA disaster readiness, response, and recovery, yet it is unknown if PHAs are utilizing these resources, especially as they struggle with an overall lack of funding to engage in DRM [37]. Moving forward, Congress must dedicate monetary resources to HUD, and subsequently to PHAs, to implement effective technical assistance and educational strategies around DRM. HUD can also help facilitate relationships between PHAs and affordable housing non-profit organizations. Nonprofits can serve as a valuable partner for PHAs, as they possess technical expertise and local relationships that are crucial when disasters happen. As such, nonprofit organizations can help bridge the resource gap for HUD and PHAs by providing technical assistance and staff training, as well as lead implementation of a DRM policy evaluation at PHAs to better understand differences between PHAs that are effectively engaging in DRM versus PHAs that are not. Ultimately, this can help to inform best practices at PHAs and contribute to organizational capacity building.

While this study was conducted at a national scale in the US and captures a first of its kind overview of DRM strategy implementation at PHAs, findings may not be generalizable to other types of housing organizations or to international housing providers. An additional limitation of this study is the potential presence of selection bias as the participants who chose to respond to the survey may be systematically different from those who did not. For example, PHAs with recent disaster experience, high hazard risk, or DRM strategies in place may have been more likely to respond. However, the research team attempted to mitigate this bias by clarifying in the survey invitation that responses were sought from all PHAs, regardless of current engagement in DRM strategy implementation or recent experience with disasters. Response bias may also have been present, as most survey questions asked respondents to self-report their PHA's engagement in DRM. Specifically, social desirability bias may have been present among PHAs overreporting their engagement in DRM if they recently experienced a disaster. Non-response bias may also have been present, as PHAs without disaster expertise or staff trained in DRM (i.e., rural PHAs) may have been less likely to respond. We attempted to mitigate this by sending out multiple reminders that asked for all views and experiences. Two of the DRM strategies that were measured in the survey asked about adequate staff and/or technical capacity and adequate financial resources to engage in DRM strategies. Since public-serving agencies are often underfunded and understaffed, the wording of the questions could have resulted in more "No" or "Do not know" answers, as survey respondents may have erred on the side of caution when answering. Another limitation was that this research investigated self-reported perceived hazard risk among PHAs since a dataset of each PHA's units that they oversee was not available to match with an objective hazard risk dataset at an appropriate level of geography. Future research should incorporate objective hazard risk assessments to better quantify how PHA DRM strategy implementation may vary based on hazard risk. Overall, a 16% response rate was achieved in this study. While comparative meta-analyses of online surveys have reported an average response rate of 34–36% [94,95], other studies suggest survey data is reliable with 5–10% response rate if the sample size is at least 500 [96]. Thus, the large sampling frame of our survey may mitigate potential non-response bias and obtain reliable estimates with lower response rate. Lastly, mitigation was not specifically included within the definition of DRM in this study because it is not currently addressed in HUD's PHA disaster readiness, response, and recovery guidebook [29]. Future studies could incorporate mitigation strategies to better understand if they are being implemented at PHAs, since mitigation is essential to prioritize as structural improvements to aging housing stock will become increasingly important in the face of accelerating hazard exposure.

Conclusion

Increasing disaster risk, including those resulting from climate-sensitive hazards, along with an intensifying affordable housing crisis in the US, highlight the urgency of engaging PHAs in DRM to better protect low-income renters. Through a national-level survey, this research assesses implementation of DRM strategies among US PHAs, as well as the association of community and organizational-level characteristics with their implementation. Our findings suggest that MTW status, PHA size, urban classification, state-level political affiliation, and perceived hazard risk are all important characteristics that influence implementation of multiple DRM strategies. Notably, having dedicated disaster funding, a DRM department, and partnerships in place were associated with multiple community- and organizational-level characteristics. As well-resourced PHAs are more likely to engage in DRM activities, it is essential for policymakers to identify and make monetary resources available to HUD so that PHAs can engage in DRM capacity development.

Supporting information

S1 Data. Survey tool.
(DOCX)

S1 Table. Table of "Do Not Know" responses.
(DOCX)

S2 Table. Tables of DRM strategies, including "Yes" and "No" responses.
(DOCX)

Author contributions

Conceptualization: Amber S. Khan, Rebecca J Walter, Sara Hamideh, Andrew Aurand, Nicole A Errett.

Data curation: Amber S. Khan, Nicole A Errett.

Formal analysis: Amber S. Khan.

Funding acquisition: Amber S. Khan, Rebecca J Walter, Andrew Aurand, Nicole A Errett.

Investigation: Amber S. Khan.

Methodology: Amber S. Khan, Rebecca J Walter, Sara Hamideh, Nicole A Errett.

Project administration: Amber S. Khan.

Software: Nicole A Errett.

Supervision: Rebecca J Walter, Sara Hamideh, Andrew Aurand, Nicole A Errett.

Writing – original draft: Amber S. Khan.

Writing – review & editing: Amber S. Khan, Rebecca J Walter, Sara Hamideh, Andrew Aurand, Jamie Vickery, Nicole A Errett.

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