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Perceived risk and preferences of response and recovery actions of individuals living in a floodplain community

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ABSTRACT

Risk perception influences vulnerability to natural hazards in two key ways: 1) how an individual adapts to the risk, and 2) how a community responds and adjusts to these risks. Hence, risk perception plays a critical role in flood response and recovery policies for local communities. However, this perception variation among floodplain residents is not well understood, especially under varying flood threats. The research aimed to characterize how risk perceptions of varying flood threats diverged across groups of people living in floodplains and identify individuals' preferences for response and recovery actions. A household survey was conducted to determine residents' risk perceptions in the 1%- and 0.2% annual chance floodplain in Corvallis, OR. Contingency tables were used to evaluate relationships between respondents' sociodemographics, perceptions, and preferences for flood response and recovery actions. The results highlight that, even when households are exposed to similar threats of floodwater depths, survey respondents' risk perceptions and support for proposed response and recovery actions differed along sociodemographic lines. Understanding the nuanced relationships among socio-demographics, risk perceptions, and response and recovery actions can facilitate practical and better-informed approaches for community-relevant decision-making.

1. Introduction

Populations are likely to be more vulnerable if they do not adequately and accurately perceive the risk posed by floods on individual households, neighborhoods, and the broader community. Flood vulnerability is defined as the quality or state representing the susceptibility to negative impacts of flooding and consequences that a person or community members undergo due to certain sociodemographic attributes [1,2]. Changes in flood volume and flood timing due to changing climatic patterns (e.g. Ref. [3]) are expected to exacerbate flooding hazards in many areas and expose vulnerabilities (e.g., social, environmental, and infrastructure vulnerabilities) in communities [4]. As the climate continues to vary and flood threats evolve, information about how people in different sociodemographic groups perceive flooding hazards is crucial to plan a response and recovery action because it strongly influences the type of response and recovery actions a resident may adopt [5]. Unlike hazard risk, which can be measured by assessing a hazard event's probability and the potential magnitude or extent, risk perception can be influenced by an individual [6] and cultural-societal [7] factors. Risk perception is a by-product of social learning rather than individual characteristics; the social dynamics, context, and group norms can influence an individual's evaluation of risk [8–10].

It is worth noting that the influence of socio-cultural factors and physical environment on individuals' risk perceptions can be complicated and confounding. Some studies have reported that individual and cultural-societal factors related to risk perceptions can outweigh geographic proximity and exposure to potential hazards. For example, a study in four Romanian villages from the Danube River floodplain [11] found that income, gender, and flood experience were linked with

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perceptions of flood risk. On the other hand, some studies (e.g. Ref. [5]) have found little evidence for a relationship between education and income and flood risk perceptions. Further, Scolobig et al., 2012 [12] focused on the geographic impacts on risk perception and found that residents within the floodplain boundary underestimate flood risk. Another study [13] found that individuals from the same geographic location can yield different understandings of the extent of a flood occurring in the region. Beyond individual and social-cultural influences, risk perception and response have also been influenced by previous personal experience with a natural hazard [14–16]. For instance, individuals without direct prior flood experience could more likely underestimate risk, whereas individuals with direct previous flood experience could more likely overestimate risk [17]. Possession of flood insurance has been shown to influence perceptions on their resilience from flooding hazards. Residents with flood insurance feel confident in overcoming flooding disasters because they expect to benefit from insurance pay-outs and reduced losses [18]. However, overconfidence in federal flood managers' ability to help them during a flood can increase a community's flood vulnerability [19].

Individual risk perception can influence one's self-confidence in being flood-ready [20], their motivation to stay or leave the affected location [21], and an individual or community's ability to cope and adapt to flood stresses [22]. In a region threatened by floods, community perceptions of risk can influence the level of community-wide preparedness and preferred responses for existing and imminent threats [23]. Preference for a specific response and recovery measures vary significantly among individuals and communities due to different experiences, interests, and vulnerabilities [24]. Flood mitigation and recovery actions such as massive scale defenses (e.g., flood embankments, dikes, dams, reservoirs, and diversions) require significant and long-term investments. They are primarily implemented by public or private institutions [25]. Non-structural mitigation and recovery measures (e.g., moving house belongings, relocating from home, buying or upgrading flood insurance, elevating house structure) are spatially distributed throughout the community, typically smaller in scale implemented by individuals in neighborhoods [25]. Research has noted the need for more studies on people's preferences for these alternatives. For example, Glaas et al. (2017) [26] highlight the need to raise awareness of response and recovery alternatives and communicate context-specific measures that individuals/households can implement, rather than rely on generalized and centralized mitigation measures. Temporary home relocation is one of the most common non-structural response measures to flooding [27], leading to some of the population choosing to relocate [21] permanently. However, many households have personal motivations to stay at their current location, such as employment factors, distance to school, distance to shops and services, house features and landscaping, sense of community, and housing [28].

Based on the previous studies outlined above, there are many intertwined factors in a person's perception of flood risk and their preferred response and recovery actions. These factors include personal factors: sociodemographics, previous flood experience, flood insurance, and self-confidence, as well as geographic location. There remains a need for a better understanding of these factors' relationships to create practical and community-relevant strategies for flood response and recovery [29]. In addition, there is a knowledge gap on individuals' risk perceptions of varying flood threats. Hence, the overarching goal of this research is to characterize how risk perceptions of varying flood threats may diverge across groups of people living in floodplains and to identify individuals' preferences for one or more potential response and recovery actions in a local community.

2. Methods

This study's overall approach involved flood mapping, household surveys [30], and analysis of the collected data. The survey was conducted in the floodplains located along the Marys River in the southern region of Corvallis, OR. The floodplain has high exposure to riverine floods. While the area is protected by flood-regulating dams upstream, rain-on-snow events can produce floods associated with heavy snow accumulation in the mountains and foothills followed by a series of subtropical storm surges leading to widespread flooding [31]. For example, with a 5% annual chance [32], the 1996 Northwest floods [33] exposed the city's vulnerability to flooding hazards and limitations in preparedness. During this flood, two major highways, Hwy 20 and 34, were closed to all traffic, including fire department services, causing a section of the city (southern Corvallis) to be isolated from the rest of the city [34]. Similarly, in 2019, the extensive floods [35] caused Hwy 34 to be closed again to all traffic.

2.1. Study area

Data used in this study included household survey responses obtained from residents living within the limits of the 1%- and 0.2% annual chance floodplain maps, as established by the Federal Emergency Management Agency (FEMA) for the City's southern neighborhoods of Corvallis, Benton County, Oregon USA. Benton County participates in the Community Rating System CRS, which is part of the FEMA's National Flood Insurance Program NFIP [36]. The studied areas [30] are within a 1.9 km radius from the Willamette River's confluence and its tributary, the Marys River (Fig. 1). Upstream of Corvallis, the Willamette River has a drainage area of approximately 11,400 square kilometers, the runoff from which is regulated by nine dams. The Millrace is an overflow channel that leaves the Marys River. It flows through residential and commercial areas for approximately 1.6 km before re-entering the Marys River near the Willamette River [32].

2.2. Household survey and variables related to the perception of flood-risk

A voluntary household survey was undertaken using a random sampling method. The survey questionnaire [30] was reviewed and approved by the Institutional Review Board at Oregon State University. The home locations were identified within each floodplain (i.e., 1%-, and 0.2% annual chance) using available maps. This sampling preserved the proportion between the tax lots in the floodplains affected by 1%- and 0.2% annual chance floods (Fig. 1) and the population [37]. The sample population constituted 337 tax lots, of which 150 (44.5%) were in the 1% annual chance floodplain and the intersecting 0.2% annual chance floodplain. One hundred eighty-seven tax lots (55.5%) were found exclusively in the 0.2% annual chance floodplain. Some tax lots hold multi-housing addresses. Four hundred addresses were randomly selected from the 337 tax lots using the Benton County Tax Lot map [38] and Google Maps [39]. Survey questionnaires were printed in English and Spanish with a unique identification code assigned to each questionnaire and the household location. Surveys were mailed out in the last week of March 2017 with a follow-up mailing seven weeks later to non-responders. Some randomly selected addresses were visited door-to-door to remind residents of the survey completion. These visits had limited success because only 5% of the visited addresses returned completed surveys. In August, reprinted survey questionnaires were delivered in person to random addresses during working hours. This time, researchers waited while residents completed the survey. While few residents were found at home during these door-to-door visits, the rate of response was higher. Around 40% of found residents answered the survey.

For this study, twelve independent variables (IV) and forty-two dependent variables (DV) were mainly defined based on existing literature. The independent variables included: sociodemographic (IV-1), home location (IV-2), flood experience (IV-3), and flood insurance possession (IV-4). These variables were surveyed on nominal values. Each variable was reduced to a two-point scale by using a recoding approach [40]. Then, interest groups were identified within each variable (Table 1). For example, based on the data collected on the residents'

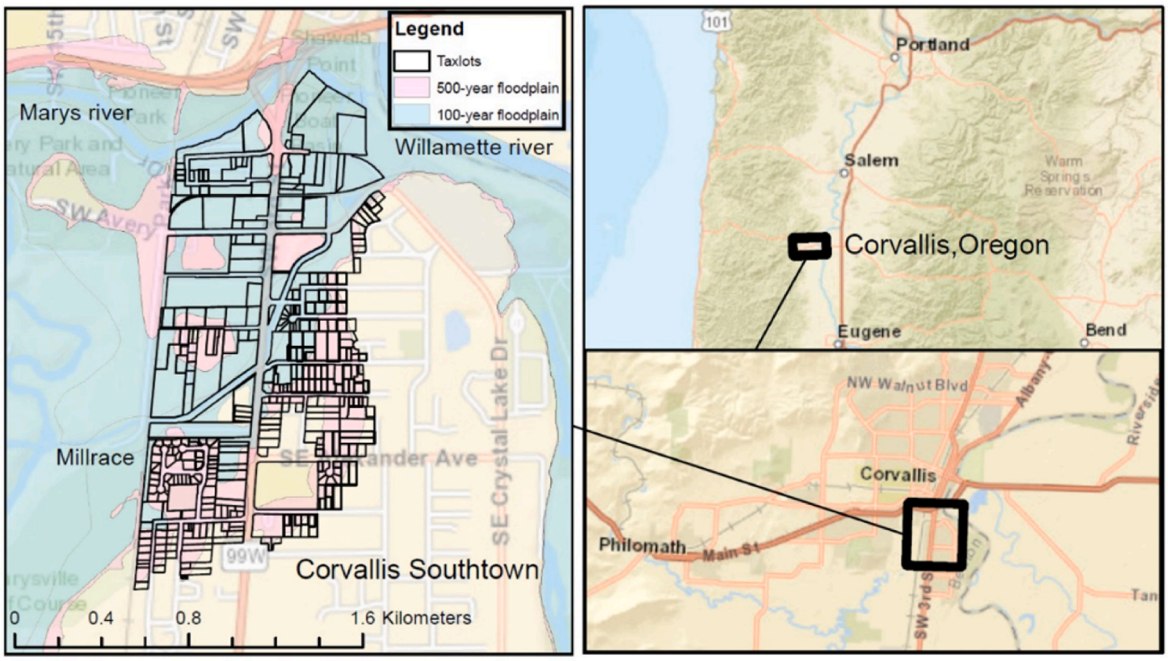

Fig. 1. Study area [30]: FEMA 100-year (1% annual chance) and 500-year (0.2% annual chance) floodplains in South Corvallis, OR (Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan).

income, Table 1 reports the percent of respondents in households with an annual income of less than $25,000 US dollars, which was selected because it is an average of the Two-Adult-Two-Child poverty thresholds for 2016–2017 in the US [41].

Similarly, the residents' age was grouped into two broad categories. Adults older than 45 years old were selected as the group of interest for this study based on a Census age breakdown where the other group of adults is between 18 and 44 [42]. The last column in Table 1 reports the available census data for Oregon ZIP code 97333 that includes the studied floodplains [43] and is used as a reference for recoding the collected variables.

The dependent variables selected in this study included: perception of flood extent, perception of self-confidence in being flood-ready, fear of life-threatening events such as flooding, fear of changing flood threats, and preferences of response and recovery actions (Tables 2 and 3).

2.2.1. *Perception of flood extent (DV-1)*

The survey included a question to measure the respondent's perception of the flood extent. The study included the question: "If there is a flooding event in Corvallis, how far away from your home, do you expect the water to reach?" Question responses were measured on a 4-point ordinal scale, with values ranging from (1) "water is likely to reach my home or property" to (4) "water is likely to reach more than two blocks away from my home or property." Then, it was recoded into a two-point nominal scale. Respondents who perceived floods to likely reach their homes were included in one group, and everyone else was included in the other group. Respondents in the group of individuals who "Believe water is likely to reach home" were selected as the group of interest for the analysis. They are listed in Table 2.

2.2.2. *Perception of self-confidence in being flood-ready (DV-2)*

The questionnaire used five conditions to measure the respondents' self-confidence in being flood-ready. This confidence was measured using the question: "Suppose your current home was to flood, how confident are you in the following possible conditions?" The variables of each condition were measured on a 5-point ordinal scale. Scale values ranged from 1 "not confident at all" to 5 "very confident." Then, the variables of each of the five conditions were recoded into a two-point nominal scale. The ones who viewed themselves as being confident or very confident were considered as part of a group of interest for the analysis. They are shown in Table 2. In contrast, others were included in the other group.

2.2.3. *Perceived fear of dying in a life-threatening event (DV-3)*

The survey compared flood fears to seven other human and natural hazards that threaten human life [44]. The following question was asked: "How afraid are you of the following types of life-threatening events to you and your family?" The perceived fear of these life-threatening events was measured on a 4-point ordinal scale. The scale varied from 1 "not afraid at all" to 4 "very afraid." Then, the variables were recoded into a two-point nominal range. The ones who viewed themselves as somewhat afraid and very afraid were part of a group of interest for the analysis and listed in Table 2. Others were part of the other group.

2.2.4. *Perceived fears for diverse flood threats (DV-4)*

The survey examined differences in residents' perceived fears for seven different situations (i.e., nighttime, daytime, more than one day, less than one day, driving at nighttime, driving at daytime, and school or workplace) that an individual may find themselves in during a flood event. Fear for each situation was measured for three scenarios of increasing flood depth severity (i.e., ankle-deep floods, knee-deep floods, and hip-deep floods or higher). Each flood depth was associated with anthropometrics [44–46] to make it easier for the survey respondent to relate the increasing magnitudes of the flood threat. The survey included the question: "If water from a flood was deep enough to reach your ankles/knee/hip-or-higher, as depicted in the cartoon, how afraid would you feel about the following situations?" Hence, fears for a total of 21 flood threat scenarios were measured, based on the combination of the three severities of water depths and seven personal situations. Each variable was measured on 4-point ordinal scales from 1 "not afraid at all" to 4 "very afraid." Then, the variables were recoded into a two-point nominal range. The ones who viewed themselves as somewhat afraid and very afraid were included in the group of interest for the analysis and are listed in Table 2. At the same time, everyone else was

Table 1
Summary of responses for independent variables of interest related to socio-demographic, home location, flood experience, and flood insurance possession, as reported by surveyed respondents (N = 75) in the floodplains susceptible to floods with 1% and 0.2% annual chance of occurrence.

Independent Variables (IV)[a]	Number (%) of responses from respondents in the region affected by floods that have a 1% annual chance (*)	Number (%) of responses from respondents in the region affected only by floods that have a 0.2% annual chance (*)	Number (%) of responses from respondents affected by either flood (*)	Census Data: % of individuals in ZIP code 97333
(IV-1) Sociodemographic				
Homeowner*	17 (52%)	21 (53%)	38 (52%)	46%
Total valid responses	*33 (100%)*	*40 (100%)*	*73 (100%)*	
Living in the same house more than one year ago	29 (88%)	33 (81%)	62 (84%)	90%
Total valid responses	*33 (100%)*	*41 (100%)*	*74 (100%)*	
Female	21 (64%)	22 (54%)	43 (58%)	50%
Total valid responses	*33 (100%)*	*41 (100%)*	*74 (100%)*	
Have at least one child at home	10 (33%)	13 (36%)	23 (35%)	40%
Total valid responses	*30 (100%)*	*36 (100%)*	*66 (100%)*	
Older than 45 years old	14 (42%)	16 (39%)	30 (41%)	32%
Total valid responses	*33 (100%)*	*41 (100%)*	*74 (100%)*	
Bachelor's degree or higher	20 (61%)	27 (66%)	47 (64%)	58%
Total valid responses	*33 (100%)*	*41 (100%)*	*74 (100%)*	
Income is less than $25,000	15 (46%)	7 (18%)	22 (30%)	29%
Total valid responses	*33 (100%)*	*40 (100%)*	*73 (100%)*	
White	23 (70%)	28 (70%)	51 (70%)	86%
Total valid responses	*33 (100%)*	*40 (100%)*	*73 (100%)*	
Latino	2 (6%)	3 (8%)	5 (7%)	7%
Total valid responses	*32 (100%)*	*37 (100%)*	*69 (100%)*	
(IV-2) Home location				
Living in the 1% or 0.2% annual chance floodplain	33 (44%)	42 (56%)	75 (100%)	
(IV-3) Flood experience				
Have flood experience	12 (38%)	6 (15%)	18 (25%)	
Total valid responses	*32 (100%)*	*40 (100%)*	*72 (100%)*	
(IV-4) Flood insurance possession				
Have flood insurance	8 (24%)	7 (17%)	15 (20%)	
Total valid responses	*33 (100%)*	*42 (100%)*	*75 (100%)*	

*Only valid survey responses for each variable are included.
[a] Recoded variables of interest used as independent variables for analysis.

considered as part of the other group.

2.2.5. *Preferences for potential response and recovery actions to cope and/or adapt to floods (DV-5)*

Residents were asked whether they endorsed ("Yes"), opposed

Table 2
Summary of responses for dependent variables of interest related to perceptions of flood extent, self-confidence, fear of life-threatening events, and fear of changing flood threats, as reported by surveyed respondents (N = 75) in the floodplains susceptible to floods with 1% and 0.2% annual chance of occurrence.

Dependent Variables (DV)[a]	Number (%) of responses from respondents in the region affected by floods that have a 1% annual chance (*)	Number (%) of responses from respondents in the region affected only by floods that have a 0.2% annual chance (*)	Number (%) of responses from respondents affected by either flood (*)
(DV-1) Perception of flood extent			
Believe water is likely to reach home	17 (52%)	13 (31%)	30 (40%)
Total valid responses	*33 (100%)*	*42 (100%)*	*75 (100%)*
(DV-2) Self-confidence in being flood ready[b] (*Confident, Very confident*)			
Able to evacuate home before flood begins	23 (72%)	32 (78%)	55 (75%)
Total valid responses	*32 (100%)*	*41 (100%)*	*73 (100%)*
Receive timely notification of flood warnings	21 (64%)	23 (55%)	44 (59%)
Total valid responses	*33 (100%)*	*42 (100%)*	*75 (100%)*
House able to withstand flooding	9 (28%)	7 (17%)	16 (22%)
Total valid responses	*32 (100%)*	*42 (100%)*	*74 (100%)*
Belief in a divine power	9 (31%)	7 (17%)	16 (23%)
Total valid responses	*29 (100%)*	*41 (100%)*	*70 (100%)*
Flood insurance able to fully cover damages	7 (23%)	4 (10%)	11 (15%)
Total valid responses	*31 (100%)*	*42 (100%)*	*73 (100%)*
(DV-3) Fear of dying in a life-threatening event[c] (*Somewhat afraid, Very afraid*)			
Car accident	19 (59%)	30 (73%)	49 (67%)
Total valid responses	*32 (100%)*	*41 (100%)*	*73 (100%)*
Illness such as cancer	19 (58%)	26 (62%)	45 (60%)
Total valid responses	*33 (100%)*	*42 (100%)*	*75 (100%)*
Earthquake	13 (41%)	19 (45%)	32 (43%)
Total valid responses	*32 (100%)*	*42 (100%)*	*74 (100%)*
Attack by any person	13 (42%)	15 (36%)	28 (38%)
Total valid responses	*31 (100%)*	*42 (100%)*	*73 (100%)*
Fire	9 (28%)	18 (45%)	27 (38%)
Total valid responses	*32 (100%)*	*40 (100%)*	*72 (100%)*
Flooding	6 (19%)	15 (36%)	21 (28%)
Total valid responses	*32 (100%)*	*42 (100%)*	*74 (100%)*
Dying in a war	5 (16%)	7 (17%)	12 (16%)
Total valid responses	*33 (100%)*	*42 (100%)*	*75 (100%)*
Landslide	5 (16%)	4 (10%)	9 (12%)
Total valid responses	*32 (100%)*	*42 (100%)*	*74 (100%)*
(DV-4) Perceived fears for diverse flood threats[c] (*Somewhat afraid, Very afraid*)			
Flood depth severity: Ankle-deep flood			

(*continued on next page*)

Table 2 (*continued*)

Dependent Variables (DV)[a]	Number (%) of responses from respondents in the region affected by floods that have a 1% annual chance (*)	Number (%) of responses from respondents in the region affected only by floods that have a 0.2% annual chance (*)	Number (%) of responses from respondents affected by either flood (*)
Flood driving at nighttime	23 (72%)	29 (69%)	52 (70%)
Total valid responses	*32 (100%)*	*42 (100%)*	*74 (100%)*
Home flooded more than one day	21 (66%)	29 (69%)	50 (68%)
Total valid responses	*32 (100%)*	*42 (100%)*	*74 (100%)*
Flood driving during the daytime	18 (56%)	24 (57%)	42 (57%)
Total valid responses	*33 (100%)*	*42 (100%)*	*75 (100%)*
Home flooded less than one day	14 (42%)	22 (54%)	36 (49%)
Total valid responses	*33 (100%)*	*41 (100%)*	*74 (100%)*
Flooding at nighttime	18 (56%)	20 (48%)	38 (51%)
Total valid responses	*32 (100%)*	*42 (100%)*	*74 (100%)*
Flooding at daytime	12 (38%)	15 (36%)	27 (37%)
Total valid responses	*32 (100%)*	*42 (100%)*	*74 (100%)*
Flooding at school or workplace	13 (42%)	15 (36%)	28 (38%)
Total valid responses	*31 (100%)*	*42 (100%)*	*73 (100%)*
Flood depth severity: Knee-deep flood			
Home flooded more than one day	26 (81%)	36 (88%)	62 (85%)
Total valid responses	*32 (100%)*	*41 (100%)*	*73 (100%)*
Flood driving at nighttime	27 (84%)	33 (81%)	60 (82%)
Total valid responses	*32 (100%)*	*41 (100%)*	*73 (100%)*
Home flooded less than one day	26 (79%)	34 (83%)	60 (81%)
Total valid responses	*33 (100%)*	*41 (100%)*	*74 (100%)*
Flood driving during the daytime	23 (72%)	30 (73%)	53 (73%)
Total valid responses	*32 (100%)*	*41 (100%)*	*73 (100%)*
Flooding at nighttime	22 (69%)	30 (73%)	52 (71%)
Total valid responses	*32 (100%)*	*41 (100%)*	*73 (100%)*
Flooding at daytime	19 (61%)	26 (63%)	45 (63%)
Total valid responses	*31 (100%)*	*41 (100%)*	*72 (100%)*
Flooding at school or workplace	17 (53%)	23 (56%)	40 (55%)
Total valid responses	*32 (100%)*	*41 (100%)*	*73 (100%)*
Flood depth severity: Hip-deep or higher flood			
Home flooded more than one day	30 (94%)	35 (90%)	65 (92%)
	32 (100%)	*39 (100%)*	*71 (100%)*
Total valid responses			
Flooding at nighttime	30 (91%)	35 (90%)	65 (90%)
Total valid responses	*33 (100%)*	*39 (100%)*	*72 (100%)*
Flood driving at nighttime	30 (94%)	33 (85%)	63 (89%)
Total valid responses	*32 (100%)*	*39 (100%)*	*71 (100%)*
Flood driving during the daytime	28 (88%)	33 (85%)	61 (86%)
Total valid responses	*32 (100%)*	*39 (100%)*	*71 (100%)*
Home flooded less than one day	30 (94%)	34 (87%)	64 (90%)
Total valid responses	*32 (100%)*	*39 (100%)*	*71 (100%)*
Flooding at daytime	27 (84%)	33 (85%)	60 (85%)
Total valid responses	*32 (100%)*	*39 (100%)*	*71 (100%)*
Flooding at school or workplace	24 (75%)	29 (74%)	53 (75%)
Total valid responses	*33 (100%)*	*42 (100%)*	*75 (100%)*

*Only valid survey responses for each variable are included.
[a] Recoded variables of interest used as dependent variables for analysis.
[b] Scale in survey: 1 to 5 (not confident at all = 1; very confident = 5).
[c] Scale in survey: 1 to 4 (not afraid at all = 1; very afraid = 4).

("No"), were not sure ("Not sure"), or would support depending on the cost ("Depends on cost") one or more of the seven pre-defined actions for coping and adapting to floods. The answers were scored on a 4-point nominal scale, respectively. Then, the variables were recoded into a two-point nominal range. The ones who endorsed the pre-defined action were included in the group of interest for the analysis. They are listed in Table 3. In contrast, everyone else was part of the other group.

2.3. Analytical methods

The Chi-square test of independence [47] was performed in this research to identify significance in relationships between nominal independent and dependent variables. As indicated earlier, the independent variables included demographics, home location, flood experience, and flood insurance. In contrast, the dependent variables included the perception of flood extent, understanding of self-confidence on being flood ready, perceived fear of life-threatening events, perceived fear of diverse flood threat, and preferences for potential flooding response and recovery actions. Tables 1–3 report the corresponding percent of the surveyed population found within each of the two floodplains (Columns 2 and 3) who agreed with the survey variables of interest in Column 1, and the percent of responders in the merged floodplain areas (Column 4) who agreed with the survey variables of interest.

The analysis accounts for the relatively small sample size in the local community. For each variable of interest in the collected data and from theoretical considerations, the chi-square with two-by-two (i.e., four entries) contingency tables was selected for its analysis because the Pearson's chi-square test has been robust with small sample sizes [48]. The analyzed contingency tables met the requirement of having an

Table 3
Summary of responses for dependent variables of interest related to preferences for potential response and recovery actions for coping and adapting to floods, as reported by surveyed respondents (N = 75) in the floodplains susceptible to floods with 1% and 0.2% annual chance of occurrence.

Variables[a]	Number (%) of responses from respondents in the region affected by floods that have a 1% annual chance (*)	Number (%) of responses from respondents in the region affected only by floods that have a 0.2% annual chance (*)	Number (%) of responses from respondents affected by either flood (*)
(DV-5) Preferences for potential response and recovery actions			
Move the house belongings to a higher elevation	22 (69%)	30 (71%)	52 (70%)
Total valid responses	*32 (100%)*	*42 (100%)*	*74 (100%)*
Appeal to the City to enact long term solutions	15 (50%)	21 (51%)	36 (51%)
Total valid responses	*33 (100%)*	*42 (100%)*	*75 (100%)*
Relocate to another house in the City	16 (50%)	18 (43%)	34 (46%)
Total valid responses	*32 (100%)*	*42 (100%)*	*74 (100%)*
Relocate to another house outside the City	11 (34%)	15 (36%)	26 (35%)
Total valid responses	*32 (100%)*	*42 (100%)*	*74 (100%)*
Remain doing only house maintenance	9 (28%)	15 (36%)	24 (32%)
Total valid responses	*32 (100%)*	*42 (100%)*	*74 (100%)*
Remain and buy/upgrade flood insurance	8 (25%)	8 (19%)	16 (22%)
Total valid responses	*32 (100%)*	*42 (100%)*	*74 (100%)*
Remain and elevate the house	4 (13%)	5 (12%)	9 (13%)
Total valid responses	*31 (100%)*	*41 (100%)*	*72 (100%)*

*Only valid survey responses for each variable are included.
[a] Recoded variables of interest used as dependent variables for analysis.

expected frequency of at least five for each entered sample [48].

Next, the lists of independent variables and the dependent variables were merged to generate contingency tables. The null hypothesis H_0 was defined as "The perception variables and preferences for response and recovery actions (Tables 2 and 3) are independent of sociodemographics, home location, flood experience, and flood insurance possession (Table 1)." To test this hypothesis, we used a significance level of alpha = 0.05, a degree of freedom = 1, and a Chi-Square critical value = 3.84. Lastly, the measure of association (effect size) that indicates the strength of variables relationships was computed using the Cramer's *V* coefficient, where *V* thresholds were selected to be 0.10, 0.30, and 0.50 for small (minimal), medium (typical), and significant (substantial) association, respectively. The statistical procedures were performed using the Statistical Package for the Social Sciences version 24.0 for Windows [49].

3. Results

A population of 352 households was used in this study. Of those households, only seventy-five residents (21% response rate) returned surveys with complete responses. Twelve percent of survey questionnaires were returned because of the lack of forwarding addresses. From the complete 75 responses, significant relationships ($p < 0.05$) were then assessed between variables related to perception and endorsement of response and recovery actions (i.e., dependent variables) and those related to sociodemographic, home floodplain location, flood experience, and flood insurance possession (i.e., independent variables). Additionally, the presence of potentially significant relationships between independent variables was also examined. This analysis includes association with home location (i.e., IV-2 in Table 1 that indicates whether a home is located within 1% annual chance floodplain or the 0.2% annual chance floodplain region) and with possession of flood insurance (IV-4 in Table 1).

3.1. Key finding #1: income and flood experience correlated with the home location

Income and flood experience had a significant relationship with the home location relative to the 1% annual chance floodplain (Table 4). A higher percentage of respondents living in the 1% annual chance floodplain had less than $25,000 of annual income than respondents living in the 0.2% annual chance floodplain. In total, twenty-five percent of all respondents reported that they had some experience with floods. Of those respondents, thirty-eight percent lived in the 1% annual chance floodplain, while only fifteen percent were in the 0.2% annual chance floodplain.

3.2. Key finding #2: age and flood experience influenced perceptions of flooding extent

Respondents older than 45 years old and those who had previous flood experience perceived that water would reach their homes during flooding events (i.e., flooding extent), as indicated in Table 5. Interestingly, no significant difference was found in perceptions of flooding extent between respondents residing in the floodplains of 1% annual chance floods versus those in floodplains affected exclusively by 0.2% annual chance floods.

3.3. Key finding #3: confidence in being "flood ready" is high, and possession of flood insurance increases confidence

Sixty percent of respondents who possessed flood insurance felt confident or very confident about getting full coverage of flood losses (Table 6). However, only twenty-four percent of respondents in the 1% annual chance floodplain said they have flood insurance (Table 1).

Most respondents reported high confidence in being able to evacuate their homes before a flood begins (i.e., 75%); and trust in receiving timely notification of flood warnings (i.e., 59%) (Table 2). However, we found no significant relationships between respondents' confidence to evacuate on time or receive flood notifications and their sociodemographics, flood experience, or home location in the floodplains.

3.4. Key finding #4: flooding was not perceived as the most fearful life-threatening event in the floodplains, particularly for families

A survey of respondents' fear of dying in life-threatening events (DV-3 in Table 2) indicated that anthropogenic events such as car accidents and severe illness were perceived by the respondents to pose a higher risk to their lives than natural hazards, including flooding. However, respondents' level (i.e., Not at all afraid to Very-afraid) of fear of dying from any of these threatening events did not significantly correlate with variables on sociodemographics, home location, and flood experience,

Table 4
Summary of significant relationships between income (IV-1) and home location (IV-2), and between flood experience (IV-3) and home location (IV-2) (N = 75, χ^2 = Chi-square value, p = significance level of alpha, *V*= Cramer's level of association).

Home Location →	% of responses from respondents affected by floods with a 1% annual chance	% of responses from respondents affected only by floods that have a 0.2% annual chance	χ2	*p*	*V*
Income is less than $25,000	46	18	6.8	0.01	0.30
Have flood experience	38	15	4.8	0.03	0.26

Table 5
Summary of significant relationships between age (IV-1) and flood extent (DV-1), and flooding experience (IV-3) and flood extent (DV-1) (N = 75, χ^2 = Chi-square value, p = significance level of alpha, *V*= Cramer's level of association).

	% of responses from respondents who believe water is likely to reach their home (DV-1)	χ^2	*p*	*V*
Older than 45 years old	57	5.45	0.020	0.27
Have flooding experience	61	4.90	0.027	0.26

Table 6
Summary of significant relationships between respondents possessing flood insurance (IV-4) and their self-confidence in being flood ready (DV-2) (N = 75, χ^2 = Chi-square value, p = significance level of alpha, *V*= Cramer's level of association).

	% of responses from respondents who are confident or very confident in getting full coverage from flood insurance (DV-2)	χ^2	*p*	*V*
Possess flood insurance	60	24.30	<0.001	0.64

and flood insurance possession.

The survey, however, also indicated that having children at home influenced perceptions of higher risk. For example, most respondents (i.e., more than 50% of respondents in the group) with children at home were more afraid of dying in an earthquake or by an attack from a person (Table 7). Further, a lack of fear for floods was significantly related to gender, age, and advanced degrees. Less than 50% of respondents in the group who were either female, adults older than 45 years old, and/or possess a bachelor's degree or higher were somewhat or very afraid of dying in flooding (Table 7).

3.5. Key finding #5: while not perceived as the deadliest event, some sets of respondents do fear different flooding threats

Many factors correlate with fears around flood threats involving the severity of flood depths and circumstances during flooding events. Gender, having children at home, and age resulted in significant factors that influenced respondents' fear for different flood threat scenarios. Flooding during nighttime was perceived as somewhat scary to very scary in all flood depths (i.e., ankle-deep, knee-deep, and hip-deep or higher flooding) for most female respondents (i.e., 62%, 83%, and 98% of female respondents, respectively). All flood depths at school or workplace were perceived as scary for most respondents (i.e., 65%) who have children at home. However, other groups of respondents ranked these threats as less frightening. A low percentage of all respondents considered daytime flooding and flooding at school or workplace as being somewhat scary or very scary (Table 2).

We also found that education level, ethnicity, and homeownership were significant factors related to the perceived fear of flooding threats. A significantly low rate of respondents with a bachelor's degree or higher showed being somewhat afraid and very afraid of daytime flooding and flooding at school or workplace reaching ankle-deep (Table 8). More Hispanic or Latino respondents showed being somewhat afraid and/or very afraid than other sociodemographic groups facing flooding. On the other hand, a low rate of adult respondents older than 45 years old showed being somewhat scared and very afraid of other sociodemographic groups facing flooding at school or workplace (Table 8).

Table 7
Summary of significant relationships between independent variables (IV-1 and IV-4) and respondents perceived fear of life-threatening events (DV-3) (N = 75, χ^2 = Chi-square value, p = significance level of alpha, *V*= Cramer's level of association).

	% of responses from respondents fearful of life-threatening events (DV-3)	χ^2	*p*	*V*
Somewhat afraid-very afraid of dying in a fire				
Have an annual income less than $25,000	19	4.8	0.027	0.25
Somewhat afraid-very afraid of dying in an earthquake				
Have children at home	65	7.17	0.007	0.33
Somewhat afraid-very afraid of dying in a landslide				
Possess a bachelor's degree or higher	4	7.69	0.006	0.33
Somewhat afraid-very afraid of dying in a flooding				
Female	36	3.59	0.058	0.22
Older than 45 years old	41	4.67	0.031	0.26
Possess a bachelor's degree or higher	17	6.95	0.008	0.31
Somewhat afraid-very afraid of dying in an attack by a person				
Have children at home	52	4.06	0.044	0.25
Somewhat afraid-very afraid of dying in a war				
Possess a bachelor's degree or higher	9	6.18	0.013	0.30
Possess flood insurance	0	5.64	0.018	0.22

Although having the home flooded more than one day and driving during nighttime flooding were the most frightening scenarios for a significant percentage of respondents (see Fig. 2 and the last column for DV-4 in Table 2). None significant relationships were found with sociodemographics, home location, flood experience, or flood insurance possession.

3.6. Key finding #6: most floodplains' residents preferred response and recovery actions that require little endeavor and low investment

Survey participants responded favorably to flood response and recovery actions that required small personal investment. Moving the house belongings to a higher elevation and appealing to the City to enact long-term solutions had the highest percentage of preferences among survey respondents (70% and 51%, respectively, in Table 3). Further, 62% of homeowners (see Table 9) were found to indicate a strong preference for the response action of appealing to the City for a long-

Table 8
Summary of significant relationships between independent variables (IV-1) and respondents who perceived being somewhat afraid or very afraid of flooding threats in the floodplains (DV-4) (N = 75, χ^2 = Chi-square value, p = significance level of alpha, *V*= Cramer's level of association).

	% of responses from respondents fearful of flood threat (DV-4)	χ^2	*p*	*V*
Flood depth severity: Flooding reaching up to ankle-deep				
Home flooded more than one day				
Female	81	8.62	0.003	0.34
Flooding during daytime				
Female	45	4.11	0.043	0.23
Possess a bachelor's degree or higher	26	5.78	0.016	0.30
Hispanic or Latino	100	11.16	0.001	0.38
Flooding during nighttime				
Female	62	5.04	0.025	0.26
Have children at home	70	4.34	0.037	0.26
Hispanic or Latino	100	7.02	0.008	0.27
Flooding at school or workplace				
Have children at home	65	9.05	0.003	0.38
Possess a bachelor's degree or higher	30	4.68	0.031	0.26
Hispanic or Latino	100	10.55	0.001	0.37
Flooding when driving during the daytime				
Have children at home	87	11.84	0.001	0.41
Hispanic or Latino	100	6.13	0.013	0.25
Flooding when driving during nighttime				
Have children at home	87	4.14	0.042	0.24
Hispanic or Latino	100	3.87	0.049	0.19
Flood depth severity: Flooding reaching up to knee-deep				
Flooding during daytime				
Female	74	5.51	0.019	0.28
Have children at home	87	7.54	0.006	0.33
Hispanic or Latino	100	4.66	0.031	0.21
Flooding during nighttime				
Female	83	7.08	0.008	0.31
Flooding at school or workplace				
Have children at home	78	6.03	0.014	0.30
Older than 45 years old	38	5.57	0.018	0.28
Hispanic or Latino	100	6.42	0.011	0.26
Flooding when driving during the daytime				
Female	83	5.71	0.017	0.28
Older than 45 years old	59	4.67	0.031	0.26
Flooding when driving during nighttime				
Homeowner	73	4.35	0.037	0.24
Female	91	4.63	0.031	0.25
Have children at home	100	8.64	0.003	0.30
Older than 45 years old	66	9.13	0.003	0.35
Flood depth severity: Flooding reaching up to hip-deep or higher				
Flooding during nighttime				
Female	98	6.06	0.014	0.28
Flooding at school or workplace				
Have children at home	96	6.44	0.011	0.29
Older than 45 years old	61	4.67	0.031	0.26

term solution. Relocate to another house in the City was preferred (i.e., 46% of respondents) before the alternatives requiring house investments or buying flood insurance (Table 3).

The preference for relocation was statistically significant among a majority of the two sociodemographic groups (Table 9). Most respondents (65%) who have children at home supported moving to another house within the City. Also, most Hispanic or Latino respondents (80%) supported moving outside the City. However, low percentages of respondents living for more than one year at the current home (34%), adults older than 45 (28%), and those who possess flood insurance (20%) preferred relocation to another house within the City. A low rate of respondents who had flood experience (12%) and owned flood insurance (13%) preferred moving to another home outside the City.

A small percentage of some sociodemographic groups preferred to remain after flooding at the current location. Besides, few homeowners (30%) approved of staying and buying or upgrading flood insurance. No respondent possessing flood insurance preferred to remain and elevate their house structure. A low percentage of homeowners (42%), respondents with bachelor's degrees or higher (41%), and low-income respondents (5%), and 0% of Hispanic or Latino respondents preferred to remain and do house maintenance after flooding.

4. Discussion

This study sought to understand the range of risk perceptions of and preferred adaptations for a sample of residents in Willamette River's floodplain in Oregon, USA. The results indicate that perceptions and fears align with flood risk in some aspects and for some demographic groups, but not for others. This discussion outlines how risk perceptions are influenced by prior experience and social determinants and how these perceptions influence one's acceptance of response and recovery options (e.g., adaptive capacity).

4.1. Risk Perceptions—General findings

Despite living in high-risk flooding areas, most respondents perceived flood hazards as being distant from their homes in both floodplains (i.e., 1%- and 0.2% annual chance floodplains). The perception of being away from flooding weakens preparedness for future flooding events [50] and underestimating one's flood risk can lead to increasing losses [51]. A lack of perceived risk for flooding among floodplain residents is not unique for the current study. For instance, Kreibich et al. (2005) [50] found that fifty-nine percent of the households affected by the 2002 flood at the river Elbe and its tributaries perceived that they did not live in flood-prone areas. Flood response and recovery planners should consider how to represent the gradient of exposure to floods, rather than binary floodplain boundaries, in risk communication. Even though floods are among the most common and deadly natural hazards [52], floodplain residents' perceptions did not proportionally reflect their risk, suggesting that floodplain residents were not well informed about the risk flooding possesses.

Over half of the casualties during flooding involve people driving into flooded water [52–55]. Interestingly, driving during a flood event, particularly at nighttime, was a fearful event by a high proportion of respondents in this study. Although the current study's responses might not be linked to an informed perception, appreciating the risk of driving in water can constitute a strength of people living in the floodplains avoiding risk exposure. However, unnecessary and risky self-sheltering at home must be prevented because early evacuation is a better strategy [56]. People tend to seek known shelters [57]. If public shelters are not known, people generally prefer shelter at relatives, friends, and their own homes. Hence, local emergency managers may need to support individuals in complying with evacuation orders and finding safe places. To help with that, emergency managers can regularly release pre-flood guidance about existing shelters [57], identify and mark safe evacuation routes [58], provide early forewarnings, assure security and property protection [57], continue to provide near real-time evacuation routes as flood conditions change [59] and support floodplain community preparedness [60].

Interestingly, prior flood experience was noticeable but did not

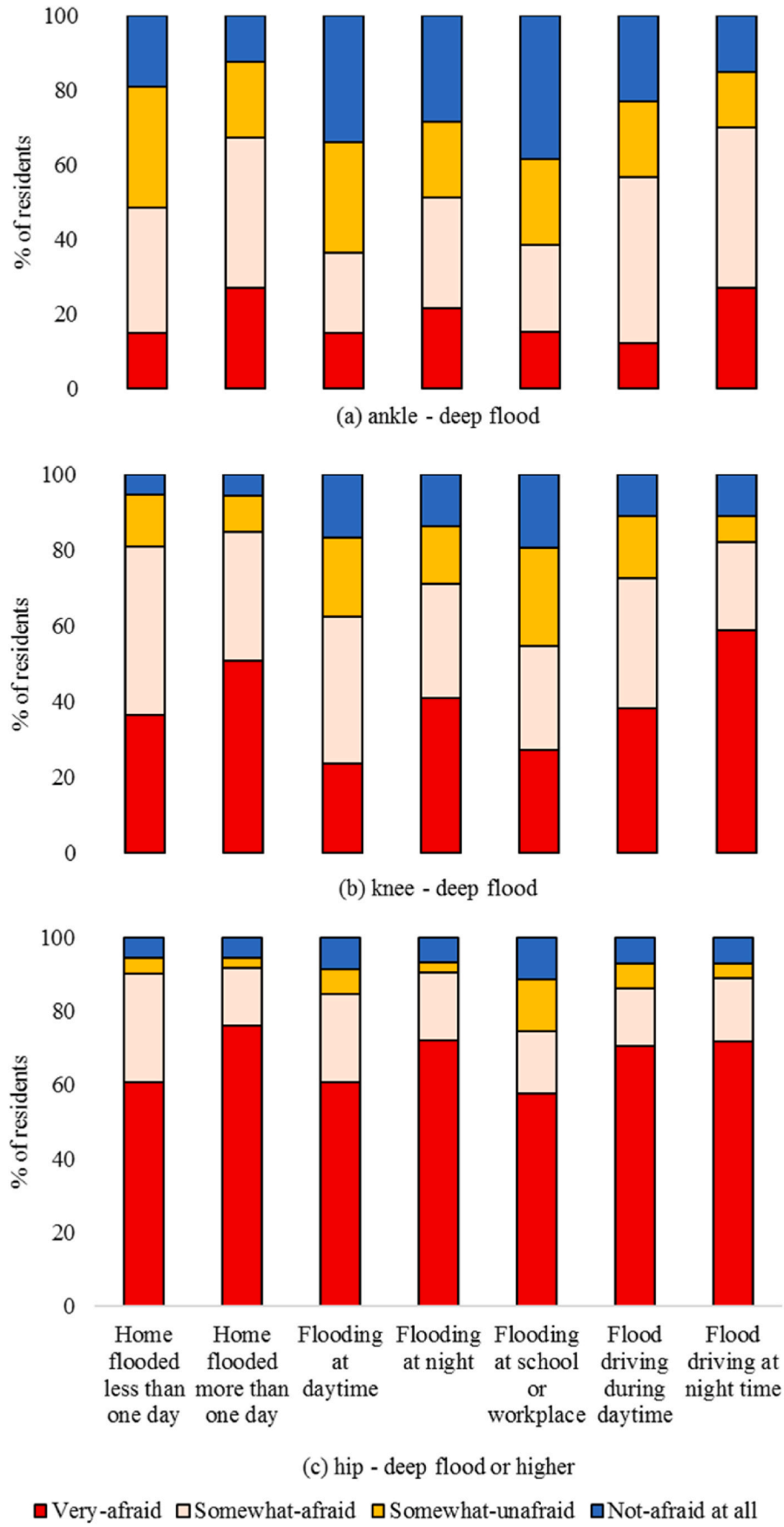

Fig. 2. The fear perception among residents for varying flood threat. (a) Ankle-deep flood, (b) knee-deep flood, and (c) hip-deep or higher flood.

Table 9
Summary of significant relationships between independent variables (IV-1, IV-3, IV-4) and respondents' preferences for response and recovery actions at the floodplains (DV-5) (N = 75, χ^2 = Chi-square value, p = significance level of alpha, *V*= Cramer's level of association).

	% of responses from respondents preferring a stated response and recovery action (DV-5)	χ^2	*p*	*V*
Prefer relocation to another house within the City				
Living for more than one year at the current home	34	5.26	0.022	0.27
Have children at home	65	3.68	0.055	0.24
Older than 45 years old	28	6.19	0.013	0.29
Possess flood insurance	20	5.45	0.020	0.26
Prefer relocation to another house outside the City				
Hispanic or Latino	80	4.55	0.033	0.26
Have flood experience	12	6.77	0.009	0.29
Possess flood insurance	13	4.44	0.035	0.23
Prefer to remain at the current location and buy or upgrade flood insurance				
Homeowner	30	3.78	0.052	0.23
Prefer to remain at the current location and do house maintenance after flooding				
Homeowner	42	3.91	0.048	0.23
Possess a bachelor's degree or higher	41	4.22	0.040	0.23
Have an annual income less than $25,000	5	12.43	<0.001	0.37
Hispanic or Latino	0	4.33	0.037	0.20
Prefer to remain at the current location and elevate the house structure				
Possess flood insurance	0	4.53	0.033	0.19
Prefer to appeal to the City for a long-term solution				
Homeowner	62	5.38	0.020	0.28

translate to fears about flooding threats or impact their adaptation preferences. Twenty-five percent of respondents reported flood experience, a rate that is higher than found in other studies (e.g., 15% for the 2002 Elbe River flood [50]). Those with flood experience were more likely to expect to see floodwaters near their home. However, this experience did not appear to translate to fear under any flooding threat or influence their response and recovery preferred actions. This outcome differs from other studies where previous flood experiences that resulted in property damage [61] led to higher perceived risk levels, which suggested that lack of flood experience among floodplain residents can reduce preparedness for future flooding events [62]. The contradicting findings suggest that flood experience cannot always be directly correlated to higher perceived fear levels. But some other additional population characteristics might explain these findings.

4.2. Social vulnerability & risk perception

Although waterfront properties located in floodplains can have higher premiums than off-water properties [63], no waterfront properties were located in this study area. Floodplain residents often lack resources for response and recovery planning due to systemic inequities that may result in higher-risk areas inhabited by low-income populations [28,64]. Floodplains in such areas are often characterized by many low-value properties, multifamily housing, mobile homes, and a growing low-income population [65–67]. Low-income homebuyers are also affected by inequities because they are less informed than high-income homebuyers about flood risks. They obtain financing from less regulated sources, including subprime lenders. Eventually, any physical damage due to flooding could diminish the buyers' property value [68]. These residents might only learn by experience about these risks. This realization might be one reason why, in this study, low-income residents did not prefer to invest in response and recovery actions. Hence, managers need to plan resource allocation and carefully analyze the communities' response and recovery options [69].

Potentially, systemic inequities lead to spatial segregation. Some state actions, such as implementing low-income housing to favor some demographic groups, can contribute to this segregation [70]. Besides, floodplain buyout programs are biased towards higher-income counties, leaving properties in low-income counties at greater risk [71]. In this study, lower-income respondents (i.e., income less than $25,000) were found mainly segregated in the 1% annual chance floodplain. These marginalized populations must always be included in community flood response and recovery planning because they are more likely to suffer more damage due to pre-existing inequities [72]. Dimensions of social vulnerability drive why communities recover unevenly from disaster events. Systemic inequities related to race/ethnicity, income, immigration, and homeownership status, and other social determinants have been linked to unequal access to financial assistance post-disaster [70,72], differential housing recovery rates [73], and the ability to access emergency services [74]. In this study, fear of flood threats was differentiated by most of the vulnerable groups (e.g., female respondents, respondents having children at home, and ethnic minorities), as also reported by Ref. [75]. This evidence should be used towards developing significant public awareness and flood protection planning. Additionally, planners and others must realize that marginalized groups may be underserved and/or fearful of accessing resources in an emergency, particularly immigrants [74].

Nuances of perceptions of fear of different flood threats were found among vulnerable groups, particularly for women and ethnic minority groups. These findings coincide with previous research that focused on social determinants of risk perception and also found more women to perceive floods as a threat to their homes [11]. Analogously, environmental risk perceptions of different racial and ethnic groups have also been correlated with the unequal distribution of environmental threats [22,76]. Additionally, having children at home was found to enhance the residents' fear levels, though other studies have found no significant household composition effect on risk perceptions [61]. Again, the contradicting findings suggest that a specific population characteristic cannot always be directly correlated to higher perceived fear levels. Hence, these nuances of correlations support the need to implement community-relevant adaptation approaches [29,77] that consider the context of the community conditions.

Research has shown that prolonged exposure to environmental threats can be devastating and can lead to anxiety disorders in people experiencing fear [78]. Since, in the present study, the respondents have shown fear of having their homes flooded for more than a day, some of these human health consequences could be anticipated. People who expect floodwaters to enter their homes and flood threats at home could make them feel fear, anxiety, and stress about being completely helpless [79]. Fear, anxiety, and stress are correlated, and one can trigger the other. Hence, adaptive strategies must be in place for coping with anxiety and stress-related disorders. Research has shown a significant relationship between disaster stress and coping skills [80]. Hence, coping strategies should be identified based on known fear levels of individuals [81].

4.3. Adaptive capacity & risk perception

This study found that flood insurance possession was related to increased flooding expectations, though only 24% of residents within the 1% annual chance floodplain possessed flood insurance. Other studies have shown that individuals who live in areas prone to flood damages do not often voluntarily buy flood insurance [82–84]. The lack of flood insurance increases vulnerability and weakens an individuals' ability to flood recovery and preparedness. Flood insurance purchase is an effective flood response and recovery measure [82,85–87] and is

often the primary financial source for recovery after a disaster [88]. Yet, the low flood insurance policy enrollment or "take-up" is characteristic of the US, where individual owners of at-risk properties have never exceeded 50% enrollment [89]. This low enrollment is due to the unaffordability of flood policies and policy misconceptions [90]. Common flood insurance misconceptions include believing that flood insurance is covered in other property insurance [91], increasing premiums, and decreasing federal subsidies [92]. Thus, response and recovery strategies may need to be innovative to enhance residents' ability and willingness to buy flood insurance [93]. Educated individuals are more likely to buy flood insurance [94]; hence, strategies may consider education's role in encouraging households to obtain flood insurance. For example, floodplain residents must be informed if they are part of programs that provide discounts in flood insurance premiums, such as the CRS [36] in the US. However, who can and cannot afford to buy flood insurance continues to be a social equity concern [90].

The results presented here indicated that some factors can influence community members' adaptation intentions. For example, while flood insurance provides a vital recovery option, flood insurance possession could diminish the residents' intentions to invest in their house structures for flood protection due to overconfidence in flood insurance. Hence, overconfidence can be a trap because adverse outcomes in flood insurance pay-outs can occur and take program participants by surprise [95]. Other studies have identified that experience reduces flood protection [96], mainly because flood insurance policies limit the amount of coverage purchased [97]. Institutional support is needed to enhance the willingness to participate in flood protection because adaptation intentions are crucial to the adaptive capacity of local communities [98]. Community-based adaptation approaches should start by identifying the most important factors that influence individuals' intentions to adapt to flooding as a community member. Then, community members can collectively participate in flood response and recovery. For example, they can collectively plan sheltering, transportation, food storage, security, and property protection during flooding [57,99].

The City of Corvallis and Benton County to which the studied floodplain community belongs, both refer to the National Weather Service as warning issuers [100,101]. The warnings may be broadcast on local radio and television stations [100]. Although most respondents reported high confidence in receiving timely notification of flood warnings, around 40% of them did not trust receiving a timely notification. The reason for the distrust was not investigated in this research. In some other communities, the inability to access flood warnings was reported [102], which can be a cause of distrust. Sole reliance upon flood forecasting and the broadcast of warnings is only partially effective [103]. Additional flood warning methods, besides phones, may be implemented in such cases. For example, knocking on each door giving adequate warning to people, loud warnings using loudspeakers, and sirens going through the neighborhood to warn residents, among others were suggested by residents of the lower Siletz River basin in Oregon [104].

5. Conclusion

Perceptions of risk from various flooding threats vary among local communities. Understanding this variability is crucial for identifying preferred and effective response and recovery actions in communities coping with and adapting to floods. The present study characterizes perceptions of risk of different groups of people residing in the same floodplains, their levels of fear for different flood threats, and their preferences for flood response and recovery actions under varying flood threats. The outcome confirms that perceptions do not always match actual flood risk. Residents' perceptions and preferences of flood response and recovery actions had significant correlations with some sociodemographic variables, home location in the floodplains, flood experience, and flood insurance possession. This study further emphasizes how those with the fewest resources and greatest vulnerability can be most impacted by risk. This study contributes to understanding factors that drive local variability in changing flood-risk perceptions, though the relationships are exclusive for the community characteristics. These outcomes support the need to implement community-based adaptation approaches. This approach should start by identifying the most important factors that influence individuals' intentions to adapt at a community level. Adaptation intentions are crucial for a community's flood preparedness and mitigation planning.

Based on the results, some recommendations for stakeholders and managers involved in flood response and recovery policies and decision-making are given. Efforts should be made to understand flood-risk perceptions as a local characteristic influenced by a set of factors. Also, there is a need to understand the presence of distrust in communities and develop effective strategies to inform residents about the benefits of flood insurance and minimize overconfidence in insurance assistance. At the same time, to minimize overconfidence, a policy can consider ways to better inform flood insurance purchasers about possible adverse outcomes in flood insurance pay-outs and take precautions against such outcomes.

Action is also needed to ensure that floodplain residents accurately understand the flood-risk as a gradient rather than a binary floodplain boundary. Response and recovery policies should strongly consider the variability in fear within individuals living in the same geographic area, especially the helplessness in vulnerable groups and ethnic minorities.

Flood hazards are diverse across different regions and also cause disparate perceptions among floodplain residents in a community with varied socio-demographic characteristics and flood experiences. Some findings of this work about perceived risk and preferences of response and recovery actions may be region-specific while others may be more generalizable. In this work, similarities and differences in the studied variables were compared with previous results. For example, the percentage of respondents with flood experience was higher than found in other studies [50]. In contrast with other studies [14–17], flood experience did not translate into adaptation preferences. In addition, results contradicted previous results on household composition enhancing the residents' fear levels [61]. On the other hand, results here agreed with other studies finding more women to perceive floods as a threat to their homes [11]. Similar to other studies [82–84], the current rate of flood insurance purchase and intentions of purchase was low among respondents. The heterogeneity of findings compared to previous research indicates the need for more extensive future work to identify if generalizable relationships exist for predicting perceived risk and preferences of response and recovery actions. Generalization may not be achievable. Instead, resources can be allocated for the widespread region- or community-specific studies on perceived risk and preferences of response and recovery actions to implement community-based adaptation approaches [29,77].

The results reflect the study community's perceptions and preferences, and care should be taken in extending results elsewhere without further study. Future research could evaluate if similar discrepancies exist between real and perceived flood risks in other areas, the factors driving those discrepancies, and the mediating factors between preferred response and recovery measures. It would also be useful to identify the sources of residents' distrust of flood insurance (e.g., bad experiences using flood insurance and misinformation about flood insurance). Also, investigations should examine why and how lower income, higher education level, and being older diminish the fear of flooding. Further work could also examine how programs like the CRS impact flood risk perception and better document how different types of flood events (e.g., coastal vs. riverine flooding) mediate perceptions of floods and adaptations.

Compliance with ethical standards

The survey was done under the study, ID 7509, reviewed by the

Institutional Review Board (IRB) at Oregon State University (OSU). The referenced study was reviewed by the OSU Human Research Protection Program (HRPP) office and determined to be exempt from full board review.

Data availability

Datasets related to this article can be found at https://doi.org/10.17632/DDC7KRKX32.1. An open-source online data repository hosted at Mendeley Data.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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