A Multidisciplinary Approach to Understanding Vulnerability and Building Climate Resilience to Levee Failures and Flooding in Historically Marginalized Communities

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RESEARCH AND THEORY

A multidisciplinary approach to understanding vulnerability and building climate resilience to levee failures and flooding in historically marginalized communities

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Abstract
With global warming amplifying the frequency and intensity of extreme precipitation events, flood risk from levee failures is significantly increasing and disproportionately affecting historically marginalized communities. This study aims to develop a comprehensive framework that integrates the assessment of risks from levee failures and the experience of vulnerable communities in the context of climate adaptation with principles of environmental justice, using the March 2023 flood in Pajaro, California, as a case study. Building on a spatial analysis of geographic, historic, and socioeconomic factors as well as interviews with residents, we develop a broader relational environmental justice framework highlighting disproportionate flood risks faced by historically marginalized communities living behind aging levees in an era of climate change. This framework elucidates how community identities shape their experiences with levee failures, flooding, and recovery efforts. Integrating human dignity with procedural justice and integrated ecological approaches, the framework calls for participatory risk assessments and adaptation strategies that consider lived experiences, human dignity, historical inequities, and ecological sustainability to align approaches to climate resilience with moral commitments to equity.

Keywords Levee · Flood risk · Climate change · Environmental justice framework · Social vulnerability · Community resilience

Environmental Justice Lens

Environmental Justice (EJ) -
The fair treatment and meaningful involvement of all people regardless of race, color, culture, national origin, income, and educational levels
with respect to the development, implementation, and enforcement of protective environmental laws, regulations, and policies.
(US EPA)

The Future of Flooding:

The Reality by 2050: A future where flood risks in the U.S. rise by **26%** due to climate change (Wing et al., 2020). Rising seas, heavier rains, and unpredictable storms make this a near-certainty.

Who's Most Vulnerable?: Vulnerability isn't just about nature, it's about **who has the resources and power** to adapt. Climate change doesn't affect everyone equally; it's shaped by deep-rooted **historical and political forces** (Gutierrez et al., 2020).

A Story of Inequality: Natural disasters, from the **Mississippi floods** to **Hurricane Katrina**, don't just devastate, they deepen **social divides**. In places where vulnerability is already high, floods leave scars that last long after the waters recede (Steinberg, 2000; Fradkin, 2005).

Floods Don't Discriminate, but We Do

Exposing Vulnerability: While floods impact everyone, **marginalized communities** bear the brunt. In fact, **annual losses** from floods in the U.S. are about **$32 billion**, with poorer communities paying a disproportionate share (Wing et al., 2022).

Why? Many of these communities are stuck in flood-prone areas because of **historical inequalities**—discriminatory land policies, limited political voice, and a lack of resources. Immigrant and/or undocumented farmworkers are invisible. Who is a worthy disaster victim?

It's Not Just a Flood: This isn't just about water rising; it's about how we, as a society, have chosen where to build, who to protect, and who gets left behind. Flood risks are **socially engineered** (Liao et al., 2019).

Los Angeles Times, March 14, 2023

The Levee Lie: Infrastructure that Masks Deeper Problems

The Illusion of Protection: Levees and floodwalls are often thought of as **defenses**, but they **redirect** floodwaters to other areas, making some places even more vulnerable (Pinter et al., 2016). They don't stop flooding, they just shift the problem.

The Environmental Justice Dilemma: As governments pour money into **flood control infrastructure (FCI)**, the focus tends to be on **economic and political priorities**, not **equitable solutions** (Liao et al., 2019). The result? Wealthier neighborhoods get protection, while poorer areas are left at risk.

The False Security of Urban Growth: Cities like **Sacramento** encourage development in **floodplains**, where the false sense of security created by levees can lead to **greater vulnerability**. It's a dangerous cycle where urban growth fuels exposure to risk (Pawley et al., 2023).

Stockton Levees

Research Questions for Our Study

(1) How do environmental justice frameworks explain the experience of flooding and flood risk in the affected Pajaro communities?

(2) How do the identities of the affected communities shape their experience of levee failures, flooding, and recovery efforts?

(3) How can an environmental justice lens guide us toward more equitable approaches in risk assessment, disaster prevention, and recovery, especially for historically marginalized communities living behind levees?

Pajaro, California

What happened

Series of record-breaking atmospheric rivers in March 2023

- Levee failure

Consequences:

1. Displaced residents
2. Housing damages
3. Loss of agriculture
4. Emotional and psychological harm

Study Design and Analytic Framework

- Objective: Examine historical and geopolitical factors contributing to levee failure and flood vulnerability in Pajaro, CA
  - Focus on Historically Underserved and Socially Vulnerable Communities (HUSVCs) living behind levees

- Mixed-methods approach integrating:
  - Quantitative socioeconomic analysis
  - Qualitative community interviews
  - Environmental justice framework

- Comparative perspective: Pajaro vs. neighboring Watsonville and California statewide indicators

Methods: Socioeconomic and Environmental Analysis

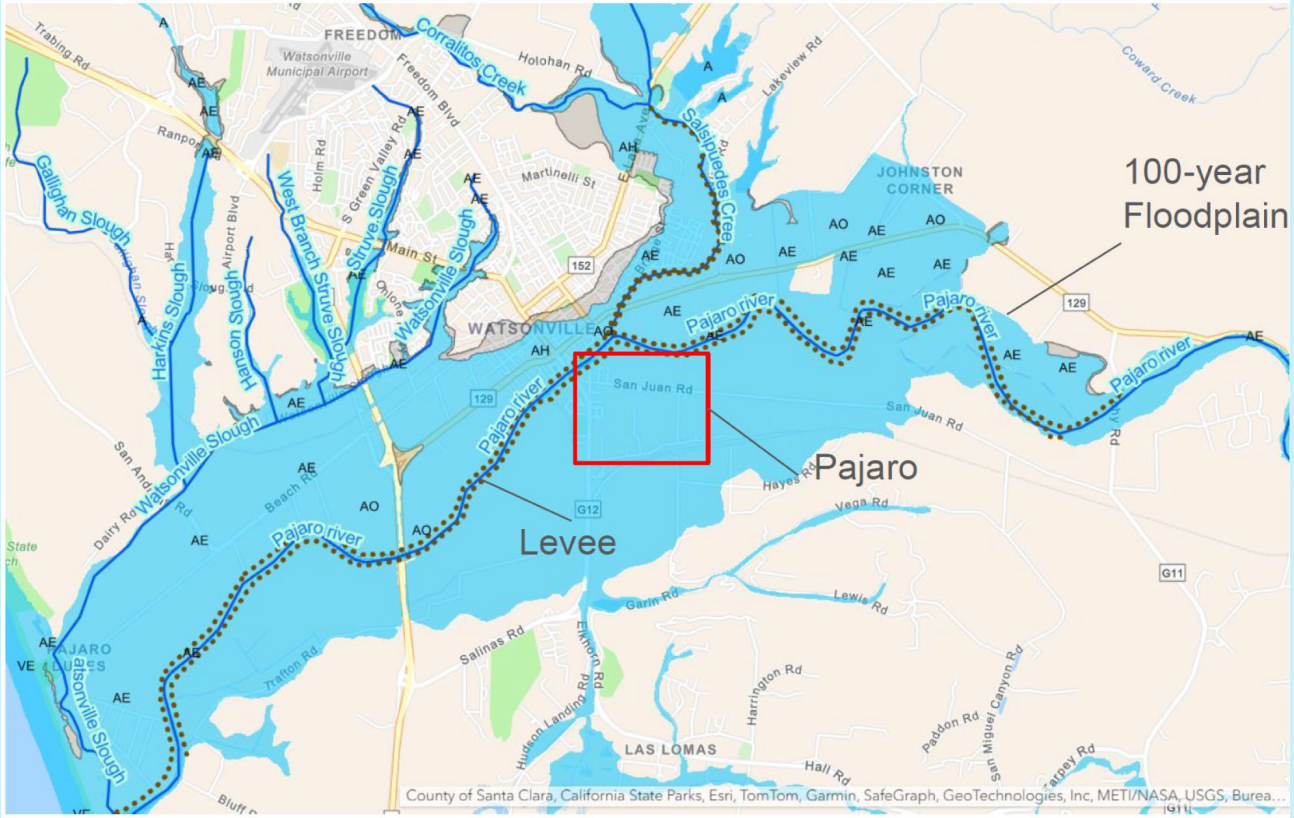
- Analysis of socioeconomic indicators including:
  - Income, employment, linguistic isolation, and demographic composition
  - FEMA Social Vulnerability Index (SVI) rankings

- Spatial and historical analysis of:
  - Flood history along the Pajaro River since the 1800s
  - Levee construction, maintenance, and documented failures
  - Flood protection standards compared to federal requirements
  - Integration of government reports (e.g., USACE, FEMA) and historical flood records to contextualize risk

Qualitative Methods: Semistructured Interviews

- Conducted semi-structured interviews (Nov 2023 – Feb 2024) with 28 Pajaro residents
- Explored lived experiences of:
  - (a) the community's overall experience
  - (b) the flooding event
  - (c) government and community support following the flood, and
  - (d) environmental justice
- Interviews conducted in Spanish by culturally trained interviewers
- Data handling:
  - Audio-recorded, transcribed, and analyzed using thematic analysis
  - Findings triangulated with policy documents, historical accounts, and environmental data
- Participant recruitment through local church, community flyers, and trusted organizations (e.g., COPA)

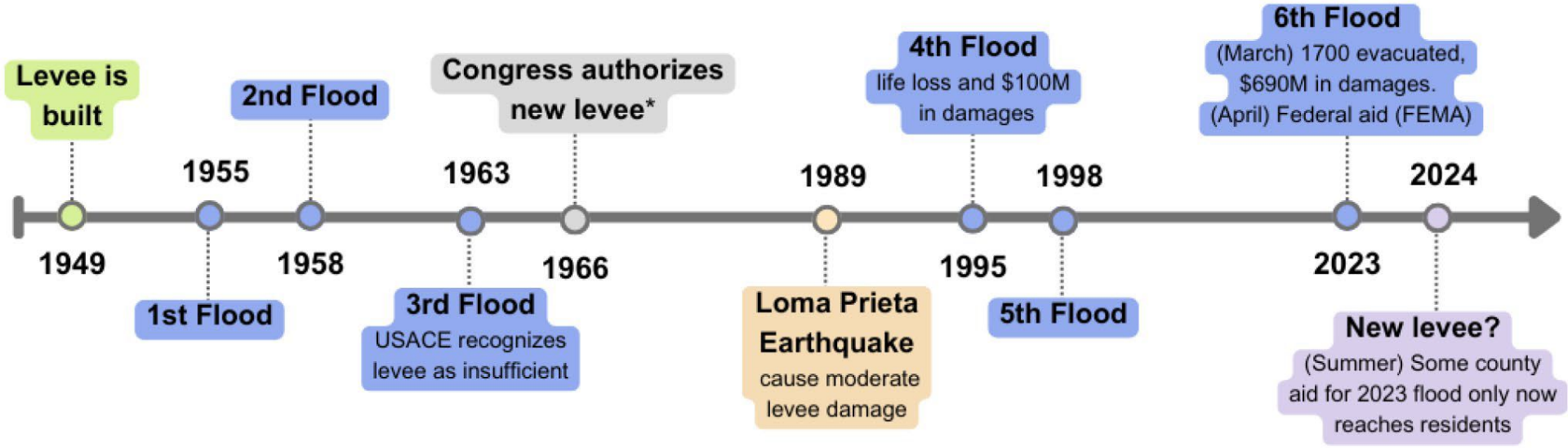
Results



Pajaro situated within the 100 year floodplain with higher risk than neighboring Watsonville

Pajaro River dividing line between Santa Cruz County (north, Watsonville) and Monterey County (south, Pajaro)

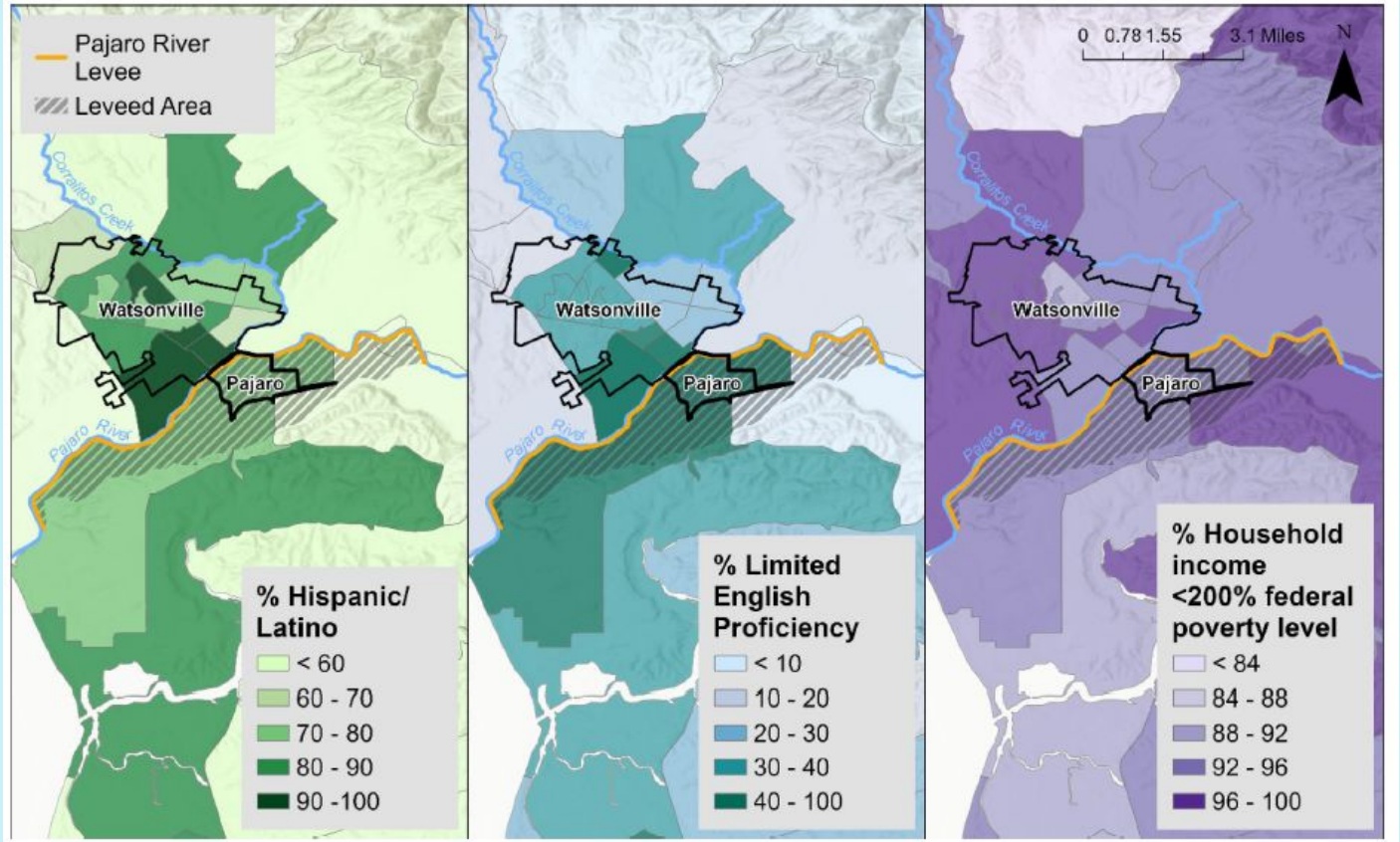
Long History of Flooding



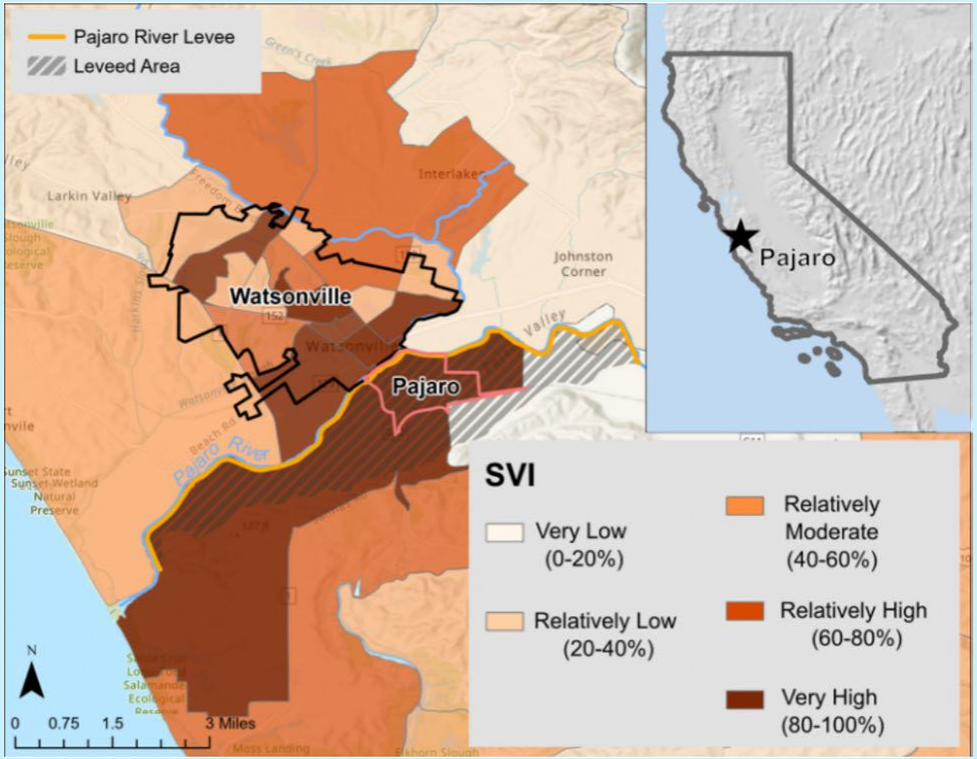
*The levee project remained unimplemented

Flood events prior to 2023 compromised Pajaro levee integrity in well-documented instances, but repair and fortification remained limited over decades. During high-water events in 1995 and 1998, localized and underseepage issues were observed along the Salsipuedes Creek. Remediation efforts took place in the spring of 2002, when approximately 325 linear feet of sheet piling was installed

High Social Vulnerability

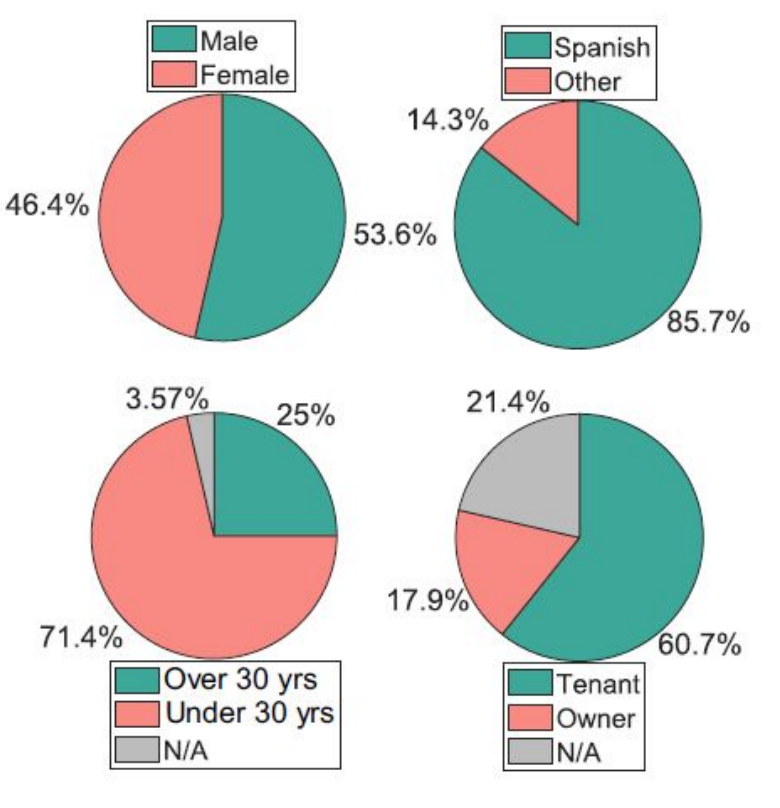


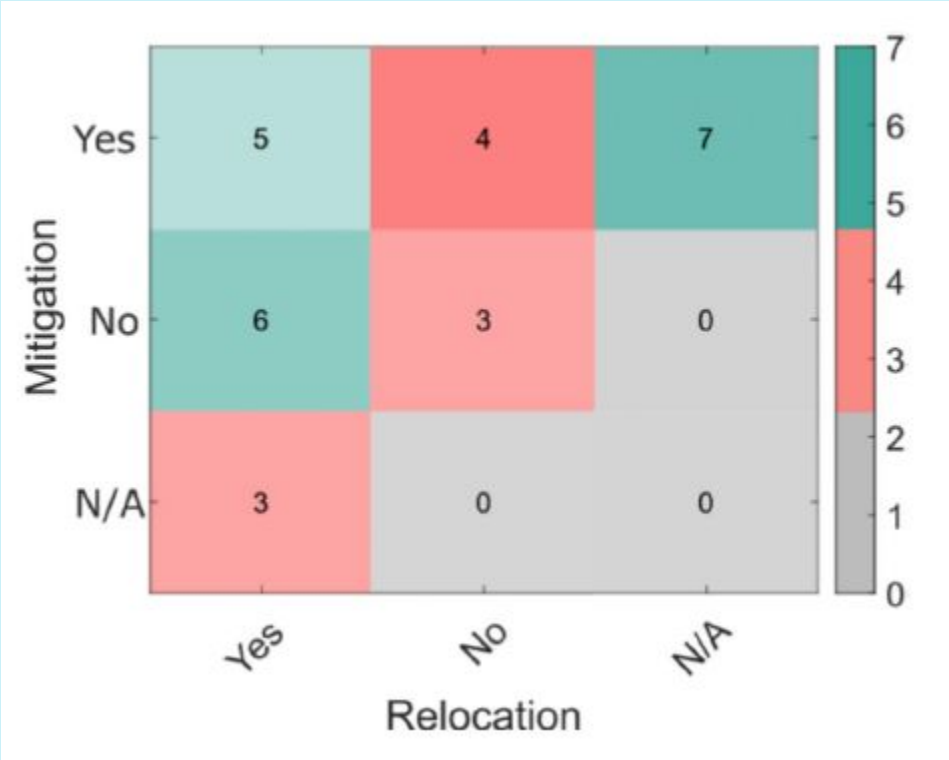
High Social Vulnerability



- Low Income, high poverty
- Employment - farmworker
- linguistic isolation: Spanish and Mixteco/Zapoteco limits access to services and information
- Predominantly Latino/a (80%)
- Intersect with high FEMA Social Vulnerability Index (SVI) rankings

Resident Interviews: Emerging themes were mitigation, disaster relief, relocation



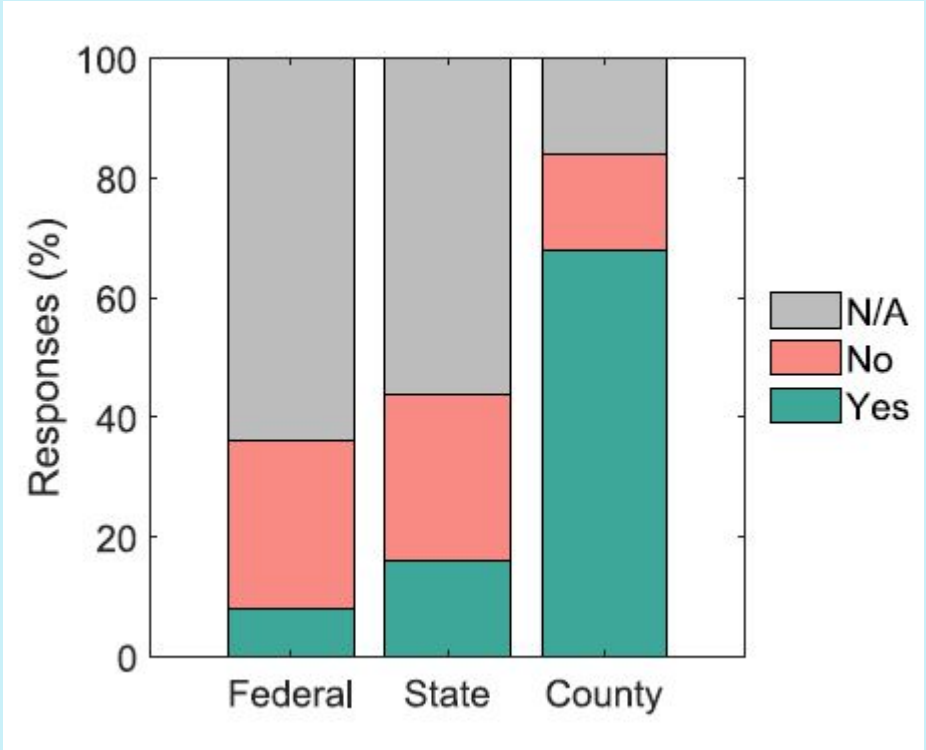


Interview Themes

- Residents expressed a desire to relocate, yet few had taken tangible mitigation measures to safeguard against future floods
- pronounced awareness of the risk of future flooding
- financial constraints hinder their ability to act proactively
- Many interviewees reported challenges in accessing insurance or government aid, describing these resources as either inaccessible or insufficient
- emphasized that their immediate focus was on rebuilding their lives in the aftermath of the flood, leaving little time, energy, or resources to plan for long-term protective measures.
- combination of financial barriers and pressing indicate limited agency in addressing flood risks and preparing for potential future disasters

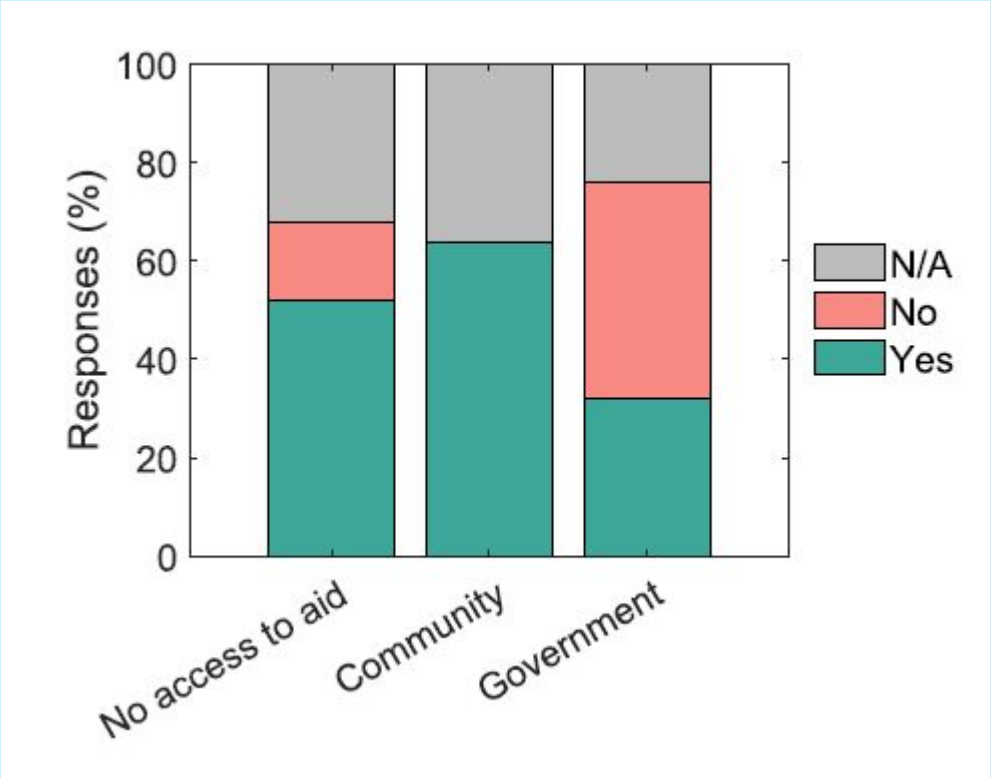
Perceptions of Responsibility

- Majority (68%) placed the responsibility on Monterey County (not Santa Cruz!) , few on state or federal agencies.
- Localized perception of responsibility
- reflects a tendency to hold higher expectations for authorities in closer proximity
- paradoxical challenge in unincorporated communities like Pajaro: there is no political authority, such as a town council or mayor, closer than the Monterey County gov
- Demographic and flood control management complexities
- Many Pajaro residents are not American citizens: significant legal barriers to their ability to influence political representation effectively, advocating for disaster preparedness and response.



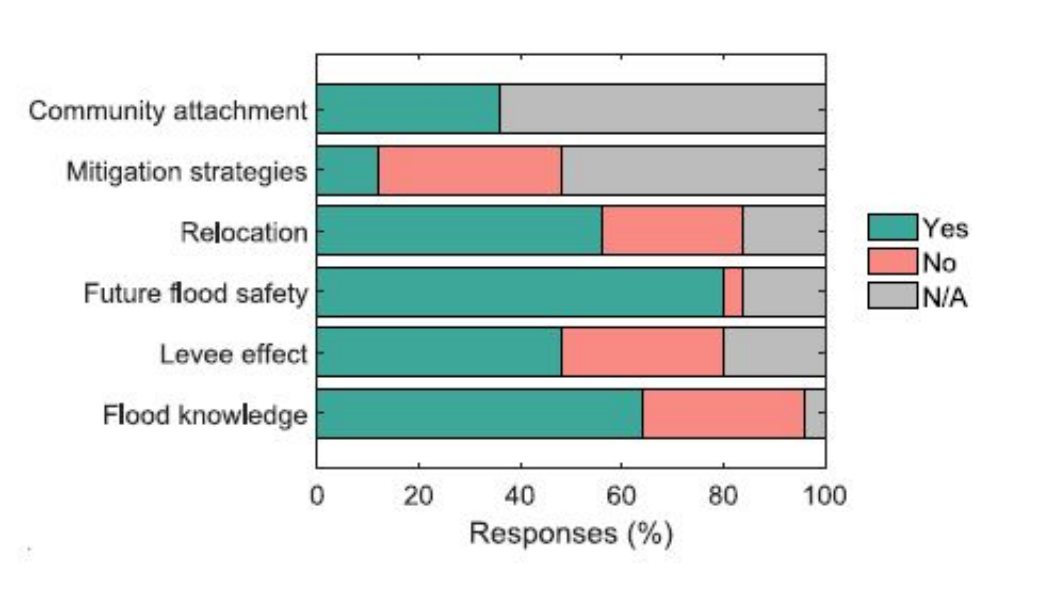
Access to Aid

- 64% community, family friends
- 32% government
- Pivotal role of local NGOs
- Feelings of neglect, lack of information/conflicting information (i.e. hotel rooms), inaccessibility (language barriers, residency status)
- Timing of aid (took more than a year)
- Conflict within the community on how funding should be spent
- Feelings of fairness
- Paradox: Need help fast, but time to do it right: Preparedness might pay



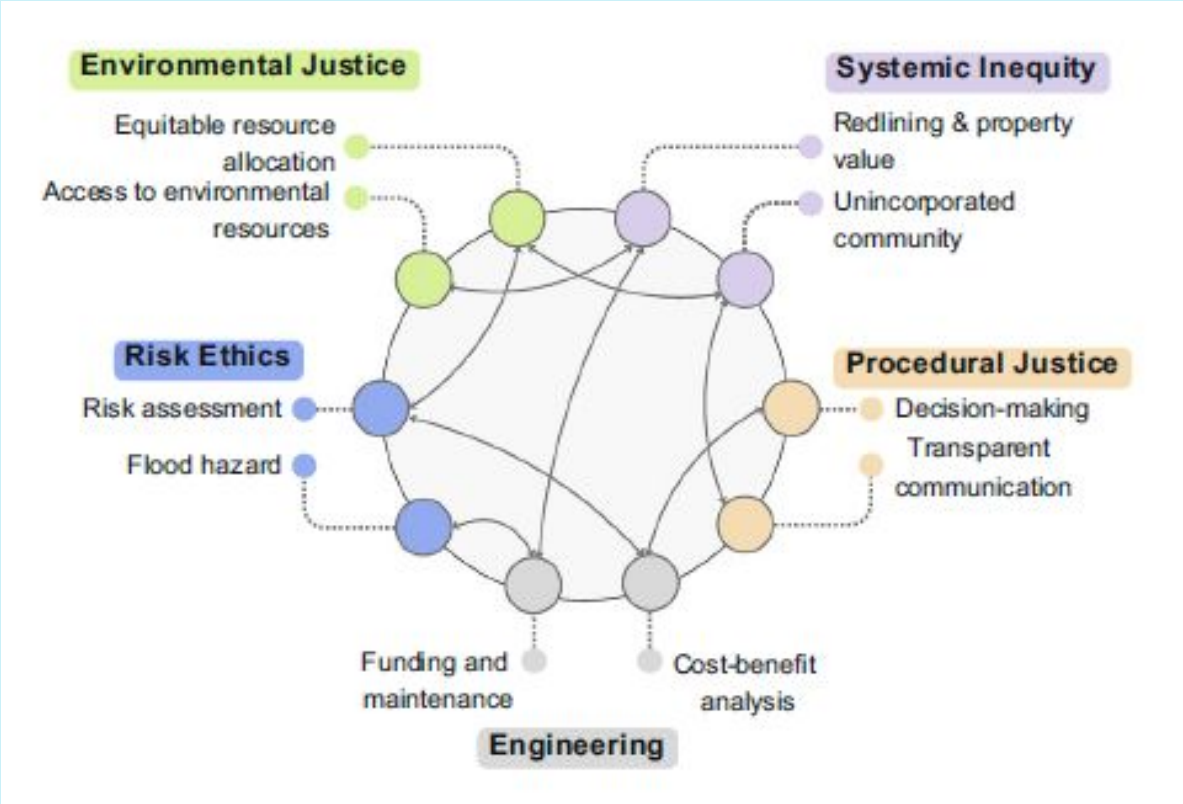
Perception of Flood Risk

- Insights on disaster response measures like relocation and mitigation strategies, along with community attachment, were explored
- despite awareness of future flood risks and potential need for preventive measures, expressed strong emotional and social attachment to the Pajaro community, including work opportunities
- Attachment often complicates decisions about relocation, showcasing the complex interplay of risk awareness and community ties.



EJ Considerations

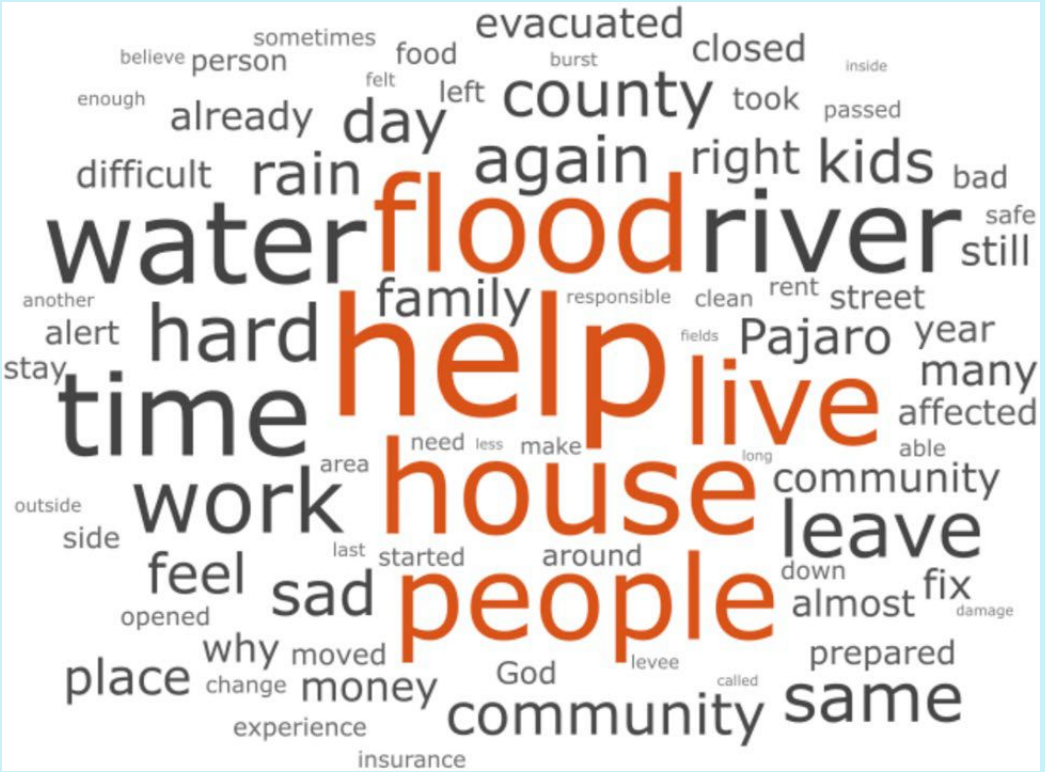
- EJ aspects identified as relevant for consideration in the funding and maintenance decision-making process for levees as proposed by this study
- Consensus that under climate change, improving the resilience of people and territories across all phases of the disaster cycle, preparedness, response, recovery, and mitigation, is essential.



Interdisciplinary Approaches are Key

- Adaptation requires changes in behavior, a deeper understanding of the territories inhabited, and the identification of areas that are either most exposed to flooding or face the greatest challenges during recovery, recognizing that these forms of vulnerability are not always aligned.

- Multidisciplinary approaches, incorporating geographic and socio-economic analysis, risk perception, and ethical considerations, are key to addressing these challenges



Stronger Protections Needed for Climate Change Planning in Vulnerable Communities

- improved language access for emergency information
- inclusive disaster and climate adaptation planning programs involving local NGOs
  - collaborations with state and local governments
  - plans for immediate and longer term aid
- disaster-planning funding for community-based NGOs
- disaster relief fund for undocumented immigrants to cover unemployment and medical costs, housing and property replacement
- Can be applied to multiple hazards and communities