UNIVERSITY OF CALIFORNIA,
IRVINE

Flood Risk and Recovery: Significance of Measures and Lenses
Case Studies from India

DISSERTATION

submitted in partial satisfaction of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

in Urban and Environmental Planning and Policy

by

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2024

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to all those who have supported me throughout my Ph.D. journey. To my advisors and committee members, your guidance has been invaluable. Dr. David Feldman, thank you for helping me always look at the bigger picture and teaching me to consider the real-world applications of our research. Dr. Doug Houston, you have been a true mentor and guide. Thank you for your critical feedback on my research and writing. Thank you for believing in me, and from you, I have learned what it means to be a true mentor. Dr. Maura Allaire, your rigorous feedback expanded and elevated my thinking and skills and pushed me to delve deeper into my research. Dr. John Hipp, thank you for your feedback on methods. Discussions with you have significantly enhanced my methodological understanding.

Thank you to my survey team in India; your assistance was crucial in collecting information on the ground. This work would not have been possible without you all. I extend immense gratitude to the households who participated in the surveys and interviews. Thank you for welcoming me and my team and sharing your experiences and stories. Dr. Pratap Raval, my mentor throughout my academic career, thank you for helping set up the fieldwork, providing insights on ground realities in India and Maharashtra, helping establish contacts, and providing valuable documents for my research.

To my friends at UP3, thank you for your friendship, love, and support. Leslie Panyanouvong, Qi Bing, Sridipta Ghatak, Amalia Mejia, Omar Perez Figueroa, Youjin Bori Kim, Amrita Jain, and Ian Baran, I'm grateful for the numerous brainstorming sessions, peer mentorship, being my writing buddies, and most importantly, my support system at UCI for five years. Komalbir, Vivek, Jaysing, Samyak, Arghya, and Sukriti, thank you for being there during tough times and celebrating my small victories.

To my family, your support has been my foundation. Thank you to my Mom, Swati Borate, for your unwavering love and constant encouragement to pursue my dreams. Thank you to my Dad, Bharat Borate, who has been my strongest pillar of support, always reminding me that I can achieve anything with dedication and hard work. To my sister, Namrata Borate, thank you for

being a friend, support, and the fuel that kept me going. To my grandparents, cousins, uncles, and aunts, thank you for your constant support throughout this journey.

I gratefully acknowledge the fellowships that provided material support for my dissertation work, making the fieldwork possible: the American Association of University Women, the Center for Asian Studies at UCI, the International Association of Emergency Managers, the Public Impact Fellowship at UCI, and the Don Owen Water Policy & Science Fellowship. Your support has been crucial in bringing this research to fruition.

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FIELD OF STUDY

Environmental Planning and Policy; Environmental and Climate Justice; GIS and Remote Sensing; Advanced Quantitative Methods

PUBLICATIONS

2023 Bukvic, A., & Borate, A. (2023). Building flood resilience among older adults living in Miami-Dade County, Florida. *Disaster Medicine and Public Health Preparedness*, 1-23.

2021 Bukvic, A., Borate, A., Hughes, S., Weaver, R., Imburgia, D., & Stiles Jr, W. A. (2021). Exploring neighborhood-level resilience to flooding: Why the context and scale matter. *Journal of Flood Risk Management*, e12698.

2020 Bukvic, A., & Borate, A. (2020). Developing coastal relocation policy: lessons learned from the FEMA Hazard Mitigation Grant Program. *Environmental Hazards*, 1-21.

2018 Bukvic, A., Gohlke, J., Borate, A., & Suggs, J. (2018). Aging in flood-prone coastal areas: Discerning the health and well-being risk for older residents. *International journal of environmental research and public health*, 15(12), 2900.

ABSTRACT OF THE DISSERTATION

Flood Risk and Recovery: Significance of Measures and Lenses
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Doctor of Philosophy in Urban and Environmental Planning

University of California, Irvine, 2024

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Flood risk and recovery are not static concepts; they vary depending on the lens and measures employed, with significant implications for aid distribution and disaster management decisions. While extensive research exists on understanding and measuring flood risk and recovery, this dissertation addresses three under-explored areas that are crucial for a more comprehensive understanding: 1) it moves beyond physical recovery towards a multidimensional assessment of disaster impacts and recovery; 2) it highlights the competing narratives of flood risk by different stakeholders; and 3) it elevates the perspective of small urban centers. The dissertation employs a mixed-methods approach, combining quantitative and qualitative methods across three chapters:

Chapter 2 uses a nationwide panel dataset (n= 23,748) and difference-in-difference approach to examine the economic well-being impacts of flooding. The results reveal that flood-affected households experience significant adverse effects on total income, consumption expenditure, and assets compared to their unaffected counterparts. Furthermore, households below the poverty line and those from scheduled castes/scheduled tribes in flood-affected villages experienced

more severe impacts on income and assets than their counterparts, highlighting the heterogeneity in impacts.

Chapter 3 focuses on disaster recovery through a case study of the 2021 flooding in Chiplun, India. It conducts ordinal logistic regressions based on a primary survey of affected households (n = 389) to assess differences in recovery of property vs. economic well-being. Findings reveal that recovery of housing and household goods are lacking two years after the event. Marginalized caste households were more likely to report lower recovery levels across all dimensions, highlighting the caste-disparate impacts beyond the immediate aftermath. Additionally, income loss emerged as a critical factor, with households experiencing higher income loss likely to report greater reductions in consumption expenditure and lower recovery levels across multiple dimensions.

Chapter 4 assesses how flood risk is defined and understood in policy making through qualitative narrative analysis of government documents, semi-structured interviews, news media, and letters written to state and elected representatives. It exposes competing narratives of flood risk, revealing a predominant focus on proximate causes, such as silt accumulation in river bodies and construction on riverbanks, rather than structural and sociopolitical issues that shape vulnerability and disatser risk. By elevating the perspective of a small urban center, this research highlights the unique challenges and dynamics of flood risk in rapidly growing yet often overlooked urban areas.

Collectively, these studies contribute to a more comprehensive understanding of flood risk and recovery, challenging the conventional ways of understanding risk and recovery and moving beyond property damage assessments and technocratic solutions.

CHAPTER 1: INTRODUCTION

1.1 Background and Significance

Flooding is the most common type of disaster globally, with an average of 163 events recorded per year directly exposing 1.81 billion people (23% of the global population) to flood risks (Rentschler et al., 2022; UNDRR, 2020). As rainfall intensifies and sea levels rise as a result of climate change, the risk of flooding is expected to escalate, exposing more people to its devastating impacts. In the last two decades, there has been a sharp increase in direct economic losses, such as the immediate effects on lives and property and the impact on economic well-being that hamper the development prospects of those affected (Hallegatte et al., 2017).

The studies in this dissertation aim to highlight the underrepresented populations, measures, and narratives. Flood exposure, its impacts, and subsequent recovery are highly uneven and rooted in society's larger socioeconomic inequalities (Wisner et al., 2004; Cutter, 2003). Empirical evidence highlights that vulnerable and marginalized groups are more exposed to flooding, more likely to experience higher losses and delayed recovery, and suffer adverse long-term impacts (Cutter, 2003; Peacock et al., 2006; Tierney, 2014; Hallegatte et al., 2017). However, traditional and dominant approaches to examining disasters often fail to provide a comprehensive understanding of disaster risk and recovery processes, overlooking the marginalized perspectives or voices (Hallegatte et al., 2017; Few et al., 2021; Alvarez, 2019; Goh, 2019; Arvind et al., 2020). In light of these increasing losses, it becomes crucial from a policy-making perspective to holistically understand the risk, impacts, and recovery from flooding.

The definition, measurement, and examination of flood risk and recovery are central to effective and inclusive disaster management. Definitions shape our understanding of the concept studied, measurement methods affect the outcomes, and metrics drive policy decisions. Flood risk and recovery are not static concepts; they vary depending on the lens and measures employed, with significant implications for aid distribution and disaster management decisions. While extensive research exists on understating and measurement of flood risk and recovery, this dissertation addresses several under-explored areas:

1. Moving beyond physical recovery and towards a more multidimensional assessment of disaster impacts and recovery (Chapters 2 and 3)
2. Highlighting competing narratives of flood risk by different stakeholders (Chapter 4)
3. Elevating the perspective of a small urban center (Chapters 3 and 4)

The three empirical studies in this dissertation collectively contribute to a multidimensional understanding of flood risk and recovery using India as a case study.

1.1.1 Contribution 1: Moving beyond physical recovery and towards more comprehensive and multi-dimensional approaches to disaster recovery

Disasters can have wide-ranging impacts, affecting everything from homes to livelihoods. However, conventional approaches to assessing the impacts of flooding events have predominantly focused on property damage assessments (Walsh et al., 2019; Markhavida et al., 2020; Allaire, 2018; Mohammadi, 2024). Research organizations, insurance firms, media outlets, and governments often take into consideration the losses to physical assets and infrastructure (Hallegate et al., 2017). These property-focused assessments are utilized to estimate the overall effects of a disaster and track the progress of disaster management efforts (Allaire, 2018; Hallegatte, 2010). Consequently, most current aid and disaster assistance programs prioritize

compensation for lost assets or properties. Domestically, via governmental agendas and globally, through the initiatives of aid organizations like the World Bank's Global Facility for Disaster Reduction and Recovery, there's a notable emphasis on addressing housing and reconstruction as primary priorities. (Tierney, 2012; Arvind et al., 2020; Hallegatte et al., 2017; Few et al., 2021).

However, on-ground interactions with affected communities reveal a different perspective. Often, housing is not the primary concern of disaster-affected individuals (Arvind et al., 2020). The official narrative about successful recovery is often centered on post-disaster housing reconstruction and infrastructure investments, while the community's concerns pertain to livelihood and well-being (Arvind et al., 2020). Loss of employment and falling incomes can have long-term adverse effects on people's well-being and long-term prospects (Hallegate et al., 2017). For instance, job losses can lead to reduced access to healthcare, education, and other essential services, further exacerbating the vulnerability of the affected (Rentschler et al., 2020; Hallegatte et al., 2017).

Studies solely focused on property damage assessments underestimate the impacts of well-being and, as a result, might leave out those struggling with unaccounted-for impacts (Mohammadi, 2024). A study conducted by the World Bank found that globally, natural disasters are estimated to cause $300 billion in direct property losses every year; the impacts become more pronounced ($520 billion) when considering the well-being (consumption) of those affected (Rentschler et al. 2020).

Furthermore, focusing only on property losses can overlook heterogeneities in recovery patterns, as the wealthy have more assets and sustain more losses in absolute terms (Markhvida et al., 2020; Walsh et al., 2019). Researchers argue that measures focused on property damages

overlook livelihood concerns, education, basic service needs, etc. Thus, the conventional property-based operationalizations of recovery widely used in decision-making are too narrow and leave out vulnerable groups without or with lower levels of property (Hallegatte, 2017; Walsh et al., 2019). From a political perspective, the prioritization of housing reconstruction stands out as a tangible intervention that showcases government support visibly to citizens, unlike livelihood-building initiatives (Few et al., 2021; Mohammadi, 2024).

In countries like India, where asset and housing relations are highly inequitable, it is crucial to understand how disaster impacts and subsequent recovery are defined, understood, and measured. **Drawing on research on disaster impacts from urban planning, economics, sociology, and geography, chapters two and three examine the dual effects of flooding in India, considering both property damage and its impact on economic well-being.** By considering both aspects, this research aims to provide a more comprehensive understanding of the consequences of flooding events and to inform more effective and equitable disaster recovery strategies. This aligns with the United Nations Office for Disaster Risk Reduction (UNDRR) definition of recovery, which emphasizes physical reconstruction as well as non-physical reconstruction-oriented activities (socioeconomic recovery) (UNDRR, 2020; Mohammadi, 2024).

1.1.2 Contribution 2: Highlighting the competing narratives of flood risk and disaster causation

Flooding is a classic `wicked problem' (Rittel et al., 1973) characterized by competing viewpoints on its causes and solutions. Understanding and defining the issue of flooding

becomes inherently challenging due to the involvement of various interconnected causes, such as urbanization, inadequate infrastructure, and climate change, which defy simple solutions.

The framing and understanding of flood risk take different forms based on one's perspective (Goh, 2019). Competing narratives emerge around flood risk, guiding how the issue is perceived and prioritizing specific solutions over others. From a biophysical lens, flooding is viewed as an issue of climatology, hydrology, and geography. Government narratives often focus on this biophysical viewpoint, and post-disaster responses have relied heavily on techno-engineering solutions when addressing flooding (Goh, 2019; Arabindoo, 2017; Padwangi, 2014; Shatkin, 2019). These approaches typically emphasize physical and external factors, such as land subsidence, rising sea levels, groundwater depletion, and extreme precipitation, as the primary causes of flooding. For instance, government-led projects like the Jakarta Urgent Flood Mitigation Project and the Jakarta Coastal Defense Strategy predominantly adopt large-scale physical infrastructural solutions based on biophysical perspectives (Goh, 2019). However, this viewpoint masks the socio-political factors contributing to the disaster and precludes a critical analysis.

In contrast, an urban-political perspective, advocated by environmental activists and civil society groups, argues that flooding results from broader processes of uneven urban development - unsustainable urbanization and land use practices and the degradation of natural ecosystems, such as wetlands and floodplains, which have compromised the city's capacity to absorb and manage excess water (Arabindoo, 2017; Goh, 2019). Proponents of this viewpoint argue for greater representation of the voices of those affected, especially the marginalized, in addressing flood risk (Alvarez et al., 2019; Goh, 2019). They contend that the socio-political dimensions of flooding remain largely absent from the government's perspective and projects.

Given these often competing narratives, the question is whose understanding of disaster risk becomes dominant, influences the disaster risk discourse, and eventually, how it impacts the outcome. The wicked nature of urban flooding, including biophysical, social, and political factors, highlights the need for a more comprehensive approach to understanding and addressing this complex issue. **Chapter four sheds light on the competing narratives surrounding flood risk within an Indian city, examining how these divergent perspectives shape the understanding of the problem and the prioritization of solutions.**

1.1.3 Contribution 3: Elevating the perspective of small urban center

While much of the existing research on disasters in India and the global south has focused on megacities like Manila, Jakarta, Mumbai, Kolkata, and Chennai (Rumbach, 2010; Doshi, 2013; Ranganathan, 2015; Parthasarathy, 2015; 2016; 2018; Arabindoo, 2016; Weinstein et al., 2019; Alvarez et al., 2019; Goh et al., 2015; 2019, Shatkin, 2019), the next fifty years are projected to witness significant urban growth in small urban centers (Birkmann et al., 2016). However, despite their increasing importance in future urban development and the growing risk to their populations, research on disaster risk and impacts in these smaller urban centers remains limited.

Small urban centers are of particular interest due to the mismatch between their risk and their governance capacity, even in the absence of disasters (Rumbach, 2015). While disasters in large cities often receive extensive coverage by national and international media, drawing attention from various stakeholders, disasters in small urban centers are usually felt only or mostly locally. This bias is reflected in the work of non-governmental organizations, think tanks, aid organizations, and foundations, which tend to prioritize megacities.

Notably, small urban centers are expected to grow faster than megacities in the coming decades, presenting an opportunity to avoid the mistakes made in larger urban centers (Rumbach, 2015). Understanding and governing urban risk in these places will be essential to managing their urban transition and development trajectories. Therefore, more studies are needed to examine the unique socio-political dynamics of small urban centers, considering factors such as urbanization patterns, governance structures, and community resilience capacities. **Chapters three and four contribute to understanding disaster risk and impacts in contexts that have been largely overlooked by elevating the perspective of small urban centers.**

1.2 Case Study: India

Communities around the world face unequal exposure, and its impacts are felt disproportionately. Around 89 percent of those exposed to flood risk reside in low- and middle-income countries (Hallgeatte et al., 2017; Rentschler et al., 2022). Moreover, countries vulnerable to the adverse effects of climate change may also be less equipped to deal with them.

India illustrates this paradox as one of the most flood-affected countries globally, lacking the necessary governance capacity and resources to effectively address the impacts of these events (Rumbach, 2016; 2017). According to a study published by the Central Water Commission (India), within the last 65 years (1952-2018), there has not been a single year when flooding has not affected people or property. India has faced devastating flooding events, especially in the last two decades, that have claimed hundreds of lives, made thousands homeless, and caused billions of dollars in damages, such as the Mumbai Floods (2005), Bihar Floods (2008), Chennai Floods (2015), and Kerala Floods (2018), among others (Jameel et al., 2020). Increased concentration in

urban areas, other precarious environments (riverbanks), and under-developed flood protection and drainage systems have exacerbated the flood exposure, risk, and vulnerability.

1.3 Summary of Findings by Chapters

Chapter 2 adds to the literature on disaster impacts by comprehensively analyzing flood impacts on households' economic welfare, considering economic and social stratification. It uses a household-level India-wide panel dataset (N = 23,748) with multi-year flood exposure information and a difference-in-differences approach to assess the heterogeneities in recoveries of households impacted by flooding. The findings reveal that flood-affected households experience significant adverse effects on total income, consumption expenditure, and assets compared to their unaffected counterparts. Furthermore, the findings show that households below the poverty line and scheduled caste/scheduled tribe households in flood-affected villages experienced a more severe impact on income and assets than their counterparts, highlighting the heterogeneity in impact.

Chapter 3 adds to the literature on disaster recovery by giving a multidimensional view of disaster recovery, examining the relationship between caste and disaster impacts, and highlighting the interconnectedness between different dimensions of recovery. It narrows the focus to a single city, Chiplun, in Maharashtra, India, to understand flood damage and recovery from the 2021 flooding event. Surveys from a sample of 389 households were collected approximately two years after the event in 2023 to examine differential losses and recovery trajectories of households affected. The study uses ordinal logistic regressions to assess factors associated with damage and recovery. The findings reveal disparities in recovery, with around half of the households struggling with housing and household goods recovery two years after the

event. Findings reveal that lower-caste households were more likely to report lower levels of recovery across all dimensions two years after the flooding. This finding extends the temporal scope of previous studies, indicating that the caste-based impacts persist beyond the immediate aftermath. Lastly, the chapter highlights the interconnectedness between different dimensions of damage and recovery. Income loss emerged as a critical factor, with households experiencing higher loss of income likely to report greater reductions in consumption expenditure and lower levels of recovery of house (structure), household goods, and income two years after the flooding. By highlighting these linkages, the research emphasizes the need for a more integrated approach to disaster recovery policies and interventions that address the cascade of impacts experienced by affected households.

Chapter 4 examines how the narratives and policies regarding flood risk after the 2021 flooding in Chiplun, India, engage with the different risk components—unsafe conditions, risk drivers, and root causes using disaster risk frameworks by Blaikie et al. (1994), Wisner et al. (2004), and Oliver-Smith et al. (2019). The findings uncover three dominant narratives: flooding as an act of nature, flooding as a result of urbanization, and flooding as a consequence of dam mismanagement. The state primarily defines 2021 flooding events as an 'externalized' threat resulting from heavy rainfall, high tide, and topography, and it attributes the 2021 flooding to the development of flood zones. Residents affected by the flooding link the flooding to water discharge from the dam (a failure of governance). Both the state and residents agree on the narrative of silt accumulation reducing the water-carrying capacity of the river.

The analysis of narratives surrounding flood risk in Chiplun reveals a predominant focus on proximate causes or unsafe conditions, such as silt accumulation, release of water for the dam, and development in flood-prone areas. This emphasis on the immediate and visible symptoms of

flood risk has led to policy decisions and funding allocations that primarily target the proximate conditions while often overlooking the deeper issues that contribute to their creation. This chapter adds to the literature on the underlying causes of disaster risk by highlighting the role of disaster narrative in a small town in India and situating flood risk within the broader context of power dynamics and development paradigms that shape urban and disaster governance. The findings emphasize the need for narratives to consider sociopolitical implications and to be holistic, moving beyond immediate triggers and physical hazards to address the drivers and root causes of risk.

The **conclusions and policy implications chapter** summarizes the dissertation's major findings, contributions, and limitations. It discusses the cross-cutting theme of environmental justice that emerges from the findings and concludes with policy implications.

1.4 Frameworks for Understanding Differential Risk and Recovery

In this dissertation, I employ the concepts of vulnerability and resilience as analytical lenses to explain the differential recovery trajectories of households affected by flooding in India. Recovery does not occur in isolation but is linked to the social context within which households are situated. Each household occupies a distinct position within the social order, characterized by varying levels of access to monetary resources, social capital, and political power and influence (Tierney et al., 2012). These socially structured positions play a crucial role in shaping recovery pathways.

The trajectories of recovery are diverse and dependent upon factors such as the severity of the disaster event, the pre-existing vulnerabilities of the households, and their resilience capacities (Tierney et al., 2012). To navigate this complexity, I draw upon social vulnerability and

resilience frameworks to guide the selection of relevant variables and develop a nuanced understanding of the recovery process. By considering vulnerability and resilience, researchers can better analyze the interplay between pre-existing conditions, exposure, and recovery capacity, shaping the varied recovery pathways observed across different social groups and communities.

1.4.1 Social Vulnerability

The concept of vulnerability is key to understanding the uneven distribution of risk and the differential impacts of disasters. Vulnerability is defined as "the likelihood that an individual or group will be exposed to and adversely affected by a hazard" (Cutter, 1996). Vulnerability theory posits that the social distribution of risk and the consequences of disasters are not uniform but rather shaped by broader social contexts and processes (Tierney 2006; Wisner et al. 2004).

Vulnerability frameworks are widely used in the literature to highlight systematic variations in three key aspects (Lindell, 2013): First, the exposure dimension, which examines the spatial patterns of where people live and work and how vulnerable households are often clustered in foreseeable locations (Cutter, 1996). Second, the structural vulnerability dimension, which considers the quality of structures people inhabit and work in, is influenced by factors such as filtering, low investment, intentional negligence, and underinvestment. Third, it analyzes how social impacts vary systematically across different groups, even when accounting for similar levels of exposure and physical vulnerability.

While the social vulnerability framing is valuable for explaining the risk of exposure and the initial impacts of a disaster, it has limitations in capturing the complexities of the recovery process (Cutter, 2008; Walsh et al., 2019). Pre-existing conditions and susceptibility are crucial

but not sufficient for understanding the decisions made by those affected by disasters and the overall welfare impacts in the aftermath.

1.4.2 Resilience

Compared to social vulnerability, which is often viewed as a traditional macro-structural approach, resilience is seen as a more actor-oriented approach focusing on the agency of those affected (Uekusa, 2017). In the past few years, resilience has become a key concept driving the discourse on disaster and climate policies (Martin-Breen et al., 2011; Doorn, 2017; Tierney, 2014). After adopting the Sendai Framework in 2015, resilience became the focus of Disaster Risk Reduction strategies for international organizations like the World Bank, Rockefeller Foundation, and federal, state, and local governments worldwide.

Resilience has been defined and used across multiple disciplines. Regardless of the disciplinary origins, resilience means "the absorptive capacity, or the ability to resist disruption and remain stable, and the ability to bounce back" (Tierney, 2014, Pg no. 164). In disaster studies literature, resilience is defined as "the ability to survive and cope with a disaster with minimum impact and damage" (Cutter et al., 2008, Pg no. 600). Thus, creating resilience is about enhancing the ability of an individual, community, etc., to anticipate, absorb, and recover from a shock and to adapt to such conditions successfully (Cutter, 2016).

Resilience is a "dynamic process that includes feedback, adaptive learning, and change" (Cutter, 2016, Pg no. 111). Such a perspective recognizes resilience as inherent and adaptive. Adaptive resilience occurs after an event and entails learning by individuals, which enables the individuals to respond successfully too, recover from, and adapt to new conditions. Resilience encompasses two key components: inherent conditions and adaptive processes. Inherent conditions are pre-

existing attributes that enable a system to withstand and manage the immediate effects of a disruptive event, while adaptive processes are post-event mechanisms that allow the system to adjust, transform, and gain insights from the experience.

Inherent resilience is "associated with properties of resistance, robustness, and existing redundancies within systems" (Tierney, 2014, Pg no 173). For example, families often have built-in safeguards against adversity, such as financial reserves to cushion economic shocks or social networks that provide support during disasters. Higher inherent resilience shields individuals from severe losses and disruptions, holding all other factors constant. This inherent robustness allows them to weather disaster impacts more effectively than those with lower resilience levels.

Adaptive resilience refers to how social units respond when under stress - including efforts to reconstitute inherent forms of resilience (Tierney, 2014). It is characterized by impromptu actions carried out during and after the disaster that aid recovery (Cutter, 2008). These actions include activating inherent resilience and developing new coping strategies to meet the challenges posed by disasters.

1.5 Implications and Contributions

This dissertation explores the multifaceted nature of disaster risk and recovery. Given the wicked nature of flooding, a multidimensional and interconnectivity lens is essential to examining disaster risk and recovery. The three studies challenge conventional approaches to understanding and addressing disaster risk, impacts, and recovery, highlighting the importance of recognition, participation, and equity in disaster management decisions.

Through this three-paper approach, the dissertation contributes to understanding flood risk and recovery by moving beyond property damage assessments, undertaking a multidimensional recovery assessment, highlighting competing narratives around flood risk, and elevating the perspective of a small city in the global south. Drawing on insights from urban planning, human geography, political ecology, and environmental economics, the dissertation aims to inform policy responses and planning efforts for more inclusive and equitable disaster management strategies.

CHAPTER 2: ECONOMIC WELFARE IMPACTS OF FLOODING ON HOUSEHOLDS IN RURAL INDIA

2.1 Abstract

Nearly 1.5 billion people worldwide are at risk of flooding, which is expected to increase in the coming years (IPCC, 2021). For successful mitigation and recovery, policymakers need to understand the impacts holistically—who is most severely affected, who takes longer to recover, and what factors are associated with the risk and recovery. In this study, I examine the impact of flooding events on the welfare (income, consumption expenditure, and wealth index) of households in rural India (n=23,748) by using household panel data from the India Human Development Survey (IHDS). This study contributes to the literature by comprehensively analyzing flood impacts on households' economic welfare, considering both economic and social stratification. It utilizes multi-year flood exposure data and examines heterogeneity in impacts based on economic class and caste (Anttila-Hughes et al., 2013; Noy et al., 2019; Del Ninno et al., 2005; Mueller et al., 2011).

By utilizing the annual variation in flood incidence, I employ a difference-in-difference approach to identify the effect of flooding on economic welfare. The results show that flooding causes losses to households' economic welfare by negatively affecting their total annual income, consumption, and wealth (assets) index in flood-affected areas. Additionally, the findings show that the magnitude of the negative impact on income appears to be stronger in the short term (1-3 years) as compared to the medium-term (4-6 years after the event), indicating that the severity of income losses may diminish as time passes since the flood event. Lastly, the results show that households below the poverty line (BPL) and scheduled caste/scheduled tribe households in

flood-affected villages experienced a more severe impact on income and assets than their counterparts. These findings align with previous literature documenting the negative impacts of flooding on household welfare. They extend our understanding by focusing on social stratification, particularly the role of caste. The results underscore the need for targeted policies and interventions to support vulnerable households in the aftermath of disasters and to build resilience against future events.

Keywords: welfare impacts, flooding, heterogeneity in impacts

2.2 Introduction

Equitable disaster management requires a comprehensive understanding of who is impacted the most, who takes longer to recover, and what factors influence disaster impacts. The severity of impacts may vary based on the types of measures used. Impact assessments after disasters are crucial as they inform risk mitigation strategies, resource allocation, aid distribution, and long-term recovery plans. However, despite the availability of a wide variety of measures and methods to examine disaster impacts, flood impact assessments often focus on property or asset losses because they are straightforward to measure (Antilla-Hughes et al., 2013; Allaire, 2018; Meyer et al., 2013; Hallegatte et al., 2017). The disaster losses reported by governments, international organizations, and media also focus on the loss of property and assets. These property-loss assessments overlook the broader welfare impacts and tend to be biased toward the wealthy, as vulnerable groups often have little to no property (Hallegatte et al., 2017).

Failure to capture welfare impacts has led to recovery efforts directed toward reconstruction or compensation for property damage (Allaire, 2018), neglecting the system-wide concerns related to livelihoods, education, and basic services (Arvind et al., 2020). A recent Intergovernmental

Panel on Climate Change (IPCC, 2021) study states that extreme climate events like flooding will increasingly impact multiple dimensions of human well-being, such as livelihoods, health, education, poverty, etc. This highlights the need to study the disaster impacts holistically.

This paper extends the existing literature on the economic impacts of disasters (Groen et al., 2020; Henry et al., 2020; Anttila-Hughes et al., 2013; Noy et al., 2019; Del Ninno et al., 2005; Mueller et al., 2011) by examining the change in the economic welfare of the households impacted by flooding in rural India. The study focuses on two questions:

- How do affected households' income, consumption, and wealth (assets index) change after flooding?
- How heterogeneous are the impacts of flooding based on household economic class and social group (caste)?

Floods cause tremendous damage to life and property in India every year. In the last few years, flooding has intensified in duration, frequency, and intensity (Singh et al., 2017). Simultaneously, India is experiencing rapid population growth, development in precarious settings, and widening inequality (Rumbach, 2017; De Sherbinin et al., 2007). Additionally, the housing and asset relations are highly unequal in India. Given this context, the definition, understanding, and measurement of disaster impacts become an equity and justice issue. This study uses a rural India-wide panel dataset at the household level to understand the welfare impacts of flooding (n = 23,748). Changes in welfare are assessed using a difference-in-differences approach, which compares the economic outcomes of flooded households to both pre-disaster outcomes and households not impacted by flooding.

This study contributes to the literature in three ways. First, it is one of the few studies that uses household data to examine the impact of flooding on the economic welfare (income, consumption expenditure, and wealth index) of households in rural India. Previous studies on the

economic welfare impacts of flooding in India focus on aggregate geographies—state, tehsil, or village levels (Sajid, 2023; Parida et al., 2019; Aggarwal et al., 2021).

Second, this multi-event study focuses on households across India, using flood exposure data for six years, unlike previous studies that trace the impacts of single large-scale events (Khanna, 2020; Patnaik et al., 2019; Beyer et al., 2022) or rainfall shocks (Hossain et al., 2022; Aggarwal, 2021; Sedova et al., 2020). The studies using rainfall shocks, while useful, have some limitations. These studies often measure the shock at a coarse spatial resolution (district level). One district in India can consist of thousands of villages (Sedova et al., 2020; Hossain et al., 2022). Thus, this level of aggregation may not capture the localized impacts of flooding, as the relationship between rainfall and flooding is complex and depends on various factors such as topography, land use, and drainage systems. By using self-reported and village-level information on flooding, this study examines the direct impacts of flooding and provides a more precise understanding of how floods affect households at a more granular level.

Third, this study explores the heterogeneity in flood impacts across India based on the economic class and caste of the household. While some studies have documented caste-based differences in disaster impacts and discrimination in disaster relief efforts (Aldrich, 2010; Arlikatti et al., 2010; Ray-Bennett, 2009; Irshad, 2014), only a few India-wide studies examine the caste-based vulnerability in disaster outcomes (Khalid et al., 2024; Tamuly et al., 2022). Additionally, the literature on economic welfare impacts of disasters in Asia tends to focus more on economic class using indicators such as wealth quintiles and poverty rather than social marginalization (Antilla-Hughes et al., 2013; Noy et al., 2018; Del Ninno et al., 2001; De Alwis et al., 2016; Poaponsakorn et al., 2015). In India, caste is an important source of vulnerability; however, prior studies on welfare impacts do not examine the differential impacts of disasters based on one's

caste (Sedova et al., 2020; Hossain et al., 2022). The caste-based vulnerability involves additional social, cultural, and systemic barriers that persist even as households advance economically. These barriers include social discrimination, geographical and occupational segregation, limited access to social networks, and political marginalization (Irshad, 2014; Arora, 2022; Deshpande, 2011; Arlikatti et al., 2010) and can affect the recovery of households.

Overall, this study demonstrates the importance of considering both economic and social stratification when assessing the welfare impacts of disasters, specifically in regions where social strata intersect with economic disparities.

2.3 Literature Review

In this section, I give an overview of the literature from environmental economics that focuses on the welfare impacts of disasters.

Prior research has shown that in the aftermath of a disaster, a household is affected in various ways, such as damage to assets and property, change in employment and income, and consumption, disruption of infrastructure and services, and health impacts (Allaire, 2018; Anttila-Hughes et al., 2013; Arouri et al., 2015; Noy et al., 2019). These impacts are often not uniform and are a function of the event's magnitude, exposure, households' vulnerability, and resilience (Hallegatte et al., 2017). Given the unequal impacts, from a policy-making point of view, it is essential to know who suffers the most, who takes longer to recover, who is impacted by the government's mitigation and recovery decisions, and who benefits from these decisions (Meyer, 2013). In this study, I focus on three dimensions of economic well-being to understand the impacts of flooding - assets, income, and consumption expenditure.

2.3.1 Assets

Previous studies have shown that natural disasters, such as floods, typhoons, and hurricanes, can significantly negatively impact household assets (Patankar et al., 2015; Jakobsen, 2012; Morris et al., 2002). The depletion of household assets due to disasters can be attributed to both direct effects—damage to housing and goods—and indirect effects on livelihood strategies and income (Hallegatte et al., 2017).

The 2005 Mumbai flooding affected assets representing lifetime savings, such as appliances and furniture (Patankar, 2019). The impact of typhoons on people's assets in the Philippines lasted for a year after the disaster (Anttila-Hughes et al., 2019). Similarly, studies assessing the impact of the Indian Ocean Tsunami and Hurricane Mitch found that affected households suffered significant losses in domestic and nonproductive assets, respectively (Arlikatti et al., 2010; Jakobsen, 2012). De Alwis et al. (2019) found that 8 years after the Indian Ocean Tsunami, affected households had 10-20 percent fewer durable assets like vehicles, appliances, and furniture compared to unaffected households, with asset losses being greater for poorer, less educated, and rural households.

Assets owned by a household serve as a measure of their economic well-being, providing insight into their medium- or long-term economic position, as they are typically accumulated over several years. However, when examining impacts solely based on assets, it is important to consider variations in household impacts, as wealthier households tend to possess more assets and may experience larger losses in absolute terms (Markhvida et al., 2020).

2.3.2 Income and Employment

Research on the impacts of disasters on income and employment presents a mixed picture. Some studies indicate disasters can have positive spillover effects, such as increased demand for labor due to reconstruction activities, leading to rising incomes (McDermott et al., 2014). Early research showed a correlation between higher frequencies of climate disasters and increased economic growth (Skidmore et al., 2007). For example, a study focused on the aftermath of Hurricane Katrina found that the workers in the construction industry experienced short-term earnings growth. Furthermore, the areas affected by the storm exhibited long-term income increases compared to the unaffected areas (Groen et al., 2020).

However, more recent studies suggest that high-intensity disasters negatively impact economic growth in the short term, while long-term impacts remain unclear (Hallegatte et al., 2017). In the short term, affected households may suffer income losses as these events damage or destroy income-generating assets and opportunities. For example, households in Thailand impacted by the 2011 flooding experienced reduced non-agricultural income (Noy et al., 2019). Similarly, the 1998 Bangladesh flood, known as the "flood of the century," resulted in employment losses for over half of the affected population (Del Ninno et al., 2001). In the Philippines, typhoons had similar detrimental effects on household economic well-being, with the average annual income of affected individuals decreasing by 6.7 percent one year after the strike (Antilla-Hughes et al., 2013). A study conducted on hurricanes that made landfall in the United States between 1970 and 2010 reveals significant impacts on per capita income at the county level (Deryugina, 2021). Hurricane landfalls led to an average decline in income per person of about 1.5 percent in the year of the hurricane. Research conducted in Vietnam revealed that residing in a commune exposed to floods reduced the income of rural households by 5.9 percent (Arouri et al., 2015).

2.3.3 Consumption

Disaster-related expenses, income fluctuations, and changes in commodity prices can influence household consumption patterns. In the aftermath of floods, whether households curtail their consumption depends on several factors, including their ability to cope with losses through resources like savings and insurance, access to external sources such as loans and government relief support, and the presence of a support network (Hallegatte et al., 2017; Allaire, 2018).

On the one hand, activities like reconstruction and restoration of lost goods and housing can lead to increased consumption as households strive to recover. An example of this can be seen in the aftermath of the 2015 Chennai flooding, where household consumption surged, particularly in categories such as health, power, and fuel (Patnaik et al., 2018). Similarly, the 2011 Great Flood in Thailand increased housing-related expenditure (Noy et al., 2019).

On the other hand, lost income, disruptions in business activities, evacuations, dislocations, or relocations can have a negative impact on consumption. For instance, the 1998 flooding in Bangladesh reduced non-food household expenditure (Del Ninno et al., 2003). Additionally, a study conducted by Anttila-Hughes et al. (2013) found that the income losses from typhoons in the Philippines translated nearly one-to-one into reduced household expenditure. They also noted that the decrease in expenditure was partially achieved through disinvestment in human capital and health-related expenses. Another study found that households impacted by the Indian Ocean tsunami largely recovered their income from pre-tsunami levels. However, consumption expenditure was still about 9 percent lower for affected households eight years after the disaster (De Alwis et al., 2019).

2.3.4 Disparities in impacts

Next, I discuss the disparities in disaster impacts, which vary significantly for different households. These differences underscore the complexity of recovery processes.

The impacts of disasters are heterogeneous and dependent upon the exposure, vulnerability, and resilience of those affected (Hallegatte et al., 2017). Researchers have employed various methods to assess this diversity in disaster impacts and subsequent recovery. There is a significant difference in how the poor and marginalized communities are affected and cope with the impacts of a disaster compared to other segments of society. These vulnerable households tend to bear a greater burden of losses, are often uninsured, and have limited capacity to mitigate these losses (Noy et al.,2018; Arouri et al., 2015; Del Ninno et al., 2001). Furthermore, marginalized and low-income households are more likely to be engaged in informal employment, which lacks security and benefits, and they often experience longer and more challenging recoveries (Patankar, 2019). They face obstacles in accessing financial resources and external support networks during recovery.

In terms of assets, the poor might be under-represented in calculations of asset losses as they often own fewer assets (Allaire, 2018; Walsh et al., 2029; Markhvida et al., 2020). This disparity is further accentuated when examining the distribution of losses. For example, those in the lowest income quintile account for only 20 percent of total asset losses but bear a disproportionately higher percentage (47) of well-being losses (Hallegatte et al., 2017). When examining the impacts of disasters on assets owned, the research shows disproportionate impacts based on one's socioeconomic characteristics. Hurricane Mitch led to an 18 percent reduction in

assets[1] for the lowest wealth quintile, while the upper wealth quintile experienced a less significant 3 percent reduction (Morris et al., 2002). Moreover, it's important to note that asset losses endured for a more extended period and were more severe among households with lower incomes in the aftermath of Hurricane Mitch (Carter et al., 2007). In Honduras, relatively wealthy households partially rebuilt their lost assets, unlike the lowest wealth quintiles (Carter et al., 2007). In terms of disparate disaster impacts on income, after the 2011 Great Flood in Thailand, higher-wealth households experienced a decline in business income, while lower-wealth households suffered a significant drop in agricultural income (Noy et al., 2018). Hurricanes Katrina and Rita also had varying impacts on income, resulting in short-term earning losses for individuals employed in the health, leisure, and accommodations sectors but an increase in the earnings for workers in the construction and agriculture sectors (Groen et al., 2020). As a result of losses in assets and income, impoverished individuals find it challenging to maintain their pre-disaster consumption levels. In terms of disparate disaster impacts consumption changes, it is important to note that household wealth can play a moderating role during and after disasters. For example, following the 2018 flooding in Chennai, there was an overall increase in consumption expenditures among affected households (Patnaik et al., 2018). However, the increase was lower for vulnerable low-income households compared to a significant rise in consumption among those who were not financially constrained. The increased spending was primarily driven by increased health, power, and fuel expenditures.

[1] They base their analysis on assets rather than income because the pre-Mitch income of each household was not known. Listing of their assets (over 60 different household items (consumer durables), tools (agricultural implements), and animals) was collected. Items that account for a significant proportion of the total asset value for poor include beds and poultry.

Research shows that without access to internal savings or investments, the lowest income quintile of society is more likely to cut back on essential consumption categories such as food, health, or education than wealthier segments (Allaire, 2019; Walsh et al., 2020). This reduced expenditure on human capital, health, and overall well-being can have adverse long-term consequences. A study conducted by Antilla-Hughers et al. (2013) found that although both poor and non-poor Filipino households experienced similar levels of damage from typhoons, the poor households' consumption took longer to recover. A meta-regression analysis of the impacts of disasters on households also reveals that poor households tend to reduce consumption of non-food items, particularly in health and education, hinting at potential long-term negative consequences (Karim et al., 2016). Additionally, asset-poor households in Sub-Saharan Africa have been found to respond to weather shocks by reducing expenditure on nutrition and children's health costs (Jensen, 2000, as cited in Hallegatte et al., 2017). In Honduras, it was found that wealthy households were able to rebuild their lost assets partially (Carter et al., 2007).

In addition, the literature on the differential impacts of disasters reveals a gap in addressing social stratification beyond economic indicators, particularly in the Indian context. While studies predominantly focus on disparities between poor and non-poor households or use wealth and income as primary indicators of stratification, they often overlook crucial social factors. In the United States, research frequently incorporates race as a key variable in analyzing disaster impacts recognizing its influence on vulnerability and recovery. However, when examining disaster impacts in India, there is a notable absence of caste-based analysis.

Caste-based divisions have long been a defining feature of the Indian social fabric, with various groups experiencing historical disadvantages and marginalization (Deshpande, 2011). Recognizing this historical discrimination, the Indian government has delineated three main caste

categories: Scheduled Castes (SC), Scheduled Tribes (ST), and Other Backward Classes (OBC). These groups remain underrepresented in governing structures, leading to their interests being inadequately addressed (Arlikatti et al., 2010). The caste-based vulnerability involves additional social, cultural, and systemic barriers that persist even as households advance economically. These barriers include social discrimination, occupational segregation, limited social networks, and political marginalization (Irshad, 2014; Arora, 2022; Deshpande, 2011; Arlikatti et al., 2010). This study addresses this gap by focusing on the impacts of disasters based on social and economic stratification.

2.4 Data

In order to examine the welfare impacts of flooding, I use the India Human Development Survey (IHDS). It is a nationally representative, multi-topic survey that collects information at the household and village levels. It is the only comprehensive, publicly available panel dataset from India and the only database of nationwide flood events. The survey was first introduced in 1993-94 by the National Council of Applied Economic Research (NCAER) and has been conducted two times after that. The first round of surveys by IHDS was conducted in 2004-05 and consisted of 41,554 households across 1,503 villages (27,010 households) and 971 urban neighborhoods (13,126 households) (Desai et al., 2015). The second round (2011-2012) covered 42,152 households and re-interviewed around 83% of households from the first round[2] (Desai et al.,

[2] The attrition rate for rural households was 82 percent (22,113 of the 27,011 round 1 rural households were surveyed again in round 2).

2015). The second round of IHDS follows the same methodology as round one, making it a valuable dataset for analyzing causal patterns.

Variables of interest are available at two levels: households and villages. IHDS data provides information on each household's total income and total household expenditures and other demographic information like household composition, education level, tenure, ownership of assets, household members' associational memberships, etc. The village schedule covers information about the key variable of interest—the incidence of flooding.

To analyze changes in household characteristics before and after flood events, I restricted my sample to households surveyed in both waves (2004-05 and 2011-12). I also restricted the sample to rural[3] households, as disaster information was not collected for urban households. I removed the observations with negative income and expenditure values, and households exposed to flooding in 2012 due to incomplete data for all states in that year. After merging, cleaning, and processing the data, the sample included 23,748 households in each wave.

2.4.1 Dependent variables - Income, Expenditure, and Household Wealth Index

This study examines how flooding affects the economic welfare of households in India. It focuses on three key indicators to measure welfare impacts: total annual household income, total annual consumption expenditure, and household assets and amenities (standard of living). Many empirical studies use household consumption expenditure as a proxy for the economic welfare of

[3] According to the Census of India, an area is considered rural if it has a population density of less than 5,000 people and a population density of less than 400 people per square kilometer.

households in developing countries because it is less volatile and less susceptible to measurement errors compared to income and because it better captures the true standard of living (Meyer et al., 2003). The household assets measure is the least volatile and measures the household's economic status in the long term (Desai et al., 2015). Most surveys of developing countries focus on expenditure or assets to measure a household's economic level (Desai et al., 2015). IHDS is one of the first Indian surveys to collect detailed information on household income. Together, the following three variables measure a household's economic well-being in 2005 and 2012 to enable comparisons across these two time periods:

1. Total Annual Household Income: The IHDS collects data on households' total annual incomes in Indian Rupees (INR). Over 50 different income sources were queried, including income from agriculture, business, salaried employment, government benefits, remittances, and others.
2. Total Annual Consumption Expenditure of the Household: The IHDS also gathers information on households' total annual consumption expenditures in Indian Rupees (INR). The total household consumption expenditure is calculated based on a series of 47 questions covering food, housing, durables, medical, school, and entertainment.

The 2005 income and expenditure values adjusted for inflation in the IHDS panel dataset.

3. Household Wealth Index: The IHDS collects information on durable goods owned by the household, access to services, and housing characteristics[4]. Following the IHDS

[4] IHDS includes the following household asset and amenity information:

methodology, I construct a household wealth index by summing up a household's assets and amenities, resulting in a score that ranges from 0 to 30 (Desai et al., 2015). A higher score indicates a better standard of living. The household assets scale has a Cronbach's alpha of 0.914.

I log-transform income and consumption variables to address the skewness in income and consumption expenditure.

2.4.2 Independent variable: Flooding

The flood exposure variable in the study takes a value of 1 if a household is located in a village impacted by flooding and 0 if a household is in an unaffected area. The second wave of IHDS added a village episodes module to collect information on disasters, including floods. Information on village episodes was collected as a part of the focus group discussions (Table 1). The respondents for the village episode questions are the knowledgeable "Key Persons" in the village: these include the village head, members of Gram Panchayat, local school teachers, and other people who are likely to know about the village. The question asked whether the village experienced flooding in a given year[5]. Since the flood information was collected from multiple informed citizens, it potentially addresses the recall bias issue (Khalid et al., 2024). By gathering

- Goods - Vehicle, Sewing machine, Mixer/grinder, Motor vehicle, any TV, Colour TV, Air cooler/cond, Clock/watch, Electric fan, Chair/table, Cot, Telephone, Cell phone, Refrigerator, Pressure cooker, Car, Air conditioner, Washing machine, Computer, Credit card, 2 clothes, Footwear.
- Services - Piped indoor water, Flush toilet, Electricity, LPG.
- Housing - Separate kitchen, Pucca wall, roof, and floor.

[5] "Now I would like to ask about some of the difficulties/calamities that might have occurred in the past 6 years in this village. Have you experienced any of the following: Flooding in 2010? A similar question was asked for each year from 2006 through 2012.

data from a range of key respondents, the survey ensures that the information is not dependent on a single source, reducing the risk of individual biases or errors. Moreover, the key respondents chosen for the village module are people deeply embedded in the village community and well-informed about the area. Many of the respondents, such as the head of the Gram Panchayat, hold official positions that require them to maintain records and stay informed about significant events in the village. Thus, this self-reported data is a more reliable way to identify the flooded "treatment group" compared to using satellite images or other coarser metrics, which may not be able to identify villages or households affected precisely (Noy et al., 2019). By using the self-reported data on flooding, my study contributes to the existing work on disaster impacts on flooding in India (Sajid, 2023; Parida et al., 2019; Aggarwal et al., 2021; Khanna, 2020; Patnaik et al., 2019; Beyer et al., 2022; Hossain et al., 2022; Aggarwal, 2021; Sedova et al., 2020; Tamuly et al., 2022).

2.4.2.1 Limitation and verification using external information

One of the limitations of the IHDS data is its binary flood incidence format, which fails to differentiate between small- and large-scale events. To verify flood exposure reported at a village level in IHDS data, I incorporate precipitation data from the Indian Meteorological Department (IMD). However, few studies establish a link between precipitation and flood damage[6] (Pielke et al., 2000; Bertnet et al., 2019). I use monsoonal precipitation data for the months of June, July, August, and September for 2006 - 2011 (Jayachandran, 2006; Hossain et al., 2022). I follow the

[6] While precipitation is a key factor in flooding, it is not the only determinant. Other factors like topography, geology, land use and land cover, river morphology and management have an impact on flooding.

approach of Jayachandran (2006) and Hossain et al. (2022) and construct a binary variable for rainfall shock. This variable takes the value of 1 if the district's rainfall in year t exceeds the 80th percentile of its rainfall distribution over the period of 1901 and 2010. Districts that do not meet this criterion are assigned the value of 0, indicating no rainfall shock.

For the flood verification analysis, I create a precipitation treatment variable for each village, assigning a value of 1 if two conditions are met: (1) the village was marked as flooded in the IHDS data, and (2) it is located in a district that received rainfall above the 80th percentile in the given year. For instance, if a village was marked as flooded in 2006 and situated in a district with rainfall above the 80th percentile in 2006, it was considered treated. Villages marked as flooded in IHDS but not located in districts with rainfall above the 80th percentile in the respective years were considered a control. This verified data is only applied to the entire country analysis. I did not run a heterogeneity analysis using this information because of the reduction in treatment size.

2.4.3 Control variables

Other explanatory variables based on the IHDS are household socioeconomic characteristics like household composition (size, number of working adults), education (number of years of education of the most literate adult), caste of the household, income quintile, below poverty line status, and number of rooms in the house.

2.5 Methods

The empirical analysis examines the change in income, consumption, and assets for households affected by flooding. In the past few years, microeconomic studies have started using panel or repeated cross-sectional data to assess the economic impacts of disasters (Henry et al., 2020;

Parida et al., 2021). Multiple observations for the same individuals in panel data allow the researcher to control for unobserved but fixed omitted variables.

2.5.1 Treatment and Control

This study's treatment group comprises households in villages that experienced flooding between 2005 and 2011. To measure the impact of flooding on households' economic welfare, I created binary variables for flood exposure for each year from 2006 to 2011 using the information collected by IHDS. For each year, the flood exposure variable takes the value of 1 if the household is located in the village that experienced flooding and 0 otherwise (Table 1). Flooding data is available for 2012; however, the data collection for the second wave of IHDS (2011 - 12) primarily occurred in 2012, resulting in incomplete flood data for some states. Thus, I dropped the households exposed to flooding in 2012 from the analysis (n = 497). To mitigate potential biases, the control group is restricted to households not exposed to flooding events between 2005 and 2012.

2.5.2 Propensity Score Weighting

Additionally, to account for potential differences between treatment and control households, I employ propensity score weighting (PSW) using the inverse probability of treatment weighting (IPTW) method (Deryugina et al., 2018). The treatment variable in the study reflects whether the household was exposed to a flooding event between 2006 and 2011.

I estimate the propensity scores using a logistic regression model, with flood exposure as the dependent variable and a set of pre-treatment household covariates as independent variables. The covariates included in the propensity score model are household characteristics before 2006, such as social group (caste and religion), income quintile, source of income, below-poverty line

status, household size, household head's secondary school completion, house type, and the number of rooms in the house. By including these covariates, the propensity score model accounts for the differences in flood exposure across various socioeconomic factors, as observed in Table 2.

The propensity scores represent the probability of a household being exposed to a flood, conditional on the observed covariates. I then use inverse propensity weighing in the analysis. The IPTW weights are calculated based on the estimated propensity scores. Households in the treatment group (flood-exposed) are assigned a weight equal to the inverse of the propensity score, and households in the control group are assigned a weight equal to the inverse of one minus the propensity score.

To ensure the common support assumption is met, I restrict the sample to those with propensity scores in the range [0.1, 0.9] (Crump et al., 2009; Deryugina et al., 2018). This restriction, known as the "common support" condition, ensures that comparisons are made only between households with comparable propensity scores, improving the validity of the causal inference. Compared to propensity score matching (PSM), an advantage of PSW is that it utilizes the full sample instead of restricting the number of controls to match the number of treated units, thus increasing the power (Deryugina et al., 2018).

I compare the standardized mean difference (SMD) to assess the balance of covariates between treatment and control groups (Zhang et al., 2019). These weights are then incorporated into a weighted DiD regression framework to estimate the causal effect of flood exposure on household outcomes.

Thus, by restricting the control group to households that did not experience any disasters between 2005 and 2012 and applying propensity score weighting to balance the observed covariates between the treatment and control groups, I can better isolate the causal effect of flooding on household economic outcomes.

2.5.3 Estimation Strategy - Difference-in-difference

Several studies in economics and policy use a difference-in-difference (DiD) approach to analyze the effects of exogenous shocks like flooding on household expenditure, income, and property prices (Noy et al., 2019; Antilla-Hughes et al.,2013; Poaponsakorn et al., 2015). DiD uses panel data to estimate the average causal effect of a treatment on the treated by comparing the outcomes between the group that received the treatment (households affected by flooding) and the group that did not (households that were not impacted by flooding). The outcome of the control group is used as a counterfactual scenario, which is what would have happened in the treatment group in the absence of the treatment, i.e., flooding in this case (Cunningham., 2021).

With cross-sectional data, there is a risk of not being able to control for the correlations between the weather indicators and other unobserved explanatory variables that influence the outcome (Le, 2020). Thus, there is a concern about omitted variable bias when examining the causal impacts of exogenous shocks with cross-sectional data. For example, households' ability to locate in areas less prone to disasters could be related to (unobserved) factors influencing the dependent variable. This could lead to biased estimates unless a rich set of controls is available (Henry et al., 2020; Arouri et al., 2015). A DiD design is a quasi-experimental strategy that removes the biases from comparisons over time and biases resulting from the differences between the two groups (Angrist, 2009).

R.Q.1. How do affected households' income, consumption, and wealth (assets index) change after flooding?

To answer question 1, I start with a standard DiD model and control for observable time-varying household characteristics that may impact the dependent variable in the absence of flooding.

$$Y_{ijt} = \beta_0 + \beta_1 Treat_{ij} + \beta_2 Post_{ijt} + \beta_3 Post_{ijt} * Treat_{ij} + \beta_4 X_{ijt} + e \quad (1)$$

where,

Post = 1 if the observation is from (2012) and 0 otherwise.
Treat = 1 if the household is located in a village impacted by flooding between 2005 and 2011, and 0 otherwise.
Y_{ijt} - Outcome variable of interest (log of total household income, log of total household consumption expenditure, or asset index) for household *i* in village *j* at time *t*.
X_{ijt} - Represents a vector of household time-varying characteristics that are likely to impact the economic welfare indicators of the household (highest education level of the household, number of rooms in the house, number of members in the household).
β_2 - Captures the time-specific effect, representing the change in the outcome variables for all households between the pre-treatment (2005) and post-treatment (2012) periods.
β_3 - Estimates the impact of flooding on the treated households, comparing the change in the outcome variable between flooded and non-flooded households.
e - The error term clustered at the village level.

Because of the dataset's panel nature, I modified the standard DiD model to control for household-specific effects (instead of only the treatment/control group effect) by adding household fixed effects (FEs). The household FEs control for the unobserved time-invariant factors that could be correlated with the household's economic welfare (Hossain et al., 2021). However, it is important to note that the indicator of flooding varies at the village level, not the household level. Including household fixed effects implies that the treatment effect is identified from the within-village variation in flood exposure across time, comparing the changes in outcomes between the treatment and control villages.

$$Y_{ijt} = a_{ij} + \beta_0 + \beta_1 Post_{ijt} + \beta_2 Post_{ijt} * Treat_{ij} + \beta_3 X_{ijt} + e \quad (2)$$

where,

a_{ij} - Represents the household fixed effects, which control for unobserved time-invariant factors that could be correlated with both the treatment status of the household and their economic welfare.

For further robustness check, I ran models with village FEs and time-varying characteristics at the village level[7].

$$Y_{ijt} = \gamma_{ij} + \beta_0 + \beta_1 \, Post_{ijt} + \beta_2 Post_{ijt} * Treat_{ij} + \beta_3 Z_{jt} + e \qquad (3)$$

where,

Z_{jt} - Represents a vector of time-varying village characteristics that are likely to impact the economic welfare indicators of the households in the village (access to a pucca road, electricity in the village, distance to the nearest town)

γ_{ij} - Represents the village fixed effects, which control for unobserved time-invariant factors that could be correlated with both the flood exposure and the economic welfare of households in the village

Adding village fixed effects allows me to account for factors at the village level between the two survey waves that might be associated with the households' economic welfare. Including village fixed effects and time-varying village characteristics strengthens the robustness of the estimates by accounting for potential confounding factors at the village level that could bias the results if left uncontrolled.

I estimate my models using OLS regression[8]. I start my analysis with a unified model that includes all years of flood exposure to assess the overall impact of flooding. This approach

[7] I do not report these models in the chapter. The findings are consistent with household FEs models.

[8] The use of OLS is justified for the wealth index variable in my data given the high mean value (>10) of the count data approximating a continuous distribution (Sturman, 1999).

allows for a comprehensive understanding of the relationship between flood events and household outcomes.

Next, I run separate models for each year of flood exposure. This approach enables a more granular analysis of the impact of flooding on households over time. By examining the effects of flood events on a year-by-year basis, I investigate whether the severity of the impact varies depending on the time elapsed since the flooding occurred. This analysis provides insights into the short-term and long-term consequences of flood events on household outcomes. However, running separate models for each year reduces my sample of treatment observations, potentially leading to less precise estimates and insignificant results.

Thus, to address the limitations of the above two approaches, I combine the flood exposure data into two three-year periods: 2006-2008 and 2009-2011. This approach allows for comparing the effects of more recent flood events (1-3 years before the survey) to earlier flood events (4-6 years before the survey). By analyzing the differences in the impact of flooding across these two time periods, I investigate whether the effects of flooding on households diminish over time and if there are variations in impacts based on the recency of the flood event.

> R.Q.2: How heterogeneous are the impacts of flooding based on household economic class and social group (caste)?

I run the analysis for 2006 - 2011 and 2006 - 2008. To examine the heterogenities in disaster impacts, I focus on 3-year flood data between 2009 and 2011 (most recent flooding events). The unevenness of a disaster's impact is captured using household demographic information at the baseline (i.e., in wave 1 of the survey). To measure the heterogeneity of impacts across households, I categorize them into groups based on their income quintile, poverty status, and

caste. Specification (4) incorporates the heterogeneous treatment effect term $Hetero_{ij2005}$. The rest of the variables are defined similarly as (1).

$$Y_{ijt} = a_{ij} + \beta_0 + \beta_1 Post_{ijt} + \beta_2 Post_{ijt} * Treat_{ij} + \beta_3 Hetero_{ij2005} * Post_{ijt} + \beta_4 Hetero_{ij2005} * Post_{ijt} * Treat_{ij} + \beta_5 X_{ijt} + \beta_5 Z_{jt} + e \quad (4)$$

where,

β_4 - Captures the heterogenous impact of flooding on households with different socioeconomic characteristics, comparing the change in the outcome variable between flooded and non-flooded households while considering their baseline socioeconomic status.

2.5.4 Clustering of Standard Errors

I cluster the standard errors at the village level to address sampling design and treatment assignment. According to Abadie et al. (2023), standard errors should be clustered for two reasons: a sampling design reason, which arises when the data is sampled from a population using clustered sampling, and an experimental design reason, where the treatment of interest is clustered.

IHDS employed a multi-stage sampling design, where villages were first randomly selected, and then households were randomly sampled within each selected village. This sampling design introduces a potential correlation between households within the same village, as they are likely to share common unobserved characteristics, be exposed to similar environmental factors, and exhibit correlated outcomes.

Additionally, the treatment in this study—exposure to flooding—is assigned at the village level. This clustered assignment mechanism for the treatment variable (occurrence of flooding) makes clustering of standard errors important to ensure valid causal inference.

2.6 Results

Regarding flooding experience, around 29 percent of the households (n = 6,896) surveyed are located in villages that experienced flooding at least once between 2006 and 2011 (Table 2-1). 16,852 (71 percent) households are located in villages that never experienced flooding between 2006 and 2011.

Table 2-1: Summary Statistics of flooded villages and households

	Households		Villages	
	Freq.	Percent	Freq.	Percent
Never flooded	16,852	70.96	921	72.98
2006	1,554	6.54	80	6.34
2007	1,005	4.23	47	3.72
2008	1,052	4.43	53	4.2
2009	1,096	4.62	55	4.36
2010	1,047	4.41	58	4.6
2011	1,142	4.81	48	3.8
Total	**23,748**	**100**	**1,262**	**100**

Table 2-2 presents the summary statistics of dependent variables and socioeconomic characteristics of the flooded (6,894) and non-flooded households (16,843) at the baseline (2005) before and after weighting. Prior to weighting, there are significant differences in the socioeconomic characteristics between households in flooded and non-flooded regions.

Without weighting, the percentage of households living below the poverty line is significantly higher in flooded areas at 27 percent, compared to 22 percent in non-flooded areas. Furthermore, the proportion of households belonging to each caste differs significantly between flooded and non-flooded areas before weighting. In villages exposed to flooding, approximately 77 percent of households rely on agriculture as their primary source of income, compared to 74 percent in non-

flooded villages. Additionally, around 52 percent of households in flooded regions reside in permanent structures, while 58 percent in non-flooded regions have a permanent structure. In terms of education, about 28 percent of households in flooded areas have an adult with secondary school as their highest level of education, in contrast to 32 percent in non-flooded areas.

To address the difference in socioeconomic characteristics of households, I weight the sample using IPTW. After weighting, there are no statistical differences between my control and treatment households for the baseline socioeconomic characteristics (2005). The similarities indicate that my definition of the control group and propensity score weighting had the expected result of identifying a comparable counterfactual for flooded-affected households.

Table 2-2: Treatment and Control Groups: Summary Statistics (before and after weighting)

	Before weighting				**After weighting**			
Variable	Flooded N = 6,894	Not-flooded N= 16,843	Abs Diff	Std Diff	Flooded N = 6,894	Not-flooded N= 16,843	Abs Diff	Std Diff
Below Poverty Line 2005	0.22	0.27	0.05	**0.11**	0.24	0.24	0.01	0.02
Income Group 2005	2.88	2.75	-0.14	**-0.10**	2.88	2.87	-0.01	0.00
Source of income - agriculture 2005	0.74	0.77	0.03	**0.07**	0.75	0.76	0.01	0.01
SCST	0.36	0.34	-0.02	-0.03	0.35	0.35	0.00	0.00
open category	0.22	0.19	-0.03	**-0.08**	0.21	0.21	0.00	0.00
other backward category	0.34	0.36	0.01	0.03	0.34	0.35	0.00	0.00
religion = Hindu	0.84	0.83	-0.01	-0.03	0.83	0.84	0.01	0.01
# persons 2005	5.87	6.20	0.33	**0.11**	6.00	6.01	0.01	0.00
# adults 2005	3.12	3.13	0.01	0.01	3.14	3.14	0.00	0.00
Permanent House 2005	0.58	0.52	-0.06	**-0.12**	0.56	0.56	0.00	0.01
# rooms 2005	2.69	2.57	-0.11	**-0.07**	2.67	2.64	-0.03	-0.02
Education SSC 2005	0.32	0.28	-0.04	**-0.09**	0.31	0.31	-0.01	-0.02

Note: The difference is significant between groups with Standardized mean difference SMD greater than ± 0.1

- BPL - Below Poverty Line
- SCST - Schedule Caste/ Schedule Tribe
- OBC - Other Backward Caste
- SSC - Senior Secondary Certificate (10th Grade)

Table 2-3 provides descriptive statistics for the sample. In 2005, households' mean income and expenditure were Rs. 82,991 and Rs. 89,650, respectively. In 2012, the mean income and expenditure were Rs.101,490 and Rs.99,525, respectively. Eighty percent of the households in the sample are Hindu, with 40 percent belonging to the Scheduled Castes and Scheduled Tribes (SCST) and 20 percent belonging to Other Backward Classes (OBC) categories. In 2005, agriculture was the main source of income for 80 percent of the households, which reduced to 70 percent in 2012. Approximately 30 percent of the households had an adult with secondary school education in 2005, and this percentage increased to around 40 percent in 2012.

Table 2-3: Summary Statistics of dependent and independent variables

Variable	Mean	Median	SD	Min	Max	N
Dependent variables						
Income 2005 (INR)	82,991	48274	132430	0	4,145,807	23066
Income 2012 (INR)	101,490	59760	183060	0	11,200,000	23066
Expenditure 2005 (INR)	89,652	64489	90624	687	1,843,521	23050
Expenditure 2012 (INR)	99,525	73986	105913	432	4,080,760	23055
Wealth Index 2005 (0-30)	10	9	5.40	0	29	23066
Wealth Index 2012 (0-30)	13	12	5.91	0	30	23066
Independent variables - Time invariant						
SCST	0.4	0.0	0.48	0	1	23736
Open Category	0.2	0.0	0.41	0	1	23736
OBC	0.3	0.0	0.48	0	1	23736
Religion = Hindu	0.8	1	0.37	0	1	23741
Independent variables - Time variant						
BPL 2005 (0 or 1)	0.23	0.00	0.42	0	1	23725
BPL 2012 (0 or 1)	0.20	0.00	0.40	0	1	23730

Main source of income - ag 2005 (0 or 1)	0.8	1.0	0.43	0	1	23742
Main source of income - ag 2012 (0 or 1)	0.7	1.0	0.44	0	1	23733
household # persons 2005	6	5	3.08	1	31	23742
household # persons 2012	5	5	2.34	1	33	23742
household # adults 2005	3	3	1.67	0	14	23742
household # adults 2012	3	2	1.39	0	18	23742
household # rooms 2005	3	2	1.68	0	18	23220
household # rooms 2012	3	2	1.65	0	26	23650
Education SSC 2005 (0 or 1)	0.3	0.0	0.46	0	1	23748
Education SSC 2012 (0 or 1)	0.4	0.0	0.48	0	1	23748
Income Group (0-5)	3	3	1.41	0	5	23741
Permanent House (0 or 1)	0.6	1.0	0.50	0	1	23475

- BPL - Below Poverty Line
- SCST - Schedule Caste/ Schedule Tribe
- OBC - Other Backward Caste
- SSC - Senior Secondary Certificate (10th Grade)

2.6.1 Welfare impacts of flooding

Table 2-4 presents the impacts of flooding on household economic welfare, controlling for household fixed effects and time-varying characteristics that may be related to the outcome variables. The results reveal that, on average, household consumption expenditure in rural India increased by 26.36%[9] from 2005 to 2012, holding other variables constant. However, households in villages affected by flooding had a 5%[10] lower consumption expenditure in 2012 than their counterparts in non-flooded areas.

[9] The dependent variables - income and expenditure - are log transformed. I report the percent change in the discussion of results.

[10] The dependent variables - income and expenditure - are log transformed. I report the percent change in the discussion of results.

A similar pattern is observed for household income. On average, household income was 28.52% higher in 2012 compared to the baseline year 2005. However, households in flood-affected villages had a 12.5% lower income compared to those in non-flooded villages, holding other factors constant.

The wealth index, which measures household wealth, also showed an upward trend. The average wealth index value increased by 3.214 units between 2005 and 2012. However, households exposed to flooding in 2012 had a wealth index that was 0.431 units lower compared to households in non-flooded areas. These findings suggest that while household economic welfare improved overall from 2005 to 2012 in rural India, households in flood-affected villages experienced slower changes in consumption expenditure, income, and asset accumulation compared to those in non-flooded villages.

Table 2-4: Effect of flooding on the economic welfare of households

	expenditure 1	**income 2**	**wealth index 3**
2012	0.234***	0.251***	3.214***
	0.012	0.016	0.059
flood*2012	**-0.051***	**-0.134*****	**-0.431*****
	0.021	0.028	0.12
constant	10.430***	10.098***	7.004***
	0.015	0.027	0.1
HH FEs	Yes	Yes	Yes
HH controls	Yes	Yes	Yes
N	44512	44472	44519
R-squared	0.23	0.13	0.42

Note: *** p<0.01, ** p<0.05, * p<0.1. Coefficients and standard errors are reported. Income and expenditure are log-transformed. SEs clustered at the village level.

To assess the differences in the magnitude of impacts based on the time since the flooding event, I ran the models separately for 2006, 2007, 2008, 2009, 2010, and 2011[11] (Table 2-5, Table 2-6, Table 2-7). The negative coefficients for income for the treatment indicate that households exposed to the treatment generally experienced lower income levels than the control group, but the statistical significance varies across years (significant for 2006, 2008, 2010). The magnitude of the negative impact on income for the flooded households appears stronger in the later years (events closer to the second wave). For consumption expenditure, the impact is negative for the flooded households but only significant for 2006. The impact of flooding on the wealth index of households is negative across the years (2006, 2008, 2009).

Table 2-5: Impact of Flooding Events on Total Household Expenditure (Year-by-Year Analysis)

Year of flooding	expenditure 2006	expenditure 2007	expenditure 2008	expenditure 2009	expenditure 2010	expenditure 2011
2012	**0.234*** **	**0.229*** **	**0.232*** **	**0.234*** **	**0.233*** **	**0.232*** **
	0.012	0.012	0.012	0.011	0.011	0.012
flood*2012	**-0.100***	-0.03	-0.073	-0.022	-0.041	-0.02
	0.042	0.053	0.043	0.04	0.04	0.048
constant	10.457***	10.457***	10.451***	10.453***	10.446***	10.455***
	0.018	0.017	0.018	0.017	0.016	0.018
HH FEs	Yes	Yes	Yes	Yes	Yes	Yes
HH Controls	Yes	Yes	Yes	Yes	Yes	Yes
N	34201	33122	33190	33364	33227	33408
R-squared	0.22	0.22	0.22	0.23	0.23	0.23

Note: *** p<0.01, ** p<0.05, * p<0.1. Coefficients and standard errors are reported. Income and expenditure are log-transformed. SEs clustered at the village level.

[11] I do not report these in the paper, since it is not the focus.

Table 2-6: Impact of Flooding Events on Total Household Income (Year-by-Year Analysis)

Year of flooding	income 2006	income 2007	income 2008	income 2009	income 2010	income 2011
2012	**0.260*** **	**0.256*** **	**0.260*** **	**0.260*** **	**0.256*** **	**0.259*** **
	0.016	0.016	0.016	0.016	0.016	0.016
flood*2012	**-0.135** **	-0.035	**-0.206** **	-0.117	**-0.217*** **	-0.094
	0.044	0.05	0.063	0.064	0.063	0.067
constant	10.064***	10.072***	10.038***	10.051***	10.076***	10.059***
	0.031	0.032	0.026	0.026	0.026	0.026
HH FEs	Yes	Yes	Yes	Yes	Yes	Yes
HH Controls	Yes	Yes	Yes	Yes	Yes	Yes
N	34172	33095	33161	33337	33202	33380
R-squared	0.14	0.15	0.15	0.15	0.14	0.15

Note: *** p<0.01, ** p<0.05, * p<0.1. Coefficients and standard errors are reported. Income and expenditure are log-transformed. SEs clustered at the village level.

Table 2-7: Impact of Flooding Events on Household Wealth Index (Year-by-Year Analysis)

Year of flooding	wealth index 2006	wealth index 2007	wealth index 2008	wealth index 2009	wealth index 2010	wealth index 2011
2012	**3.241*** **	**3.219*** **	**3.235*** **	**3.225*** **	**3.235*** **	**3.231*** **
	0.058	0.059	0.059	0.059	0.058	0.059
flood*2012	**-0.326** *	-0.152	**-1.111*** **	**-0.689** *	-0.053	-0.322
	0.163	0.274	0.279	0.279	0.297	0.292
constant	7.202***	7.131***	7.130***	7.072***	7.145***	7.251***
	0.103	0.114	0.107	0.11	0.105	0.101
HH FEs	Yes	Yes	Yes	Yes	Yes	Yes
HH Controls	Yes	Yes	Yes	Yes	Yes	Yes
N	34207	33128	33196	33370	33234	33414
R-squared	0.45	0.45	0.44	0.44	0.45	0.45

Note: *** p<0.01, ** p<0.05, * p<0.1. Coefficients and standard errors are reported. Income and expenditure are log-transformed. SEs clustered at the village level.

Table 2-8 present the results for two periods: the short-term (households affected by flooding between 2009 and 2011, i.e., 1 to 3 years before the survey) and the medium-term (households affected by flooding in 2006 and 2008, i.e., 4 to 6 years before the survey). For the short-term analysis, I only focused on households impacted between 2009 and 2011, and I dropped the households affected by flooding between 2006 and 2008 from the analysis and vice versa. 1,679 households were affected by flooding between 2006 and 2008, and 3,330 households were affected by flooding between 2009 and 2011. The reason for this separation by time periods is to examine how the effects of flooding change over time. By analyzing both short-term and medium-term data, I aim to examine if there's a noticeable difference in the severity or persistence of flooding impacts over these two time periods.

The results show that in 2012, households generally experienced higher income (around 29%), consumption expenditure (around 26%), and wealth index (3 units) compared to the pre-treatment year (2005). For households affected by flooding between 2006-2008, households had an average of 8.9% lower income than non-flooded households (Table 2-8: Models 1-3). In terms of consumption expenditure, they experienced a 7.6% lower consumption expenditure than non-flooded households. The wealth index of the flood-affected households was lower by 0.5 units on average compared to that of non-flooded households. The impact of flood events in 2009-2011 appears to be more severe for household income compared to floods between 2006 and 2008 (13% lower vs. 8.9% lower). However, for consumption expenditure, the impact of floods in 2009-2011 is not statistically significant, unlike the negative impact observed for floods in 2006-2008. Additionally, the negative impact on the wealth index of households is slightly smaller (0.35 units lower) for floods in 2009-2011 compared to floods in 2006-2008 (Table 2-8: Models 4-6).

Table 2-8: Effect of flooding on total household income (Flooded between 2006 and 2008 and flooded between 2009 and 2011)

	Flooded 2006-2008			Flooded 2009-2011		
	expenditure 1	income 2	wealth index 3	expenditure 4	income 5	wealth index 6
2012	0.232***	0.255***	3.227***	0.235***	0.254***	3.219***
	0.012	0.016	0.06	0.011	0.016	0.059
flood*2012	**-0.079***	**-0.093***	**-0.488***	-0.027	**-0.142*****	**-0.354***
	0.034	0.044	0.195	0.027	0.04	0.175
constant	10.449***	10.039***	7.159***	10.436***	10.086***	7.074***
	0.018	0.027	-0.105	0.016	0.024	0.105
HH FEs	Yes	Yes	Yes	Yes	Yes	Yes
HH controls	Yes	Yes	Yes	Yes	Yes	Yes
N	34391	34363	34397	37599	37569	37606
R-squared	0.22	0.15	0.45	0.23	0.14	0.44

Note: *** p<0.01, ** p<0.05, * p<0.1. Coefficients and standard errors are reported. Income and expenditure are log-transformed. SEs clustered at the village level.

2.6.2 Heterogeneity in impacts

The ability to cope with flooding depends on one's economic and social status. Equation (4) is used to understand the heterogeneity in impacts. I categorize households into groups based on socioeconomic characteristics—Below-Poverty Line (BPL) status, income group at the baseline (2005), and caste of the households. Results show that households in rural India experienced an increase in the wealth index by 3.085 units. The increase was smaller for those below the poverty line in flooded areas (lower by 0.605) (Table 2-9). Affluent households in flood-affected villages reported a 12.4% higher consumption expenditure and 31.3% higher income in 2012 compared to the poorest wealth quintile (Table 2-10).

Table 2-9: Heterogenous treatment effect: Below the Poverty Line (Flooded between 2009 and 2011)

	expenditure 1	income 2	wealth index 3
2012	0.062***	0.219***	3.085***
	0.01	0.015	0.061
flood*2012	-0.009	-0.123**	-0.197
	0.029	0.04	0.176
2012*BPL	0.502***	0.02	0.265*
	0.016	0.031	0.109
flood*2012*BPL	-0.071	-0.06	**-0.605***
	0.039	0.071	0.267
constant	10.522***	10.145***	7.208***
	0.014	0.021	0.093
HH FEs	Yes	Yes	Yes
HH controls	Yes	Yes	Yes
N	37599	37569	37606
R-squared	0.28	0.14	0.44

Note: *** p<0.01, ** p<0.05, * p<0.1. Coefficients and standard errors are reported. Income and expenditure are log-transformed. SEs clustered at the village level.

Table 2-10: Heterogenous treatment effect: Income Groups (Flooded between 2009 and 2011)

	expenditure 1	income 2	wealth index 3
2012	0.260***	0.934***	3.080***
	0.017	0.024	0.09
flood*2012	-0.032	-0.243***	-0.367
	0.04	0.071	0.288
2012*2nd quintile	0.013	-0.583***	0.281**
	0.018	0.025	0.104
2012*middle quintile	-0.077***	-0.844***	0.221*
	0.02	0.028	0.108
2012*4th quintile	-0.150***	-1.062***	0.057

	0.021	0.031	0.119
2012*affluent quintile	-0.250***	-1.332***	-0.329*
	0.024	0.036	0.14
flood*2012*2nd quintile	-0.059	0.079	-0.177
	0.044	0.07	0.245
flood*2012*middle quintile	0.028	0.121	-0.117
	0.051	0.066	0.285
flood*2012* 4th quintile	0.014	**0.206***	-0.038
	0.052	0.081	0.336
flood*2012*affluent quintile	**0.117***	**0.272****	0.55
	0.055	0.088	0.359
constant	10.576***	10.296***	7.253***
	0.015	0.019	0.092
HH FEs	Yes	Yes	Yes
HH controls	Yes	Yes	Yes
N	37599	37569	37606
R-squared	0.22	0.28	0.44

Note: *** p<0.01, ** p<0.05, * p<0.1. Coefficients and standard errors are reported. Income and expenditure are log-transformed. SEs clustered at the village level.

Flooding adversely impacted the income of scheduled caste/scheduled tribe (SCST) households. The effect is even more prominent when focusing on flooding events between 2009 and 2011. In 2012, SCST households in flood-affected areas in 2009-2011[12] had 14.7% lower income than non-SCST households in flooded areas (Table 2-11). On the other hand, the income of upper-

[12] I also run models for flooding between 2006 and 2011 as well as flooding between 2006 and 2008. I chose to report the most recent models for heterogeneity impacts to access the results for the most recent period.

caste households was 21% higher compared to non-upper-caste households in flood-affected areas (Table 2-12).

Table 2-11: Heterogenous treatment effect: Schedule Caste/Schedule Tribe (Flooded between 2009 and 2011)

	expenditure 1	**income 2**	**wealth index 3**
2012	0.177***	0.206***	3.201***
	0.013	0.018	0.069
flood*2012	-0.029	-0.081	-0.343
	0.031	0.046	0.188
2012*SCST	0.01	0.053*	-0.158
	0.017	0.024	0.093
flood*2012*SCST	0.02	**-0.159***	0.004
	0.04	0.066	0.269
constant	10.545***	10.146***	7.215***
	0.015	0.021	0.093
HH FEs	Yes	Yes	Yes
HH controls	Yes	Yes	Yes
N	37599	37569	37606
R-squared	0.20	0.14	0.44

Note: *** p<0.01, ** p<0.05, * p<0.1. Coefficients and standard errors are reported. Income and expenditure are log-transformed. SEs clustered at the village level.

Table 2-12: Heterogenous treatment effect: Open Category (Forward Caste) (Flooded between 2009 and 2011)

	expenditure 1	**income 2**	**wealth index 3**
2012	0.191***	0.226***	3.182***
	0.012	0.017	0.063
flood*2012	-0.035	-0.180***	-0.464*
	0.029	0.043	0.192
2012*open	-0.049*	-0.007	-0.159

	0.021	0.028	0.103
flood*2012*open	0.062	**0.192***	0.544
	0.048	0.077	0.279
constant	10.544***	10.144***	7.213***
	0.015	0.021	0.093
HH FEs	Yes	Yes	Yes
HH controls	Yes	Yes	Yes
N	37599	37569	37606
R-squared	0.20	0.14	0.44

Note: *** p<0.01, ** p<0.05, * p<0.1. Coefficients and standard errors are reported. Income and expenditure are log-transformed. SEs clustered at the village level.

Table 2-13: Heterogenous treatment effect: Other Backward Classes (Flooded between 2009 and 2011)

	expenditure 1	**income 2**	**wealth index 3**
2012	0.169***	0.232***	3.076***
	0.013	0.018	0.067
flood*2012	-0.007	-0.131**	-0.313
	0.03	0.044	0.194
2012*OBC	0.032	-0.022	0.206*
	0.018	0.026	0.102
flood*2012*OBC	-0.041	-0.023	-0.09
	0.039	0.073	0.234
constant	10.544***	10.146***	7.214***
	0.015	0.021	0.093
HH FEs	Yes	Yes	Yes
HH controls	Yes	Yes	Yes
N	37599	37569	37606
R-squared	0.20	0.14	0.44

Note: *** p<0.01, ** p<0.05, * p<0.1. Coefficients and standard errors are reported. Income and expenditure are log-transformed. SEs clustered at the village level.

2.6.3 Robustness checks

2.6.3.1 Placebo analysis

I randomly assign treatment to a subset of control households (20 percent), and then I estimate the difference-in-difference regression model using the placebo treatment instead of the actual treatment. A placebo analysis helps ensure that the observed effects in the main analysis are not due to chance by demonstrating that the effect is present only for the actual treatment and not for the randomly assigned placebo (Cunningham., 2021). Placebo tests also help alleviate concerns about selection bias if the treatment is not randomized. The coefficient for the placebo and year interaction term is not significant for any of the well-being variables.

Table 2-14: Placebo Analysis using random treatment assignment to a subset of control households

	expenditure 1	income 2	wealth index 3
2012	0.224***	0.268***	3.261***
	0.012	0.016	0.059
placebo*2012	0.013	-0.015	-0.091
	0.013	0.02	0.074
constant	10.474***	10.052***	7.355***
	0.017	0.026	0.101
HH FEs	Yes	Yes	Yes
HH controls	Yes	Yes	Yes
N	32463	32417	32477
R-squared	0.22	0.148	0.454

Note: *** p<0.01, ** p<0.05, * p<0.1. Coefficients and standard errors are reported. Income and expenditure are log-transformed. SEs clustered at the village level.

2.6.3.2 Verification of flood exposure using precipitation data

I run a difference-in-difference model using the precipitation verification flood data (Table 2-15). The results for income are robust to verification. The missing observations in IMD data, combined with the no data for 2011 in IMD, resulted in a reduction in the sample size of the treatment group (n1=3,746). This smaller size of the treatment group can impact the statistical power of the analysis, making it difficult to detect significant effects. On average, total household income in rural India increased by 16.7 % from 2005 to 2012, holding other variables constant. However, households in villages affected by flooding had a 7.5% (vs. 12.5 % for non-verified data) lower change in income from 2005 to 2012 than their counterparts in non-flooded areas. The direction of the effects for expenditure (4 % lower vs. 5 % for non-verified data) and asset index (0.15 units lower vs. 0.34 units for non-verified data) aligns with the non-verified data; however, the coefficients are not significant. I do not run the analysis by years and socioeconomic characteristics using the verified flood data.

Table 2-15: Analysis using verified flood data

	expenditure **1**	**income** **2**	**wealth index** **3**
2012	0.178***	0.223***	3.155***
	0.011	0.015	0.057
flood*2012	-0.047	**-0.112****	-0.154
	0.035	0.039	0.184
constant	10.580***	10.166***	7.362***
	0.016	0.031	0.102
HH FEs	Yes	Yes	Yes
HH controls	Yes	Yes	Yes
N	35063	35037	35070
R-squared	0.19	0.13	0.44

Note: *** p<0.01, ** p<0.05, * p<0.1. Coefficients and standard errors are reported. Income and expenditure are log-transformed. SEs clustered at the village level.

2.7 Discussion and Conclusion

This study adds to the literature on disaster impacts by comprehensively analyzing flood impacts on households' economic welfare, considering both economic and social stratification. It utilizes granular multi-year flood exposure data and examines heterogeneity in impacts based on economic class and caste (Anttila-Hughes et al., 2013; Noy et al., 2019; Del Ninno et al., 2005; Mueller et al., 2011). The literature on the economic impacts of flooding events at the micro/household level in a low-income country context is limited (De Alwis et al., 2019; Anttila-Hughes et al., 2013; Arouri et al., 2015). Moreover, the literature on economic welfare impacts of disasters tend to focus more on economic class and poverty rather than social stratification (Antilla-Hughes et al., 2013; Noy et al., 2018; Del Ninno et al., 2001; De Alwis et al., 2016; Poaponsakorn et al., 2015). In the Indian context, only a few comprehensive studies examine caste-based vulnerability in disaster outcomes (Khalid et al., 2024; Tamuly et al., 2022).

The results show that flooding had a negative impact on the household's income, consumption expenditures, and assets. These findings are consistent with the existing literature, which suggests that the impacts of flooding on household income are severe and negative in the short term (Hallegatte et al., 2017; Banerjee, 2007; Banerjee, 2010; Mueller et al., 2011; Groen et al., 2020; Deryugina et al., 2021; Deryugina et al., 2022). The negative impact on income is also robust when verified using external precipitation data. The results show that, on average, the change in total household income of households in villages affected by flooding between 2006 and 2012 was 13 percent lower than that of their non-flooded counterparts in 2012. Based on the literature, the decrease in income from disasters could be attributed to both direct damages and

indirect effects, such as the disruption of economic activities and employment, decreased consumer spending, and the migration of people and jobs. In the Indian context, having lower household income could be a result of rural households' heavy dependence on the agriculture sector and the migration of labor from the agricultural to the non-agricultural sector following disasters, which suppresses overall economic activity (Mueller et al., 2011). The magnitude of the negative impact on income appears to be stronger for households that experienced flooding events between 2009 and 2011 (1-3 years before the survey) compared to households that experienced flooding between 2006 and 2008 (4-6 years before the survey). This finding indicates that the severity of income losses may diminish as time passes since the flood event, which is in line with prior research showing that the short-run impacts of flooding on income dissipate after 1-2 years on average (Deryugina et al., 2021; Deryugina et al., 2022).

Flooding also negatively impacted household consumption expenditures in affected areas. On average, households in flood-affected villages experienced a 5 percent lower change in consumption expenditures in 2012 compared to their non-flooded counterparts. This finding aligns with previous studies documenting decreased consumption expenditure among disaster-impacted households (Del Ninno et al., 2003; De Alwis et al., 2019; Anttila-Hughes et al., 2013).

Households in rural India experienced an increase in the wealth index by 3.214 units; however, households in villages exposed to flooding saw a smaller increase (lower by 0.43 units) in their wealth index. Previous studies have consistently shown that natural disasters lead to a depletion of household assets (Patankar, 2019; Antilla-Hughes et al., 2019; Arlikatti et al., 2010; Jakobsen, 2012; De Alwis et al., 2019).

Lastly, these findings show that households below the poverty line (BPL) experienced a negative impact on their assets, and scheduled caste/scheduled tribe households experienced a severe flood impact on income compared to other socioeconomic groups in affected areas. Based on the literature, this negative impact on the income of lower caste households could be attributed to their employment in the informal sector, which is more susceptible to external shocks like disasters (Patankar, 2015; Hallegatte et al., 2017). On the contrary, the highest-income group in flood-affected villages experienced a higher increase in consumption expenditure and household income in 2012 compared to the poorest quintile, highlighting the disparities in the effects of disasters based on socioeconomic status. Furthermore, upper caste households in villages affected by flooding between 2009 and 2011 saw an increase in wealth index, suggesting their higher resilience to flood impacts. These findings highlight the importance of considering social stratification in addition to economic stratification when assessing the welfare impacts of disasters. It aligns with the existing literature on the heterogeneous impacts of natural disasters. Studies in Vietnam, Honduras, and Peru have demonstrated that households with higher expenditure or wealth experienced smaller declines in assets and consumption compared to their poorer counterparts in the aftermath of natural disasters (Arouri et al., 2015; Carter et al., 2007; Morris et al., 2002; López-Calva et al., 2009).

The failure to capture welfare impacts in traditional assessments and government decisions has led to disaster recovery policies and efforts that are oriented toward reconstruction or compensation for property damage (Hallegatte et al., 2017). This study emphasizes the need for targeted and inclusive disaster risk management strategies that consider the welfare impacts on different sections of society. As communities worldwide prepare for more frequent and intense

extreme weather events, a comprehensive understanding of disaster impacts is crucial for developing effective and equitable policies.

2.8 Limitations and Future Research

The flood exposure information in IHDS was collected through focused group discussions with key knowledgeable persons in the village. This perception-based information collected at the village level has several benefits and limitations. On one side, the data allows the capture of localized flood events that might be missed in broader datasets of flooding or precipitation at the district level. By relying on the knowledge of local sources, IHDS data captures flooding events that were significant enough to be remembered by knowledgeable local sources. Additionally, relying on multiple key informants helps corroborate the information and reduce individual bias.

However, this approach has certain limitations. The lack of standardized criteria for defining a flood event could lead to inconsistencies across different villages or states, as perceptions of what constitutes a flood may vary. The binary nature of the data (flood occurred or did not occur) makes it difficult to differentiate between events of varying magnitudes and severities. Additionally, there is a potential for recall bias, especially for events that occurred further in the past, as the survey covers a seven-year period.

Future research could incorporate more standardized measurements, such as water depth, duration, and quantifiable damage assessments to improve these results. This will address the issue of standardization, recall bias, and different magnitudes of events. High-resolution satellite data, such as the Joint Research Center's Global Surface Water Dataset, could be used more accurately to demarcate flooded areas at a 30-meter resolution. Additionally, future studies could benefit from using household panel data with more granular geographic information, such as the

dataset provided by the Center for Monitoring the Indian Economy (CMIE). This would allow for a more detailed analysis of flood impacts at the household level and enable better integration with external flooding data. By combining granular flood information with household panel data, future research could develop a more comprehensive and accurate understanding of flood events and their impacts on communities in India.

CHAPTER 3: A MULTIDIMENSIONAL APPROACH TO POST-DISASTER HOUSEHOLD RECOVERY – PROPERTY VS. ECONOMIC WELL-BEING

3.1 Introduction

Disaster recovery is a complex and multidimensional phenomenon (Wisner et al., 2015; Chang et al., 2010; Tierney et al., 2012). Disaster recovery researchers continue to grapple with conceptual and measurement questions (Peacock et al., 2006; Rodriguez et al., 2007; Arlikatti et al., 2010). The types of losses tracked to assess recovery have implications for recovery efforts and how we understand the impact of disasters on households. These assessments help inform the allocation of resources and aid and guide long-term recovery plans. The central argument of this study is that the path to achieving equitable and just recovery starts with the type of losses that are considered.

There is abundant literature on identifying factors that contribute to one's recovery following a disaster, but most studies are unidimensional, i.e., focusing on one aspect (e.g., housing or income) at a time (Peacock et al., 2014; Zhang et al., 2009; Antilla-Hughes et al., 2013; Arouri et al., 2015). This study addresses these limitations by conducting a survey (n=380) of households affected by the 2021 flooding in Chiplun, Maharashtra, India. In this study, household recovery is assessed in terms of the household's perception of recovery (5-point scale) for property

(housing and household goods) vs. economic well-being (income and consumption)[13]. Using a comparative approach across property-based vs. well-being-focused aspects of recovery, this chapter addresses the following questions:

1. How do damage and recovery vary across different dimensions - property vs. well-being?
    a. This captures differential impacts across dimensions.
2. How do economic class and caste influence the damage and recovery of property vs. well-being?
    a. Together, they capture the household's vulnerability and resilience in the Indian context[14].
3. How does recovery/damage in one dimension influence recovery in another dimension (e.g., the relationship between income recovery and housing recovery)?
    a. This captures the interconnectedness of outcomes.
4. How do income, housing, and household goods damage and recovery relate to the household's economic well-being (change in consumption expenditure)?

This study makes three contributions to the literature on disaster recovery:

First, while many studies focus on singular aspects of recovery, such as economic well-being or housing restoration, this research offers a comprehensive view by examining multiple dimensions, including changes in income and consumption, housing reconstruction, and the recovery of household goods. This multidimensional approach aligns with the body of literature that emphasizes the importance of considering various aspects of recovery for a comprehensive

[13] Change in total consumption and income in 2023: 1 - Decreased significantly, 2 - Decreased slightly, 3 - Stayed the same, 4 - Increased slightly, 5 - Increased significantly.
Change in condition of housing, appliances, furniture, and vehicles: 1 - Significantly worse, 2 - Slightly worse, 3 - It has sStayed the same, 4 - Slightly better, 5 - Significantly better.

[14] Instead of using a social vulnerability index or the combined components of socioeconomic data, I examine individual components driving the household's vulnerability and resilience. Social vulnerability indices are sensitive to weighting or combination schemes.

understanding (Bolin et al., 1983; Bates et al., 1992; Arlikatti et al., 2010; Patankar, 2015; Markhvida et al., 2015; Walsh et al., 2019; Sou et al., 2021).

Second, this study highlights the critical role of caste-based marginalization in the context of disaster recovery in India. Quantitative studies focusing on the relationship between caste and disaster impacts in India are limited (Arlikatti et al., 2010; Aldrich et al., 2010; Irshad, 2014; Arora, 2022). By addressing this gap, the research sheds light on how caste-based marginalization influences the disaster impacts.

Third, the study reveals the interconnectedness between different dimensions of recovery, such as the impact of income recovery on housing conditions and household consumption. However, most recovery studies do not consider interdependencies in their assessments (Mohammadi, 2024). By highlighting these linkages, this chapter emphasizes the need for a more integrated approach to disaster recovery policies and interventions that address the multiplicity of impacts experienced by affected households.

3.2 Literature Review

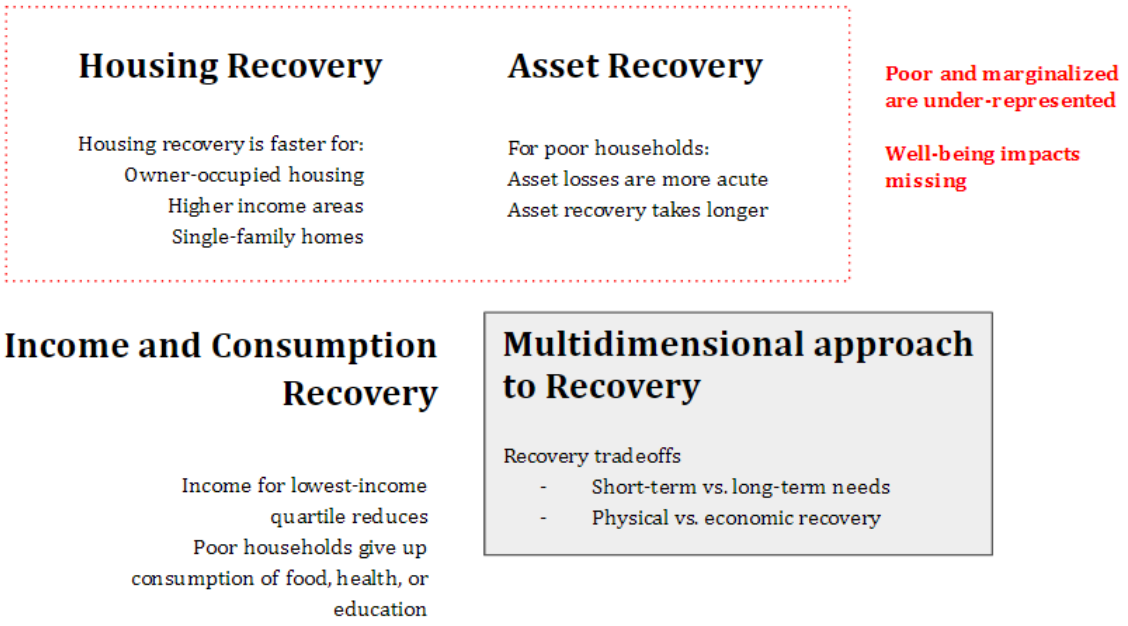

Figure 3-1: Literature on recovery at the household level

Disaster recovery is a multidimensional phenomenon, and how recovery is assessed has implications for those affected. Recovery is studied as a process, an outcome, an endpoint, a stage-like progression, and an adaptation to a new normal. The two core concerns surrounding the discussions on disaster recovery include whether recovery should be formulated as a return to pre-disaster levels and what types of losses should be used to assess recovery. In this chapter, I focus on the second, the type of losses that should be assessed.

Recovery occurs at multiple levels, and the factors affecting recovery exist at different levels. Examining recovery at higher geographic levels like wards, cities, or regions provides few insights into the differences in recovery trajectories of residents and households affected. Aggregation is more useful when communities are homogenous. However, in countries like India, a wide disparity

exists within a single geographical unit, such as a ward. Thus, the differences get blurred when recovery is assessed at a less granular level. Broad-scale recovery metrics ignore individual experiences and obscure the differential impacts of recovery (Peacock et al., 2006); thus, understanding recovery at more granular levels becomes crucial from a policy-making perspective. I focus on understanding recovery at the household level.

3.2.1 Conceptualization of disaster losses and recovery at the household level

Household impact and recovery have been measured in multiple ways, including objective measures, like restoring housing and lost assets, regaining income and employment (Andrew et al., 2013; Arlikatti et al., 2010; Bates, 1982; Bolin et al., 1983; Peacock et al., 1987) and subjective measures, like households' perceptions of recovery (Bolin et al., 1983). Conventional disaster impact studies tend to emphasize property damage assessment (Allaire, 2018; Hallegatte et al., 2017) and equate social recovery with reconstruction (Tierney et al., 2012). However, an emerging literature in economics has developed approaches to evaluate the effect of disasters on well-being (Hallegatte et al., 2017).

In the following subsections, I provide a brief overview of the conceptualization and evaluation of losses and recovery at the household level. I draw on literature from environmental economics, human geography, urban planning, and policy to understand how disaster recovery has been studied.

3.2.1.1 Property impacts (housing and assets)

Restoration of housing is considered essential for people to resume their daily routines and functions (Peacock et al., 2017). Delays in housing recovery can cause further delays in other dimensions of recovery, and thus, this dimension has remained the focus of many studies.

Recovery literature in urban planning primarily focuses on housing recovery (Peacock et al., 2014). Additionally, most disaster aid programs internationally are oriented toward compensation for property damage.

Housing recovery studies focus on the change in the value of housing, restoration of the structure, property abandonment, frequency of sales, change in land use, and perceptions to examine recovery trajectories (Peacock et al., 2014). Returning to the base year value (i.e., value before the event) indicates that average assessed values have been restored to the pre-disaster levels while exceeding the pre-disaster value is considered recovery beyond restoration (Peacock et al., 2006; Peacock et al., 2014). Numerous studies assess the impact of flooding on property prices in developed countries; however, evidence in developing countries like India remains lacking due to the limited availability of key data on property sales, prices, and taxes. (Andrew et al., 2013; Arvind and Ranjit, 2020).

The key factors contributing to uneven housing recovery, particularly affecting low-income and minority households, stem from disparities in initial damage and challenges in accessing resources and financial assistance (Peacock et al., 2017). Inadequate infrastructure, informal housing conditions, and social inequalities compound these issues in developing countries.

In addition to repairing and rebuilding housing, recovery and reconstruction activities include accumulating and reacquisition of assets to carry out normal domestic or household functions (Arlikatti et al., 2010) as well as restoring the productive capacity (Hallegatte et al., 2017). Disasters reduce the assets of those affected (Patankar et al., 2015; Jakobsen, 2012; Morris et al., 2002). After a disaster, resuming day-to-day activities depends on restoring assets on which these activities depend. Thus, one way of assessing the impacts of disaster and recovery is by

focusing on household goods/assets. Post-disaster asset studies can be categorized into two groups: one with origins in economics that focuses on quantifying the monetary value of asset losses and their impact on productive capacity (Jakobsen, 2012; Morris et al., 2002) and the other in sociology that focuses on the importance of household assets in maintaining daily life[15] (Bates et al., 1984; 1987; 1992; Arlikatti et al., 2010).

3.2.1.1.1 Limitations of property-based studies

While property-based disaster recovery studies provide valuable insights into housing and asset restoration, they have limitations in capturing the full extent of disaster impacts on well-being. Studies focusing primarily on property damage assessments often underestimate the impacts on well-being, such as decreased income and lost wages, temporary or permanent relocation, and forgone consumption (Allaire, 2018; Markhavida et al., 2020; Hallegatte et al., 2017). Moreover, focusing only on housing and assets can obscure the heterogenous patterns of recovery, as wealthy households have more assets and sustain more losses in absolute terms (Markhvida et al., 2020).

Researchers argue that quantitative measures focused on post-disaster housing recovery overlook system-wide concerns related to livelihoods, education, and basic service needs. (Arvind & Ranjit, 2020; Hallegatte et al., 2017). This is particularly evident in countries like India, where a narrow focus on housing reconstruction may not adequately address the diverse needs of affected

[15] Bates et al., (1984; 1987; 1992) introduced the concept of a Domestic Assets Index (DAI) to measure the impact of disasters on household possessions and amenities, rooted in sociology. Studies using DAI have defined recovery as meeting or exceeding the level of domestic assets the household would have attained, given no disaster. Building on DAI, Arlikatti et al. (2010) developed a modified domestic asset index (MDAI) that moves beyond the focus on housing and considers a set of assets utilized in day-to-day functions[#].

communities. A research project conducted by the Indian Institute for Human Settlements (IIHS) titled "Recovery with Dignity" found that while the state government prioritized housing reconstruction in areas affected by cyclones, there were limited efforts to support survivors in rebuilding their lives more holistically:

> *"For state government, building a pucca house was the ultimate sign of recovery. But for the affected communities, it featured lower on the list of long-term priorities…. What is the point of having a house but no job?"* (Arvind & Ranjit, 2020)

Moreover, formal institutional and governmental capabilities to assess damages in India and worldwide are often limited to direct capital loss assessments because they are straightforward to measure. However, relying on these narrow, property-focused metrics in decision-making may exclude vulnerable groups with little or no property (Hallegatte, 2017; Walsh et al., 2019). When housing and asset ownership are highly unequal, the definition, understanding, and measurement of recovery become matters of equity and justice.

3.2.1.2 Welfare or well-being impacts (income and consumption)

Moving beyond property damage assessments, researchers have focused on the welfare or well-being effects of disasters, particularly on income and consumption. The literature on the welfare or well-being effects of natural disasters is growing (Arouri et al., 2015). Disasters can damage or destroy livelihood-generating assets and opportunities, leading to income losses (Dercon et al., 2005; Antilla-Huges et al., 2013). In developing countries, where a large proportion of the population depends on informal work and wages, these income effects are particularly concerning (Patankar, 2015; Hallegatte et al., 2017).

Disaster-related expenses, changes in income, and changes in the price of commodities alter the consumption of those affected. Following floods, individuals from different socioeconomic

groups can lose income; however, whether they reduce consumption is a function of their internal ability to cope with losses (savings, insurance, etc.), access to external sources (loans, government relief support), and support. Moreover, some households might not lose income, but their consumption may still be impacted by increased expenditure on reconstruction and replacement of assets.

Studies have shown that disasters can have significant negative impacts on both income and consumption expenditure. For example, areas affected by Hurricane Katrina experienced a decrease in earnings (Groen et al., 2020). Antilla-Huges et al. (2013) found that typhoons in the Philippines reduced the average income by 6.7 percent and expenditure by 7.1 percent the year after the strike. Similarly, Arouri (2014) found that living in a commune impacted by floods reduced income by 5.9 percent. Noy et al. (2019) found a drop in Thai households' non-agricultural income and per-capita expenditure following the 2011 flooding.

Disasters have an impact on the consumption of households across various categories, such as food, durables, and education. However, low-income households are particularly vulnerable to the impacts of disasters on food consumption. In the aftermath of a disaster, price increases and food shortages are common occurrences, as noted by Sen (1983). These changes can have severe consequences for low-income households, which often allocate a substantial portion of their monthly expenses to food.

3.2.1.3 Combination of property and well-being recovery

There have been attempts to understand impacts and recovery using multiple aspects (Bolin et al., 1983; Bates et al., 1992; Arlikatti et al., 2010[16]; Patankar, 2015[17]; Markhvida et al., 2015[18]; Walsh et al., 2019[19]). However, these studies have limitations in terms of their scope or methodology (Bolin and Bolton, 1983[20]); they mostly rely on hypothetical scenarios or use simulated scenarios (Markhavida et al., 2015; Walsh et al., 2019); only perform loss assessments without tracking recovery (Patankar, 2015); or rely on secondary panel datasets (Antilla-Huges et al., 2013).

There are frameworks and guidelines developed by international organizations to provide a standardized approach for countries to assess disaster impacts and recovery needs across various sectors, including at the household level. One such framework is the Rapid Risk Assessment, which captures the initial disaster impacts but does not track recovery processes. Another tool is the Post-Disaster Needs Assessment (PDNA) developed by the UN Development Group (UNDG), the World Bank, and the European Union (EU). The PDNA guidelines cover various

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[16] Bates et al. (1984, 1987, 1992) and Arlikatti et al. utilize a domestic asset index (DAI) that moves beyond the focus on housing and considers a set of assets utilized in day-to-day functions to assess disaster impacts in varied contexts.

[17] Patankar et al. (2019) considered a wide range of direct (house and household goods) and indirect impacts (loss of workdays and jobs, damage cost as a percentage of household income) of flooding on households affected by flooding in Mumbai.

[18] Using simulated disaster scenarios in the San Francisco Bay Area, Markhavida et al. (2020) model the impact of earthquakes on housing, household goods, and income.

[19] Walsh et al. (2019) use an agent based model to estimate the asset losses and resulting income and consumption losses over the recovery period. The authors do not analyze the impacts of a specific historical flood event in Sri Lanka. They use the flood hazard data to estimate the potential impacts of floods.

[20] Bolin and Bolton (1983) measure recovery using multiple objective measures: income recovery, home-size recovery, and recovery of home conveniences.

dimensions of household impacts, such as damage to housing and assets, livelihood disruption, food security, health, education, and social impacts (Jeggle et al., 2018). While these tools offer a valuable tool for comprehensive impact assessment, they still largely focus on immediate to short-term impacts and needs.

Since disasters affect households in multiple ways, a more comprehensive and multidimensional approach is needed to fully understand and address the needs of those affected. Building on prior studies, my research aims to fill this gap by empirically examining the interconnections between different aspects of recovery, such as property reconstruction and livelihood restoration.

3.2.1.4 Perceptions of recovery

The disaster recovery process consists of actions after the initial impact, including those directed toward a return to normality (Tierney, 2007). Short-term recovery starts immediately after the disaster and consists of activities like restoring basic services, clearing debris, securing temporary housing, and laying the groundwork for long-term rebuilding efforts (Shaw, 2014). Long-term recovery constitutes restoring the built environment and re-establishing human, social, and economic capital levels. Recovery can take years, and complete recovery is often impossible because of permanent disaster impacts. Thus, instead of assessing recovery as a binary outcome, this study looks at the time and perception of recovery.

Studies on perceptions of recovery (Bolin et al., 1983; Andrew et al., 2010) recognize that recovery is a subjective and personal experience shaped by perspectives and priorities. For the Nicaraguan study, perception of recovery included four measures of pre-vs-post-disaster estimation by the head of the household (Bolin et al., 1983). Chandrasekhar et al. (2018)

examine the effect of various socioeconomic factors, aid availability, and neighborhood conditions on the household's perception of recovery.

3.2.2 Explaining the differences in damages and recovery

Social vulnerability and resilience are two commonly used frameworks in the disaster literature to explain recovery. Rapid and successful recovery is associated with low levels of pre-disaster vulnerability, high inherent resilience, and the ability to undertake post-disaster coping (adaptive resilience) (Tierney, 2014). This study uses a combination of vulnerability and resilience frameworks to explain the mechanisms driving damages and subsequent recovery.

3.2.2.1 Vulnerability Framework

The vulnerability framework is primarily used to highlight systemic variation in exposure of people as a result of their location (Cutter, 1996), systemic variation in terms of quality of structure (Elliot et al., 2006), and systemic variation in social impacts after controlling for exposure and structural vulnerability. While the social vulnerability framing is good for explaining the risk of exposure and the initial impacts of an event, it is not very useful in explaining the recovery following disasters. Pre-existing conditions and susceptibility are crucial but not sufficient in understanding the decisions made by those affected by disasters and the overall welfare impacts (Walsh et al., 2019; Cutter, 2008).

3.2.2.2 Resilience Framework

In the past few years, resilience has become a key concept driving the discourse on disaster and climate policies (Martin-Breen et al., 2011; Doorn, 2017; Tierney, 2014). There has been a strong emphasis on the relationship between resilience and recovery post-disasters, especially

since the Hyogo Framework for Action (HFA) adoption in 2005 (Uekusa, 2017; Manyena, 2006). The latter includes a more actor-centric approach; however, it lacks in terms of its emphasis on external factors influencing the ability of those affected to deal with disaster impacts (Tierney, 2014).

In the disaster studies literature, resilience is defined as "the ability to survive and cope with a disaster with minimum impact and damage" (Cutter et al., 2008, Pg no. 600; NRC, 2006). Resilience could be broadly categorized into two types - inherent and adaptive. Inherent resilience is "associated with properties of resistance, robustness, and existing redundancies within systems" (Tierney, 2014, Pg no. 173). Adaptive resilience occurs after an event and consists of learning by individuals, which enables the individuals to respond successfully to, recover from, and adapt to new conditions. It is often characterized by impromptu actions carried out during and after the disaster (Cutter, 2008). Households employ various coping strategies, such as reliance on social networks and household coping to recover from the losses and fill the gaps created by the lack of government assistance and a formal insurance market to cover the costs of disasters (Hallegatte et al., 2017; Patankar, 2015). The focus on resilience goes beyond what happens to the affected household to what the households do to cope, recover, and adapt (Chandrashkar et al., 2019).

3.2.2.3 Indicators of Vulnerability and Resilience in the Indian context

In the Indian context, economic class and caste are crucial indicators of vulnerability and resilience, shaping the distribution of damages and recovery among affected households.

3.2.2.3.1 Economic Class

Economic class or income is considered to be a reliable proxy for a person's capacity to prepare for, endure, manage, and bounce back from flood events (Rentschler et al., 2020). Low-income groups tend to be located in areas prone to natural hazards due to reasons like the cost of housing, affordability concerns, and limited housing choices. Locating in high-risk areas is often a choice because these areas offer economic opportunities, services, or potentially higher incomes. (Hallegatte et al., 2017). For instance, Patankar (2015), in her study of repetitively flooded areas in Mumbai, notes that households are aware of the flooding risks but still decide to locate in such places because of access to jobs, education, and other facilities. Lower-income households also, over time locate in homes and neighborhoods as they deteriorate physically through the process of filtering (Elliott, 2006; Fothergill et al., 2004; Cutter, 1995).

Moreover, poor households suffer more losses, are uninsured, and have limited capacity to deal with the losses. They lack access to financial resources and external support networks during recovery. Lower-income households are also more likely to work in informal jobs that lack security and benefits.

3.2.2.3.2 Caste

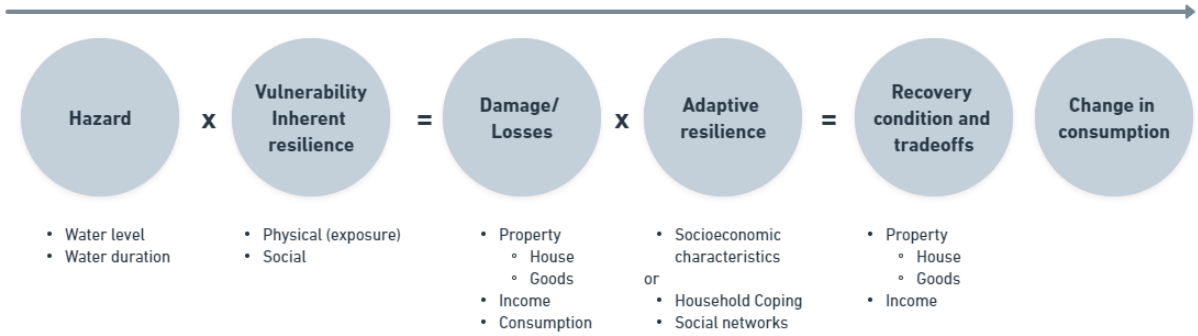
Caste-based divisions have long been a defining feature of the Indian social fabric, with various groups experiencing historical disadvantages and marginalization (Deshpande, 2011). Recognizing this historical discrimination, the Indian government has delineated three main caste categories: Scheduled Castes (SC), Scheduled Tribes (ST), and Other Backward Classes (OBC). These groups remain underrepresented in governing structures, leading to their interests being inadequately addressed (Arlikatti et al., 2010).

Multiple forms of marginalization exist when considering caste—political, geographical, and employment-based. The geography of settlements in India is closely linked with caste. For instance, a 1999 study conducted in the Jagatsinghpur district of coastal Odisha found that upper-caste households live in elevated areas and own sturdier concrete houses, while lower-caste wage workers reside on the village outskirts in low-lying areas (Jain, 2019). Additionally, lower-caste communities are often employed in precarious occupations such as waste picking and daily wage labor, making them more vulnerable to disasters. According to the Arjun Sengupta Committee Report (2007), around 88% of the SCs experience poverty and face various forms of vulnerability (National Commission for Enterprises in the Unorganized Sector, 2008). The National Sample Survey Office's 68th round, conducted in 2011-12, reveals that nearly 63% of the Scheduled Castes are wage laborers.

Prior empirical evidence also suggests that these communities face a much harsher impact after disasters. Disasters such as the Gujarat earthquake (2001), the Indian Ocean tsunami (2004), the Kosi River floods in Bihar (2007), and the recurring Assam floods have consistently highlighted the systemic exclusion of Dalits from relief and rehabilitation efforts (National Dalit Watch, 2012). These calamities have underscored the slower recovery processes and limited access to crucial resources and support networks experienced by marginalized communities.

Given this context, I assess the distribution of damages and recovery among these historically marginalized groups in this chapter.

3.2.3 Conceptual Framework



Source: Conceptual model of impacts of flooding: Modified version of model from Hallegatte et al., 2017

Figure 3-2: Interconnected Disaster Impact and Recovery Framework

The proposed conceptual framework for this chapter (Figure 3-2) builds upon the work of Hallegatte et al. (2017), who present a sequential model that traces the path from a natural hazard to its ultimate impact on well-being, involving multiple drivers. Their model begins by considering the asset losses resulting from the disaster, which may include damage to property, livestock, infrastructure, and other tangible resources. The extent of income loss is then estimated, taking into account the productivity of the lost or damaged assets, the degree of income diversification, and the speed of recovery. In the immediate aftermath of the disaster, income is expected to decrease in proportion to the value of the lost assets.

The next step involves translating income losses into consumption losses. This stage of the model incorporates various post-disaster responses and coping mechanisms that can help mitigate the impact of lost income on consumption. These mechanisms include formal and informal insurance schemes, remittances from family members or other sources, ad hoc transfers from government or non-governmental organizations, and the scaling up of social protection

measures. By providing additional resources and support, these coping mechanisms can help offset some of the income losses and dampen the effect of consumption losses.

I modified the framework for this chapter and began the analysis by focusing on two primary dimensions of damage: property damage and income loss. These initial impacts are then used to assess the loss of consumption in the immediate disaster aftermath and in the long term.

3.2.3.1 Disaster Damage or Losses

Studies have consistently shown that low-income and minority households are disproportionately affected by disasters, suffering higher levels of damage to housing and assets compared to their more affluent counterparts (F. L. Bates, 1982; F. L. Bates & Peacock, 1987; Blaikie et al., 1994; Bolin, 1982, 1986, 1993; Quarantelli, 1982). This relationship can be attributed to factors such as lower-quality building materials and assets, reduced investment in risk-reduction measures, and a diminished capacity to withstand flood damage (Bolin, 1986; Bolin & Bolton, 1986; Van Zandt, 2007). In the United States, disaster researchers have explored the influence of race and ethnicity on the extent of damage from disasters, particularly in relation to the quality and location of assets (Cutter, 2006; Elliott and Pais, 2006). However, there is a scarcity of quantitative studies investigating the impact of caste on property damages in the Indian context (Irshad, 2014; Arora, 2022).

In the immediate aftermath of a flood, affected households may experience a reduction in income as economic activity in the area comes to a near halt (Hallegatte et al., 2017; Noy et al., 2019; Del Ninno et al., 2001; Antilla-Hughes et al., 2013). Existing research indicates that low-income

households, such as those below the poverty line[21], often incur disproportionately higher income losses. This vulnerability is attributed to their reliance on informal employment and limited income diversification (Hallegatte et al., 2017; Patankar, 2019). Similarly, households belonging to lower caste categories are more likely to work in precarious settings and engage in wage labor, resulting in higher susceptibility to income losses.

Damage to property and loss of income can affect household consumption. Some households may face increased expenses related to the disaster, such as repairs, temporary housing, or medical treatment. Others might struggle to maintain even their pre-disaster consumption levels due to income disruptions and price shocks (Hallegatte et al., 2017).

3.2.3.2 Disaster Recovery

Recovery is considered to have occurred when a household has reached or surpassed its pre-disaster conditions (Bolin et al., 1983). In other words, a household is deemed to have recovered if the condition of its house and household goods, income, and consumption levels are equal to or greater than their respective pre-disaster levels.

The extent of damage and the household's capacity to restore the damages shape property and income recovery. Socio-demographic characteristics play a crucial role in determining people's access to resources and their capacity to deal with and recover from the effects of disasters (Van Zandt et al., 2012).

[21] For example, in the aftermath of the 2005 flooding in Mumbai, Below Poverty Line (BPL) families incurred damage costs equivalent to approximately 12 months' worth of income, whereas wealthier families experienced losses amounting to only 1-2 months' income (Patankar, 2019).

The direction and magnitude of income changes depend on factors such as the extent of direct damage, the household's wealth, race, and profession (Hallegatte et al., 2017; Groen, 2016; Antilla-Hughes et al., 2013). Lower-income and marginalized groups may experience slower income recovery due to their precarious employment situations and limited access to resources. Moreover, the type of employment (salaried, wage, or business ownership) plays a crucial role in determining the trajectory of household income recovery.

This final stage of the chain demonstrates how the recovery of housing structure, household goods, and income ultimately influences the change in household well-being, measured by consumption expenditure.

The impact of disasters on household consumption expenditure is complex and can vary depending on various factors. On one hand, consumption may decrease due to reduced income, damages to housing or goods, or other flood-related losses (Del Ninno et al., 2003; Antilla-Hughes et al., 2013). In such cases, households may prioritize maintaining their pre-disaster food consumption levels while reducing their consumption of non-essential goods, such as durables. Some households may even reduce their consumption of essentials to bolster their reconstruction efforts. Conversely, consumption could increase in the aftermath of a flood due to recovery efforts, such as repairing or replacing damaged belongings, or due to the additional costs associated with living in a post-flood environment (Patnaik et al., 2018; Noy et al., 2019). These competing factors contribute to the mixed findings observed in studies examining consumption recovery and impacts.

The household's socioeconomic status also plays a significant role in determining the change in consumption expenditures following a disaster. Previous research has shown that the poor are

more likely than the wealthy to forgo consumption (Hallegatte et al., 2017). In the absence of access to internal savings or investments, marginalized households are more likely to cut back on essential consumption categories, such as food, health, or education, compared to wealthier segments of the population (Walsh et al., 2020).

3.2.3.3 The interconnectedness of different dimensions

In the aftermath of a disaster, households are presented with multiple decisions when allocating their resources towards recovery. During the recovery process, households often make difficult tradeoffs, often balancing the competing demands of rebuilding their homes, replacing essential assets, and securing their livelihoods. The physical reconstruction and socioeconomic recovery are interconnected and should be addressed in tandem for effective recovery (Mohammadi, 2024)

The decisions (tradeoffs) that households make during the recovery process can have significant implications for the speed and trajectory of their overall recovery. For example, a household may prioritize restoring their home over replacing lost household goods, directing their resources towards housing repairs and reconstruction. While this decision may speed up the housing recovery, it can come at the expense of a slower recovery in terms of household assets, potentially prolonging the time it takes for the household to fully regain its pre-disaster standard of living. Conversely, some households may prioritize livelihood restoration over housing recovery, focusing their efforts on regaining lost income. While this strategy can help households recover their income more quickly, it may delay the restoration of their damaged homes, extending the time they spend in temporary or substandard housing.

Interconnectedness is seen as both a strength and a potential weakness in the literature (Mohammadi, 2024). For example, interconnections across dimensions of recovery can be a driver of resilience and control. However, it can also cascade impacts, where slow recovery across multiple dimensions can compound the challenges households face. For instance, a household that experiences prolonged income loss may struggle to finance the repair or reconstruction of their damaged home, which in turn can hinder their ability to replace lost household goods. This cascading effect can trap households in a cycle of vulnerability, where the slow recovery in one dimension perpetuates the slow recovery in others.

Despite their importance, recovery tradeoffs and cascading impacts remain understudied in the literature. Studies focusing on housing recovery emphasize that it is a long-term process (Peacock et al., 2014; Zhang and Peacock, 2009). On the other hand, some studies have shown that livelihood restoration often precedes the restoration of housing or household goods for affected households (Mukherji, 2014; Skoufias, 2003). However, there is a need for more research on how the recovery of one dimension affects recovery in other dimensions.

3.2.3.4 Hypotheses

The 2021 flooding in Chiplun was unprecedented, and given the event's magnitude, the lack of an evacuation warning, and the short time to prepare, I expect the households to have suffered significant damage to their houses and household goods.

Chiplun is primarily a commercial town, with most of its economic activity and employment concentrated in the old Bazarpeth area (market area) located next to the river. Due to the severe damage to the market area during the 2021 flooding, I anticipate a drop in economic activity and incomes of those affected in the immediate aftermath.

In terms of consumption, I expect households to decrease their total consumption in the immediate aftermath as they deal with reduced income, closed markets, and other losses from the flood.

> ***Hypothesis 1:*** *Flooding resulted in a reduction in income and consumption expenditure (Question 1)*
>
> ***Hypothesis 2:*** *Lower-income and lower-caste households experienced more damage to housing, household goods, income, and consumption expenditure (Question 2)*
>
> ***Hypothesis 3:*** *Higher impact (damage and subsequent recovery) on income, house, and household goods resulted in a reduction in consumption (Question 4)*

The recovery process after the 2021 Chiplun flooding is expected to vary based on socioeconomic status and caste. Upper-caste and higher-income households are likely to recover faster in terms of housing and household goods due to greater resources and support networks. In contrast, marginalized and lower-income households may face greater challenges in rebuilding homes due to limited financial means and potential discrimination.

The impacts on income recovery could be mixed, depending on the type of employment and the household's economic status. Those with formal employment may recover smoothly, while households relying on informal or precarious work may face greater difficulties regaining livelihoods.

Poorer and marginalized households are more likely to cope by cutting consumption expenditures, potentially compromising food, health, and education.

> ***Hypothesis 4****: Lower-income and lower-caste households experienced a poorer recovery (condition and time) (Question 2)*
>
> ***Hypothesis 5:*** *The recovery processes across different dimensions (housing, household goods, income, and consumption) were interconnected. For example, recovery in one dimension influenced the recovery in other dimensions (Questions 3 and 4)*

3.3 Data

This section describes the case study area, sampling and survey strategy, and survey questions used to assess damage and recovery.

3.3.1 Case study description

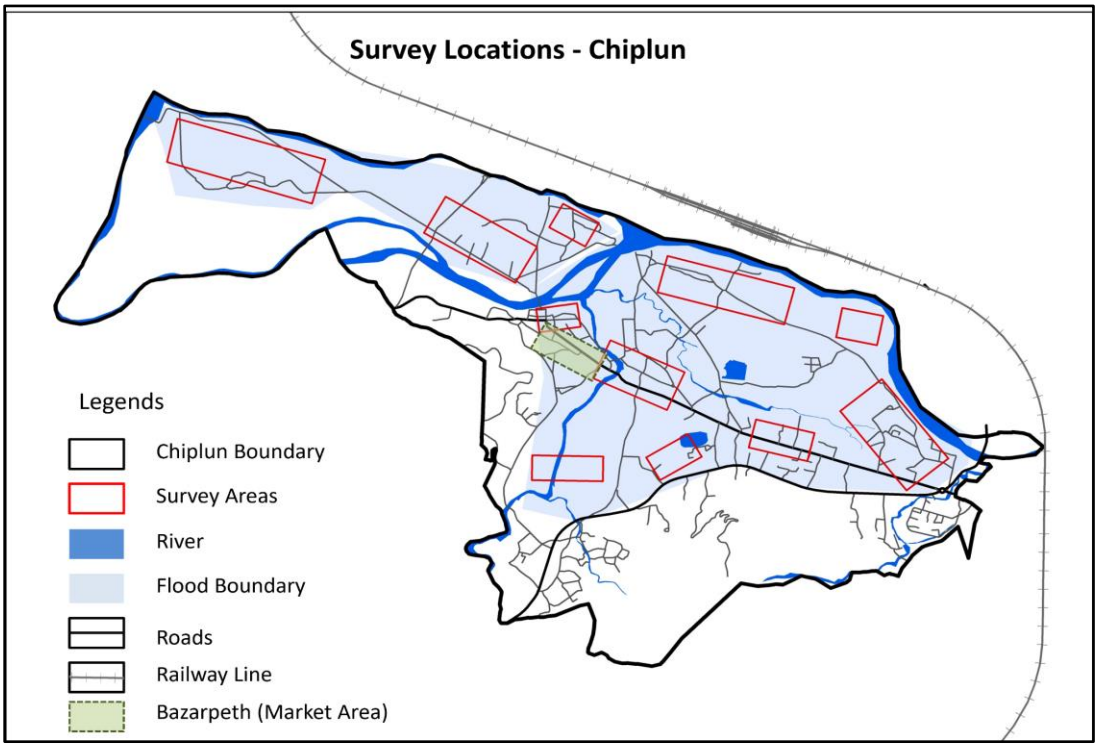
In July 2021, eight districts in western Maharashtra, India's third-largest state, experienced torrential rains that led to unprecedented flooding. Chiplun was particularly hard hit, with around 70 percent of the city submerged in water for 2-3 days. The flood caused extensive damage to approximately 6,000 houses and 5,000 shops (Chiplun Municipal Council, 2021). In addition to the damage to buildings, the flood also heavily impacted vehicles and infrastructure. The Municipal Council's preliminary estimate of the losses stands at 470 crores (approximately USD 63 million). However, these estimates do not fully capture the broader socioeconomic costs of the flooding. Monsoonal flooding is a recurring annual phenomenon in the Konkan coastal area of Maharashtra. Due to its topography, parts of Chiplun experience waterlogging yearly during the monsoon season. The city experienced large-scale floods in 1965, 2001, and 2005, but the 2021 flooding was unparalleled in its severity (Water Resources Department, 2022).

Chiplun is situated 90 km northeast of the city of Ratnagiri in the Ratnagiri district of Maharashtra. The city is located at the foothills of the Sahyadri mountain range in the Konkan region, with the Vashishthi and Shiv Rivers surrounding it on two sides. The Vashishti River flows east to west along the city's northern edge, while the Shiv River flows south to north and meets the Vashishti River in the north. Chiplun is approximately 30 km from the Arabian Sea. Its distance from the sea and topography makes the town prone to flooding.

According to the 2017 estimates by the Chiplun Municipal Council, the city has a population of around 72,261 and covers an area of 14.6 square kilometers. The focus of this study is to understand the differences in recovery among affected households, so the target population for the research is the approximately 7,755 households that were directly impacted by the flooding.

3.3.2 Study sites, sampling, and fieldwork

A primary survey was conducted in May-June 2023 to understand the vulnerability and recovery of households from the 2021 flooding in Chiplun, Maharashtra, India (Appendix A). The aim was to assess the impacts of the 2021 flooding and recovery trajectories approximately two years after the event. The data used in this study was collected from a random sample of 389 households surveyed in June 2023 in communities in Chiplun affected by the 2021 flooding.



Source: City and flood boundary, water bodies, and transportation networks information shared by Chiplun Municipal Council

Figure 3-3: Map showing the locations of survey neighborhoods

The Chiplun Municipal Council demarcated the areas impacted by the flooding (Figure 3-3). Neighborhoods affected by flooding were selected purposively across the city with the help of local government officials based on socioeconomic status. Flood water levels in the town varied from 1ft to 10 ft. The sampled communities consisted of Bazarpeth, Muradpur, Govalkot Road, Khendi, Jama Masjid Mohalla, Shankarwadi, Markandi, and Pethmap.

The total target sample size was 600 respondents. To the extent possible, we tried to sample respondents from each residential area across the entire spatial area of the neighborhood. These target neighborhoods are classified as Low Income Group (LIG) or Economically Weaker Section (EWS) and Middle Income Group (MIG). However, the composition of neighborhoods in most cases was mixed; thus, not all households in the LIG-EWS area were poor, and vice versa. Gated communities in middle-income areas were difficult to reach, and people hesitated to answer the surveys. People with individual homes (not gated) were more approachable and willing to participate. As a result, we collected more surveys in the city's low and lower-middle-income areas. In some situations, a group of households (homemakers) were interviewed. In the evenings, surveys were also conducted in the city's market area, where people were more approachable and willing to participate.

The survey instrument was evaluated for its content, cognitive, and usability standards through expert reviews and pilot testing. The translated survey instrument was pretested twice in May 2023 and modified slightly to address problems related to language and question clarity. The round 1 pilot test was completed with 20 households, and the round 2 pilot was done with 10 households. I also collaborated with the Masters of Planning studio at the College of Engineering, Pune to pilot

test the survey instrument. The respondents (households affected by flooding) were told to “think out loud” as they answered the questions. Surveyors noted down the questions that were unclear or the questions respondents hesitated to answer.

I collaborated with the students at the College of Engineering, Pune, and a consulting agency, Abhinyas, to conduct household surveys in Marathi, the city's native language. The lead researcher and the head of Abhinyas trained the interviewers on survey protocols and strategy. During the survey, the head of Abhinyas supervised the enumerators.

After identifying the survey neighborhoods, a door-to-door survey was conducted on May 23, 2023, and from June 06 to June 16, 2023. Every survey took 20 - 45 minutes to complete. A team of eight enumerators, including myself, conducted door-to-door surveys. The enumerators worked independently, with each one conducting surveys at different households. I completed the IRB review for the study, and the study was determined to be exempt. Formal approval was obtained from the Chiplun Municipal Council before starting the survey. Households were first given information about the study and asked for consent before proceeding. The enumerators carried copies of questionnaires in the local language (Marathi) if respondents were interested in looking at the information.

Screening questions were asked at the start of the survey to determine whether the household had flood water in their house during the 2021 flooding event. Only households that experienced minor housing damage were invited to participate in the survey, and information was only obtained from people 18 years of age and older.

If the household refused to answer the survey or was not reachable during the visit, the household was dropped from the survey and replaced with a neighbor. No identification or location information was collected from the surveyed households, but the community of each survey was recorded in the data. Lastly, all the information collected was anonymized, ensuring the privacy and confidentiality of respondents.

3.3.3 Survey Questions

3.3.3.1 Severity of flooding

To assess the severity of flooding, the survey asked respondents about two key factors: the depth of water in their homes and the duration of the flooding. For water depth, responses ranged from 1 "ankle-deep (less than 0.4 feet)" to 5 "having their entire ground floor underwater (10 feet or more)." Regarding the duration of the flooding, respondents were asked to indicate the number of days water remained in their homes, with options ranging from 1 day to more than 2 days.

3.3.3.2 Sociodemographic characteristics

Questions regarding sociodemographic characteristics were asked to gather information for a comparative analysis of flood and recovery experiences across different types of households in the community. The survey collected data on the number of people in the household, gender, age, educational level, employment status, income, religion, caste, and occupation. Sociodemographic characteristics were collected for each member of the household (except Caste and Religion).

For the analysis, the caste of the household was coded as a binary variable. Hindu upper caste (open category) households were assigned a value of 1, while all other households, including

Other Backward Classes (OBC), Scheduled Castes/Scheduled Tribes/Nomadic Tribes (SC/ST/NT), and Buddhists, were coded as 0. Additionally, a separate variable was created to account for households belonging to other religions that do not adhere to the Hindu caste system, as caste information was not applicable to them.

The survey also gathered information on pre-disaster household income, which was categorized into six categories ranging from Rs. 5,000-10,000 per month to more than Rs. 50,000 per month. Researchers have raised concerns about the efficacy of income questions in household surveys. Thus, instead of asking for an exact amount of income, we used a categorical question.

3.3.3.3 Damage

Next, the survey questions gathered data that could be used to quantify and categorize the damage incurred by households due to the 2021 flooding. Respondents were asked to indicate whether their household experienced losses in various categories, such as income, housing, and household goods.

To assess the damage to the house, respondents were asked to report the type of damage—paint and plaster wearing off, damage to plumbing or electric circuits, significant damage to the floor, walls, or roof, unusable rooms, or complete destruction of the entire house. Based on this information, I classified the damage to the house into three categories: minor damage, significant damage, and house destroyed.

To estimate the loss of income, respondents were asked, "Because of the 2021 flooding, how did the overall income of your household change?" The responses were measured on a scale of 1, “decreased significantly,” to 5, “increased significantly.” Based on the distribution of responses,

I created a new variable for income loss with three categories - no income loss (stayed the same or increased), moderate loss (slightly decreased), and significant loss (significantly decreased).

To measure the damage to household goods, respondents were asked to report damage to appliances (TV, computer, fridge, washing machine, Fan/AC/Cooler, other) and damage to furniture (Couch, table and/or chairs, bed, closets, armoires, and/ or wardrobe, other). I created a scale by adding the dichotomous items indicating the loss of appliances and furniture, resulting in a scale ranging from 0 to 9. I then categorized the scale into four levels of damage, based on the distribution of responses: 0 "no damage" to 3 "high damage."

To assess damage to consumption, respondents were asked "Because of the 2021 flooding, how did your household's spending change?" The responses were measured on a scale of 1 "decreased significantly," to 5 "increased significantly." Based on the distribution of responses, I created a new variable for consumption loss with three categories - no loss (stayed the same or increased), moderate loss, and significant loss.

3.3.3.4 Recovery

The survey instrument included multiple questions about household recovery (condition and time). Respondents were asked about their household income and consumption at the time of the survey compared to their pre-flood income[22] and consumption to assess recovery. The income

[22] Questions were framed differently based on the type of employment. For salaried employees who experienced income loss due to flooding, the survey asked about the duration it took to secure a new job, the comparative salary level, and the period of unemployment. For wage workers, details on the typical income and the duration of work disruption were collected. Business owners and self-employed participants were asked about the typical revenue from their businesses, the duration of business closure, and the income lost during the closed period. This comprehensive approach aimed to capture the nuances of income recovery and employment restoration following the July 2021 flooding, aligning with established research frameworks.

and consumption categories ranged from 1 (“significantly reduced”) to 5 (“significantly increased”). Based on the distribution of responses, I collapsed the two increased categories (slightly increased and significantly increased) into one.

Survey questions regarding the recovery of house and household goods aimed to assess the impacts of the July 2021 flooding on the respondents' living conditions. To gauge the condition of the house two years after the event, participants were prompted to compare the state of paint, walls, floor, and roof to their condition before the July 2021 flooding. Response options were collected on a 5-point scale and ranged from 1 (“significantly worse”) to 5 (“significantly better”). Similarly, for household goods (appliances and furniture items), participants were asked to compare the current condition of these goods to their status before the flooding, with response options ranging from 1 (“significantly worse”) to 5 (“significantly better”). Based on the distribution of responses, I collapsed the condition responses into four categories - significantly worse, slightly worse, stayed the same, and better.

3.3.3.5 Open-ended questions - qualitative

To supplement the quantitative analysis, I also collected qualitative data through open-ended questions in the survey. These questions asked the respondents to share their personal experiences of recovery. To understand the recovery priorities, respondents were asked, “Why did you prioritize the repair/ rebuilding/ restoration in that order?” Households were also asked to share their experiences about the event at the end of the survey.

3.4 Methods

This section provides an overview of the analytical approach, and the methods used to examine the research questions.

3.4.1 Analytical Approach

3.4.1.1 Assessment of damage and recovery

To answer RQ.1., I examine the distribution of responses to assess the extent of damage and recovery of households across different dimensions, including housing, household goods, income, and consumption.

3.4.1.2 Factors associated with damage and loss

To examine the factors associated with damage and loss (RQ.2), I conceptualize that the event's magnitude, the pre-flooding household income, and caste are associated with damage to the house, household goods, and income. I estimate the damage to the house, household goods, and loss of income using ordinal logistic regression (Model 2). To estimate the change in consumption, I include damage to the house (structure), household goods, and income, in addition to the magnitude of the flood and socioeconomic characteristics of the household.

Model 1

$$logit\ (P(Y \leq j) = \beta_{j0} + \beta_{j1}\ Water\ level + \beta_{j2} Duration + \beta_{j3} Pre-flood\ Income + \beta_{j4} Caste$$

Model 2

$$logit\ (P(Y \leq j)) = \beta_{j0} + \beta_{j1}\ Water\ level + \beta_{j2} Duration + \beta_{j3}\ House\ Damage + \beta_{j4}\ HH\ goods\ Damage + \beta_{j5}\ Income\ Loss + \beta_{j6}\ Pre-flood\ Income + \beta_{j7} Caste$$

where,

- $j \in [1, J-1]$ are the levels of the ordinal outcome variable Y model 1 (damage to house, household goods, or income loss) and model 2 (consumption loss).
- $(P(Y \leq j)$ is the probability that the level of damage or loss is less than or equal to a specific category j.
- β_{j0} is the intercept term that varies across the levels of the ordinal outcome variable, allowing for different baseline probabilities for each category.
- β_{j1}, β_{j2}, β_{j3}, (and β_{j5}, β_{j6}, and β_{j7}) are the regression coefficients for the independent variables. These may vary across the levels of the ordinal outcome variables if the parallel lines assumption is violated.

3.4.1.3 Factors associated with recovery

Next, to assess the factors associated with recovery (RQ.2), the interconnectedness across recovery dimensions, and the impact of different dimensions on change in consumption expenditure, I estimate the following:

Model 3

$$logit\ (P(Y \leq j)) = \beta_0 + \beta_1\ House\ Damage + \beta_2 HH\ goods\ Damage + \beta_3\ Income\ Loss + \beta_4 Pre-flood\ Income + \beta_5 Caste$$

Model 4

$$logit\ (P(Y \leq j) =$$

$$\beta_{j0} + \beta_{j1}\ House\ Damage + \beta_{j2} HH\ goods\ Damage + \beta_{j3}\ Income\ Loss + \beta_{j4} Pre-flood\ Income + \beta_{j5} Caste + \beta_{j6}\ House\ Recovery + \beta_{j7}\ HH\ goods\ Recovery + \beta_{j8}\ Income\ Recovery$$

where,

- $j \in [1, J-1]$ are the levels of the ordinal outcome variable Y (recovery of house, household goods, income, and consumption).
- $P(Y \leq j)$ is the probability that the level of recovery is less than or equal to a specific category *j*.
- β_{j0} is the intercept term for each category *j*.
- $\beta_{j1}, \beta_{j2}, \beta_{j3}, \beta_{j4}, \beta_{j5}$ and (β_{j6}, β_{j7}, β_{j8}) are the regression coefficients for the independent variables.

The model specification for consumption recovery differs from the recovery models for other dimensions. In the analysis, I hypothesize that the immediate loss of consumption is a direct consequence of the disaster itself and may not necessarily be reflected in the long-term recovery process. Direct disaster damages, short-term disruptions to the supply chains, temporary displacement, etc., could drive consumption loss in the immediate aftermath. For example, households in Chiplun might have experienced a sudden drop in their consumption expenditures due to the destruction of their belongings, temporary displacement, or unavailability of goods and services. However, the change in consumption after two years could be associated with

sustained damages (house, household goods, and income) and the recovery tradeoffs households make. Over time, households may develop new consumption patterns or prioritize certain expenses over others as they make recovery decisions.

Additionally, including consumption loss immediately after the disaster in the consumption recovery model may introduce compounding effects, obscuring the influence of other relevant factors that shape consumption recovery at that time. This complexity could be a reason why the models do not converge when immediate consumption loss is included in the analysis.

3.4.2 Analysis

3.4.2.1 Multicollinearity

I checked for multicollinearity before proceeding with the analysis. I employed Spearman's rho to assess the magnitude and direction of associations among my independent variables (primarily binary and ordinal). Spearman's rank correlation quantifies how strongly two ranked variables are related and in what direction their relationship trends (Schober et al., 2018). The interpretation of Spearman's correlation coefficient is similar to that of Pearson correlation coefficients. A large Spearman's correlation coefficient (either positive or negative) suggests a strong monotonic relationship between the ordinal variables. In addition to Spearman's correlation coefficient, I tested for variance inflation factors (VIF). Spearman's rank correlation and VIF results do not indicate multicollinearity between the independent variables.

Table 3-1: Spearman's rank correlation

		1	2	3	4	5	6	7	8	9	10	11	12	13
1	hh goods damage	1												
2	income damage	0.03	1.00											

3	house damage	0.05	0.00	1.00										
4	house recovery	-0.12	-0.20	-0.09	1.00									
5	assets recovery	-0.06	-0.17	-0.14	0.56	1.00								
6	income recovery	0.04	-0.48	-0.04	0.21	0.18	1.00							
7	caste missing	-0.04	0.01	0.06	-0.17	-0.10	-0.09	1.00						
8	upper caste	0.03	-0.04	-0.04	0.24	0.14	0.14	-0.37	1.00					
9	income 2021	0.13	-0.17	0.03	0.13	0.20	-0.06	0.03	0.17	1.00				
10	water level	0.13	0.10	0.15	-0.11	-0.12	-0.07	0.03	0.08	-0.06	1.00			
11	duration	-0.05	0.07	0.05	0.03	-0.05	-0.04	-0.06	0.09	-0.03	0.14	1.00		
12	salaried	-0.01	-0.40	-0.05	0.16	0.15	0.23	-0.05	-0.06	0.16	0.02	-0.02	1.00	
13	business	0.08	0.32	0.04	-0.06	-0.01	-0.29	0.04	0.02	0.13	0.02	-0.05	-0.48	1

3.4.2.2 Proportional Odds Assumption

In ordered logistic regression, it is assumed that the effect of independent variables is uniform across all outcome level comparisons (Agresti, 2012). This assumption, known as the proportional odds assumption or parallel regression assumption, implies that "the coefficients describing the relationship between the lowest versus all higher categories of the response variable are identical to those describing the relationship between the next lowest category and all higher categories, and so forth" (de Talancé, 2017, Pg no. 140). Essentially, there is only one set of coefficients or a single model, as the association between all pairs of groups is assumed to be the same. Without this assumption, different models would be necessary to describe the association between each pair of outcome groups, reflecting varying relationships across the outcome categories.

3.4.2.3 Partial proportional odds models for ordinal dependent variables

The partial proportional odds model estimated using *gologit* is less restrictive than the proportional odds model, which assumes that the coefficients are constant across the levels of the

ordinal outcome variable (parallel lines assumption); however, it offers greater simplicity and ease of interpretation compared to non-ordinal methods like multinomial logistic regression (Liu et al., 2012). I use the *autofit* option to test the assumption of parallel lines for each predictor variable. This allows the coefficients to vary across the levels of the outcome variable when the assumption was violated.

3.4.2.4 Multivariate Analysis[23]

Since my study's damage and recovery variables are ordinal, I estimated ordinal logit models to examine the factors associated with damage and recovery across different dimensions, such as housing, household goods, income, and consumption.

To assess the interconnectedness across dimensions, I incorporate damage and recovery variables as predictors in the models. For example, when modeling housing recovery, I include variables representing damage to and recovery of household goods and income. Lastly, to assess the impact of recovery tradeoffs on change in well-being, I include predictor variables representing damage to and recovery in housing, household goods, and income.

I run the damage analysis on the entire sample. After accounting for missing values, the sample size ranges from 360 to 350. For the recovery analysis, I drop the observations with missing values. The sample size for recovery models is 334.

[23] I compare the results of ordinal logit and generalized ordinal logit models to check for the magnitude and direction of the coefficients. I do not find any significant differences across models. Since the substantive impact on the conclusions is minor, I report the ordinal logit model results because it is easy to interpret and more parsimonius.

3.4.2.5 Correlation to Assess Interconnectedness

However, the bidirectional relationship between recovery dimensions can lead to endogeneity between recovery variables. There is a question of which recovery occurs first, and it is possible they influence each other simultaneously. Thus, I also test for correlation between different recovery dimensions for the analysis of the interconnectedness of recovery. I run a Spearman's correlation for recovery dimensions. For this, I focus on households that experienced recovery across all dimensions (n = 290).

3.4.2.6 Qualitative Insights into Household Experiences

I report the findings from open-ended questions to capture the feedback loops in recovery and to understand the underlying mechanisms and interconnectedness of recovery processes. I examined the responses to open-ended questions to identify common themes and patterns, which gave me more insights into the findings of the quantitative analysis. I use the categories from the quantitative results section to code my qualitative data - interconnectedness, income recovery, and change in consumption.

3.5 Results

3.5.1 Magnitude of flooding and socioeconomic characteristics

The majority of the respondents reported flood water beyond waist level in their house during the 2021 flood event, with water submerging the ground floor up to 10 feet (48%), followed by water at the overhead level (33%) (Table 3-2). Approximately 22% had water in their homes for a day, while 15% had water for more than 2 days. A significant majority, 63%, reported being affected for two days, indicating prolonged inundation for many.

Around 35% of the surveyed respondents belonged to an upper caste. Most respondents fell within the 10,001-20,000 per month income bracket, comprising 29% of the population, followed by those earning 20,001-30,000 per month (20%). Around 15% of the respondents fell within the 5,001-10,000 per month range, while the respondents earning between 30,001-40,000 per month accounted for 16%. The higher income brackets above 40,000 per month collectively represented 20% of the sample.

Table 3-2: Descriptive Statistics of Flood Exposure and Socioeconomic Characteristics

Water level (n = 383)	**Percent**
Knee deep (0.4 - 1.5 ft)	2.87
Waist deep (1.6 - 3.3 ft)	2.35
Mid chest (3.4 - 5.5ft)	13.32
Overhead (5.6 - 6 ft)	33.16
Ground floor underwater (10 ft)	48.3
Duration (n = 389)	**Percent**
1 d	21.85
2 d	63.24
More than 2 d	14.91
Income (n = 367)	**Percent**
5,001- 10,000 per month	15.26
10,001- 20,000 per month	28.61
20,001 - 30,000 per month	19.89
30,001 - 40,000 per month	16.08
40,001 - 50,000 per month	6.27
More than 50,000 per month	13.9
Caste (n = 389)	**Percent**
upper caste = 0	65.04
upper caste = 1	34.96
Salaried (n=389)	**Percent**
salaried = 0	66.07

salaried = 1	33.93
Business (N=388)	**Percent**
business = 0	77.58
business = 1	22.42

3.5.2 Damage

Around 37% of the surveyed households reported minor damage to the house, and around 60 % reported considerable damage. Around 96% of the surveyed households reported damage to household goods (appliances and furniture) (Table 3-3). A significant portion (57%) of the surveyed respondents reported medium damage to their household goods (4-6 appliances/ furniture items damaged).

Table 3-3: Descriptive statistics of damage across dimensions

Variable		Category	Percent
House damage (n = 375)	1	minor damage	36.8
	2	significant damage	59.47
	3	house destroyed	3.73
Household goods damage (n = 389)	1	no damage	3.6
	2	low damage (1-3)	27.25
	3	medium damage (4-6)	56.56
	4	high damage (7-9)	12.6
Income loss (n = 375)	1	no loss	40.53
	2	moderate loss	34.67
	3	significant loss	24.8
Total Consumption loss (n = 389)	1	no loss	39.07
	2	moderate loss	44.99
	3	significant loss	15.94
Food Consumption loss (n = 366)	1	no loss	54.37
	2	moderate loss	32.51

	3	significant loss	13.11
Durable Consumption loss (n = 366)	1	no loss	22.68
	2	moderate loss	43.99
	3	significant loss	33.33

In terms of income, around 41% of surveyed households reported no loss of income (i.e., no change or a slight increase in their income), 35% reported a moderate loss of income (i.e., slight decrease), and around 25% reported a significant income loss.

Around 39% of the households reported that their total consumption expenditure stayed the same or increased slightly in the immediate aftermath of the flooding. At the same time, 61% of the households reported that they experienced a decline in their total household consumption immediately after the flooding. Most surveyed households (54%) either maintained or experienced a slight increase in food expenditure post-flood. Around 23% of households reported no change or increased expenditure on durable goods. A significant portion of the households (77%) experienced decreased spending on durable goods.

3.5.2.1 Factors associated with damage - house (structure), household goods, and income

All explanatory variables in the models meet the parallel lines assumption. Thus, I report the output from an ordinal logit model. The flood water level was significantly associated with damage to the house (structural damage), household goods, and income loss (Table 3-4).

In terms of income loss, as the household's pre-flooding income increased, the likelihood of post-flooding income loss was reduced (Table 3-4: Models 3 & 4). Households with salaried employees were more likely to report lower income loss (a stable income or an increase) immediately after the flood. Conversely, households with businesses were more likely to report a

post-flooding income loss. Business owners could have experienced income losses due to business closures, reduced consumer demand, and supply-chain disruptions. On the contrary, pre-flooding income had a positive association with the loss of household goods. As the pre-flooding income increased, the likelihood of damage to household goods also increased, suggesting the higher income households in Chiplun were more likely to experience greater damage to household goods.

Table 3-4: Factors associated with damage to income, house, and household goods using ordinal logit regression

	house damage 1	hh goods damage 2	income loss 3	income loss 4
water level	**0.316****	**0.305****	**0.267***	**0.303****
	0.117	0.107	0.109	0.117
duration	0.124	-0.228	0.22	0.231
	0.18	0.172	0.171	0.179
upper caste	-0.141	-0.118	-0.096	-0.357
	0.247	0.233	0.228	0.241
Pre-flooding income (2021)	0.086	**0.162***	**-0.199****	**-0.213****
	0.071	0.067	0.066	0.073
salaried				**-1.261*****
				0.273
business				**0.910*****
				0.253
cut1	1.755*	-2.024*	0.784	0.792
	0.832	0.798	0.782	0.829
cut2	5.566***	0.697	2.402**	2.680**
	0.894	0.759	0.791	0.842
cut3		3.496***		
		0.782		
N	351	362	353	353

pseudo R-squared	0.018	0.019	0.025	0.119
AIC	568.205	761.226	756.496	688.83
BIC	595.23	792.359	783.561	723.629

Note: *** p<0.01, ** p<0.05, * p<0.1. Coefficients and standard errors are reported. Significant coefficients are in bold and highlighted

3.5.2.2 Factors associated with loss of consumption in 2021

Flood water level was significantly associated with loss of food and durable consumption, while the duration of water in the house was associated with loss of total consumption in the immediate aftermath of flooding (Table 3-5). Belonging to a higher income group and upper caste appears to mitigate the adverse effects on consumption in the immediate flood aftermath. The household's pre-flooding income was associated with the changes in consumption, with higher-income households reporting lower damage to consumption (stable or increased spending on durables) post-disaster, aligning with previous studies (Antilla-Hughes et al., 2013; Karim et al., 2016; Walsh et al., 2010; Hallegatte et al., 2017). Similarly, if a household belonged to the Hindu upper caste, the likelihood of higher loss of consumption was reduced.

3.5.2.3 Interconnectedness: Change in consumption and damage

To capture the interconnectedness between damage and change in consumption, I examine the relationship between damage across different dimensions and consumption immediately after the 2021 flooding (Table 3-5: Models 2, 4, and 6). Households with greater income loss were more likely to reduce their overall consumption expenditure as well as consumption expenditure on food and durables. Additionally, households with higher damage to house (structure) were more likely to report reduced total consumption and consumption of food.

Table 3-5: Factors associated with loss of total consumption, food consumption, and durable consumption in the immediate aftermath of 2021 flooding using ordinal logit regression

	total consumption loss 1	total consumption loss 2	food consumption loss 3	food consumption loss 4	durable consumption loss 5	durable consumption loss 6
water level	0.213	0.07	**0.300***	0.194	**0.346****	0.238
	0.111	0.121	0.12	0.126	0.113	0.122
duration	**0.387***	**0.423***	0.131	0.139	0.352	0.313
	0.174	0.187	0.184	0.193	0.18	0.19
upper caste	**-0.758****	**-0.826****	**-0.962*****	**-1.040*****	**-1.106*****	**-1.147*****
	0.238	0.255	0.258	0.268	0.243	0.253
Pre-flooding income (2021)	**-0.289*****	**-0.238****	**-0.255*****	**-0.252****	**-0.292*****	**-0.228****
	0.067	0.075	0.074	0.079	0.07	0.075
income loss		**1.243*****		**0.557*****		**0.827*****
		0.157		0.146		0.15
house damage		**0.420***		**0.422***		0.341
		0.204		0.213		0.205
hh goods damage		0.002		0.233		-0.154
		0.166		0.175		0.173
cut1	0.333	2.653**	0.691	2.242*	-0.139	1.085
	0.804	0.965	0.843	0.987	0.784	0.914
cut2	2.639**	5.467***	2.610**	4.285***	2.047**	3.405***
	0.816	1.007	0.855	1.011	0.792	0.934
N	362	343	342	324	342	324
pseudo R-squared	0.06	0.166	0.059	0.092	0.08	0.123
AIC	707.927	605.99	638.307	599.513	684.548	624.197
BIC	735.168	644.367	665.151	637.32	711.391	662.004

Note: *** p<0.01, ** p<0.05, * p<0.1. Coefficients and standard errors are reported. Significant coefficients are in bold and highlighted

3.5.3 Recovery

At the time of the survey (around two years after the flood), a significant portion of respondents reported their house condition as either worse (54%) or similar to the pre-flood situation (27 %) (Table 3-6). At the same time, a smaller percentage noted slight improvements in house condition (20%). Around 42% of the surveyed households reported a decline in the condition of their household goods two years after the flooding. In terms of income, 68% of households reported no change in their income compared to the pre-disaster situation.

Around 70% of households reported that their total consumption spending and spending on food consumption stayed the same. However, only 32% reported similar spending on durables, while 64% reported a reduced durable expenditure even two years after the flood. This indicates that many households may have had to cut back on non-essential purchases or could not replace durable goods lost or damaged in the flooding. A decline in the condition of household goods and reduced spending on durables two years after the flooding suggest that households could be prioritizing essential needs over non-essential items as they deal with the impacts of the 2021 flooding.

Table 3-6: Descriptive statistics of recovery across dimensions

Variable		Category	Percent
house condition recovery (n = 350)	1	significantly worse	12.86
	2	slightly worse	40.57
	3	stayed the same	26.57
	4	better	20
household goods recovery (n = 350)	1	significantly worse	6.29
	2	slightly worse	36
	3	stayed the same	43.43

	4	better	14.29
income recovery (n = 350)	1	slightly reduced	28.29
	2	stayed the same	68
	3	increased	3.71
total consumption (n = 338)	1	significantly reduced	4.44
	2	slightly reduced	21.01
	3	stayed the same	70.41
	4	increased	4.14
food consumption (n = 339)	1	significantly reduced	4.72
	2	slightly reduced	21.83
	3	stayed the same	71.09
	4	increased	2.36
durable consumption (n = 340)	1	significantly reduced	12.94
	2	slightly reduced	51.18
	3	stayed the same	32.35
	4	increased	3.53

3.5.3.1 Factors associated with recovery dimensions

In this section, I assess how caste and economic class of the household are associated with recovery across different dimensions.

The caste of the affected household was a significant factor associated with recovery conditions in housing, income, and household goods. Belonging to a higher caste offers protection against decreased income and deterioration in housing and household goods conditions. Households belonging to the Hindu upper caste were more likely to report higher levels of recovery of income, house (structure), and household goods.

The pre-disaster income of the household was associated with the recovery of income and household goods. Pre-disaster income was not associated with the change in housing conditions.

The relationships are different for the recovery of income and household goods. In the case of household goods recovery, higher pre-flooding income is associated with the same or improved condition of household goods. In the case of income recovery, higher pre-flooding income is associated with a lower level of income recovery. Additionally, the results indicate a negative relationship between business and income recovery, indicating that households with businesses as a source of employment are more likely to report lower levels of income recovery.

Analysis of the open-ended questions shows why the income recovery of businesses is lacking. While large business owners have more resources to draw upon compared to their poorer counterparts, they face significant challenges in income recovery, such as not being able to access insurance payouts. As a result, they had to rely on substantial loans and assistance from various sources to recover:

> *We had insurance for the shop but we had not read the clause properly. Loan (16 lakhs) with interest from moneylenders and family/ friends.* (Survey 1701)
>
> *The recovery will depend on market condition. No insurance because water fills in this area regularly [maybe they mean insurance companies do not provide insurance to business owners here].* (Survey 1810)
>
> *Moved vehicles to a higher ground. waited for 2 monsoons to fix the house. Insurance claims do not happen here. Even the insurance companies do not give money here. They are aware of the topography. After 2005 flooding, insurance companies removed the claim. So now no insurance after 2005.* (Survey 1714)

3.5.3.2 Interconnectedness: Recovery and Damage

To understand the interconnectedness across dimensions, I examine the association between each dimension of recovery with damage across all dimensions (Table 3-7: Models 1, 3, and 5). Recovery of house (structure), household goods, and income were negatively associated with income loss, indicating that households with higher loss of income were more likely to report a

lower condition of house and household goods and lower recovery of income two years after the event. Recovery of household goods was negatively associated with damage to the house (structure), suggesting that households with higher damage to their homes were more likely to report lower condition of household goods. An interesting finding is the positive association between income recovery and damage to household goods (Table 3-7: Models 6 and 7), indicating that households with higher damage to household goods were more likely to report better income recovery. This could indicate the prioritization of income restoration over the replacement of household goods.

3.5.3.3 Interconnectedness of Recovery Dimensions

I also assess the interconnectedness between recovery dimensions (Table 3-7: Models 2, 4, 6 and 7). In terms of interconnectedness of recovery dimensions, the results show that households with same or improved housing conditions are more likely to report same or better recovery of household goods (Table 3-7: Model 4).

Table 3-7: Factors associated with loss of recovery of house, household goods, and income using ordinal logit regression

	house recovery 1	house recovery 2	hh goods recovery 3	hh goods recovery 4	income recovery 5	income recovery 6	income recovery 7
house damage	-0.221	0.035	**-0.483***	**-0.404***	-0.216	-0.085	0.013
	0.189	0.199	0.196	0.204	0.281	0.244	0.248
income damage	**-0.410****	-0.224	**-0.305***	0.028	-0.578	**-1.564*****	**-1.660*****
	0.134	0.16	0.135	0.163	0.306	0.212	0.204
hh goods damage	-0.303	-0.27	-0.182	-0.08	0.433	**0.528***	**0.508***
	0.159	0.171	0.165	0.175	0.232	0.207	0.206
pre-flooding income (2021)	0.128	0.022	**0.229****	**0.228****	**-0.375*****	**-0.274****	**-0.369*****
	0.067	0.073	0.07	0.075	0.111	0.095	0.094

upper caste	**0.725****	**0.545***	**0.482***	-0.029	**1.112****	**0.989****	**0.738***
	0.228	0.239	0.233	0.248	0.349	0.312	0.31
income recovery		0.218		0.43			
		0.249		0.25			
hh goods recovery		**1.718*****					0.313
		0.172					0.205
house recovery				**1.442*****			0.203
				0.152			0.173
salaried						0.184	
						0.356	
business						**-0.824***	
						0.325	
cut1	-2.999***	1.712	-3.486***	1.038	-2.150*	-4.503***	-3.302***
	0.58	0.904	0.61	0.914	1.013	0.81	0.924
cut2	-0.698	4.652***	-0.934	4.079***	2.432*	0.974	2.077*
	0.552	0.931	0.565	0.92	1.123	0.766	0.913
cut3	0.569	6.317***	1.243*	6.961***			
	0.553	0.962	0.571	0.985			
N	334	334	334	334	201	334	334
pseudo R-squared	0.047	0.188	0.047	0.194	0.087	0.239	0.235
AIC	844.668	726.333	777.966	664.835	294.837	403.117	405.056
BIC	878.969	768.256	812.267	706.757	321.264	441.228	443.167

Note: *** p<0.01, ** p<0.05, * p<0.1. Coefficients and standard errors are reported. Significant coefficients are in bold and highlighted

Pre-flooding income of the household was positively associated with each measure of consumption expenditure recovery (Table 3-8). Caste is not associated with recovery of consumption.

In terms of interconnectedness, households with a higher loss of income were more likely to report lower levels of recovery for each measure of consumption expenditure. Additionally,

households with higher levels of housing recovery were more likely to report stable or increased spending in 2023 (2 years after the survey).

Table 3-8: Factors associated with recovery of total consumption, food consumption, and durable goods consumption

	total consumption recovery 1	total consumption recovery 2	food consumption recovery 3	food consumption recovery 4	durable consumption recovery 5	durable consumption recovery 6
income damage	**-0.697*** **	**-0.643*** **	**-0.579*** **	-0.358	**-0.763*** **	**-0.742*** **
	0.163	0.184	0.163	0.186	0.15	0.171
house damage	0.099	0.165	-0.144	-0.098	-0.049	-0.016
	0.226	0.231	0.228	0.237	0.201	0.202
hh goods damage	-0.285	-0.226	**-0.438***	**-0.414***	-0.183	-0.156
	0.19	0.193	0.194	0.199	0.17	0.171
pre-flooding income (2021)	**0.321*** **	**0.272** **	**0.333*** **	**0.334*** **	**0.340*** **	**0.321*** **
	0.087	0.091	0.09	0.096	0.075	0.077
upper caste	0.28	0.129	0.494	0.243	-0.075	-0.175
	0.28	0.288	0.288	0.297	0.242	0.248
house recovery		**0.337***		**0.437** **		0.213
		0.162		0.166		0.144
hh goods recovery		0.264		0.128		0.114
		0.189		0.193		0.171
income recovery		-0.065		0.411		-0.074
		0.276		0.281		0.258
cut1	-3.549***	-2.138*	-3.784***	-1.292	-2.560***	-1.840*
	0.708	1.055	0.716	1.065	0.618	0.93
cut2	-1.377*	0.115	-1.658*	0.91	0.264	1.045
	0.664	1.033	0.675	1.057	0.593	0.92
cut3	3.260***	4.844***	3.455***	6.188***	3.183***	3.962***
	0.713	1.1	0.748	1.158	0.659	0.972

N	322	322	322	323	322	324
pseudo R-squared	0.078	0.099	0.077	0.105	0.08	0.087
AIC	526.745	521.198	507.909	499.588	665.93	669.458
BIC	560.716	566.493	541.88	544.919	699.901	714.827

Note: *** p<0.01, ** p<0.05, * p<0.1. Coefficients and standard errors are reported. Significant coefficients are in bold and highlighted

I also test for correlation between different recovery dimensions given the potential endogeneity between recovery dimensions (Table 3-9). The correlation between house (structure) recovery and household goods recovery is moderate, indicating that households might be recovering these two dimensions simultaneously.

Table 3-9: Spearman's rank correlation: Interconnectedness of recovery dimensions

	house recovery	hh goods recovery	income recovery
hh goods recovery	**0.5887***		
income recovery	0.2659*	0.2378*	
total consumption recovery	0.2677*	0.2723*	
food consumption recovery	0.3149*	0.2913*	0.1376
durable consumption recovery	0.1315	0.1479*	-0.0503

Analysis of open-ended questions provides additional insights into potential feedback loops in recovery and helps understand the underlying mechanisms and interconnectedness of recovery processes.

The story below recounts how a household lost their tempo (a source of income) and how the daughter's education was impacted:

> *Could not pay school fees. One daughter was removed from school now she is going to public school. Fees are pending. The fee is 1 K/month. My husband used to drive a tempo which was on loan. We could not pay the loan. The bank took it back.* (Survey 1603)

Households also reported tradeoffs between different dimensions of recovery:

> *Cannot afford constructing a new house. education fees of kids important.* (Survey 1912)
>
> *Income recovery is a priority…restoring house and household goods is not a priority.* (Survey 1915)

In the following case, the household consists of salaried employees with an income of more than 50,000 per month. They did not loose income from the flood. After the flooding recovering their house (structure) was the first priority:

> *We did not take any help from organisations…. We were stable so did not feel any significant impact. We stayed upstairs in the same building on rent for 1 year…. We tiled the entire house to protect from future flooding.* (Survey 1901)

In the next case, the household had a relatively stable monthly income from multiple sources - business and salaried employment. The loss of income was low. Despite the severe impact of the flood on their previous house and belongings, the family managed to reconstruct a new house within 18 months, demonstrating a degree of financial resilience and recovery:

> *Government was not giving permission to construct new homes in red line. We constructed a new house with parking level matching the previous flood level height. We stayed on rent while the house was being constructed. We have previous flooding experience in 2007 and 2019.* (Survey 2303)

Loss of income also had an impact on the consumption expenditure of households:

> *Big loss in income….still cutting on consumption.* (Survey 1801)
>
> *.. still cutting on essential and non-essential consumption to deal with costs.* (Survey SAM1901)

Household experiences highlight how recovery is not a linear process and how the flooding impacts on different dimensions are all intertwined. They also highlight how a setback in one area can delay the progress in other areas, thereby prolonging the recovery process further for

some. Experiences shared by the households also demonstrate that households with lower loss of income (with secure jobs, stable incomes, and alternative sources of income) were better positioned to bounce back from the impacts of the 2021 Chiplun flooding.

3.6 Discussion and Conclusions

This study employs a case study approach, utilizing data from household surveys (n = 380) to assess damage and recovery across multiple dimensions following the 2021 flooding in Chiplun, Maharashtra, India. The central argument of this study is that a just and equitable recovery begins with how recovery is conceptualized and measured. This research extends the literature on disaster recovery in three ways.

First, the study offers a more comprehensive view of disaster damages and recovery, examining multiple dimensions, including income and consumption change, housing restoration, and household goods recovery. This multidimensional approach aligns with the body of literature that emphasizes the importance of considering multiple aspects of recovery (Arlikatti et al., 2010; Patankar, 2015; Markhvida et al., 2015; Walsh et al., 2019; Sou et al., 2021). Moreover, it resonates with frameworks and guidelines developed by international organizations for assessing post-disaster impacts (Jeggle et al., 2018). The findings reveal disparities in recovery across different dimensions. Around half of the surveyed households reported struggling with the recovery of house and household goods two years after the flood. This aligns with the previous literature that has highlighted the long-term nature of property and asset recovery (Peacock et al., 2014; Morris et al., 2002; Carter et al., 2007). Additionally, around 65 percent of households reported reduced expenditures on durable goods at the time of the survey (Hallegate et al., 2017). Qualitative data from open-ended survey questions give

further insights into the reasons behind the slow recovery of certain dimensions. Many households noted that they had either delayed the repair and restoration of housing and damaged goods or feared another flood would impact their homes again. Some noted that they were prioritizing livelihood restoration and basic needs above the restoration of housing and household goods.

Second, this study adds to the limited quantitative literature examining the relationship between caste and disaster impacts by focusing on social stratification to study disaster impacts. In India, lower-caste communities face multiple forms of marginalization - geographical, occupational, and political, increasing their exposure and vulnerability to disaster (Arlikatti et al., 2010). Prior empirical evidence shows that lower-caste communities face systematic discrimination in evacuation, relief, and rehabilitation processes (National Dalit Watch, 2012; Irshad, 2014), which influences their overall recovery.

In a study conducted after the 2004 Tsunami, caste was found to be a strong predictor of aid distribution (Aldrich, 2010; Jain, 2019). In the current study, the caste of households in Chiplun was consistently associated with the change in consumption expenditure across all categories in the immediate aftermath of the disaster. This association could be attributed to challenges in receiving aid from external sources, a hypothesis supported by qualitative data from the fieldwork. Respondents from Gandhinagar (a lower-caste community) reported challenges in accessing aid, disparities in compensation, lack of proper assessment by the government, loss of ration cards, and diminished support compared to more accessible parts of the city.

Furthermore, findings reveal that lower-caste households were more likely to report lower levels of recovery across all dimensions two years after the flooding. This finding extends the temporal

scope of previous studies (Arlikatti et al., 2010), indicating that the caste-based impacts persist beyond the immediate aftermath. Housing and infrastructure conditions in lower-caste communities were noted to be poor, with houses having developed significant cracks in the walls post-flooding. Lastly, the research also highlights the occupational vulnerabilities of lower-caste communities (National Commission for Enterprises in the Unorganized Sector, 2008). Households in these communities, primarily engaged in daily wage labor, including construction and domestic work, reported a significant decline in job opportunities following the 2021 flooding.

In terms of economic class, results indicate that higher pre-flooding income was associated with a higher recovery of household goods but a lower income recovery. Prior research has shown that lower-income households tend to allocate fewer resources toward mitigating risks and possess lower-quality assets, exacerbating the impact of disasters (Hallegatte et al., 2017; Jakobsen, 2012). Studies following disasters like Hurricane Mitch have shown that the lowest wealth quintile experienced significant asset reduction, with losses lasting longer and more severe for poorer households (Morris et al., 2002; Carter et al., 2007).

Conversely, households with higher income levels in 2021 were more likely to report lower levels of income recovery two years after the event compared to their baseline levels. The negative association could be because the business community in Chiplun faced disproportionate losses and was still struggling to restore businesses and income to pre-disaster levels at the time of the survey. Businesses requiring storage, such as clothing stores and grocery shops, suffered substantial losses. Developers in the city are facing a stall in work because of new government restrictions and a significant decrease in demand. Furthermore, business owners reported challenges in receiving insurance payouts due to restrictive policies.

By examining both caste and class dimensions, this study underscores the need for tailored policy measures to address the diverse recovery challenges faced by different segments of society, such as business revitalization programs and targeted policies focused on housing restoration and income support for lower-caste households.

Third, the research highlights the interconnectedness between different dimensions of damage and recovery. Income loss emerged as a critical factor in the findings. In the immediate aftermath of the 2021 flooding, households with a higher loss of income were likely to report greater reductions in consumption expenditure. This finding aligns with a study conducted in the Philippines, which found that typhoon-induced income losses translated almost directly into reduced household expenditures (Antilla-Hughes et al., 2013). This indicates that, in the absence of effective coping strategies, the households could be forced to make substantial adjustments to their consumption expenditure in response to the financial strain caused by the disaster.

Two years after the flooding, households that had experienced higher income loss were more likely to report lower levels of recovery across multiple dimensions, including house (structure), household goods, and income. These findings underscore the need for livelihood restoration policies to support a more holistic recovery in the aftermath of disasters.

3.7 Limitations and Future Research

3.7.1 Adaptive Resilience

I collected information on the coping strategies utilized by the household to capture their adaptive resilience. Respondents were asked to indicate which coping strategies they employed post-flooding. The strategies included household coping (sale of assets, use of savings) and

reliance on social networks (receiving monetary assistance from various formal and informal organizations).

A bivariate analysis of household coping strategies and demographic characteristics depicts significant differences. Non-Hindus relied more on social networks than Hindus, lower-caste households depended more on social networks compared to upper-caste households, and lower-income households showed greater reliance on social networks. On the other hand, results show that higher-income households relied more on household coping mechanisms like the sale of assets and the use of savings.

Open-ended responses provided additional insights: some households didn't seek organizational help because their houses were in good condition, financially stable individuals often relied on their own resources rather than social networks, and some respondents expressed pride in self-reliance and reluctance to accept outside help. These responses and results of the bivariate analysis indicate pride or stigma could be associated with seeking social assistance. Studies in the past have found that disaster victims from certain communities and socioeconomic backgrounds often struggle with accepting aid in the aftermath of disaster due to their self-perception and social status (Fothergill, 2003). Future research will explore this stigma associated with disaster assistance. Additionally, future research will assess the complex relationship between the types of coping mechanisms used and household recovery and the interaction between social network reliance and household sociodemographic characteristics.

Table 3-10: Bivariate Analysis of Coping Mechanisms and Household Characteristics

Variable	Reliance on Social Networks	No Reliance on Social Networks	p-value
Income	3.58	4.38	0.00

Religion (Hindu = 1)	0.67	0.76	0.05
Caste (Upper Caste = 1)	0.34	0.48	0.02
Variable	**Reliance on Household Coping**	**Reliance on Household Coping**	**p-value**
Income	4.32	3.76	0.00

Note: Only significant differences reported

3.7.2 Interconnections and Recovery Pathways

This study's interconnectivity analysis is limited because of its design, which relies on perception-based questions and cross-sectional data. Future studies could use longitudinal data to tease out the causal pathways between different dimensions of recovery. Panel surveys that follow the same households before and after a disaster, assessing their housing conditions, household goods, income, and detailed consumption expenditure, combined with rich flooding information, could provide a more robust understanding of the underlying recovery mechanisms.

Lastly, future research should also explore how recovery pathways vary based on socioeconomic characteristics. This analysis could highlight potential inequities in the recovery process, helping us understand how people from various socioeconomic backgrounds make these tradeoffs. Future research is needed in other localities across India and in other disaster scenarios to better understand how the patterns observed in Chiplun apply to other regions and contexts.

CHAPTER 4: UNPACKING FLOOD RISK IN CHIPLUN, MAHARASHTRA: UNDERSTANDING RISK DRIVERS AND ROOT CAUSES

4.1 Abstract

This study examines the narratives and policies surrounding flood risk in Chiplun, Maharashtra, in the aftermath of the 2021 flooding. Using disaster risk frameworks by Blaikie et al. (1994), Wisner et al. (2004), and Oliver-Smith et al. (2019), it assesses how narratives of different stakeholders engage with various dimensions of risk. Using narrative analysis, I examine how disaster causation is understood, how responsibilities are assigned, and how various voices are portrayed in flood risk policies.

Findings uncover three dominant narratives around flood risk in Chiplun: flooding as an act of nature, flooding as a result of urbanization, and flooding as a consequence of dam mismanagement. Different stakeholders attribute causation to different factors. The state primarily defines the 2021 flood event as an 'externalized' threat resulting from heavy rainfall, high tide, and topography and attributes flood risk to the development of flood zones. In contrast, residents affected by the flooding link the flooding to water discharge from dams (a failure of governance). A narrative where both the state and the residents agree is that of silt accumulation for reducing the water-carrying capacity of the river.

Emerging from these narratives, policies and projects implemented include technocratic solutions like removing silt from the river and dam management and urban governance decisions such as restrictions on development in flood zones. However, the proposed solutions and policies

barely engage with the risk drivers, such as poor governance or economic and development priorities that link the root cause to unsafe conditions. Root causes are deeply entrenched in a society's political economy, reflecting the distribution of power, resources, and decision-making authority (Wisner et al., 2004; Oliver-Smith et al., 2019) but remain unaddressed in policy discussions.

The study adds to the literature on underlying causes of disaster risk by highlighting the role of disaster risk narratives in a small town in India. It situates flood risk within the broader context of power dynamics and development paradigms that shape urban and disaster governance in India. The findings emphasize the need for the narratives to be holistic, moving beyond immediate triggers and physical hazards to address the underlying drivers and root causes of risk.

Keywords: Risk drivers, root causes, narratives

4.2 Introduction

Urban flooding is a growing concern in India and worldwide, posing a significant threat to people's health, livelihoods, and overall well-being as an increasing population becomes clustered in urban areas. With its rapid urban growth and changing climate patterns, India has witnessed a recent surge in the frequency and intensity of urban flood events (Singh et al., 2017). This underscores the need to understand and address the factors contributing to flood risk in Indian cities.

Urban flooding is a wicked problem characterized by its inherent complexity, uncertainty, and the involvement of multiple stakeholders with often competing interests (Rittel et al., 1973). Different actors attribute the causes of flood risk to different sources, processes, and entities,

which then become the basis for risk management policies (Marchezini et al., 2017). Narratives play a crucial role in policy-making as they reveal the underlying assumptions, values, and priorities that shape the understanding of the issue at hand (Lahsen et al., 2021). Narratives also allow for a more comprehensive understanding of the complex interplay of factors contributing to risk by uncovering the power dynamics, political interests, and ideological underpinnings that influence the decision-making process. I employ narrative analysis as an analytical tool to examine how disaster causation is understood, how responsibilities are assigned, and how various voices are portrayed in policies related to flood risk.

Since the 1970s, researchers have argued that disasters are not merely natural events but are deeply rooted in the social, economic, and political structures that shape societal exposure and vulnerability (Blaikie et al., 1994; Pelling, 1999; Wisner et al., 2004; Cutter, 1996; Oliver-Smith, 2019). This perspective calls for a more holistic understanding of disaster causation. Using the disaster risk frameworks by Blaikie et al. (1994), Wisner et al. (2004), and Oliver-Smith et al. (2019), I adopt a multi-layered approach to understanding the causes of flood risk, distinguishing between proximate causes (unsafe conditions), dynamic pressures (risk drivers), and root causes.

Using the case of the 2021 flooding event in Chiplun, India, this study aims to provide a deeper understanding of how flood risk is discursively produced and addressed in Indian cities by answering the following research questions:

1. What narratives emerged about flood risk after the 2021 flooding?
2. How do different actors perceive and approach the problem of flood risk?
3. How do these narratives relate to the observed policy responses or outcomes?
4. How do these narratives and policy responses engage with different aspects of disaster risk—unsafe conditions, dynamic pressures, and root causes?

The study makes two empirical contributions to the literature on disaster risk. First, it extends the existing knowledge by employing a narrative analysis approach and highlighting the discursive and political dimensions of risk production and management. The study's multi-layered approach, drawing from disaster risk frameworks, adds to a more comprehensive understanding of the complex interplay of factors contributing to flood risk, underscoring the need to address proximate causes, risk drivers, and root causes. Despite the growing need of the importance of addressing the root causes, research efforts focused on understanding them remain limited (Rumbach, 2017; Oliver-Smith, 2019; Wisner et al., 2015; Alcántara-Ayala et al., 2023; Marchezini et al., 2017). Moreover, studies take a historical approach to assessing the production of risk. No studies in the Indian context have analyzed the extent to which narratives of different actors/stakeholders engage with the root causes of flood risk. Second, the study highlights the perspective of a small urban place in India, a context often overlooked in the disaster studies literature. This study contributes to a more inclusive and contextually grounded understanding of flood risk in India by elevating the voices and concerns of an often-overlooked context.

In the next section, I give a brief overview of the evolution of theories and frameworks for understanding disaster risk, drawing on insights from geography, political ecology, and critical urban studies. I then outline the study's methodology, focusing on narrative analysis to examine the discursive construction of risk and the policy implications of different narratives. The study's findings consist of an analysis of the narratives and solutions addressing the causes of the 2021 Chiplun floods. It relies on a mix of primary interviews and secondary data collected during a 30-month period after the event. The data includes 15 semi-structured interviews with affected households, government officials, and representatives of different civic groups, letters written to the ministers of the state, government reports, affidavits, discussions on the city's development

plan, and news media coverage. Next, using the frameworks of disaster root causes, I examine how the narratives and proposed solutions engage with unsafe conditions, dynamic pressures, and root causes of flood risk. The conclusion reflects on the implications of the study's findings for our understanding of flood risk in Indian cities and summarizes the key contributions of the study, its limitations, and directions for future research.

4.3 Literature Review

4.3.1 Understanding of Disaster Causation

Over the past few decades, our understanding and theorizing of disaster causation have significantly evolved. These changes have influenced research, knowledge accumulation, discourse, and policy decisions. I give a brief overview of the evolution of disaster theories, focusing on political ecology, geography, and urban planning.

4.3.1.1 Disasters as Acts of God

The causal typology of disasters begins with "Disasters as Acts of God." Historically, disasters were considered uncontrollable forces of nature, and earlier explanations viewed disasters as acts of God beyond man's control (Verchick, 2012; White et al., 2001; Hewitt et al., 1971; Oliver-Smith et al., 2016). This explanation has been used by those in power or those responsible to avoid accountability for disasters. For example, in response to the Buffalo Creek disaster, the coal company attributed the calamity to an act of God. When pressed for clarification, a spokesperson suggested that the dam failed because it was unable to contain the water poured into the dam by God (Erikson, 1976).

4.3.1.2 Disasters as Acts of Nature (Nature-based paradigm)

Over time, the focus on natural causes started taking center stage, and disasters began to be attributed to environmental factors such as climate, geography, and topography (Hewitt, 1983). For example, floods occurred because of heavy precipitation, reduced soil carrying capacity, and the region's topography. A good definition of natural disaster is "an outside attack upon social systems that 'broke down' in the face of such an assault from outside" (Quarantelli, 1998, p. 266). Much of the early urban risk research views disasters as a one-off event. The prevention then focused on the form of damming rivers, building levees, etc. However, this approach was criticized for being highly technocratic and was dominated by geoscientists, engineers, landscape architects, etc.

4.3.1.3 Disasters as joint effects of nature and society (Perception Paradigm)

In the 1940s, the interest in understanding the human occupancy of hazard zones grew in policy and research. White's work represents a paradigm shift in how disasters were researched. Using a human ecology perspective, he conceived floods not as separate from society but as defined and shaped by human society (Rumbach, 2011). A fundamental insight into human adjustments came from White's work in 1945 (as cited in Macdonald et al., 2012, Page no. 125), where he writes, "Floods are acts of God, but flood losses are largely acts of man." This approach recognized that human settlements in the floodplains contribute significantly to the substantial annual total of flood-related losses.

The perception paradigm developed in the 1960s by White, Kates, and Burton incorporated psychological tests into fieldwork to understand how people perceive and respond to natural

hazards. It aimed to explain people's behavior and decision-making in the face of natural hazards. However, it focused more on human perception of risk and their actions than the societal conditions before the event (Gall, 2013; Wisner, 2016). The fieldwork conducted by White's students in the 1970s and 1980s demonstrated that issues such as poor governance, corruption, unequal resource access, and inadequate infrastructure investment played a more crucial role in turning natural hazards into disasters than individual risk perception, hazard-specific policies, or engineering solutions (Wisner, 2016). The risk perception paradigm did not adequately account for these broader structural factors that shape vulnerability to disasters.

4.3.1.4 Disasters as Social Constructions

In opposition to earlier frameworks that portrayed disasters as acts of nature or contented that humans put themselves in the way of hazards, around the 1970s, a critical body of disaster scholarship began to view disasters and disaster risk as socially constructed (Blakie et al., 1994; Cutter, 1996). Recent studies in political ecology and critical geography view them as products of societal inequalities, political struggles, and economic systems (Pelling, 1999; Wisner, 1994; Oliver-Smith, 2022). The concept of vulnerability and exposure emerged as key factors in understanding disaster risk and impacts under this paradigm (Oliver-Smith et al., 2019). The social constructionist perspective challenges deterministic views of disasters and emphasizes the role of human agency and social constructions in defining and responding to disasters. For instance, it is argued that disasters result not solely from natural hazards but also from political decisions and policy frameworks that perpetuate power imbalances and social inequities within societies (Oliver-Smith, 2022). This approach recognizes that vulnerability is socially

constructed and varies across different social groups based on factors such as race, class, gender, and ethnicity.

While natural and technological forces still dominate the research on hazards and disasters, today, vulnerability approaches based on social construction have become mainstream for examining risk and recovery (Cutter, 2003; Rumbach, 2010). Vulnerability frameworks offer a nuanced understanding of disasters, diverging from traditional linear explanations. First, they view disasters as cyclical phenomena shaped by conditions before, during, and after the event, emphasizing the interconnectedness of hazards and the lasting impacts of previous disasters. This departure from linear models is crucial in urban contexts where various hazards and stresses interact (Pelling, 2003). Second, vulnerability approaches contextualize hazards within broader economic, political, and institutional dynamics, highlighting how specific households and groups are disproportionately affected. Disasters are not isolated incidents but reflections of systemic failures within societies and places.

O'Keefe et al.'s (1976) paper, "Taking the Naturalness out of Natural Disasters," argues that the rising vulnerability to hazards and disasters globally stemmed from intensified political and economic struggles. This perspective, rooted in political ecology, shifted the focus towards recognizing human-driven factors as key contributors to vulnerability rather than viewing disasters as natural phenomena (Cutter, 2009). This political ecology approach was more human-centric and examined who was most vulnerable and why.

Subsequent theoretical developments, such as Blaikie and Wisner's "At Risk" model, further underscored the human-centric approach to understanding vulnerability (1990). Their pressure

and release model (PAR) outlined how vulnerability was produced through the interaction of "dynamic pressures" (forces like urbanization, globalization, etc.) with pre-existing conditions or "root causes" (socioeconomic characteristics, e.g., limited access to resources). PAR tracked the progression of vulnerability from root causes to dynamic pressures that interact with natural events.

Table 4-1: The progression of understanding of disaster risk

Causation of disaster	**Description**	**Solutions or policies**
Act of nature	Focus on the physical aspects like precipitation, topography, etc, as the primary cause of disaster	- Employing technological interventions to engineer nature - Passively accepting disasters without intervention
Joint Effects of Nature and Society (White, Burton, Kates)	Floods shaped by human actions	Proactive measures such as careful zoning, raising awareness of floodplains, seismic areas, and wildfire zones, and implementing effective land use management strategies to mitigate disaster risks.
Social Constructions (Blaikie, Wisner, Cutter, Hewitt, Oliver-Smith)	This approach delves deeper into the root causes of vulnerability to disasters. It recognizes that social, economic, and political factors influence vulnerability	Policies addressing the root causes 1. Access to power, structure, resources 2. Political systems 3. Economic systems

4.3.1.4.1 Root cause analysis of disaster risk

The "disasters as social constructions" perspective makes clear that vulnerabilities are not predetermined by nature but are deeply entwined with societal structures and power dynamics (Pelling, 1999; Oliver-Smith, 2022). However, some scholars criticize the current understanding of vulnerability and exposure as insufficient for developing effective policies and strategies

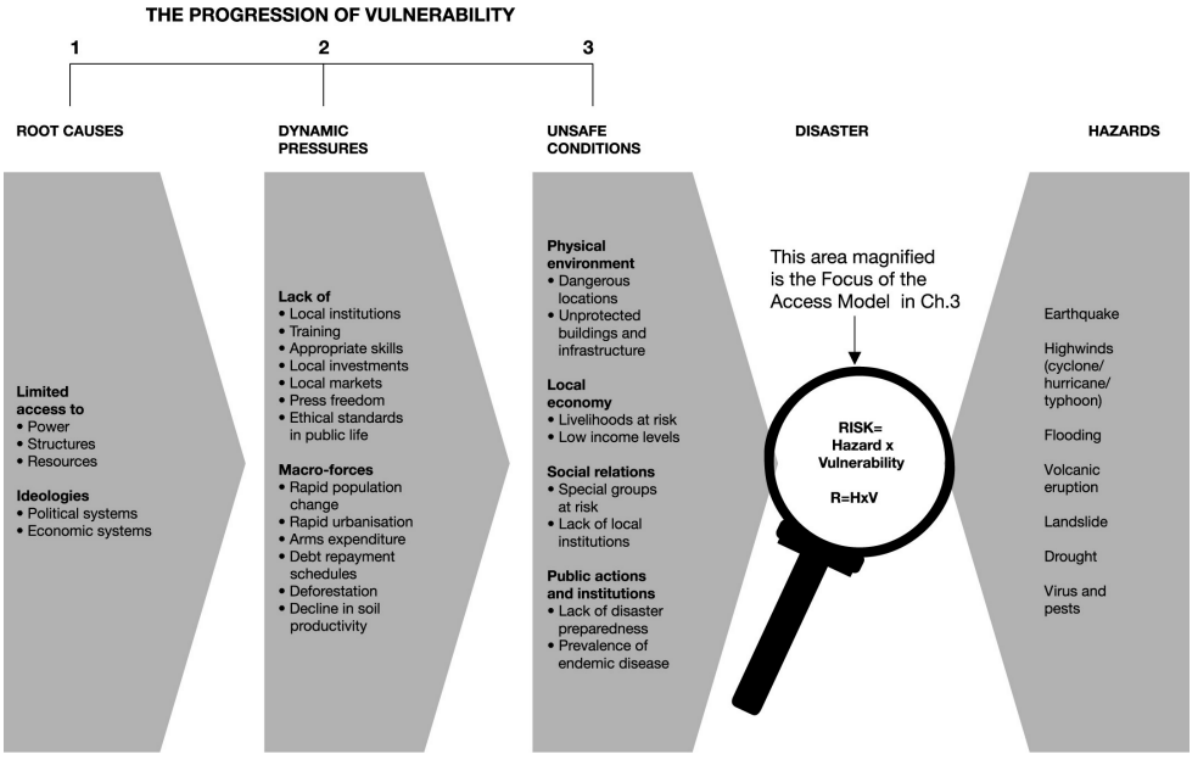
because it does not explain why and how such conditions exist and how they evolve over time (Oliver-Smith et al., 2019). The search for causal explanation has led to the development of diverse conceptual frameworks that focus on the idea of root causes (also referred to as fundamental, structural, or underlying causes), dynamic pressures or risk drivers, and proximate conditions (Blaikie et al. 1994; Wisner et al. 2004, 2011; UNISDR, 2009, 2011, 2015a) to understand disaster risk.

These models explain risk as a function of the hazard event, the level of exposure, and the vulnerability of people and property exposed.

Risk = Hazard * Exposure * Vulnerability

Unsafe conditions are the specific, localized manifestations of exposure and vulnerability that directly contribute to disaster risk. Dynamic pressures are a set of processes that transform root causes into more immediate, localized, and contemporary factors that contribute to unsafe conditions. Dynamic pressures/ risk drivers are decadal trends spanning one to three decades, involving business cycles, population change, governance dynamics, and land use change (Fraser et al., 2020; Wisner et al., 2012). Finally, root causes are underlying factors that refer to social and economic structures, such as the characteristics of wealth, power and distribution of resources, dominant ideologies, and historical setup. (Blaikie et al., 1994; Wisner et al., 2004; Oliver-Smith et al., 2019). Root causes are often spatially and temporally distant from the event and change slowly over time. A root cause analysis helps uncover the dynamic pressures linked to unsafe conditions. The PAR (Pressure and Release) framework and FORIN (Forensic Investigations of Disasters) guide this chapter's analysis of narratives and proposed policies. I

use the concepts of unsafe conditions, risk drivers, and root causes to understand how narratives by different stakeholders engage with the different components of risk.



Source: Pressure and Release (PAR) model: the progression of vulnerability (Page no 51). Wisner, B., Blaikie, P., Cannon, T., & Davis, I. (2003). At Risk: Natural hazards, people's vulnerability, and disasters (2nd ed., Part I). Routledge. https://www.preventionweb.net/files/670_72351.pdf

Figure 4-1: The progression of vulnerability - Pressure and Release (PAR) Model

4.3.2 Narratives

While analyses and scholarly debates provide valuable insights into the complexities of disaster risk, narratives play a pivotal role in framing these issues within the broader public discourse and influencing policy decisions.

Narratives represent a specific form of discourse, conveying stories or sequences of actions or events that evolve over time (Somers, 1994). They encompass stories associated with particular themes or topics individuals construct, believe in, share, and embody. Thus, narratives offer interpretations of certain physical or social phenomena. Narratives attribute causality differently and imply varying degrees of responsibility and action. Thus, different narratives prioritize different factors and relationships, influencing perceptions of the problem and its solutions (Lahsen et al., 2021; Davis, 2022; Paschen et al., 2014).

The strength of narratives lies in consolidating diverse events, processes, and human experiences into cohesive, purposeful narratives (Polkinghorne, 1995). These stories effectively link actors, their beliefs or actions, events, and aspects of the physical and social environment (Roe, 1994). Narratives can also be contested terrain, reflecting competing interests and ideologies. Narratives may emerge as responses, solutions, or strategies for addressing various issues. They also shape the context and significantly influence which choices, policies, and groups are prioritized or marginalized (Molle, 2008; Shore et al., 1997).

4.3.2.1 Narratives in policy analysis

Public policy aims to identify problems and formulate strategies and ways forward (Roe, 1994). Narratives play a crucial role in every step of the process. Stone (2002) emphasizes that the reliance on policy narratives is evident upon even a quick examination of policy discussions, whether in informal or official contexts. Both citizens and politicians, even policy analysts, utilize causal narratives to communicate the nature, character, and roots of policy problems.

In policy analysis, narrative analysis is closely associated with problem definition and setting, which are considered fundamental steps in the analytic process (Fischer, 2003). Narrative analysis highlights the subjective and contentious nature of problem definition, emphasizing the significant role language and stories play in shaping these definitions through negotiation. However, the utility of narrative analysis extends beyond problem definition alone. It also holds relevance in examining the entirety of the policy cycle, particularly in areas such as implementation and evaluation. Narratives, in their political function, serve a dual role: they shape decision-making and behavior as well as justify choices made and their outcomes (Molle, 2008).

Policymaking serves as a platform for dialogue where societal problems, such as flooding, are articulated and defined. This process creates shared understanding by framing issues and proposing potential solutions to the challenges facing societies (Feindt et al., 2005; Davis, 2022). Various scholars have underscored the influential role of discourses in shaping agendas (Chmutina et al., 2019; Hajer et al., 2005; Leipold et al., 2019). How disasters are narrated and discussed by various stakeholders can play a significant role in shaping how disaster causation is understood and how responsibilities are assigned. These narratives can influence disaster governance and ultimately impact how risk and vulnerability are experienced by affected communities. Narrative analysis allows for a more comprehensive understanding of the complex interplay of factors contributing to risk by revealing the underlying power dynamics, political interests, and ideological underpinnings that shape the decision-making process. It can help uncover the root causes rooted in the distribution of power, resources, and decision-making authority within the political economy.

4.4 Case Background

This section provides an overview of the case background and includes a description of the 2021 flooding event, the case of a small town, and policies in India influencing the disaster risk.

4.4.1 Chiplun and the 2021 flood event

Chiplun, situated in the Ratnagiri district of Maharashtra, is a historic market town. The city has an area of 10.31 sq. kilometers and is 4 to 7 meters above mean sea level. It is situated at the foot of the Sahyadri mountains and is surrounded by the Vashishthi and Shiva rivers. The city forms a saucer-like shape and has a population of 55,139 as per the 2011 census.

In 2021, Chiplun, Maharashtra, experienced an unprecedented flooding that caused widespread devastation throughout the city. Despite the annual monsoonal inundation that typically leads to waterlogging in low-lying areas, the severity of the 2021 floods surpassed all previous recorded occurrences. The city had previously encountered moderate flooding in 1972, 1973, 1975, 1989, 1993, and 2019, with notable impacts from floods in 1965 and 2005 (Water Resources Department, 2022). However, the intensity of the last two large-scale floods in 2005 and 2021 raised concerns about Chiplun's future.

In 2005, water levels reached approximately 8 to 9 feet in parts of the city, causing severe damage to Chiplun's market area and households. In 2021, the Indian Meteorological Department (IMD) had warned of heavy precipitation in Ratnagiri District days before the floods. In response, some residents took measures, such as moving valuables to higher ground, based on their experience from 2005. However, these measures were insufficient to mitigate the impact of the 2021 floods. Between 5.30 am and 7.00 am on July 22nd, 2021, the water level

rose by approximately 10 feet. The flood reached its highest level of 13 to 14 feet, trapping thousands of residents in their houses and on roofs. Parts of the city were underwater for 20 hours or more. The financial losses exceeded Rs. 1000 crore, causing significant setbacks to the city's economy and development efforts (Water Resources Department, 2022).

Official reports revealed that on July 21, 2022, the area experienced an unprecedented 450 mm of rainfall, followed by a rapid rise in the water level of the Shivnadi River by 5.60 meters, surpassing danger levels. The high tide during the same period compounded the crises, exacerbating the situation in the city. The municipal council initiated rescue operations promptly, but the speed at which the floodwaters rose caught many residents off guard.

During emergencies like the Chiplun flooding, the National Disaster Response Force (NDRF) is typically tasked with rescue operations. However, in this instance, the NDRF did not arrive in Chiplun for over 24 hours post-flooding. Compounding the delay, local police and municipal officials were not prepared to carry out rescue efforts due to a lack of essential tools and equipment. Crucial rescue equipment, such as boats, were stored in the municipality building, among the first locations submerged during the 2021 flooding. As a result, rescue and relief operations in the city relied heavily on assistance from outside municipalities in surrounding districts[24], highlighting a significant dependency on external support that hindered response efforts during and after the flood.

[24] Based on the suggestion of the state's Chief Minister and urban development minister, Thane Municipal Corporation, Mumbai Municipal Corporation, Navi Mumbai Municipal Corporation, Vasai-Virar Municipal

After the flood waters receded, heaps of mud and other debris were left behind, which were not cleared for at least another week. Restoration of the infrastructure and other services started after a week of water receding. Complete restoration of utilities took approximately 2-3 weeks.Affected households and businesses received monetary compensation from the government approximately two months after the flooding.

Residents voiced suspicions that water discharge from the Koyna hydroelectric power plant might have worsened the severity of the flooding (Water Resources Department, 2022). In response, civil society groups took action, writing letters to ministers and elected representatives, urging for permanent measures to address flooding impacts (Media reports; Water Resources Department, 2022). A Public Interest Litigation (Joglekar, 2022) was filed in the Mumbai High Court, criticizing the government's response and pleading for assistance, alongside calls for long-term flood mitigation measures.

4.4.2 Importance of looking at a small town

Much of the existing research on disaster risk in India (Rumbach, 2010; Ranganathan, 2015; Parthasarathy, 2016; Arabindoo, 2016; Weinstein et al., 2019) and in global south (Alvarez et al., 2019; Goh et al., 2019, Shatkin, 2019) tends to focus on megacities such as Manila, Jakarta, Mumbai, Kolkata, and Chennai. Disasters in large cities are heavily covered by national and international media and draw attention, while small-city disasters are felt locally. This bias is

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Corporation, Ratnagiri Municipal Council, Khed Municipal Council, Dapoli, Devrukh, Guhagar Nagar Panchayat, and Rajapur Municipal Council provided a large amount of manpower and material. They also helped with waste disposal (Municipal Council Presentation).

also reflected in the work of non-governmental organizations, think tanks, aid organizations, and foundations (Rockefeller foundation's 100 Resilient Cities project). Much is known about the discourse on disaster risk in India's megacities (Weinstein et al., 2019), but more work needs to be done to understand the discourse surrounding disaster risk in small urban places.

According to the 2011 census, 40 percent of the Indian population lives in cities and towns with fewer than 100,000 inhabitants. In the next fifty years, much of the urban growth is expected to occur in small urban centers (Birkmann et al., 2016). Small urban centers[25] will account for most urban development in Asia in the coming decades but remain largely absent from the literature on urban risk (Pelling, 2012).

A defining characteristic of small towns in India is their lack of governance capacity and lack of redundancy[26] of urban systems (e.g., infrastructure), which is the foundation for effective Disaster Management (DM) (Rumbach, 2015). In India, the issue of flooding is exacerbated by their lack of fiscal and governance capacity of Indian cities[27] (Weinstein et al., 2019). Planners, architects, and engineers tend to be located at the municipal level, while state agencies have the

[25] Small urban centers are generally considered to have a population ranging from 20,000 to 500,000 inhabitants. This range encompasses both small towns and small cities, reflecting the diversity of urban settlements in the region (United Nations, 2014).

[26] "Redundancy, or a system's properties that allow for "alternate options, choices, and substitutions under stress", is a core feature of resilience" (O'Rourke 2007 , 25).

[27] The 74th Amendment made Indian Urban Local Bodies (ULB) into self-governing institutions devloving them duties and responsibilities. However, the states across India have not be able to effectively implement the 74th Amendment. ULBs lack fiscal autonomy due to state control, financial constraints from over-reliance on state grants and inefficient tax collection, political interference leading to short-term policies, and capacity challenges including a lack of technical expertise and institutional capacity within urban local bodies. These factors collectively hinder efficient urban governance, infrastructure development, and service delivery, perpetuating the disempowerment of Indian cities which are all crucial for effective flood risk management in cities.

power to make urban development decisions. Small towns, in particular, are impacted more by this disempowerment because they have fewer financial resources and rely heavily on state grants for funding. Moreover, small towns face challenges in shaping their regulations, visions, and plans and implementing projects on the ground (Kundu et al., 2014).

The case of smaller urban centers provides an important research case because of the mismatch between the risk they face and their governance capacity, even in the absence of disasters. As these places are expected to grow faster than megacities, small towns can potentially avoid mistakes made in larger cities before environmental, physical, and socioeconomic risks become unmanageable. Understanding and governing urban risk in the small urban centers of Asia will be essential to managing their urban transition (Rumbach, 2015).

4.4.3 Policies Influencing Flood Risk in India

This section provides a brief overview of two significant policy processes that are directly related to and impact flood risk in India and more specifically to the 2021 flood events in Chiplun. While multiple departments and their respective policies influence the flood risk scenario, such as the irrigation department's water management policies, the current analysis will focus on urban development and disaster management.

4.4.3.1 Disaster Management (DM)

The Disaster Management Act (DMA) 2005 provides for the setting up of authorities at multiple levels, and it defines the roles of different agencies and their funding responsibilities. The DMA lays down the rules for the establishment of disaster management authorities at different levels (national, state, and district), the appointment of officers and other employees, the constitution of

the advisory committee, power and functions of, and the minimum standard of relief. (Government of India, 2005).

Figure 4-2 shows the institutional framework for Disaster Management in India. The National Disaster Management Authority (NDMA) sets the overall policies, plans, and guidelines for disaster management across the country. At the state level, the State Disaster Management Authority (SDMA) develops and implements state-specific strategies in line with the national framework. The District Disaster Management Authority (DDMA) acts as the primary planning, coordinating, and implementing body at the district level, responsible for taking necessary disaster preparedness, response, and recovery measures. Local authorities (Municipal councils, Panchayati Raj, etc.) are responsible for carrying out relief, rehabilitation, and reconstruction activities in the affected areas and for preparation of Disaster Management plans that align with the guidelines provided by the higher authorities, promoting a cohesive and integrated approach to disaster management in India.

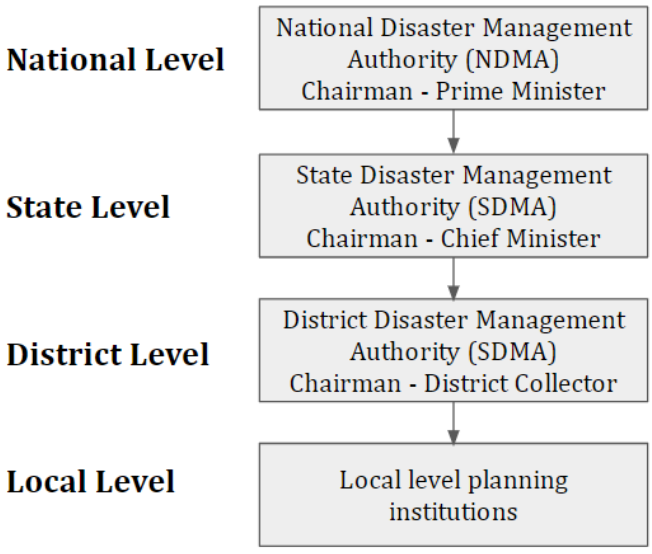

Figure 4-2: Institutional Framework for Disaster Management in India

4.4.3.2 Development Planning Process

The development plan process provides guidelines for the physical development of the city. In the state of Maharashtra, the Maharashtra Regional and Town Planning Act 1966 provides a legal framework for urban planning and development. Under the Act, Urban Local Bodies (ULB) are required to prepare draft development plans for the areas under their jurisdiction. The draft development plans serve as a blueprint for future growth and development. DP outlines the proposed land use patterns and provision for infrastructure and services. The DP and Development Control Regulations (DCR) together facilitate planning at the local level. The DP period is generally 15 to 20 years.

The DMA calls for the integration of Disaster Management into the developmental agenda of cities (Ministry of Home Affairs, 2009). Despite the DMA's implementation in 2005, there has been minimal integration between development policies and disaster management planning. These two areas continue to operate in separate institutional spheres, independent of each other.

4.4.3.3 Ad-hoc Policy Process Post-2021 Flooding

The post-flooding period in India is often marked by an ad-hoc policy process depending on impacts and conditions. In response to the 2021 flooding, the Chiplun Bachav Samiti[28] was formed by the residents of the town to raise concerns, address the issue of recurring floods, and

[28] Chiplun Bachav Samiti is a citizen's group formed in Chiplun in response to the severe flooding in July 2021. The group's goals are to help with relief, rehabilitation, raise awareness about issues faced by the affected people, and advocate for better disaster management in the region.

advocate for permanent solutions to prevent future occurrences. Thousands of citizens joined forces with the committee, advocating for a flood-free Chiplun. Public meetings were held across the city to garner support and gather citizens' opinions. The committee, comprising ten prominent Chiplunkars, organized a 29-day movement from December 6, 2021, to January 4, 2022. This movement featured fasts, rallies, and peaceful demonstrations, drawing widespread participation from over 254 institutions and organizations across the state.

The government responded by holding a meeting under the chairmanship of the Deputy Chief Minister of the State of Maharashtra in December 2021. 24 members were present at the meeting, including ministers of various departments of the state, members of parliament and assembly, chief secretaries of various departments, engineers, collectors of different districts in Konkan, the Mayor of Chiplun, Chief Officer of the Municipal Council of Chiplun, and members of Chiplun Bachav Samiti. The Chiplun Bachav Samiti presented a list of demands to the state government, including increasing the carrying capacity of the Vashishti River, addressing silt accumulation issues, regulating water discharge from dams, ensuring adequate disaster response infrastructure, and canceling the blue and red flood lines.

The government responded to the demands presented in this meeting and continued to engage in discussions with the Chiplun Bachav Samiti’s representatives in December 2021. This included a grant of Rs. 10 crores for desilting efforts initiated by the committee, indicating a tangible outcome of the committee's advocacy efforts.

To further investigate the flood's causes and impacts, the government established a nine-member committee led by a Retired Engineer from the Water Resources Department. The primary scope of

the study group[29] was to investigate the impact of water released from Kolkewadi Dam on the flooding in Chiplun and surrounding areas. The study group was also an effort by the government to address public concerns and restore confidence in its flood management. The group held four meetings over four months in 2022 to examine the causes of the 2021 flooding (May 26th, June 22nd, July 8th, August 22nd). The study group meetings involved government officials from different local and state-level agencies, experts, and members from Chiplun Bachav Samiti.

Following the criticisms from the citizens and the Chiplun Bachav Samiti, riverbed cleaning commenced in 2022. Continued protests were necessary to ensure that the desilting process continued. A non-governmental organization, the NAAM Foundation[30], played a crucial role in clearing and revitalizing the river's sediments. The community mobilization and advocacy in addressing critical issues affecting the welfare of Chiplun's residents not only started the discussions on the causes and impacts of flooding but also resulted in securing government action toward flood mitigation.

4.4.3.3.1 Flood zone policy - Integration of flood risk in development planning decisions

The flood line policy by the State of Maharashtra integrates flood risk management into city development planning. The policy was highlighted during the post-flood discussion in Chiplun, was on Chiplun Bachav Samiti's agenda, and was mentioned by different associations in the city.

[29] Additionally, it aimed to determine the volume of the water discharged from the Kolkewadi Dam during that period and ascertain the reasons for discharge. It also aimed to develop a revised Standard Operating Procedure (SOP) in coordination with relevant departments to discharge water into the Vashishti River post-electricity generation from the Kolakevadi Dam.

[30] NAAM foundation is a non-profit organization in Maharashtra.

In 2015, a case filed by an environmentalist compelled the National Green Tribunal (NGT[31]) to instruct the Maharashtra irrigation department to delineate flood lines along all rivers in the state. In response to the escalating flood risks and directions from NGT, the Irrigation Department issued guidelines in 2018 aimed at restricting construction in flood-prone areas and demarcating flood lines to mitigate future damages.

These guidelines delineate the "red line," indicating the area likely to be impacted by a flood occurring approximately every 100 years, and the "blue line," marking the zone expected to be affected by a flood recurring every 25 years. The area between the two blue lines on the opposite sides of the river constitutes the prohibitive zone where no construction is permissible, with a few exceptions[32], and the area between the blue and red lines is designated as the Development Restrictive Zone[33](Government of Maharashtra, 2020). According to the guidelines, the prohibitive zone should only be used for open land, such as parks and playgrounds, without obstructing the river's flow or reducing its carrying capacity. The restrictive zone can be used for essential public interest projects like sewerage schemes, roads, and water supply pipelines, provided they do not alter the river.

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[31] The National Green Tribunal (NGT) was established in 2010 and serves as a specialized judicial body dedicated to resolving cases related to environmental protection and conservation. The NGT has the authority to enforce legal rights concerning the environment, give compensation for environmental damage to people and property, and handle environmental issues.

[32] "*The area between the river bank and blue flood line (Flood line near the river bank) shall be prohibited zone for any construction except parking, open vegetable market, garden, lawns, open space, cremation and burial ground, sewage treatment plant, water / gas / drainage pipe lines, public toilet or like uses, provided the land is feasible for such utilization"* (Government of Maharashtra, 2020, Pg no 42).

[33] "*The construction within this area may be permitted at a height of 0.45 m. above the red flood line level*" (Government of Maharashtra, 2020, Pg no 42).

Under the new guidelines, the Water Resources Department is responsible for demarcating the floodplain zones, and the ULBs are tasked with ensuring that construction in both floodplain zones does not impede river flow or alter its capacity.

The flood lines were implemented in 2021. However, the implementation has been followed by a lot of pushback from the Chiplun Bachav Samiti and the Real Estate Developers Association of Chiplun. Currently, there is a complete ban on new construction on vacant plots inside the flood zones in the city. As the ban continues, conversations are going on regarding changing the demarcation of the floodlines. Members of Confederation of Real Estate Developers Associations of India (CREDAI), traders associations, and Chiplun Bachav Samiti have held meetings with the Chief Minister of the state (Newspaper Article Source) and heads of other state departments.

4.5 Data

After large-scale hydrological events, community and policy discussions about disasters take place, and often, these events open a window of opportunity for designing policies, plans, and mitigation strategies. These discussions engage with the causes of disaster risk, assign responsibility, and reveal the intricacies of DM and policy formation. After the 2021 floods in Chiplun, much attention in the public, state, and media realms turned to the causes of the event and the solutions for minimizing the impacts of future floods. Using the 2021 flooding in Chiplun and the policy discussions and decisions surrounding flood risk, this study examines how different actors involved in the process understand and frame flooding causes, responsibilities, and solutions.

This study aims to examine how flood risk is produced and addressed in Indian cities by answering the following research questions:

1. What narratives emerged about flood risk after the 2021 Chiplun flooding?
2. How did different actors perceive and approach the problem of flood risk?
3. How did these narratives relate to the observed policy responses and outcomes?
4. How did these narratives and policy responses engage with different aspects of disaster risk—unsafe conditions, dynamic pressures, and root causes?

The way different stakeholders perceive the causes of flooding and the power they hold in making the decisions has an impact on the way the issue of flood risk is framed and how solutions are proposed (van Eaten, 1997; Niles et al., 2013). As I am interested in understanding the different narratives surrounding flood risk in Chiplun, I analyze various narrative sources to give a comprehensive view (Table 4-2). The two main groups of actors analyzed are the state and the affected residents.

Table 4-2: Data Sources

Stakeholder	**Resources**	**Detail**	**Description**
State	Study Group Meetings and Findings	4 meetings from May 2022 to August 2022	9 members - 5 government officials (1 from Municipal Council), 1 expert (Professor), and 3 residents (2 Chiplun Bachav Samiti members) - Meetings were held on May 26th, June 22nd, August 6th, August 22nd, 2022
State and environmental activists	Affidavit regarding flood lines	February 2024	Public Interest Litigation filed by NGO Vanshakti against the government regarding floodplains of rivers and tributaries in Maharashtra. The document consists of the latest PIL and a summary of previous guidelines and cases regarding flood lines.
State	Planning Documents	Multiple	- Development Plan of Chiplun - Unified Development Control Regulations - Guidelines for restriction on construction in flood zone

State and citizens	Other meetings	Meeting conducted by COEP Masters of Planning Students on May 8, 2023	- A stakeholder meeting was conducted by the College of Engineering Pune (COEP) students focused on the city's development plan process and the flood risk in Chiplun. - The meeting involved local architects and business owners, CREDAI (Confederation of the Real Estate Developers Association of India) secretary, 2 officials from the Chiplun Municipal Council, 1 Journalist, 1 member of the Chiplun Bachav Samiti, and 1 Social Activist- and 25 students
Citizens	Letters	Multiple	- Articles on Development Plan Politics and Flood Mitigation - A letter by CREDAI - A letter by the Traders' Association of the City - Public Interest Litigation in Bombay High Court
State and citizens	Interviews (n = 15)	Household and government officials	- Affected households, members of the Chiplun Bachav Samiti, business owners - City officials
State, citizens, experts, and activists	News media coverage	2021 onwards	- National, state, and local coverage of the event immediately after the event - Coverage of the policy process over time
Citizens	Fieldwork and resident surveys	May - June 2023	I observed and collected data about the 2021 flooding event. I conducted household surveys (n=380). The open-ended survey questions asked participants to share their thoughts and experiences about the event and the state's role in it.

Note: I completed the IRB review for the study, and the study was determined to be exempt.

The state's narrative is captured through the analysis of government documents - a report prepared by a committee appointed by the state government of Maharashtra to study the causes of 2021 flooding, a presentation prepared by the municipal council, Development Plan (DP), Development Control Regulations (DCR), an affidavit regarding flood lines, and interviews with the municipal council officials. The government report captures the post-flood ad-hoc policy process that unfolded, providing a summary of four meetings conducted over four months and offering viewpoints from different stakeholders, including the community, civil society

organizations, and various government agencies. The report also gives an overview of the proposed projects, funds disbursed, and recommendations to address the flooding issue. Additionally, I conducted five semi-structured interviews with government officials in the Chiplun Nagar Parishad (Municipal Council) during two visits in May and June 2023. These interviews with government officials focused on the state's response to the event and their capacity to deal with it. They were conducted with officials who were present during the visits and interested in participating.

To capture the public's narrative, I analyzed public interest litigations (PIL) by non-governmental organizations and local activists, letters written by civic society groups to elected representatives and government officials, and discussions on the city's development plan created after the 2021 flooding. Additionally, I conducted 15 semi-structured interviews with households affected by the July 2021 flooding in Chiplun. These interviews focused on the causes of flooding and the state's role. Households were selected using snowball sampling through common contacts in Chiplun and during fieldwork in June 2023, during which affected residents active in discussions surrounding flood risk and interested in participating were interviewed (Appendix B).

Lastly, I collected news media coverage, including videos and articles, to understand the causes and factors contributing to the devastating 2021 floods in Chiplun. After the flooding, the news media became an important arena for debate and an avenue for contextualizing and understanding the event. These news media sources offer various perspectives, as they are produced by journalists who rely on multiple actors for their information (Carvalho, 2008). Analyzing how floods are framed in the media is useful for understanding the broad public perception of floods.

In summary, the data for this study consists of:

1. **Accounts from local residents and civic groups:** These provide firsthand experiences and understanding of the 2021 flood situation, offering valuable insights into the public's perception of the event and its causes.
2. **Official statements and findings:** These include statements from officials such as the district collector and ministers of the state of Maharashtra, captured by the news media, as well as the findings of the government-appointed state group. These sources provide information on the causes of flooding from the state's perspective and outline plans to address flood risk.
3. **Expert opinions:** Insights from professionals like engineers offer a technical understanding of floods and potential solutions, adding depth to the analysis of the event and its management.

4.6 Methods

Data analysis for the study was an iterative process. I started by conducting phone interviews with the residents of Chiplun who were affected by the 2021 flooding and by collecting news media articles and videos of the event for the time period 2021 to 2023. I simultaneously conducted data analysis while collecting data. In April 2023, I collaborated with College of Engineering Pune (COEP) students on their development plan preparation studio. They conducted a stakeholder meeting to understand the urban development of Chiplun and its role in the 2021 flooding event. I conducted fieldwork in May and June 2023, where I conducted in-person interviews with the local government officials, affected households, and members of different organizations in Chiplun, like Chiplun Bachav Samiti, Confederation of Real Estate

Developers Associations of India (CREDAI), and the traders association. During the fieldwork, I also gained access to documents the government prepared regarding the 2021 flooding, the PILs, and letters written by different civic groups. As I collected the data, I read through the material and translated it from Marathi to English.

To facilitate a systematic analysis, I organized the data by actors and source type. In the first round of coding, I categorized the data to understand the content and different perspectives represented. During this process, I took notes on initial observations, recurring themes, and storylines emerging from the data. I then identified the main storylines in each source, focusing on how the causes of the 2021 flooding were portrayed. This approach allowed me to systematically analyze the narratives surrounding the flooding event and gain insights into the various perspectives on the causes of the disaster.

I developed a coding scheme that included categories such as 'official responses,' 'environmental factors,' 'natural causes,' and 'man-made causes.' Using Atlas.ti software, I applied this coding scheme to the data. The coded data was then analyzed to identify patterns, relationships, and differences among the narratives and to examine how different actors (local residents, government officials, experts, and activists) constructed and presented their narratives.

Next, I use narrative analysis to deconstruct the narratives in the policy discussions after the 2021 flooding in Chiplun and how these together relate to proposed solutions surrounding flood risk. There are multiple ways to conduct narrative analysis for policy analysis (Fischer, 2003). By applying Burke's pentad, I examine the narratives and counter-narratives surrounding the 2021 flooding in Chiplun (Burke, 1945, 1955).

In Burke's Dramatistic Pentad framework, narratives are viewed as fundamentally focused on goal-oriented, intentional action. It delineates five crucial elements: the act (the action performed), the scene (the context of the action), the agent (the individual or entity performing the action), the agency (how the action is executed), and the purpose or motive (the reason behind the action) (Burke, 1945, 1955). Burke's pentad allows me to deconstruct the narratives into common elements and to create categories (Davis et al., 2022; Polkinghorne, 1995). I chose this analysis method because I am interested in understanding how different narratives are constructed, i.e., how the issue of flood risk is framed, how strategies are suggested by different stakeholders, and how they engage with the risk drivers and root causes of disasters.

I use the coding framework in Table 4-3 to deconstruct the narratives by diverse stakeholders into act and agent. The scene of this analysis is the discussions after the 2021 flooding. I focus on act and agent from Burke's pentad to examine how the causation is attributed and how the proposed strategies are linked to diverse narratives.

Table 4-3: Coding framework for deconstructing the narratives around the 2021 flooding event

	Act		**Agent**
Scene	**Goal**	**Strategy**	**Responsibility for Action**
2021 flooding event in Chiplun	What goals or desired outcomes are outlined in the narratives?	What solutions or strategies are proposed in the narratives?	Who or what entities are attributed responsibility for action according to the narratives?

After identifying and deconstructing the main narratives by the state, experts, and citizens, I use the disaster risk frameworks to understand how the narratives and policies engage with different risk components, such as unsafe conditions, risk drivers (dynamic pressures), and root causes.

Using the coding framework in Table 4-4, I try to separate the unsafe conditions and dynamic pressures and link them to the root causes.

Table 4-4: Coding framework for understanding the proximate conditions, risk drivers, and root causes of flood risk

Actor	**Narrative**	**Solution**	**Unsafe Condition**	**Risk Driver**	**Root Causes**
Whose narrative is it?	What/ who does it attribute causation to?	What is the outcome of the narrative?	What causes does the narrative highlight?	What are the dynamic processes that translate the root causes into unsafe conditions?	What are the root causes contributing to flood risk?

4.7 Results

Results examine the narratives that circulated after the 2021 flooding event and the associated policy discussions and processes related to flood risk management. First, the analysis highlights the dominant narratives that emerged, how they attributed causation and responsibility to specific processes or entities, and how these narratives became the basis for particular types of flood risk management initiatives in Chiplun. Second, the analysis connects these narratives to policy outcomes. Third, the analysis uses the root cause frameworks by Blaikie et al. (1994), Wisner et al. (2004), and Oliver-Smith (2019) to evaluate the aspects of the 2021 flood event that these narratives and policy outcomes address and overlook.

4.7.1 Narratives

4.7.1.1 Narrative 1: The 2021 flooding was an act of nature

The most prevailing narrative from the state attributed the 2021 flooding to natural factors. Government meetings in the aftermath and subsequent reports sought to identify the physical factors leading to the flooding. The state's analysis of the event identified high tide, heavy rainfall from a cloud-burst-like situation in the catchment of *Vashishthi*, and the region's topography as the factors causing the 2021 floods:

> *"…even though global warming since 2005 has not resulted in a significant increase in global precipitation, the precipitation is concentrated rather than scattered, resulting in a downpour in a short period of time."* (Chairman of the study group, May 26th, 2022, Water Resources Department, 2022, Pg no. 1)
>
> "…*unprecedented rainfall in the last 100 years was recorded recently near Koyna (dam).*" (A statement by the Former Union Agriculture Minister, Times of India, 2021)

The study group constituted after the 2021 flooding drew parallels with catastrophic rainfall events witnessed in other parts of the country as well as globally in places such as Germany and China. Similar attributions regarding previous floods across Maharashtra were made, citing unprecedented precipitation. For instance, a report prepared by the state government after the 2019 flooding in Sangli and Kolhapur identified heavy precipitation in short duration as one of the causes of flooding (Government of Maharashtra, 2019):

> "*In mountainous terrain, rivers and streams often flow in multiple directions, obstructing water flow. This phenomenon is particularly notable at the confluence of the Jagbudi and Vashishti rivers in Chiplun.*" (Water Resources Department, 2022, Introduction Section, Pg no. ii)

The region's topography was cited as a critical factor contributing to the significant water flow during the flooding. One government official noted that the town's saucer-shaped layout, surrounded by hills on three sides, amplified water flow and intensity, adding to the intensity of flooding (Government Official 1). Moreover, the government officials pointed out that the hilly terrain distinguished Chiplun from flatter areas like Sangli and Kolhapur, where water flow during floods is comparatively less intense. This comparison primarily attributes the widespread devastation to the former region's topography without addressing the governance failures.

4.7.1.2 Narrative 2: The 2021 flooding was not an act of nature but a failure of disaster governance

The second narrative that emerged regarded the failure of disaster management. The citizens and activists took to public platforms and rallied together, demanding accountability for what was essentially a man-made disaster and a failure of governance. Residents of Chiplun and members of the Chiplun Bachav Samiti mentioned that the discharge of wastewater from the Kolakewadi Dam after power generation during the rainy season was one of the main factors responsible for the 2021 floods. Household interviews suggest that the government's decision to release water from the dam was known in advance but not communicated effectively to the citizens, leading to damage that could have been prevented, as described by a local politician:

> *"We understand that the dam needs to release water, but at least make us aware and don't surprise us like this in the middle of the night…"* (Local Politician, Al Jazeera, July 20, 2021).

However, the state's narrative was that the release of water from the Koyna/Kolkewadi hydroelectric project did not exacerbate the flooding in Chiplun. According to the technical

analysis conducted by a state-appointed committee, the maximum discharge from the project on July 22, 2021, was significantly lower than the total river flood discharge, with the wastewater contributing only 3.81% to the total discharge. The report further emphasized that the rainfall intensity in catchment areas necessitated the release of floodwater from the dam, as the dam lacked the capacity to contain the increased water from heavy rainfall (Water Resources Department, 2022). Through these analyses and statements, the government sought to absolve itself of accountability for inadequate disaster preparedness and potential shortcomings in the state's disaster management efforts.

4.7.1.3 Narrative 3: The 2021 flooding was a result of urbanization (development in flood zones)

The third narrative about the 2021 flooding event highlights rapid urbanization, development, and encroachment in floodplains as potential causes of the event. All stakeholders involved—the state, citizens, and activists—mention that urbanization played a significant role in increasing the flood risk in the area. However, they each assign the responsibility for this urbanization to different sources or entities.

The rapid development of public and private buildings, infrastructure, and amenities in flood-prone areas of the city has created obstacles to drainage. Like many other Indian cities, Chiplun, once known as the "city of lakes," has experienced a significant reduction in its natural open

spaces. While ancient records mention over 60 lakes in the city, only a few[34] remain today. Some ponds were repurposed for paddy cultivation, while others were filled to accommodate urban development projects by the local government, such as playgrounds and parks, mirroring similar trends in other Asian cities (Ranganathan, 2015; Weinstein et al., 2019; Rumbach, 2010; Shatkin, 2019).

Narratives from government officials like the district collector and deputy chief minister highlight how the town's urban growth has affected the natural spaces that carry water. The study group appointed by the state government noted that uncontrolled population growth and human interference in the river plains have affected the land's natural open spaces and slopes and reduced the water drainage capacity. By emphasizing population growth as a driver of urbanization, the government shifts the responsibility away from its own actions and/or inactions that may have contributed to flood risk:

> *"It is the fact that various constructions are made inside the flood lines of most of the rivers in Maharashtra. The state government will have to take some decision regarding the same."* (Former Union Agriculture Minister, Times of India, 2021)

> *"There has been some illegal constructions near the river bed, which have added to our misery. The dam water (from Kolakewadi), extremely heavy rainfall and illegal constructions in the river bed - all have contributed to the current situation. It is partially a man-made disaster."* (District Collector, Times of India, July 23, 2021)

The concerns raised by environmental activists, local professionals, and citizens state that the government's actions, or lack thereof, have significantly contributed to the increased flood risk in

[34] Ramtirtha, Narayan, Veereshwar, Krishneshwar, and Vindhyavasini-Rawatale (Kumbharathale) Lakes.

Chiplun and other parts of Maharashtra. Environmental activists across the country and in Maharashtra have criticized the government's actions, attributing the recent surge in flood losses to increased development in flood-prone areas. They allege that the state redefined flood lines to benefit developers and prioritize their interests over those of citizens (Srivastava, 2019). Similarly, local architects, planners, and developers also attribute the 2021 flooding in Chiplun to urbanization and emphasize the lack of enforcement of development plans as a contributing factor to flood risk, holding the government accountable for its failure. The citizens of Chiplun and members of the Chiplun Bachav Samiti have highlighted the obstructions in water flow created by government infrastructure projects such as roads and bridges. They argue that these obstructions have exacerbated the flooding situation in the city, further underscoring the government's role in the disaster:

> *"...unparalleled deforestation" and absence of urban planning measures were the prime reasons for the man-made disaster. There has been immense amount of earth-moving and tree-cutting for the purpose of the new Mumbai-Goa National Highway and Pune-Bijapur state highway…. Chiplun used to be a wetland area, but in the past 10-15 years, there has been the construction of residential societies on those lands. Chiplun did not follow any urban policy guidelines and ignored the environmental impact of the constructions on these wetlands,"* (Environmentalist, Al Jazeera, July 30, 2021)

4.7.1.4 Narrative 4: The 2021 flooding was a result of urbanization (silt accumulation in the river)

In the fourth narrative identified, the government and citizens both state that siltation has reduced the river's carrying capacity over the years. However, they diverge in their perspectives on what has led to the silt accumulation in the river. Silt accumulation in rivers and dams is a common phenomenon that reduces the depth of the water bodies over time.

Residents perceive the accumulation of silt as a result of governmental neglect spanning several decades in addressing the issue and hold authorities accountable for the resultant flooding. Residents also pointed to specific government projects, including excavation for power plants, tunnel constructions, and the Tivare Dam burst before the flooding, for exacerbating river siltation.

> *"Tivare Dam burst three years ago. The silt from the dam and the area above it in the Sahayadri catchment area accumulates directly into the river"* (Water Resources Department, 2022, Page no. 1 of the Summary of demands by Chiplun Bachav Samiti)

The state government's narrative attributes siltation in the river to a combination of natural processes and various development activities while disputing the citizens' claim that government projects are the primary cause. The government argues that silt accumulation is inherent to river systems and that loose soil from land excavation and filling during construction activities flows into the river during rains, gradually accumulating in the riverbed. Additionally, the state points to continuous deforestation in the Sahyadri valley over the past 4-5 decades, which has led to large-scale landslides, landslips, and rock falls due to reduced vegetation, causing soil upheaval and erosion. However, the government acknowledges its responsibility for desilting rivers and dams, even when siltation occurs naturally and is not directly caused by state projects.

> *"After construction, excavation is often done to level the land or fill it with soil. While doing all this, heaps of soil or loose fillings are made. In every rain, this soil gradually but effectively accumulates in the river bed in the form of silt. As a result, the depth of the river basin decreases, and the slope of the river also decreases."* (Water Resources Department, 2022, Page no. 36)

4.7.2 Connecting Narratives to Policy Outcomes

4.7.2.1 Outcome 1: Political denial and technocratic solutions

When the issue of flooding is approached from a biophysical perspective, it often leads to two main policy responses: passively accepting disasters without interventions or employing technocratic interventions to re-engineer nature (Goh, 2019). Both of these are present in Chiplun's post-flood discussions and solutions.

The government's attempt to attribute the severity of the 2021 flooding event to uncontrollable factors like high tide, heavy rainfall, and the town's topography is rooted in a discourse of political denial. This discourse deflects citizen inquiries and avoids deeper political analysis or action of the issue (Arabindoo, 2016; Davis, 1995; Sturken, 2001; Smith, 2006). By employing rhetorical strategies, the state has constructed a narrative under the guise of scientific authority, suppressing more in-depth discussions of disasters. The state's statements aligning the flooding with a broader narrative of global calamities reflect a worldwide trend (Arabindoo, 2016; Sturken, 2001). In Chiplun, policies shaped by this narrative also emphasize engineering solutions and natural resource management strategies, including dam management (controlled release of water from dams), construction of more dams and embankments, and installation of rain gauges to monitor the water levels, and removals of obstruction to the flow of water[35].

[35] Similar projects and policies can be observed in other locations. For example, in Jakarta, the causes of flooding were attributed to expansion into the watershed, an increased frequency of high-intensity events, urban development, and waste clogging water bodies (Shatkin, 2020). In response to these identified causes, the Indonesian government

4.7.2.2 Outcome 2: Desilting of rivers (hybrid approach - technocratic and participatory)

The government's decision to desilt the rivers in response to Chiplun Bachav Samiti's advocacy efforts can be classified as a hybrid approach. While river desilting itself is a technocratic solution, relying on technical expertise and physical intervention to address the immediate problem of siltation, the push for this decision came from civic activism.

The state government proposed various measures to control accumulation, including removing silt, implementing soil conservation strategies to mitigate erosion, and adopting biophysical measures to prevent rockfalls and mountain collapses. Moreover, the persistent advocacy efforts by the Chiplun Bachav Committee prompted the government to allocate funds for desilting efforts:

> "*Finally, due to the protests of the Chimplun Bachav Committee, the government provided funds to remove silt from the river.*" (Joglekar, 2022)

Even though this outcome is a result of civic activism and the work was partially implemented by a non-profit organization, this approach could be primarily seen as technocratic in nature because it is a structural and short-term measure to mitigate the immediate effects of siltation on rivers' water-carrying and dams' storage capacity. However, the ad hoc provisions for desilting rivers lack a long-term focus and do not include a plan for continued maintenance.

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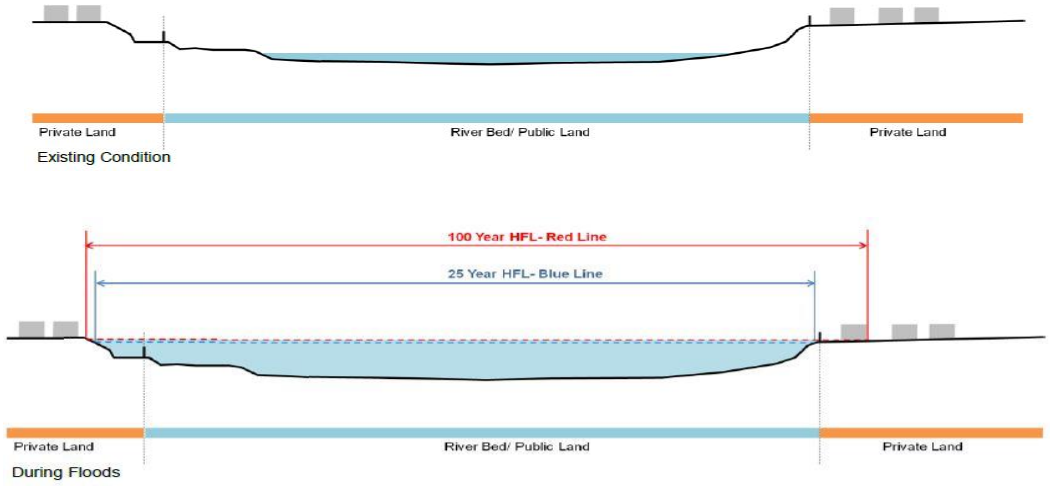
initiated several infrastructure projects that involved widening and concretizing riverbanks to mitigate the impact of flooding.

4.7.2.3 Outcome 3: Restriction of development in flood zones

When the issue of flooding is approached from an urban governance perspective, it involves planning and control of development and open space (Goh, 2019). In India, there is a growing recognition of the importance of protecting against flood losses through robust policy measures and proactive planning strategies. Against the backdrop of these discussions, in April-May 2021, the state's Irrigation Department delineated flood lines across the state (Figure 4-3). Researchers have argued that the threat of increasing losses due to flooding provides the state with a powerful discursive mechanism to regulate the uses of urban space, such as restriction on development in flood zones (Shatkin, 2019; Alvarez, 2019).



Source: Pune Municipal Corporation. (n.d.). Frequently asked questions. Retrieved August 5, 2024, from https://www.pmc.gov.in/en/river-front-faq

Figure 4-3: Flood line policy

4.7.2.3.1 Concerns about accuracy

The policy of a complete ban on construction in flood zones has raised questions about its accuracy, effectiveness, and social impacts on the people who live there. CREDAI argued that

the demarcation process does not consider the city's development and topography and has raised concerns about the accuracy of the lines when the river is full of silt. The citizens and CREDAI have pointed out that there has been a lack of public participation in the process of demarcating flood lines. This lack of consultation and consideration of the context highlights a disregard for the perspectives and concerns of those directly affected by the demarcation:

> *"Without taking any measures, the blue line (Prohibitive area) and the red line (Restricted area) have been drawn illegally in Chiplun City and the areas adjacent to the river. The method adopted for demarcating these lines is technically invalid, and thus, the restrictions imposed by it should be removed immediately. A detailed survey should be carried out after the silt from the river is removed. Lines should be demarcated after inviting objections and suggestions and using flood frequency analysis."* (CREDAI, 2022)

4.7.2.3.2 Impacts of the policy

The demarcation of flood zones has impacted hundreds of existing, ongoing, and proposed residential and commercial structures in Chiplun and other municipalities in the state. The blue line, delineated by the Water Resources Department, encompasses 70% of Chiplun City and the entirety of the city's market area.

Table 4-5: Percent of land affected by flood line demarcations

	Area	Floodline	Percent of impacted area
1	Chiplun city	Blue	70 %
2	Main market area of the city	Blue	100 %
3	Chiplun city	Blue and Red	6 %
4	Chiplun city	Red	25 %

Source: CREDAI Maharashtra. (2020, September 12). [Letter to Eknath Shinde, Chief Minister of Maharashtra, regarding making additional provisions to allow construction in flood-affected areas in Chiplun City].

Imposing strict development restrictions within flood lines has implications for existing landowners, businesses, developers, and government revenue. Landowners within the designated flood zones cannot redevelop or sell their properties, and existing businesses are not eligible for insurance coverage under this policy. Thus, even if the policy does not evict people, it compounds the financial risks and uncertainties that city property owners and businesses face. Developers in the city are impacted as a substantial portion of the city falls within these prohibited zones. According to developers, the policy's implementation has led to a decline in authorized construction activities and subsequent revenue losses for the developers. A government official noted that a complete ban on development within prohibitive zones has also reduced the government's revenue from property sales and construction-related activities, putting a financial strain on the already resource-constrained urban local body.

4.7.2.3.3 Unauthorized construction - increased vulnerability

Local planners, architects, and developers do not see the removal of unauthorized construction from the river banks as straightforward due to political interference, inadequate government staff, a lack of timely and adequate police protection, and court battles.

> *"Even if it is decided to remove the illegal construction from the river banks, it does not mean that all such constructions will be removed entirely, and new constructions will continue to take place. Therefore, even the solution of removal of unauthorized construction will not be able to save the flood-affected villages from flooding."* (Snippet from a letter by a Local Architect)

The policy aims to reduce encroachments in the flood zones and reduce the risk of future events. However, with no alternatives or support from the government, CREDAI, Chiplun Bachav Samiti, and the citizens noted that owners within the flood lines might proceed with unauthorized constructions:

> "*In view of the decision made by the Department of Water Resources on May 3, 2018, if the criteria mentioned above are applied, there will be a large number of unauthorized constructions in the area….. If such unauthorized construction takes place, the situation will worsen in the future. Therefore, in areas like Konkan, especially for small towns, it is necessary to amend the criteria to allow construction/ development."* (CREDAI, 2022)

During the interviews with affected households and government officials, it was mentioned that in some places, people have proceeded with reconstruction without obtaining the appropriate permissions from the local government. Despite being aware of these unauthorized constructions, which often disregard state building guidelines and heighten the vulnerability of structures within the city, officials have refrained from intervening. This policy can exacerbate existing disparities, allowing those with means and resources to elevate their homes or relocate, while the poor and marginalized might be forced to engage in substandard construction without proper authorization. In prior instances, it has been observed that those with power and means are able to influence the law in their favor to further their interests (Kundu et al., 2014). As a result, enforcing flood lines without addressing underlying causes and vulnerabilities may exacerbate risks and increase the likelihood of future adverse events.

4.7.2.3.4 Call for amendments to the policy

CREDAI, the Chiplun Bachav Samiti, and local architects and planners advocated for amendments to allow construction within flood lines under certain conditions, such as elevating structures above flood levels and allowing for commercial construction at ground level in market areas to support local businesses. These groups stress the need for practical considerations, especially in smaller cities like Chiplun, where strict restrictions on development may impede economic growth:

> "*The blue and red lines set by the Water Resources Department regarding the current flood level are affecting the development of the city, so they should be canceled and reassessed.*" (Chiplun Bachav Samiti, Water Resources Department, 2022)

4.7.3 Risk drivers and root causes of the 2021 flood event: What do these narratives and outcomes address vs. overlook?

Using the PAR and FORIN frameworks for disaster risk analysis (Blaikie et al., 1994; Wisner et al., 2004; Oliver-Smith et al., 2019), I adopt a multi-layered approach to understand how flood risk is defined and addressed in the post-flood discussions, distinguishing between proximate causes (unsafe conditions), dynamic pressures (risk drivers), and root causes.

The analysis of narratives surrounding flood risk in Chiplun reveals a predominant focus on proximate causes or unsafe conditions, such as silt accumulation in the river, water release from the dam, and development in flood-prone areas. This emphasis on the immediate and visible symptoms of flood risk has led to policy decisions and funding allocations that primarily target the proximate conditions while often overlooking the deeper issues that contribute to their creation.

The unsafe conditions in Chiplun can be attributed to a combination of risk drivers or dynamic pressures, which are easily observable and explicit than the underlying root causes (Oliver-Smith et al., 2019). In the case of Chiplun, I broadly categorize these risk drivers into two main categories: poor governance and development priorities (Wisner et al., 2004; Oliver-Smith et al., 2019). Poor governance encompasses factors such as inadequate disaster governance and urban planning, lack of enforcement of building codes, insufficient investment in flood control measures, etc. On the other hand, development priorities include the emphasis on economic growth and urbanization, often at the expense of environmental protection and DRR (Weinstein

et al., 2019). These risk drivers work in tandem to create unsafe conditions that exacerbate flood risk in Chiplun.

4.7.3.1 Risk drivers

4.7.3.1.1 Lack of coordination in the governance structure

The analysis identified poor governance as one of the dynamic pressures driving flood risk in Chiplun. Institutional fragmentation across departments and between governance levels, combined with weak enforcement of policies, regulations, and standards, has contributed to the exacerbation of flood risk in the city. Citizens repeatedly cited the release of water from the dam during heavy precipitation and high tide as a cause of flooding, which could be linked to a lack of coordination between different agencies such as MahaGENCO, DDMA, and the ULB. This lack of coordination is a characteristic of India's governance structure and has played a significant role in the mismanagement of flood risk in Chiplun (Parthasarathy, 2016).

> "*....officials of Water Resources Department and MahaGENCO said they have no coordination with each other related to flood conditions, weather conditions, time of tides, etc*." (BBC News, 2021)

Environmental degradation, another significant risk driver, exemplifies poor governance and urbanization at the expense of environmental protection. For example, the deforestation in the Sahyadri region, which includes the catchment areas of rivers in Chiplun, has increased soil erosion and sediment transport, leading to silt accumulation in dams and rivers. Additionally, the silt accumulation in riverbeds resulting from development activities and environmental degradation over time illustrates the lack of plans for infrastructure maintenance.

In the context of disaster management, there are lapses in implementing risk reduction measures and preparedness plans. Despite the establishment of the DMA in 2005, the focus of DM in India

is primarily on early warning systems, evacuation, and relief (Parthasarathy, 2015; Ogra et al., 2021). A 2017 report from India's Comptroller and Auditor General revealed that, despite the DMA being enacted 12 years earlier, 10% of the country's districts had yet to finalize and approve the disaster management plans outlined in section 31 (Noronha, 2018). To this day, very few states in India have built the administrative capacity in this regard:

> *"According to the Disaster Management Act of 2005, in the last 16 years, it was mandatory for the state government to take measures with public money. However, due to their negligence in taking such measures, Chiplun was hit by a devastating flood in 2021, again after 2005 (which is why we are claiming compensation)."* (Joglekar, 2022)

The narratives by the state, experts, and the media have repeatedly referred to unstructured urbanization as a major factor exacerbating flood risk. This rapid growth of settlements and infrastructure in flood-prone areas, often without adequate planning or regulation, has altered the natural drainage patterns and reduced the river's capacity to carry water after a heavy downpour.

Today, India lacks regulations concerning the protection of river floodplains (Srivastava, 2019). Only a few states have floodplain zoning policies, such as Manipur, Rajasthan, Uttarakhand, Jammu, and Kashmir (Srivastava, 2019). Maharashtra is another state where floodplain zoning has been partially implemented through regulations. Although the irrigation department issued guidelines mandating the marking of flood lines for all rivers in the state in 1989, many rivers in Maharashtra remained without demarcated flood lines until 2021.

4.7.3.1.2 Economic and development priorities

In addition to poor government coordination and implementation, Chiplun's flood risk is driven by economic and development priorities prioritizing unsustainable urban growth over risk reduction measures over the last few decades. Disasters are manifestations of unresolved

development problems (Wisner, 2015). The development of Chiplun, like many other cities in India, results from growth-oriented development models that have externalized risk and environmental costs for years (Weinstein et al., 2019). The state's decisions regarding land use planning, infrastructure development, and regulatory frameworks determine the pace, scale, and consequences of urban development.

Regulatory failures and lax oversight by the state have facilitated the development of flood zones in Indian cities over the past few decades. Multiple practices of deregulation, manipulation (of laws), and alterations of land use reservations are characteristic of urban development in India (Kamath et al., 2014; Kundu et al., 2014; Coelho et al., 2014). The spatial planning tools, such as the Development Plan (DP) and Development Control Regulations (DCR), which are designed to facilitate planning and development, inadvertently reinforce and exacerbate socio-spatial and political disparities (Kundu et al., 2014). Over the last two decades, there have been growing concerns about threats from climate-induced flooding; however, India's development planning has repeatedly focused on development-driven economic growth (Weinstein et al., 2019). Through the process of regulatory capture[36], powerful actors, such as real estate developers and political leaders, have influenced the decision-making to prioritize economic interests over disaster risk reduction in Indian cities (Kundu, 2014; Kamath, 2014; Vanashakti & Anr. v. Union of India & Ors, 2023).

[36] "Regulation is acquired by the industry and is designed and operated for its benefits" (Stigler, 1971).

After experiencing ad-hoc, unplanned, and rapid growth over the last few decades, with the new restrictions on development, small towns like Chiplun now find themselves caught up in a complex web of development constraints that play out unequally within the city (Kundu et al., 2014). With the notification of floodplain restrictions prohibiting any development activity within blue lines, Chiplun's development has become an area of contestation between land owners, real estate developers, state government agencies, environmental activists, and the ULB, each claiming it for different purposes. These competing narratives about development policy and its implications highlight conflicts between environmental interests (disaster management in this context), development interests, and property rights that have been characteristic of rapidly growing cities in the Global South over the last few decades.

4.7.3.2 Root causes

Lastly, the root causes of flood risk are deeply entrenched in a society's social, political, and economic structures, reflecting the distribution of power, resources, wealth, and dominant ideologies.

A root-cause approach enables researchers to examine how and where power was exercised, who benefited from those decisions, and how it contributed to the creation of risk in urban places (Mustafa, 2002; Oliver-Smith et al., 2019). Much of the urban development, not just in India but in the global south, happens outside official planning documents (Roy, 2009; Weinstein et al., 2019), a pattern that is an outcome of asymmetric power between the state, interest groups, and the citizens (Kamath et al., 2014; Kundu et al., 2014; Coelho et al., 2014).

Today, while crucial, disaster risk management (DRM) efforts in Chiplun fall short of addressing the risk drivers and deeply rooted systemic issues contributing to increased vulnerability. For

instance, the flood line policy in Chiplun can be seen as an attempt to integrate DRM into development planning by regulating construction in flood-prone areas. However, the policy fails to engage with the problems of asymmetric power distribution and poor governance that result from the underlying social, economic, and political factors. Meaningful disaster risk reduction efforts will require systemic changes focusing on power imbalances (Davis, 2022). Policies informed by this approach draw upon theories highlighting the role of neo-liberalization, globalization, and marginalization in disaster risk, emphasizing the need for effective urban governance, community engagement, and multi-stakeholder collaborations to enhance resilience to flooding (Goh, 2015; 2019; Weinstein et al., 2019; Alvarez et al., 2019).

The study does not delve deeper into the root causes of flood risk in Chiplun, as they are spatially and temporally removed from the event and not directly observable using the data collected. Instead, I use risk drivers or dynamic pressures as a starting point to move toward a more profound explanation. By highlighting the relationship between these drivers and unsafe conditions, this study provides a foundation for future research on flood risk in Indian cities. Future studies can build on this work by attempting to assign causality and shifting the focus of the flood risk analysis in India back along the causal chain.

4.8 Discussion and Conclusion

This study adds to the literature on disaster management in two ways: by examining narratives of the causes of the 2021 flooding in Chiplun and associated policy outcomes, by engaging with how the different components of flood risk manifested around this event, and by elevating the perspective of a small city, a context often understudies in disaster risk literature.

The analysis of narratives and policy outcomes in the aftermath of the 2021 Chiplun floods reveals a complex interplay of perspectives and approaches to understanding and addressing flood risk. Despite the growing need of the importance of understanding the risk drivers and root causes, research efforts focused on understanding them remain limited, especially in the Indian context. Through narrative analysis, this study highlights the discursive and political dimensions of risk production, situating flood risk within the broader context of power dynamics and development paradigms that shape urban and disaster governance. While many previous studies on root causes often look at historical trends and archival data (Rumbach, 2017; Oliver-Smith, 2019; Marchezini et al., 2017), this study takes a different approach by examining how different stakeholders frame and engage with various aspects of disaster risk and how these interpretations shape policy outcomes in today's urban India. The immediate aftermath of an event creates a fertile ground for discussions and debates. Analysis of these discussions captures the current understanding of flood risk and highlights the power dynamics by bringing forward the causes that get addressed in policy.

The findings reveal that different stakeholders attributed causation to diverse factors while engaging in a limited way with risk drivers of flooding. The state's narrative defines 2021 flooding as an externalized event resulting from heavy rainfall, high tide, and the region's topography. This finding aligns with prior research conducted in different contexts, which consistently demonstrates governments' prevailing narrative tends to be that disasters are primarily a 'natural phenomenon' (Arabindoo, 2016; Marchezini et al., 2017). By adopting this narrative, the state effectively depoliticizes the issue and obscures the role of its own decisions in exacerbating flood risk (Tierney, 2014). Additionally, by proposing technocratic solutions, the state reassures the public that it has the technical expertise and capacity to manage the risk.

However, this approach allows the government to sidestep more complex and difficult questions about the social and political factors that contribute to risk creation in the first place and that perpetuate the problem of risk creation (Rumbach, 2011; Wisner et al., 2004).

The state's narrative also emphasizes the need to regulate and control development in flood-prone areas to reduce the potential impacts of flooding. This aligns with the larger narrative of the state across India in which illegal constructions and development in flood plains are repeatedly flagged as key causes of flooding (National Institute of Disaster Management, 2021; Government of Maharashtra, 2020; Ranganathan, 2015; Weinstein et al., 2019). However, missing in these narratives is the consideration of the state's role in the creation of development in flood-prone areas, as pointed out by the narratives of local architects and environmental and local activists. Amidst these competing attributions of haphazard development, the flood line policy is proposed to restrict development in flood zones. However, the policy lacks consideration for the structural aspects responsible for development in flood-prone areas such as the influence of asymmetric power on urban development in risk-prone areas. For instance, the ULBs in Maharashtra responsible for enforcing the implementation of the flood zones have granted permission for construction inside prohibitive zones (blue line) over the years, which has exacerbated the flood situation of cities (Kurtkoti, 2023, Vanashakti & Anr. v. Union of India & Ors, 2023).

Citizens' narratives, on the other hand, point to the government's decision to release water from the dam as a cause of flooding in Chiplun. While the state dismisses this claim, it does make recommendations for dam management. This disconnect highlights the dynamic pressure of poor governance, its fragmented nature, and the lack of enforcement of laws, policies, and regulations. Both the state and the citizens agree that the high volume of silt in the Vashishthi and Shivnadi

rivers contributed to the 2021 flooding event. While river desilting has commenced after citizen activism and funding allocation, it engages with the symptoms of the issue, only provides short-term relief, and does not address risk drivers such as environmental degradation in the catchment areas.

A narrow understanding of flood risk, as evidenced by the solutions and policies in Chiplun, neglects the underlying causes and sociopolitical implications and is shortsighted when it comes to the advancement of long-term disaster resilience and climate change adaptation in the cities in the Global South.

By focusing on Chiplun, the study elevates the perspective of a small city, a context often understudied in the disaster risk literature. The mainstream narratives about India's urbanization and disaster risk have mostly focused on the megacities (Rumbach, 2016; Rehman et al., 2023). Given South Asia's urban transformation, it is crucial to study these largely overlooked spaces. A small city could also be seen as analogous to a neighborhood of a megacity, with similar processes playing out at a smaller scale. However, a key difference lies in the limited governance capacity of the city and the strains that events such as the 2021 flooding put on its capacity. At the same time, their smaller scale can potentially allow for more direct community engagement, as illustrated by the citizen activism in this Chiplun case study.

4.9 Limitations and Future Research

This research provides a descriptive analysis of unsafe conditions, risk drivers, and root causes of flood risk in Chiplun. While it does not make causal claims or trace the process of risk creation, it lays the groundwork for future in-depth root cause analysis of flood risk. There are multiple frameworks, such as PAR, FORIN, and PEARL, to trace the proximate causes of flooding to the

underlying root causes. The narratives broadly cover different voices - the state, experts, and affected residents. However, it could be further expanded to differentiate between affected communities based on their vulnerabilities. For example, is there a difference between the risks and impacts faced by lower-caste and low-income communities as opposed to other groups in the city? Lastly, I started to look at the narratives and government reports prepared after other large-scale flooding events in India. The similarities observed in narratives and government responses to large-scale flooding events across India point to the potential for broader analysis. Future research could expand the study to examine flood events across cities in India to understand the discursive nature of flood risk and policy formulation.

CHAPTER 5: CONCLUSIONS AND POLICY IMPLICATIONS

This concluding chapter summarizes the dissertation's contributions and then discusses the findings from each empirical chapter. It also discusses the potential limitations of the research design and datasets employed in the dissertation studies. I also discuss the cross-cutting theme of environmental justice that emerges from the findings. Finally, the chapter concludes with policy implications.

5.1 Redefining Disaster Risk and Recovery: A Multidimensional and Interconnected Approach

Given the wicked nature of flooding, I argue that a multidimensional and interconnectivity lens is essential to understanding disaster risk and recovery. The three studies together challenge conventional approaches to understanding and addressing disaster risk, impacts, and recovery, highlighting the importance of recognition, participation, and equity in disaster management decisions.

The central argument of chapters 2 and 3 is that achieving a just and equitable recovery begins with how disaster impacts and recovery are conceptualized and measured. Current recovery literature and policies focus more on property loss assessments or are primarily unidimensional in nature (focus on one dimension at a time). The focus on property damage does not account for the needs of those struggling with unaccounted-for impacts or those difficult to precisely quantify, like low-income or marginalized households with low or no property. The first two chapters go beyond the conventional approach of assessing property loss by assessing broader impacts, such as the effects on well-being (income and consumption). Chapter 3 adds to the

literature on disaster impacts by exploring the interconnected nature of damages and recovery by examining the recovery of property vs. economic well-being. Damage to income emerges as a crucial factor in the analysis. The findings show that loss of income in the immediate aftermath of the event is associated with lower recovery of housing, household goods, and consumption. Chapter 3 contributes to understanding of recovery in terms of the mechanisms that influence the process.

Chapter 4 examines the narratives of different stakeholders emerging after the 2021 flood event and how they engage with different dimensions of risk. It makes an empirical contribution to the literature on disaster risk by highlighting the discursive and political dimensions of risk production and management. The findings reveal a complex interplay of perspectives and approaches to understanding and addressing flood risk. The findings demonstrate how different actors, such as politicians, government officials, media, experts, and affected residents, construct and contest narratives about the causes of and responsibilities for flood risk. It emphasizes the need to consider the underlying drivers and root causes of risk, such as governance structures, economic priorities on the part of decision-makers, and development practices, rather than focusing solely on immediate triggers or physical hazards.

Additionally, by focusing on India, particularly the experiences of households from rural areas and small towns, my dissertation contributes to the limited literature on disaster risk and recovery in these contexts. In India, where a significant portion of the population resides in rural areas and small towns, understanding and addressing disaster risk and recovery in these settings is crucial for understanding recovery.

5.2 Summary of findings

Drawing on the environmental economics literature, **chapter 2** examines the economic welfare impacts of flooding on households in rural India. Using household panel data (n = 23,748) from the India Human Development Survey (IHDS) and a difference-in-differences approach, the study found that flooding has a significant negative impact on affected households' total annual income, total annual consumption expenditure, and wealth (asset index) as compared to non-flooded households.

One of the key findings of this study is that the magnitude of the negative impact on income is stronger in the short term (1-3 years after flooding) than in the medium term (4-6 years). This suggests that the severity of income losses may diminish over time after a flood event. While this is not surprising, individual trajectories may differ based on one's socioeconomic characteristics. Prior research has shown that the impacts of disasters tend to be negative in the short term, and they lessen as economic and structural recovery occurs. Additionally, floods also lead to lower consumption expenditures and smaller increases in household assets for affected households. Another contribution of this chapter is the exploration of heterogeneity in flood impacts based on households' socioeconomic status. The findings reveal that households below the poverty line and scheduled caste/tribe households in flood-affected villages experienced more severe negative impacts on income and wealth compared to other groups. In contrast, the households with the highest income quintile saw an increased consumption and income after flooding compared to the lowest income quintile, highlighting disparities in flood impacts and recovery.

The findings of this dissertation have important implications for policymakers, development practitioners, and disaster researchers. First, the results emphasize the need for targeted

interventions and support mechanisms to assist vulnerable households in coping with and recovering from flood events. This may include social protection programs, livelihood diversification initiatives, and access to financial services and insurance (Hallegatte et al., 2017; Antilla-Hughes et al., 2013). Second, the heterogeneous impacts of flooding across socioeconomic groups highlight the importance of considering both social and economic stratification in disaster risk management and policy interventions. Finally, this research underscores the need for future research on the long-term impacts of disasters on economic well-being, how households cope with and adapt to these shocks, and implications for flood risk reduction programs through better planning and foresight regarding the built environment in cities. Future research could explore the role of social networks, institutional support, and government policies in shaping household resilience and impacts.

Chapter 3 delves into the case study of Chiplun, a small city in India affected by flooding, to examine the disparities and interconnectedness of recovery dimensions. By taking a multidimensional approach, the study analyzes the recovery of economic well-being (income and consumption) vs. property (house and household goods) of affected households (n = 389).

The findings highlight disparities in recovery trajectories across different dimensions, with housing recovery lagging behind income and household goods recovery even two years post-disaster. Additionally, the research reveals the role of social and economic marginalization in shaping disaster vulnerability, resilience, and, consequently, recovery in India.

One of the key findings is that lower-caste households face greater challenges in recovery across all three dimensions. This underscores the need for targeted interventions to ensure equitable recovery for marginalized groups and address the systemic barriers and discrimination faced by

lower-caste and minority communities in India. Additionally, the study found that higher-income households reported better recovery of household goods but experienced slower income recovery, particularly for business owners. This emphasizes the need for tailored economic revitalization efforts to restore the business community's livelihoods post-disaster.

Consistent with the previous findings, the decline in household consumption, especially of durable goods, suggests long-lasting impacts on living standards. During the household surveys, many households mentioned that they were either unable to repair and restore housing and damaged goods or feared another flood would impact their homes again, thus delaying the restoration. This finding highlights the need for disaster recovery efforts to go beyond temporary relief and include measures for boosting household purchasing power and access to essential goods.

Lastly, the study also uncovers interconnections between different dimensions of recovery, with income loss linked to restoration of housing and household goods and change in consumption of durables. Thus, more policies need to be implemented that directly address income loss. Similarly, results show a positive association between housing recovery and household goods recovery. This implies that disaster recovery requires a holistic, integrated approach to simultaneously address the cascading impacts across multiple aspects of household well-being.

It is important to note that this study relies on household perceptions to assess disaster damages and recovery. In addition to perception-based questions, future research using multidimensional approaches could benefit from using more objective and standardized indicators and longitudinal survey designs to capture recovery at multiple points. This would provide a more dynamic understanding of change in recovery over time rather than measuring it at one point in time.

Chapter 4 examines the narratives and policies surrounding flood risk in Chiplun, Maharashtra, India, after the devastating 2021 flooding. The study adds to the literature on disaster risk by examining how different narratives and policy outcomes engage with different components of risk - proximate causes, dynamic pressures, and root causes (Wisner et al., 2004; Oliver-Smith et al., 2019). The study also highlights the political and discursive dimensions of disaster risk production and management and sheds light on the perspective of a small town in India, an often overlooked context in disaster studies.

Using narrative analysis, the study deconstructs how disaster causation is understood, responsibilities are assigned, and various voices are portrayed in the decision-making process around flood risk and how that influences policies designed to manage flood risk. Despite recognizing that disasters are never entirely natural and are partially shaped by societal factors, it is still common to hear narratives describing disaster events as forces of nature. In the case of the 2021 flooding in Chiplun, the politicians, government officials, and the media often attributed the flood to heavy rainfall, high tide, and the region's topography. Moreover, these narratives place blame on new uncertainties associated with climate change. However, these descriptions were challenged by experts and citizens who presented alternative perspectives. Experts blame the nature of development and the decision-making responsible for it, while the affected residents argue that governance issues cause flooding.

The policies and projects implemented in response to these narratives include technocratic solutions like restrictions on development in flood zones, removal of silt from the river, and structural or public works solutions to water resource management, including flood alleviation. However, the study highlights the absence of engagement with the risk drivers and root causes of flood risk in Chiplun, such as governance structure and economic and development priorities,

which contribute to the creation of unsafe conditions of development in flood zones, siltation, and release of water from dams.

Through narrative analysis, it highlights the discursive and political dimensions of risk production and management. It situates flood risk within the broader context of power relations and development paradigms shaping urban and disaster governance in India. Additionally, the study elevates the perspective of a small urban place in India, a context often overlooked in disaster studies, contributing to a more inclusive and contextually grounded understanding of flood risk. The findings underscore the need for a holistic understanding of disaster causation that moves beyond immediate triggers and physical hazards to address the underlying socio-economic drivers and root causes of risk. This is crucial for developing effective and equitable risk management strategies in the face of increasing flood risks due to climate change and rapid urbanization.

Chapter 4 focuses on flood risk narratives and policies in a small coastal town in India. The approach used to assess how narratives engage with different dimensions of disaster risk—unsafe conditions, risk drivers, and root causes—could be applied in other contexts and disasters. Its application to cities and disasters across India can reveal patterns in how disaster causation is attributed and what policies are proposed. While the chapter examines the narratives and policies surrounding flood risk in Chiplun, it could benefit from a more comprehensive inclusion of the perspectives and experiences of marginalized communities, particularly those from lower-income and lower-caste groups.

5.3 Data Sources and Challenges in Disaster Impact Research

Researchers often make tradeoffs in terms of data availability and accuracy when studying the impacts of disasters. There is a discussion in the natural hazards literature about the appropriate measures to use for disaster occurrence and magnitude. Common indicators include disaster incidence dummies (Noy et al., 2020; Poaponsakorn et al., 2015), disaster magnitude (Anttila-Hughes et al., 2013)[37] or frequency (Le, 2020)[38], damage estimates (Nabangchang et al., 2014), or indices (Henry et al. 2020)[39] as proxies for disaster events. The disaster information is typically obtained through reports/datasets of governments and international agencies, on-ground surveys, data from ground stations, and satellite images.

The ground station data for flooding records water velocity, depth, and precipitation. Although data from ground stations increases the accuracy of the analysis, this information is hard to obtain for developing countries. Satellite imagery is more widely available and is used where ground station data is not available. It provides information on the flood duration and extent, precipitation, etc, but often lacks information about velocity and water depth. Satellite data is also criticized for its lack of precision at the local level. For example, Poaponsakorn et al. (2015) use satellite images to determine the provinces impacted by the 2011 Thailand floods. However,

[37] Anttila-Hughes et al. (2013) use province level typhoon incidence data (wind speed) to represent the disaster shock.

[38] In Le's study, the flooding indicator is a continuous variable that ranges from 0 to 1, and it measures the proportion of village flooded. The study aggregates daily flooding data from MODIS Flood Water Images into annual information.

[39] Henry et al. (2020) build a household specific hurricane destruction index using the physical characteristics information of the storm. The max wind speed for each storm is calculated for the centroid of the districts which is the location indicator for the household data.

because of the poor resolution, the authors could not distinguish between flooded and non-flooded households in densely built environments and had to mark everyone in Bangkok as affected.

Other sources of data available at the global level are reports/datasets from international agencies. They publish the data at aggregate levels (e.g., regions, states). EM-DAT (Emergency Events Database) provides information on the loss of life and property from various disasters, including floods. However, the global datasets have a few limitations. First, it provides spatially aggregated information, which is less precise at the local level. Second, these agencies often only record events beyond a certain threshold of losses, therefore missing information on more local disasters.

On-ground surveys collect detailed information from impacted households or local institutions. They record information about the exposure to flooding, duration and severity of the event, and loss of life and property. Noy et al. (2018) use self-reported flood information from household surveys to assess the effects of 2011 catastrophic flooding in Thailand. They argue that the self-reported data provides a more reliable measure of disaster incidence than satellite images because they can separate affected and non-affected households in the flooded areas. Nbangchang et al. (2015) surveyed affected households in the heavily affected region of Bangkok using a specially designed household survey. Similarly, after the 2005 flooding in Mumbai, Patankar (2018) surveyed 1,168 families in the most vulnerable neighborhoods of Mumbai. However, a drawback of the self-reported measures is that they do not capture the varying severities of weather shocks and are prone to misreporting bias (Le, 2020). Furthermore, the subjective measures raise issues of endogeneity and measurement error, which are likely to

be correlated with the socioeconomic characteristics of households. Additionally, surveys suffer from methodological and budget constraints.

In this dissertation, I use survey data on flood incidence. Chapter 2 uses the India Human Development Survey (IHDS), which collects information on flood exposure through focused group discussions with knowledgeable persons at the village level. While the IHDS data provides a spatially granular estimate of flooding (at the village level), it has some limitations regarding the lack of a standardized definition of flooding, recall bias, etc., which I discuss in detail in Chapter 2. Chapter 3 employs a primary survey of households affected by the 2021 flooding event. I collected information on the depth and duration of water in the house and damages sustained to the property, household goods, income, and consumption. Household surveys, while valuable, are expensive and time-consuming if one is interested in a multi-event analysis.

Each data source presents unique advantages and challenges. Future research on flooding impacts in India could benefit from a combination of these datasets. Here is a summary of datasets for flooding and economic well-being available for India.

Table 5-1: Economic well-being datasets available for India

Dataset	**Information**
India Human Development Survey (IHDS)	**Type**: Repeated cross-sectional survey **Conducted by**: University of Maryland and National Council of Applied Economic Research (NCAER) **Waves**: 2004-05 and 2011-12 **Coverage**: National **Variables**: Socioeconomic indicators and questions on disasters
National Family and Health Survey (NFHS)	**Type**: Repeated cross-sectional survey

	Conducted by: Ministry of Health and Family Welfare (Demographic and Health Surveys - DHS program) **Waves**: Five rounds - 1992-93, 1998-99, 2005-06, 2015-16, and 2019-21 **Coverage**: National **Variables**: Health and demographic indicators
National Sample Survey (NSS)	**Type**: Repeated cross-sectional survey **Conducted by**: National Sample Survey Office **Waves**: Annual, with different topics **Coverage**: National **Variables**: Socioeconomic indicators
Consumer Pyramids Household Survey (CPHS)	**Type**: Panel survey **Conducted by**: Centre for Monitoring Indian Economy (CMIE) **Frequency**: Continuous, with data released quarterly **Coverage**: National **Variables**: Socioeconomic indicators

Note: This is not a comprehensive list

Table 5-2: Flood datasets available for India

Dataset	Information
Joint Research Centre (JRC) Global Surface Water Dataset	**Resolution**: High-resolution (30m) satellite-derived data **Frequency**: Monthly water classification since 1988 **Limitation**: It doesn't provide flood depth or flow velocity
Dartmouth Flood Observatory Global Active Archive of Large Flood Events	**Resolution**: Compilation of flood events from news, governmental, instrumental, and remote sensing sources **Frequency**: Covers major floods from 1985 onwards **Limitation**: Spatial precision may not be sufficient for granular analysis and there is a potential for reporting bias towards more populated or accessible areas. There is no consistency in terms of how the events are reported.

EMDAT (Emergency Events Database)	**Resolution**: Global database on natural and technological disasters. Includes flood events that meet certain criteria (e.g., ten or more people reported killed) **Frequency**: Records of disasters from 1900 to the present day **Limitation**: Lacks precise geographic information, and there could be reporting inconsistencies across regions and over time
Disastrous Weather Events Data by IMD	**Resolution**: Information on various extreme weather events, including flooding **Frequency**: Online reports have been available since 1967 **Limitation**: Often, the reports provide only broad geographic descriptions. Events may be reported at various scales (districts, state, etc.)
India Meteorological Department (IMD) precipitation Data	**Resolution**: District level **Frequency**: Monthly rainfall data as a proxy, not a direct flood measurement **Limitation**: It may not capture localized heavy rainfall events well

Note: This is not a comprehensive list

5.4 Environmental Justice (EJ) as a cross-cutting theme

Environmental justice is a dominant theme in this dissertation's research design and findings. The three studies in my dissertation engage with different dimensions of EJ, including distributive justice, procedural justice, and recognition of injustice. The research provides valuable insights into the complex interplay of social, economic, and political factors that shape disaster risk and recovery outcomes. The findings show that current DM practices and policies perpetuate existing injustices by neglecting disasters' differential impacts, failing to design targeted policies, and failing to consider the sociopolitical implications of floods.

Distributive justice focuses on the equitable distribution of environmental benefits and burdens across different social groups (Bullard, 1996; Schlosberg, 2007; Camacho et al., 1998). By

moving beyond property damage assessments to examine the broader economic welfare impacts on households, chapters 2 and 3 argue for a more comprehensive understanding of the distributional consequences of disasters, which is a key concern in environmental justice. Recovery efforts that prioritize property loss may inadvertently exacerbate existing inequalities and hinder the ability of marginalized communities to bounce back from disasters. There is a growing recognition in the disaster studies literature about the importance of equity-focused measurement practices. By critically examining the ways in which disaster impacts and recovery are measured, researchers and practitioners can work towards promoting a more just and equitable distribution of resources and support to affected communities.

Chapter 3 highlights disparities in recovery across different dimensions (housing, household goods, income, and consumption) and heterogeneities in impacts based on socioeconomic characteristics. It underscores the importance of acknowledging and addressing diverse experiences and needs in disaster recovery processes. By challenging conventional approaches that prioritize property loss and overlook marginalized communities' diverse needs and experiences, my research contributes to a growing body of literature on environmental justice that emphasizes the importance of recognition, participation, and equity in shaping disaster recovery outcomes.

Procedural justice emphasizes the fairness, transparency, and inclusivity of decision-making processes related to environmental issues (Schlosberg, 2007). Chapter 4 engages with the procedural justice dimension by examining the diverse narratives in policies surrounding flood risk in Chiplun. The lack of involvement of the affected residents in the flood line policy implementation and the dismissal of residents' claims regarding dam mismanagement by the state depict a lack of procedural justice.

Recognition of in**justice** emphasizes the acknowledgment and respect for the diverse experiences, identities, and needs of different individuals and communities, especially those who are marginalized or disadvantaged and who, therefore, are likely to experience exclusion. Recognition-based injustice in disaster contexts involves acknowledging and representing all sections of society, knowledge systems, and value structures (Jenkins et al., 2016; Shreshta et al., 2019). It prompts researchers to consider: Whose disaster knowledge is considered valid in decision-making (Shreshta et al., 2019)? How is disaster-related information generated? And whether mainstream groups accurately comprehend and interpret knowledge from marginalized communities (Figueroa, 2018).

The concept of recognition is crucial for understanding and addressing the diverse interests, priorities, and knowledge of those most affected by flooding. In the case of Chiplun, the state's narratives that were used to explain the causes of the 2021 flooding in Chiplun is an issue of recognition of justice. The state's narrative, which primarily attributes the flooding to external factors like heavy rainfall, high tides, and the region's topography, fails to acknowledge the perspectives and experiences of the affected communities. By presenting the flooding as a purely natural event, the state obscures its own role in exacerbating or ignoring the flood risk. Moreover, the state's dismissal of the citizens' concerns over the release of water from the dam and the lack of effective communication and warning systems demonstrate a failure to recognize the legitimate needs and rights of the affected communities. This misrecognition of the needs and concerns of those most vulnerable to flooding is an issue of recognition of justice. It might lead to policies that may further exacerbate inequalities and undermine justice.

5.5 Policy Implications

5.5.1 Recovery

The findings from this study provide more evidence to policymakers regarding the detrimental impacts of flooding on the welfare of affected households. The government's response to a disaster in India often prioritizes monetary compensation or housing reconstruction while diminishing the importance of well-being-focused aspects such as livelihood recovery. After the 2021 flooding in Chiplun, the State Government provided Rs.10,000 (US$120) to affected households and Rs.50,000 ($600) to the impacted businesses as a relief. According to the DMA, 2005, the money disbursed for relief is essentially "*to reduce the level of suffering and mitigate the distress so as to bring out the affected people from the shock and trauma of suddenly losing their means of livelihoods*" (Government of India, 2005).

However, the monetary compensation provided after the floods does not address the diverse needs. A uniform amount of relief without considering the range of factors affecting inequality as well as other social and economic conditions creates equity issues. For instance, the compensation given to the households impacted by the 2021 floods in Chiplun was based on damage to houses and businesses. This left out renters, informal workers, wage workers, and hawkers who were impacted by flooding but did not own a house or business. Despite the demands from the trader's association in Chiplun for assistance in terms of restoring their livelihoods, business owners reported receiving no support from the state. Additionally, multiple households reported that the amount provided was insufficient even to carry out the cleaning activities, and the households had to rely on mechanisms such as drawing money from savings, selling assets, or borrowing to manage repairs and consumption expenditure in the aftermath.

The National Policy on Disaster Management (NPDM) acknowledges the importance of livelihood recovery and the need for a multi-pronged approach to address the diverse needs of affected communities (Ministry of Home Affairs, 2009). However, the implementation remains an issue because of institutional fragmentation, lack of clear guidelines, capacity constraints of the local and state-level institutions, and a more reactive than proactive approach to disaster management in general.

> "*State governments will have to lay emphasis on the restoration of the permanent livelihood of those affected by disasters and special attention to the needs of women-headed households, artisans, farmers and people belonging to marginalized and vulnerable sections*" (Ministry of Home Affairs, 2009, Pg no. 41).

Additionally, the Sendai Framework for Disaster Risk Reduction (2015), which India is a part of, emphasizes the importance of capturing a more comprehensive range of flood impacts (Allaire, 2018).

Thus, there is a need to move beyond temporary relief because the findings show that flooding slows down household economic growth by reducing income, housing conditions, and consumption. With extreme weather events predicted to get more frequent, there is a need for disaster management and development policies to focus on livelihood concerns and more targeted policies for disaster relief and recovery. Studies have shown that well-designed social protection programs, such as cash transfers and involvement in public works projects like infrastructure construction, can help mitigate disasters' impacts on household welfare and promote faster recovery (Markhvida et al., 2020).

5.5.2 Disaster Risk

After every flood, its adverse impacts raise many questions about disaster management in India. Despite the government's emphasis on a paradigm shift to disaster mitigation, most parts of the country continue to follow a post-disaster ad-hoc approach rather than a proactive prevention, mitigation, and preparedness path. This reactive approach has resulted in a patchwork of actions implemented nationwide, often lacking coherence and long-term thinking.

One of the major challenges in India's disaster management is the focus on local or event-centric policy decisions. After every flood, the actions taken are largely reactive and focus on the immediate causes, geography of the region, and the hazard itself (cloud burst, high tide, etc) that led to the flooding. The official narratives, plans, and policies fail to address the risk drivers and root causes of flood risk, as illustrated by the case of Chiplun. Pre-disaster decisions about urban development and disaster management significantly impact the creation of disaster risks. However, local-level development planning decisions rarely consider flood risk (Weinstein et al., 2019; Rumbach).

While understanding proximate causes and conditions may help assess risk in a specific time and place and provide temporary relief recommendations, it does not fully highlight the actors and processes responsible for producing and distributing risk. This limited understanding of the causation is not sufficient for shaping future development in a manner that reduces risk equitably. Policies and plans to address the flooding issue must move beyond short-term remedial solutions like desilting river beds and strengthening embankments towards more comprehensive urban development and disaster management policies.

Experts, states, and the media frequently cite urbanization as a cause of flood risk. Reports by the Parliament of India to the State Government on the 2019 Maharashtra floods and the 2021 Chiplun floods consistently identify illegal constructions and development in flood plains as key causes of flooding. The proposed solution is often to clear flood channels by removing unauthorized structures or restricting further development in flood zones. Although crucial, these proposals often lack public participation, contextual considerations, and an understanding of the sociopolitical implications of a sudden ban on development. For example, the demarcation of flood lines in Chiplun has restricted development in 70 percent of the city. A ban on new development without any concrete plan to provide relief to the property owners (homes and businesses) might worsen existing disparities and lead to more unauthorized construction.

In India, urban local bodies (ULBs) are responsible for guiding urban development through spatial planning instruments, development plans (DPs), and development control regulations (DCRs). However, the selective use and implementation of these instruments across the country has allowed powerful interest groups to influence the preparation, modification, and enforcement of plans to further their interests. Through regulatory capture[40], influential actors, such as real estate developers and political leaders, have prioritized economic interests over disaster risk reduction (public interest). For example, ULBs in Maharashtra responsible for enforcing flood zone implementation have granted permission for construction inside prohibitive zones (blue line) over the years, exacerbating the flood situation in cities (Sarang Yadwadkar -Mongabay,

[40] "Regulation is acquired by the industry and is designed and operated for its benefits" (Stigler, 1971).

2023). This discretionary interpretation of laws highlights the broader issue of urban governance, where economic interests often take precedence over disaster risk reduction, perpetuating socio-economic inequalities and environmental degradation (Weinstein, 2019; Alvarez et al., 2019).

Integrating disaster management considerations into urban development decisions is necessary to enable more holistic, equity-oriented approaches to building urban resilience. The new flood line policy and development control regulations are an attempt in the direction of integration; however, they lack public participation in the process. Policies accommodating the voices of those affected will ensure that the DM policies and development practices do not perpetuate or exacerbate environmentally harmful strategies and the marginalization of the vulnerable. This could be achieved through a mandate that urban plans include hazard response and prevention with participatory approaches.

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APPENDICES

5.6 Appendix A: Survey Questionnaire

(*Note to the interviewer - after explaining the purpose of the survey, ask whether the household is willing to participate.*)

Please confirm you agree with the following statement: " I am 18 years or older, I have reviewed the study information, and I agree to participate."

- Confirm. I agree to participate.
- Do not confirm. Decline to participate.

Screening questions *(Before proceeding, check whether the households meet the following criteria)*

1. Are you the owner of the house/ apartment?
    - Yes
    - No (*don't proceed*)
2. Was there floodwater in your house during the July 2021 flooding?
    - Yes
    - No (*don't proceed*)

If the household refuses to participate, or if the household does not meet the above criteria, or if the household is not available after 2 visits, then **begin a new survey at the door/ structure next to the original door/ structure.**

Survey Identification Number:

Date:

Time:

Household Information:

Sector:

Flood (*Now I would like to ask you questions about the 2021 July flooding)*

1. How long was there flood water in your house?
   _____(days)

2. How did you become aware of the rising water level in your neighborhood? (*Hint: ask if they were informed by the government, family, friends, or neighbors or did not receive any information. Write in 1 sentence)*
   _____
   _____

3. What action did you take after experiencing rising water levels or receiving information? (*check all that apply*)
   Evacuated to a safer place
   Warned others
   Tried to block water
   Moved items to a higher ground
   Other _____(*specify*)

4. Do you have previous flooding experience of floodwater impacting your house or business?
   - Yes
   - No

5. How did you prepare for the 2021 monsoon season based on your previous experience? (*check all that apply*)
   Purchased insurance (e.g., house, vehicles, other)
   Minor structural changes to the house (e.g., sealed windows, doors; moved valuable items to higher ground)
   Major structural changes to the house (e.g., elevated the house, constructed barriers to water entry)
   Other _____ (*specify*)

6. What was the highest water level inside your house during the 2021 flood? *(Ask them to point at the wall. Use the values in brackets for reference)*
   - Ankle deep (< 0.4 ft)
   - Knee deep (0.4 - 1.5 ft)
   - Waist deep (1.6 - 3.3 ft)
   - Mid chest (3.4 - 5.5ft)
   - Overhead (5.6 - 6 ft)
   - Ground floor underwater (10 ft)
   - Other _____ (*specify*)

7. Where did you stay when there was water and silt in your house? (*check all that apply*)

Own house
Relatives House
Friends House
Designated shelter by the government
Other _____ (*specify*)

8. For how long did you stay outside your house because of flooding impacts?
   _____ days/ months

Losses and Recovery (*I would like to ask you questions about losses of flooding and recovery from flooding)*

Consumption Losses and Recovery

9. Because of the 2021 flooding, how did your household's spending change on the following items? (*Use the following scale to fill out the table. Enter changes for each item in the table. **This is a very crucial question**)*
   1. Decreased significantly
   2. Decreased slightly
   3. Stayed the same
   4. Increased slightly
   5. Increased significantly

	Loss	**Recovery**	
	Right after the event (~ 2 months)	July 2022 (1 year after the event)	At the time of the survey
a. Food b. Durables (footwear, clothing, and bedding) c. Education (school/ college/ tuition fees or school books and other educational articles, etc.) d. Healthcare (medicine, doctors' fees, etc.) e. Utility and services (electricity, water, gas)			

10. What type of losses did your household incur due to the 2021 flooding? What was the approximate amount of the losses? When did you recover?

	Losses	**Recovery (month)**	
Now, I would like to ask you about your losses from flooding. I will read the items one by one, and you can say yes or no.	approximate amount of the loss	If recovered, approximate month and year of replacement/ repair/ restoration	If not recovered, approximate month and year of the expected replacement/ repair/ restoration
One or more members of the household experienced loss of income *(check all that apply)* ● Lost job/work ● Could not go to work for a few days ● Business temporarily closed ● Business permanently closed ● Other _____ (*specify*)			
Damage to the house *(check all that apply)* ● **Paint and/or plaster** wearing off ● Considerable damage to the **floor, wall, and/or roof** ● Damage to **plumbing/ electric circuits** ● **One or more rooms** of the house were unusable ● **Entire house destroyed** ● Other _____			
Damage to appliances *(check all that apply)* - TV - Computer - Fridge - Washing Machine - Fan/ AC/ Cooler - Other _____ (*specify*)			

Damage to furniture *(check all that apply)* - Couch - Table and/or Chairs - Bed - Closets, Armoires, and/or Wardrobes - Other _____ (*specify*)			
Damage to vehicles *(check all that apply)* - 2 wheeler(s) - 4 wheeler(s) - Other _____ (*specify*)			
Loss of food (*check all that apply*) - Grains and flour (e.g., rice, wheat, jowar, and bajra) - Milk, poultry, and meat products. - Cereal products (e.g., bread, muri, maida, suji, and noodles) - Processed foods (e.g., biscuits, cake, pickles, and sauce) - Condiments (e.g., salt, sugar, and spices) - Other _____(*specify*)			
Loss of utilities - Electricity - Water - Gas			
Animals/ Husbandry			
Health (injury and/or sickness due to flooding)			
Other losses _____ (*specify*)			

Recovery of Income

11. Because of the 2021 flooding, how did the overall income of your household from all sources change:
    1. Decreased significantly
    2. Decreased slightly
    3. Stayed the same
    4. Increased slightly

5. Increased significantly

	Before July 2021	1 year after the flood (around July 2022)	At the time of the survey
12. How many earning members do you have in the household?			
13. What is the closest approximation of total household income from all sources? (in Rs.) ● 5,001- 10,000 per month ● 10,001- 20,000 per month ● 20,001 - 30,000 per month ● 30,001 - 40,000 per month ● 40,001 - 50,000 per month ● More than 50,000 per month ● Don't know			

14. Members in your household are a (*check all that apply*)?
    - Business owner
        - Small business
        - Organized business (more than 5 employees)
    - Salaried employee (private or government)
    - Wage worker/ laborer
    - Other _____ (*specify*)

Fill the respective columns based on the answer to the previous question. One household can have multiple working members. Fill in all that apply.	Business owner	Salaried employee	Wage worker
15. What was your income from business/ job/ work in July 2021? _____ rupees/ month			
16. Did you lose income because of flooding? ○ Yes ○ No (*skip next question*)			
17. How long did it take to get back to			

job/ work? _____ (days or months)			
18. How does your current income compare to your income before July 2021 flooding? 1. Decreased significantly 2. Decreased slightly 3. Stayed the same 4. Increased slightly 5. Increased significantly			

Recovery of House and household goods

19. How long has your household occupied this house/ apartment?
    a. less than 2 years
    b. 2 - 5 years
    c. 6 - 10 years
    d. 11 - 20 years
    e. 20 + years

20. If less than 2 years, why did you move here?
    a. Because of flooding
    b. Other reasons

21. How does the condition of your house (paint, walls, floor, roof) today compare to the condition before July 2021 flooding?
    1. Significantly worse
    2. Slightly worse
    3. It has stayed the same
    4. Slightly better
    5. Significantly better

	Before July 2021	July 2022	At the time of the survey
22. Number of usable rooms in the house			

23. Did you make repairs to your house after the event?
    ○ Yes

- No (*skip next question*)

24. What is the approximate value of repairs made on the house?
_____ Rs

25. How does the condition/ number of your vehicles today compare to the condition/ number before the July 2021 flooding?
    1. Significantly worse
    2. Slightly worse
    3. It has stayed the same
    4. Slightly better
    5. Significantly better

26. How does the condition/number of your appliances today compare to the condition/number before the July 2021 flooding?
    1. Significantly worse
    2. Slightly worse
    3. It has stayed the same
    4. Slightly better
    5. Significantly better

27. How does the condition/number of your furniture items today compare to the condition/ number before the July 2021 flooding?
    1. Significantly worse
    2. Slightly worse
    3. It has stayed the same
    4. Slightly better
    5. Significantly better

Recovery of consumption

	Before July 2021	July 2022	At the time of the survey
28. Do you have a ration card? ○ Yes ○ No			
29. Do you get ration from government shops? ○ Yes ○ No			

30. What type of ration card does the household have?
    a. Orange

b. Yellow
c. White

Cross-check questions

31. Have you completely recovered from the impacts of the July 2021 flooding?
    1. Strongly disagree
    2. Disagree
    3. Neither agree nor disagree
    4. Agree
    5. Strongly agree

32. Why do you think your household has not recovered from the July 2021 flooding? (*check all that apply*)

    House not fully repaired
    Assets not fully replaced
    Lower savings now due to costs
    Increased debt
    Lost job and is still unemployed
    Lost job and the new job is less paying
    Lost business clients (that still did not come back)
    Business closed permanently
    Still cutting on essential consumption to deal with costs (like food, healthcare, etc)
    Still cutting on non-essential consumption to deal with costs (clothes, electronics, non-essential food like meat and alcohol)
    Other _____ (*specify*)

33. How long did it take for you to recover from the impacts fully? (*If they think they have not recovered fully, ask)* when do you expect to fully recover from the impacts of the July 2021 flooding?
    _____ (approximate month and year)

34. How did you prioritize your repairs/ rebuilding/ restoration? (*Rank the following on a scale of 1-5; 1 being the first or highest priority and 5 being the last or least priority*)

	Rank
Lost income	
Damaged house (paint, walls, floors, roof)	
Damaged household goods (appliances, furniture, vehicles)	

Expenditure on food, education, and health	
Other	

35. Why did you repair/ replace/ fix the above first? (*This is an open-ended question. Write 1-2 sentences. For example, ask why you chose to fix your income first*)

_____
_____
_____

Coping strategy (*Now I would like to ask you questions about different coping mechanisms used by the household to deal with the impacts of flooding)*

36. What coping strategy did your household use post-flooding? (*check all that apply*)

Coping Mechanism	If yes, amount
Sale of assets	
Use of savings	
Received monetary assistance: - NGOs - Religious organizations - Family/ friends/ relatives - Other _____	
Loans with interest from - Formal sources (Banks, etc.) - Moneylenders - Family/ friends/ relatives - Other _____	
Borrowed without interest from - Family/ friends/ relatives	

37. Did you receive government aid (monetary assistance)?
    - Yes
        - Business _____ rupees
        - Home _____ rupees
    - No (*skip next 2 questions*)

38. How satisfied were you with the monetary aid from the government aid?

1. Very Satisfied
2. Satisfied
3. Not satisfied or unsatisfied
4. Unsatisfied
5. Very Unsatisfied

39. What did you use government aid for? (*This is an open-ended question. Write 1-2 sentences.*)

_____

_____

Controls (*Now, I will ask you questions about household characteristics because we want to compare the flood and recovery experiences across different types of households in the community. As a reminder, your household will never be identified by name or address. This information will only be used for research purposes*)

40. Gender of the respondent
    a. Female
    b. Male

41. Is the respondent head of the household?
    a. Yes (*skip next question*)
    b. No

42. Gender of the household head
    a. Female
    b. Male

43. What is the age of the household head?

    _____

44. What is the religion of the head of the household?
    a. Hindu
    b. Muslim
    c. Christian
    d. Sikh
    e. Buddhist/ Neo-Buddhist
    f. Jain
    g. Tribal
    h. Others _____ (*specify*)

45. Caste (*if Hindu*)
    a. Open
    b. OBC
    c. SC/ST/NT
    d. Other

46. How many people are there in your household? (*Think about people who usually live here and share meals)*

_____ persons

47. Household Roster

HH #	Sex	Age	Education	Employment status	Occupation
	1. Male 2. Female 3. Other		What is the highest level of education obtained by (NAME)? 1. Less than class 10^{th} 2. Class 10^{th} - 12^{th} 3. Bachelors 4. Above Bachelor	What is the employment status of (NAME)? 1. Employed 2. Unemployed 3. Not in labor force	1. Agriculture and allied agriculture (cultivation, agricultural wage labor) 2. Non-agricultural wage labor 3. Independent work/ petty shops/ small business 4. Organized trade/ Business (*if more than 5 employees)* 5. Salaried employed 6. Retired 7. Household work 8. Other _____ *(specify)*

48. Type of dwelling unit? (*interviewer will fill this out*)
    - Bungalows
    - House with shared walls (Rowhouse)
    - Apartments
    - Chawls
    - Slum housing
    - If you cannot tell from the above categories, mention it here _____ *(Specify)*

49. Material of construction (*interviewer will fill this out*)

Floor	Roof	External Walls
Concrete Brick Stone	Iron sheets Tiles Asbestos	Concrete Cement Blocks Thatch

Cement Screed Rammed Earth Wood Other _____ (*specify*)	Concrete Tin Thatch Plastic Other _____ (*specify*)	Stabilized bricks Unburnt brick with cement Unburnt bricks with mud Wood Mud and pole Plastic Other _____ (*specify*)

Notes (*Any other noteworthy information the household shared about the event, something that is not captured in the survey*):

5.7 Appendix B: Interview Guide

Experience of flooding and recovery

1. Tell me about your experience of July 2021 flooding?
2. Tell me about your experience of recovering from the flooding?

Recovery

3. How will you know your household has recovered?
4. Have you recovered from the flooding?
5. What tradeoffs did you make during the process?
    a. Income vs. house vs. household goods
    b. What was the process like?
6. What is remaining, according to you?

Social forces

7. Can you tell me about the external conditions (economic, social, and political) during your recovery?
8. And how that affected your recovery?

Role of the state: Pre-disaster

9. How do you think the actions of the state before flooding impacted your situation during the 2021 flooding?

Role of the state: Before and during flooding

10. Did you receive any emergency warning and evacuation assistance from the government? Could you tell me about it?
11. When did you receive the relief aid from the government? Can you tell me about it?
    a. Were your needs met by the help provided by the government?
    b. Could you tell me how did you use the monetary assistance provided by the government?
12. How was your experience navigating the post-disaster aid and assistance system from the government? What problems did you face in accessing government assistance?
13. Were there sufficient avenues or opportunities for participation in the decision-making process of the government post-flooding?
14. How did you utilize the state's resources?
15. Can you recall how you felt enabled or restrained by what the government did?

Role of the state: Effectiveness of state's actions

16. In your opinion, were these efforts the best way to assist the affected household? What the state could have done more?