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PARTICIPATORY FLOOD RISK MANAGEMENT FOR SUSTAINABLE CLIMATE ADAPTATION IN MEXICO CITY

A literature review and case study

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Abstract In the context of rapid urbanization and the increasing intensity of flood events in metropolitan areas such as Mexico City, the urban poor became particularly vulnerable to flood hazards. Hence, it is a timely manner to implement inclusive strategies for flood risk management. This study aims to fill the gap in understanding the present conditions, risks, and responses to flood hazards in Mexico City from a people-centered perspective. The paper draws on a purposive literature review and case study approach to explore how public policy can involve community-level actors in flood risk management and thereby, promote long-term sustainability. The findings show that policymakers can shift from technocratic to participatory resilience strategies by investing in generic capacity-building and poverty alleviation with geographic literacy and technological flood control innovations.

1. Introduction

Rapid urbanization has led to so-called megacities with an unprecedented area of impermeable surfaces, altering runoff patterns and exacerbating flood risk (Bertilsson et al., 2019). In addition, climate change and the disruption of global precipitation patterns increase the frequency and intensity of flood events (Romero-Lankao et al., 2013). The urban poor in developing megacities, such as Mexico City, are particularly vulnerable to these risks. This increased vulnerability roots in economic insecurity, limited capacities

to absorb climate shocks, lack of social services, and exacerbated risks due to the nature of construction and location of informal settlements (Mays, 2007). The flooding of informal settlements disrupts infrastructure, and leads to pollution as well as water contamination, ultimately hindering sustainable development (Eakin et al., 2016). Hence, establishing sustainable flood risk management is crucial for the development of Mexico City in the face of climate change. Numerous studies have shown the influence of local socio-economic and cultural context on flood resilience (Bayón & Saraví, 2013; Moctezuma, 2001; Chelleri, Schuetze & Salvati, 2015). Thus, the scientific consensus on the relevance of community participation for effective public service supply for risk management is growing (UNDRR, 2015). Yet, the public policy landscape and humanitarian frameworks for flood risk management and sustainability in Mexico City show little consideration of these community-based initiatives.

Therefore, this study aims to fill the gap in understanding the present conditions, risks, and responses to flood hazards in Mexico City from a people-centered perspective. The paper draws on a purposive literature review and case study approach to explore how public policy can mobilize community actors to contribute to the flood resilience of informal settlers in Mexico City. In answering this research question: "How can public policy integrate community-based risk resilience to address flood hazards in the informal settlements of Mexico City?", the study maps out the vulnerabilities of informal settlers in Mexico City. Furthermore, the research investigates how community actors contribute to the flood resilience of informal settlers to develop public policy strategies incorporating local communities into participatory flood risk management frameworks. Thereby, the study hopes to inform policymakers, as well as humanitarian aid workers, on inclusive, and sustainable risk management.

The findings show by framing flood resilience within a long-term sustainable development paradigm, policymakers can shift from technocratic to participatory resilience strategies. Hence, it is proposed to invest in generic capacity-building and poverty alleviation with geographic literacy and technological flood control innovations to increase community flood risk resilience of informal settlers in Mexico City for sustainable development. In the long-run, these strategies have the potential to generate public trust and collaborative networks for sustainable developments.

2. Theory

2.1 The Sendai Framework for Disaster Risk Reduction 2015-2030

To answer the research questions, the following sets out a theoretical framework for the literature review. First, the Hyogo Framework for Action 2005-2015 conceptualizes a hazard as a "potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation." (UNISDR, 2005, p.1). This categorization is particularly important when looking at flood hazards as a socially constructed phenomenon with socio-economic consequences, ultimately hindering sustainable development (UNDRR, 2015). In general terms, subjects of flood hazards are susceptible in terms of their vulnerability and resilience to hazards. The vulnerability approach depends on variables of time and space which determine exposure to flood hazards. Thus, it refers to a system's sensitivity to flood events, and capacity to adapt (Adger, 2006). Flood resilience, on the other hand, is defined as the ability to absorb, recover, and prevent flood hazards through transformation and learning (Folke et al, 2010; Sayers et al., 2013). The paper looks at how community actors in Mexico City experience vulnerability and transform their assets to generate bottom-up flood resilience.

With the Brundtland Report in 1987, international development organizations and governments have set out to address disaster resilience as an interdependent issue of sustainable development and poverty eradication, calling for integration at all levels of society (World Commission on Environment and Development, 1987). The UNDRR Sendai Framework integrates this notion to promote participatory disaster risk reduction in the context of sustainable development (UNDRR, 2015). The report's guiding principles point out that effective disaster risk reduction requires inclusivity and access for all people in a non-discriminatory and empowering manner. In fostering participatory processes and knowledge transfer from those affected to those in power, disaster risk reduction strategies can be tailored to the needs of users, while incorporating social and cultural contexts and perceptions. Hence, the Sendai Framework aims at the promotion of resilient communities through the involvement and collaboration with households and civil society organizations in pursuing sustainable development.

2.2 The welfare regime theory

In addressing policymakers to adopt the Sendai Framework for participatory risk resilience, the research looks at flood resilience from the welfare regime perspective. Therefore, this paper uses the welfare regime theory for developing countries by Gough and Wood (2006) (see Figure 1). The welfare regime is defined as the process of social development, the support and empowerment of rights, and the obligation of the state to provide protective services (Esping-Andersen, 1990). Hence, it provides the basis for sustainable development as defined under the Brundtland Report (1987).

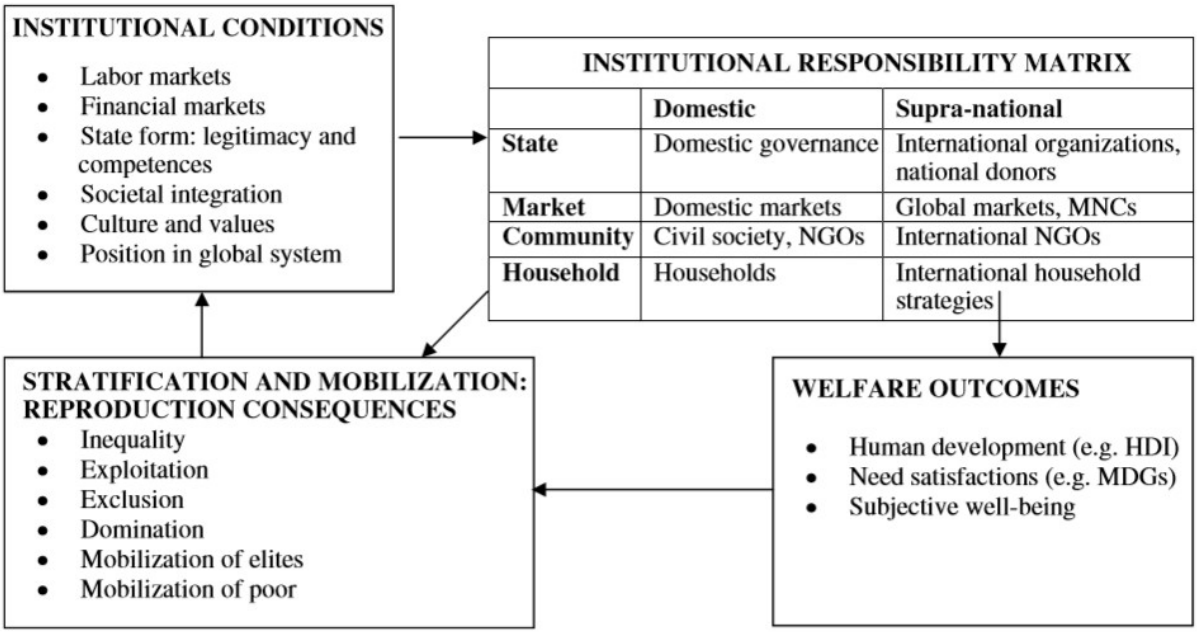

Figure 1: Theoretical framework for comparing welfare regimes (reproduced with permission from the authors Gough & Wood, 2006, p.1701)

The welfare regime theory by Gough and Wood (2006) is adapted for developing countries and reflects circumstances of poverty or inconsistent security, thereby capturing informal processes (see also Barrientos, 2004). Welfare provides the means for disaster resilience and can be articulated through informal and community-based policies (Gough & Wood, 2006). In its institutional responsibility matrix (see Figure 1), the welfare regime theory captures actors at all levels. For instance, on the bottom-level, the policy process includes bureaucrats, local NGOs, and households. Hence, the findings synthesize the contributions of these actors to flood resilience. Each actor translates their

needs and interests into a certain strategy or type of social policy. Due to the scope of this study, the findings will focus on domestic actors and networks. Additionally, the study looks at the political stratification and mobilization of power referring to relations of domination, exclusion, and inequality (Kooiman et al., 2008). Notably, poverty can reproduce itself due to a lack of political agency, leading to "dependent security" (Gough & Wood, 2006). Dependent security constraints the control of recipients over institutions, hence, inducing further insecurity and uncertainty. This bears much relevance for the exploratory study of community-based mechanisms for flood resilience. Thus, the research applies the above framework to evaluate the landscape of informal and community-based policies in Mexico City from a bottom-up perspective.

3. Methodology

To answer the questions set out in the previous section, the study relies on a case study approach and a purposeful literature review. The case study approach is characterized by Merriam and Tisdell (2015) as "in-depth description and analysis of a bounded system" (p.40) to examine the functioning of an entity. Hence, the study design corresponds to the specific problem approached by the research question (Merriam, 2009). The qualitative methodology of this study applies data collection instruments sensitive to underlying meanings within a certain context (Gray, 2014). In analyzing participatory climate adaptation, the case study uses a snowball approach for secondary data collection (Gerring, 2004). The constructivist ontology of the synthesis enables a holistic analysis of how different actors construct and interact towards creating flood resilience (Stake, 2000). Although the case of Mexico City is unique in its context and complexity, it facilitates knowledge to understand the relevance and potential of participatory risk management in the context of urban flooding (Barrientos, 2012; Carnes & Mares, 2015).

A case study approach allows for numerous methods of data collection (Merriam & Tisdell, 2015). For the purpose of this study, the data collection focuses on qualitative readings. This allows inquiry into perceptions, values, controversies, or actors' expectations of the phenomenon (Gerring, 2004). Applying qualitative instruments sensitive to underlying meanings offers a holistic perspective on previous research, a tool to identify any contradictions or gaps, and if applicable, proposes new ways to look at a

particular matter. The case study uses a relatively small database, thereby focusing on an in-depth analysis of the literature. To generate a detailed investigation of the case, the study uses a snowball approach for secondary data collection, including journal articles, national policy documents, as well as reports from external organizations such as INGOs. The search was conducted through the databases of Google Scholar, Columbia University, and Maastricht Library. The search words, as well as criteria for inclusion, are based on the concepts of the overall research question, relevant agents, and identified subthemes (see Figure 2). Subsequently, the study categorizes the literature according to their themes and actor perspective and builds a matrix for the following synthesis.

Agents	Themes	Subthemes
Governmental Organizations	General Topics	The city
		The slum
		Floods
		Livelihoods
		Violence
		Insecurity
		The *fraccionamiento*
		Hazards and risks
		Housing policy
		Urban development
NGOs	Institutional Arrangements	Civil protection
		Patronage
		Clientelism
		Corruption
		Disasters: *emergency, coping, mitigation*
		Networks
		Service provision
Dwellers ***Slum** ***Fraccionamiento**	Strategies	Daily life experiences
		Community sense
		Community building
		Leaders
		Land purchasing
	Sociopolitical unforeseen factors	Access to services and social aids
		Contesting power

Figure 2: Recurring themes in the roles of different actors (own elaboration, based on Güiza et al., 2017, p.216. Reproduced with author's permission.)

4. Findings

4.1 How are informal settlers in Mexico City vulnerable to flood hazards?

Mexico City is the third most populated city in the world (Chelleri et al., 2015). The rapid expansion of the urban center of the valley coupled with neoliberal reforms has increased both environmental and economic hazards. About six million people, or a third of the documented population in Mexico City's Metropolitan Area (MCMA), are considered vulnerable to flood hazards due to their geographic location, many of whom live also without access to basic public services, such as health care. In 2015, around 60% of MCMA'S population lived below the poverty line, with 22% living in informal settlements, which are considered particularly vulnerable to flood hazards due to the lack of government control (Chelleri et al., 2015). The economic insecurity of these populations reduces their ability to absorb shocks and transform assets for adaptation. Their poverty status is further perpetuated through the reoccurring asset shocks imposed by flood events. Hence, informal settlers are vulnerable to flood hazards through their poverty status and asset deficiency, further diminishing their negotiation power in formal decision-making processes, which ultimately leads to dependent security (Gough & Wood, 2006).

The probability of flood hazards in Mexico continues to increase. For instance, from 2000-2010, the risk of flash floods saw a 22% increase (Salinas et al., 2016). These flash floods are the result of surface runoffs and lacking infiltration, and particularly affect settlements of lower-income-citizens in the cities' periphery. Residents report skin irritations after exposure to floodwater because of contamination through the city's sewage system. These impacts can perpetuate illnesses and have led to a widespread distrust of public infrastructure and services (Eakin et al., 2016). Additionally, rainwater is considered as a potential trigger for flood hazard in terms of drainage conveyance. In MCMA, rainfall events exceeding 30 mm/h can provoke landslides (Chelleri et al., 2015). These vulnerabilities are expected to worsen with climate change and ongoing urban expansion, occupying flood-prone areas (Romero-Lankao et al., 2013). Although there are formal mechanisms to protect inhabitants against flooding, such as social services they are unequally distributed and practically non-existent in informal settlements (Bonasia & Lucatello, 2019).

To comprehend the vulnerability of informal settlers, it is necessary to consider the intricate socioenvironmental conditions which underpin flood events (Güiza et al., 2017). The growth of informal settlements is a result of the commercialization and gentrification of space, indicating a class hierarchy in the geographic structure of the city, with informal settlements located on the periphery (Bayón & Saraví, 2013). Nevertheless, a study by Güiza et al. (2017) points out that slum dwellers should not be conceptualized as passive receivers of their poverty status and related flood hazards. The limited availability of space and competition for employment in MCMA leads to complex decisions on the trade-off between risks and opportunities, such as proximity to public services. Hence, interviews with inhabitants of informal settlements reveal how many perceive flood events as being a manageable risk compared to the uncertainties of their economic environments and structural processes of urban expansionism. Similar studies show how the flood vulnerability of informal settlers is linked to a perception of indifference and reluctance to adapt which in turn justifies the lack of government intervention. However, government policies show little focus on understanding the complex layers of the risk experience of informal settlers (Nygren, 2016). As a result, flood vulnerability of informal settlers in MCMA can be understood as the outcome of inequality and exclusion with political and social consequences, mirroring and reproducing the cities' geography of poverty (Güiza et al., 2017)

4.2 How do community actors contribute to the flood resilience of informal settlers?

To cope with the recurring flood hazards, actors at all levels develop strategies to create capacities for flood resilience. These actors at the community level in Mexico City include governmental organizations, NGOs, as well as the dwellers themselves. NGO's often form coalitions or collaborate with government agencies to increase their influence, whereas informal settler's resort to local leaders, and self-help. Some of their roles and concerns are listed in Figure 2. However, the overall influence of both NGOs and informal settlers is weakened by the technocratic ethos of policymakers in Mexico City, in addition to a lack of participatory mechanisms in local governance structures. Hence, the position of different actors within governance structures relates to the amount of political power that groups have. These groups influence negotiations over urban resources, and the distribution of space, according to their assets (Güiza et al., 2017).

To begin with the individual level, flood governance for informal settlers has been turned into a matter of self-reliance and community adaptation (Nygren, 2016). Dwellers have little assets and thus, comparatively small networks of influence. Hence, informal settlers use two strategies to cope with risks. First, households lacking access to safety nets and institutional risk-mitigating support programs resort to self-help (Eakin et al., 2016). For instance, households use their limited assets for repairs and physical barriers out of recycled materials to prevent excessive flooding. Women take on a leading role in cleaning up after floods and being at the forefront of alleviating the consequences of floods (Eakin et al., 2016). Figure 3 lists a number of those coping strategies for adaptation. Moreover, dwellers invest their own labor force to meet basic needs and provide services for their families and neighborhoods. Many invest in improving their property by raising furniture or building second stories for their bedroom to maintain habitable conditions and improve their living standard. Hence, individuals engage in continuous efforts to cope with flood hazards, and other socio-political threats by improving their infrastructure (Güiza et al., 2017). In the absence of generic capacities to leverage collective action, households divert their assets to cope with flooding, undermining their ability to build networks for social mobility, and to gain influence over their structural conditions of vulnerability. Poverty traps are thus inherently political (Eakin et al., 2016).

Action (Adaptation)	**Description**	**Cost**
Storage	*Tinaco* purchases, Cistern construction	Opportunity cost of domestic labor and time, Economic investment ($)
Barriers	Threshold elevation; sandbags; sidewalk construction	Infrastructure investment ($), labor
Source diversification	Purchase from private tankers; purchase of potable water	Financial investment in water purchases ($),time and labor in "looking" and "waiting" for water
Collective action	Demand attention from public authorities; closing streets to protest water situation	Time and labor in social organization, political capital when vote exchange is expected
Action (Coping)		
Cleaning	Cleaning up after flood (home and street)	Health exposure, time and labor
Collective maintenance	Clear garbage from drains; maintain communal water pipes	Time, labor, and financial investment ($) health exposure
Property replacement	Replacing personal belongings following flooding	Financial investment ($), anxiety over losses

Figure 3: Summary of adaptive and coping actions (own elaboration, based on Eakin et al., 2016, p. 330. Reproduced with author's permission.)

Second, if collective action is possible, dwellers organize in local communities to pool risks in different ways, alleviating the individual burden of the hazard. This can happen in the realm of space, such as mobility, time, asset diversification, and exchange (see Figure 3) (Eakin et al., 2016). Occasionally, residents organize in groups for protests, demanding improved access to services and public infrastructure. Informal settlers express an element of social cohesion and reciprocity with their surroundings when floods strike, by defending their properties, and choosing leaders to represent their interests (Güiza et al., 2017). Hence, community networks and a strong sense of dignity support dwellers in processes of mental recovery from disaster-related trauma as well as in efforts to pursue their human rights (Nygren, 2016). However, prevalent governance structures of vertical fragmentation often undermine efforts towards participatory flood risk governance, which can perpetuate dependent security (Gough & Wood, 2006).

Social interactions between the privileged and the lower classes in Mexico City are unusual and controlled to avoid any encounter with the "other" in public spaces. (Bayon & Saravi, 2013). Thus, local leaders play a key role in managing community cohesion and demands towards higher bureaucratic levels. Within informal settlements, these chosen leaders maintain social order and peace through their charisma and connectedness (Güiza et al., 2017). These leaders organize protests periodically to demand legal recognition of land ownership and the provision of public services. One of the most notable effects of these protest movements has been the empowerment of women in leadership positions within civil society organizations (Moctezuma, 2001). In their position, local leaders mediate between the dwellers and local authorities to bargain over political support. It is not unusual that these local leaders collect payments from the informal settlers in exchange for ensuring their safety. Notably, Mexico City tries to acknowledge and incorporate these community structures by appointing local actors to transnational climate change leadership positions (Romero-Lankao et al., 2013). With their context-specific knowledge, local leaders provide insider information on the risks and experiences of areas that are often not captured by official documents or census data. Thereby, local leaders can expand on the interests of dwellers and negotiate participatory flood risk governance with the authorities.

Additionally, in recent years, Mexico City has followed global trends of engaging with NGOs and supporting grassroots developments for sustainable development. These NGOs build a bridge between the formal and informal sector because they support

protests to negotiate agency while sharing local experiences for integration in formal decision-making processes. Until today, independent organizations in Mexico City continue to be formed, uniting different parts of the population affected by the implications of flood hazards, such as peasants, teachers, and urban dwellers (Moctezuma, 2001). Different sectoral and administrative levels of the Mexican government have engaged with civil society organizations in the form of consultation, creating space for civil society to voice their concerns and priorities related to climate change, which also concerns the increasing exposure to flood hazards in the metropolitan area (Romero-Lankao et al., 2013). Despite these efforts for inclusion, trade unions and grassroots organizations are facing the struggle of overcoming a technocratic ethos, whereby scientific knowledge and expertise acquire a predominant role in formal decision-making processes (Zunino, 2006). The prevalence of elitist knowledge construction undermines the legitimacy and experiences of less-educated sectors of the population, such as informal settlers and their exposure to flooding (Romero-Lankao et al., 2013).

Lastly, local governments and bureaucrats are a determining factor in governing flood risks in informal settlements. It is noteworthy that the governance structure of Mexico City is formally decentralized (Bonasia & Lucatello, 2019). Economic liberalization and retrenchment of the state have redistributed the responsibilities of governing functions to the local level and private sector which, at first, allowed local actors to be more involved in decision-making processes concerning solutions to climate change (Romero-Lankao et al., 2013). Nevertheless, the overall governance framework for flood hazards is fragmented and coordination is predominantly horizontal. The lack of formal risk-mitigating institutional support, for instance in the form of green infrastructure, is the primary driver for the above-mentioned informal networks and communal strategies for flood control. While the government offers some financial compensation following floods, in most cases residents cover the financial burden of material loss (Eakin et al., 2016). Local government responses to flooding can look disarticulated and uncoordinated (Bonasia & Lucatello, 2019). This is because local governments lack resources. have limited involvement in national planning, as well as insufficient knowledge and training on how to engage with informal actors and locate hazards (Ruiz-Rivera & Lucatello, 2017) The local government landscape is thus characterized by clientelism and local political chiefdoms that negotiate on behalf of their

communities. While such clientelist relationships can satisfy immediate needs, they rarely enable plans for longer-term security (Eakin et al., 2016). Hence, this is an unsustainable strategy that ultimately hinders long-term participation and security for informal settlers because their agency is once again based on material assets.

4.3 How can public policy incorporate local communities into participatory flood risk management frameworks?

The main challenge for transition processes towards urban flood resilience and sustainability in Mexico City is the lack of transformation of political structures (Chelleri et al., 2015). Participatory approaches are one method for transformation and require a recognition of how informal settlers desire to participate in political structures. By understanding their complex experiences and perceptions of flood risks in the context of socio-economic pressures, public policymakers can set out to alleviate underlying insecurities and enable inclusive strategies for flood risk management. For instance, public flood risk protocols must account for the poverty traps that informal settlers are exposed to through reoccurring flood exposure. This involves a shift from technocratic to participatory flood resilience strategies that link science and technology with social and cultural adaptation mechanisms. According to some reports from the FAO (Bonasia & Lucatello, 2019), the UNDRR (2015) and other international organizations, participatory decision-making approaches representing a multitude of vulnerable settlers, such as women, can substantiate expert opinions within regular consultations and generate public trust through the accessibility and transparency of decisions and subsequent actions.

Strategies to establish opportunities for participation can be cultural or technological. For instance, to create a greater exchange and coordination between different levels of society could be free urban spaces for encounters. In the words of Bayon and Saravi (2013): "the construction of otherness as an aspect of urban sociability depends not primarily on the characteristics of residential spaces but on the public spaces potentially open to encounters between people of different classes" (p.45). Creating space for exchange within shared institutions, and thus generating shared experiences can generate recognition and enable greater incorporation of the demands of informal settlers

into formal frameworks. Furthermore, promoting educational programs and geographic literacy, enables informal settlers to participate in community self-diagnosis of flood risks and develop strategies for alleviation that capture their realities. In terms of technological solutions, Bonasia and Lucatello (2019) propose a community-based flood hazard mapping technique that aims to address the gap between top-down approaches for disaster risk reduction and bottom-level framework of self-reliance and informality. These strategies provide a relevant basis for enabling informal settlers to be recognized as active citizens and gaining agency on their flood vulnerability to develop sustainable, and resilient capacities.

5. Conclusion

Framing flood resilience in Mexico City within a framework of sustainable development is particularly effective for showing underlying vulnerabilities and perceptions of long-term risks within informal settlements. The study shows that informal processes and community-based resilience are the products of different actors translating their needs for security into a multitude of coping strategies. However, it is important not to romanticize the adaptability of informal settlements but instead acknowledge the realities and structures of domination and exclusion that they act within. Conceptualizing governance as an arena of negotiation, reconfiguration and contestation offers opportunities to question the existing policy frameworks and transform existing structures to harness capacities for sustainable development in the face of increasing flood risks.

This study shows that by combining generic capacity-building and poverty alleviation with geographic literacy and technological flood control innovations, the community flood risk resilience of informal settlers in Mexico City can increase. This is especially relevant for sustainable development because it allows these actors to transform their assets into sustainable capacities and become active participants in the formal processes that determine their environments. Hence, this study encourages policymakers and humanitarian actors alike to consider the socially constructed realities of power in the sustainable development realm and challenge existing frameworks of collaboration for an equitable and sustainable future.

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