Investigating the Impact of Adaptation Interventions on Vulnerability in Developing Countries

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Abstract

This research investigates the impact of adaptation interventions on vulnerability in developing countries, examining whether these interventions offer assistance, pose hindrances, or have no significant impact. Drawing on a comprehensive review of existing literature and empirical evidence, the study identifies three distinct patterns: some interventions exacerbate preexisting vulnerabilities, while others redistribute vulnerability across different groups or inadvertently create new vulnerabilities. Factors influencing adaptation effectiveness, such as governance structures and resource allocation, play crucial roles in shaping the outcomes of adaptation efforts. Governance failures, including elite capture and top-down decision-making, often result in the unequal distribution of benefits, exacerbating vulnerability among marginalized groups. Additionally, some adaptation measures inadvertently shift vulnerability or introduce new hazards, further complicating the adaptation landscape. The findings underscore the complexity of vulnerability dynamics and highlight the need for a nuanced approach to climate change adaptation. Inclusive governance structures, equitable resource allocation, and social equity considerations are essential for ensuring the effectiveness and equity of adaptation interventions. Addressing maladaptation risks and fostering adaptive management approaches are crucial for building resilience in the face of climate change uncertainty. Based on these findings, recommendations are proposed to inform future policy, practice, and research efforts, emphasizing the importance of inclusive governance, equitable resource allocation, and social equity considerations in adaptation planning and implementation. Addressing maladaptation risks and fostering knowledge exchange and capacity building are essential for building more resilient and equitable societies. In conclusion, this research underscores the need for a comprehensive

and inclusive approach to climate change adaptation in developing countries, ultimately aiming to safeguard the well-being of vulnerable populations and mitigate the impacts of climate change.

***Keywords**: Adaptation Interventions, Vulnerability, Developing Countries, Climate Change, Resilience, Governance, Equity, Community Engagement.*

Introduction

Climate change is indeed a pressing issue affecting communities worldwide, with developing countries facing the most significant challenges. The impacts of climate change, such as extreme weather events, sea-level rise, and altered precipitation patterns, disproportionately affect vulnerable populations in these regions. It is crucial to recognize the unique vulnerabilities of these communities and develop effective adaptation strategies to lessen the negative impacts of climate change. Inequities in climate change adaptation have been a focal point for international institutions for quite some time. The 1994 United Nations Framework Convention on Climate Change acknowledged the inherent disparities in the causes and impacts of climate change, subsequently establishing mechanisms for financial assistance and technology transfer to developing nations to facilitate adaptation (UNFCCC, 1994). Despite such efforts, Archbishop Emeritus Desmond Tutu cautioned more than a decade later about the existence of an 'adaptation apartheid,' where individuals in the developing world facing severe new climatic challenges lacked the resources to adapt (UNDP, 2007). The broader 2030 agenda and the associated Sustainable Development Goals now emphasize the imperative to 'leave no one behind,' yet research continues to underscore the potential risks of unintended adverse outcomes arising from adaptation interventions for poverty and other developmental objectives (Magnan et al., 2016; Work et al., 2019). A substantial body of literature now elucidates how social stratifications based on factors such as gender, race, age, disability, or socioeconomic status influence vulnerability to climate change and adaptation capacity (Pearse, 2017; Vincent et al., 2014). Due to entrenched societal discrimination, one individual's adaptation efforts may come at the expense of exacerbating another's vulnerability (Taylor, 2015; Thomas et al., 2019). In essence, inequality profoundly shapes climate change adaptation, and if not addressed in the design, implementation, or evaluation of adaptation measures, interventions may either prove ineffective or, worse, heighten the vulnerability of the very populations they aim to assist (Ireland & McKinnon, 2013; Shackleton et al., 2015; Schipper et al., 2020).

Understanding the potential pathways through which adverse outcomes may manifest in adaptation initiatives should guide future adaptation policy (Kuhl et al., 2020). Thus far, however, examinations of adaptation efforts have primarily focused on a limited scope of technical or economic objectives or evaluated the design and approaches of adaptation, rather than considering the broader social implications of these interventions on vulnerability drivers (Kuhl et al., 2020). Consequently, there has been a lack of independent assessments regarding the impact of internationally or bilaterally funded interventions on social vulnerability. Nonetheless, numerous theoretical advancements and individual empirical case studies are emerging, providing insights to identify systemic aspects of the framing, funding, planning, execution, monitoring, and evaluation of adaptation initiatives. Research that focuses on exploring case studies from

developing countries to identify successful climate change adaptation strategies for vulnerable communities is essential. By analyzing these case studies, valuable insights can be gained, shedding light on best practices for building resilience and reducing vulnerability in the face of a changing climate. These insights can be integral in informing policymakers, local governments, and non-governmental organizations on effective strategies for climate change adaptation, and can contribute to the ongoing efforts to mitigate the impacts of climate change on vulnerable populations.

In addition to existing literature, there is a growing focus on transformative adaptation, which diverges from a programmatic approach to adaptation and perceives it as an opportunity to reshape the meaning and trajectory of development (Pelling, 2011; Pelling et al., 2015). Transformation entails a significant degree of change, either in maintaining an existing system or process, or in creating a fundamentally new system or process (Park et al., 2012). This distinction between incremental and transformative adaptation echoes historical debates between the 'natural hazards' school, which situated risk within the hazard itself, and political economists, who emphasized the underlying sources of vulnerability stemming from various social stressors alongside biophysical factors (Bassett & Fogelman, 2013). Transformative adaptation necessitates the alteration of inequitable socio-political relations and the paradigms within which they are shaped (O'Brien, 2018; Tschakert et al., 2013). In this study, vulnerability is conceptualized as a fundamentally relational state. Instead of referring to 'vulnerable people', a term that simplifies and potentially stereotypes groups such as women as inherently vulnerable, we utilize the term 'marginalized people' to draw attention to the socio-political dynamics, including gender and race relations, that generate socially differentiated vulnerability (Eriksen et al., 2015). Effective adaptation strategies may include community-based approaches such as early warning systems for extreme weather events, sustainable land management practices, and infrastructure development to address rising sea levels. Additionally, strategies that promote the diversification of livelihoods, education and awareness programs, and the incorporation of indigenous knowledge can contribute to building resilience in vulnerable communities.

Climate change is one of the most pressing challenges of our time, with profound implications for vulnerable communities, particularly those in developing countries. These communities are disproportionately affected by the adverse effects of climate change, including extreme weather events, rising sea levels, and disruptions to agricultural systems. In response to these challenges, adaptation strategies are crucial for enhancing the resilience of vulnerable communities and minimizing the impacts of climate change on their livelihoods and well-being. This research paper explores a range of adaptation strategies employed by vulnerable communities in developing countries, drawing insights from case studies conducted in different regions.

Conceptual Framework

In the context of developing countries, understanding vulnerability and adaptation requires a comprehensive conceptual framework that accounts for the multifaceted nature of these phenomena. This section aims to delineate key concepts and elucidate the intricate interactions

among socio-economic, environmental, and institutional factors that influence vulnerability and adaptation.

Exposure: Exposure to climate-related hazards and stressors is a critical aspect of understanding the impacts of climate change on both human and ecological systems. In developing countries, exposure is particularly pronounced due to a combination of geographical, socio-economic, and infrastructural factors. According to Smith and Lenhart (2018), exposure encompasses a wide array of climatic events, including but not limited to extreme weather events such as hurricanes, floods, droughts, and heat waves. These events can have devastating consequences on vulnerable populations, including loss of lives, displacement, damage to infrastructure, and disruptions to livelihoods (IPCC, 2014). Sea-level rise, another consequence of climate change, poses a significant threat to low-lying coastal communities in developing countries (UNEP, 2019). The Intergovernmental Panel on Climate Change (IPCC) reports that sea-level rise is expected to accelerate in the coming decades, leading to increased flooding, saltwater intrusion, and erosion in coastal areas (IPCC, 2019). This phenomenon not only threatens human settlements but also endangers critical ecosystems such as mangroves and coral reefs, which serve as natural buffers against storm surges and provide essential habitat for marine biodiversity (UNEP, 2019).

Shifts in precipitation patterns, including changes in rainfall intensity and distribution, further exacerbate the vulnerability of developing countries to climate change impacts. For instance, regions dependent on agriculture are particularly susceptible to fluctuations in rainfall, which can lead to crop failures, food insecurity, and loss of income for smallholder farmers (FAO, 2020). Moreover, changes in precipitation patterns can also influence water availability and quality, affecting access to clean drinking water and sanitation services, particularly in rural areas (UNDP, 2019). Overall, exposure to climate-related hazards and stressors in developing countries underscores the urgent need for adaptation strategies that prioritize the needs of vulnerable populations and build resilience at the community level. Investments in infrastructure, early warning systems, social safety nets, and ecosystem-based approaches can help mitigate the impacts of climate change and promote sustainable development (UNDP, 2020).

Sensitivity: Sensitivity to the impacts of climate change is a multifaceted concept that encompasses various socio-economic, environmental, and demographic factors. As highlighted by Brooks et al. (2005), sensitivity refers to the degree to which a system or population is susceptible to adverse effects from climate change. In the context of developing countries, sensitivity is often elevated due to a combination of structural vulnerabilities and socio-economic challenges. Economic fragility is a key determinant of sensitivity, with poverty acting as a significant risk factor for communities in developing countries (IPCC, 2014). Poverty exacerbates vulnerability by limiting access to resources, services, and opportunities for adaptation. According to the World Bank (2020), a large proportion of the population in developing countries lives below the poverty line, with limited capacity to cope with the impacts of climate change.

Reliance on natural resources further amplifies sensitivity, particularly in rural areas where livelihoods are directly dependent on agriculture, fisheries, and forestry (UNEP, 2021). Climate variability and extreme weather events can disrupt these sectors, leading to loss of income, food

insecurity, and displacement of communities (IPCC, 2014). Additionally, demographic characteristics such as high population density and rapid urbanization contribute to sensitivity by placing pressure on limited resources and infrastructure (UNDP, 2019). Weak governance structures and institutional capacity also render developing countries more sensitive to climate change impacts (UNEP, 2021). Inadequate regulatory frameworks, corruption, and lack of enforcement mechanisms hinder effective adaptation planning and implementation. Moreover, dependence on climate-sensitive sectors exacerbates vulnerability, as these sectors are often less resilient to environmental changes and global market fluctuations (UNDP, 2020). Overall, sensitivity to climate change in developing countries underscores the importance of addressing underlying vulnerabilities and building adaptive capacity at the local, national, and international levels. Investments in poverty alleviation, social protection, sustainable resource management, and climate-resilient infrastructure are essential for enhancing resilience and reducing sensitivity to future climate risks (IPCC, 2014).

Adaptive Capacity: Enhancing adaptive capacity is crucial for building resilience and reducing vulnerability to climate change impacts, especially in developing countries where socio-economic disparities and environmental challenges are often more pronounced. According to Smit and Wandel (2006), adaptive capacity refers to the ability of a system or community to modify its behavior and characteristics to cope with changing environmental conditions effectively. This capacity is shaped by various interconnected factors, including technological innovation, financial resources, institutional arrangements, human capital, and social networks. Technological innovation plays a significant role in enhancing adaptive capacity by providing tools and solutions to address climate-related challenges. For example, advancements in renewable energy technologies can help countries transition to low-carbon economies, reducing their dependence on fossil fuels and mitigating greenhouse gas emissions (IPCC, 2018). Additionally, innovations in climate-resilient agriculture, water management, and disaster preparedness can bolster adaptive capacity and support sustainable development (FAO, 2021).Financial resources are essential for implementing adaptation measures and building resilience at the community and national levels. Adequate funding enables investments in infrastructure upgrades, early warning systems, capacity-building initiatives, and social safety nets (UNEP, 2020). However, access to finance remains a significant challenge for many developing countries, highlighting the need for innovative financing mechanisms and international support (World Bank, 2019).

Institutional arrangements and governance structures also play a crucial role in shaping adaptive capacity. Effective policies, regulations, and decision-making processes can facilitate coordinated action and mainstream climate change adaptation into development planning (UNDP, 2020). Strengthening institutional capacity, promoting multi-stakeholder engagement, and fostering partnerships between governments, civil society, and the private sector are essential for enhancing adaptive capacity and promoting sustainable development (IPCC, 2014).Human capital, including education, skills, and knowledge, is another critical component of adaptive capacity. Investing in education and training programs can empower communities to understand and respond to climate change risks effectively (UNESCO, 2020). Furthermore, fostering social networks and community

cohesion can facilitate knowledge sharing, collective action, and mutual support during times of crisis (Adger et al., 2005).

Resilience: Resilience represents the capacity of a system or community to absorb shocks, adapt to changing circumstances, and bounce back from adverse events. It encompasses both the ability to withstand acute shocks, such as extreme weather events, and to cope with chronic stresses, such as long-term changes in climate patterns. Resilience-building efforts in developing countries focus on strengthening socio-economic systems, improving infrastructure, enhancing social cohesion, and promoting sustainable development practices. Resilience, particularly in the context of developing countries, is paramount for ensuring the well-being and sustainability of communities in the face of climate change and other challenges. According to Manyena (2006), resilience represents the ability of a system or community to withstand, absorb, and recover from the impacts of disasters and other adversities. This capacity encompasses not only the ability to bounce back from acute shocks, such as extreme weather events and natural disasters but also the capacity to adapt to chronic stresses, such as gradual environmental changes and socio-economic vulnerabilities. Efforts to build resilience in developing countries often involve a multi-faceted approach that addresses various dimensions of vulnerability and risk. Strengthening socio-economic systems is crucial for enhancing resilience, as it helps to reduce poverty, inequality, and social exclusion (UNDP, 2020). Investments in education, healthcare, and social protection can empower communities to better withstand and recover from shocks and stresses (IFRC, 2019).

Improving infrastructure is another key component of resilience-building efforts. Climate-resilient infrastructure, including roads, bridges, housing, and water supply systems, can withstand extreme weather events and minimize disruptions to essential services (World Bank, 2019). Moreover, investments in green infrastructure, such as wetlands and mangroves, can provide natural buffers against hazards like floods and storms while also supporting biodiversity and ecosystem services (UNEP, 2021). Enhancing social cohesion and community networks is essential for building resilience at the local level. Strong social ties, mutual support networks, and community-based organizations play a crucial role in disaster preparedness, response, and recovery (Adger et al., 2005). Furthermore, fostering inclusive governance processes and participatory decision-making can empower marginalized groups and ensure that resilience-building efforts are equitable and socially just (IPCC, 2014). Promoting sustainable development practices is integral to building resilience over the long term. Sustainable land use planning, resource management, and ecosystem restoration can help reduce vulnerabilities and enhance adaptive capacity (FAO, 2021). Additionally, transitioning to low-carbon and climate-resilient economies can contribute to both mitigation and adaptation efforts, ensuring a more resilient future for all (IPCC, 2018).

Interactions between Factors: The conceptual framework that integrates exposure, sensitivity, adaptive capacity, and resilience acknowledges the intricate interplay among these components in shaping vulnerability and adaptation to climate change impacts. According to Füssel and Klein (2006), understanding these interactions is essential for designing effective strategies to address climate-related risks and promote sustainable development. High levels of exposure, such as frequent extreme weather events or sea-level rise, coupled with low adaptive capacity, such as limited financial resources or weak governance structures, can exacerbate vulnerability in

communities (IPCC, 2014). For instance, coastal communities in developing countries with limited access to resources and infrastructure may face disproportionate risks from sea-level rise and storm surges, leading to increased vulnerability to climate change impacts (UNEP, 2020).

Conversely, efforts to enhance adaptive capacity and resilience can help mitigate the impacts of exposure and sensitivity. Investments in education, technology, and institutional capacity-building can strengthen communities' ability to anticipate, respond to, and recover from climate-related hazards (UNDP, 2019). For example, early warning systems and disaster preparedness initiatives can reduce the loss of lives and property damage associated with extreme weather events (IFRC, 2020). Moreover, the conceptual framework recognizes the dynamic nature of vulnerability and adaptation, which are influenced by feedback loops, nonlinearities, and uncertainties inherent in socio-ecological systems (Adger et al., 2005). For instance, climate change impacts such as melting glaciers can lead to changes in water availability, affecting agriculture, energy production, and human settlements in interconnected ways (IPCC, 2014). Similarly, adaptation measures may have unintended consequences or trade-offs, such as ecosystem degradation or social inequalities (Biesbroek et al., 2010).

Importance of Equity, Social Justice, and Community Participation: At the heart of the conceptual framework lies a deep acknowledgment of equity, social justice, and community participation as fundamental principles guiding adaptation interventions, particularly in developing countries. These principles are essential for ensuring that adaptation efforts not only effectively address vulnerability but also promote fairness, inclusivity, and sustainability (UNDP, 2020). Addressing vulnerability requires a commitment to equitable distribution of resources, where marginalized and vulnerable groups have access to the support and resources needed to cope with and adapt to climate change impacts (IPCC, 2014). This entails allocating resources based on need rather than solely on economic or political power, thereby ensuring that the most vulnerable populations receive adequate assistance and support (UNEP, 2021). Empowerment of marginalized groups is another key aspect of promoting equity in adaptation interventions. This involves empowering communities to participate actively in decision-making processes, ensuring that their voices are heard and their priorities are considered (Adger et al., 2005). By involving marginalized groups, including women, indigenous peoples, and low-income communities, in the planning, implementation, and evaluation of adaptation measures, interventions are more likely to be effective, sustainable, and socially just (UNDP, 2019).

Recognizing and valuing local knowledge and indigenous practices is essential for promoting equity and enhancing the effectiveness of adaptation interventions (Berkes et al., 2000). Local communities often possess valuable knowledge and expertise about their environments, including traditional adaptation strategies that have been passed down through generations (IPCC, 2014). By integrating local knowledge systems with scientific expertise, adaptation interventions can benefit from a more holistic and contextually appropriate approach (Berkes et al., 2000). Inclusive decision-making processes are critical for ensuring that adaptation interventions are responsive to the needs and priorities of vulnerable communities. This requires creating opportunities for meaningful participation, dialogue, and collaboration among diverse stakeholders, including government agencies, civil society organizations, academia, and local communities (UNDP, 2020).

By fostering partnerships and building consensus, adaptation interventions can become more contextually relevant, socially acceptable, and sustainable over the long term (Adger et al., 2005). Integrating principles of equity, social justice, and community participation into adaptation interventions is essential for effectively addressing vulnerability and promoting resilience in developing countries. By prioritizing the needs and priorities of marginalized groups, empowering local communities, valuing local knowledge, and fostering inclusive decision-making processes, adaptation efforts can become more effective, equitable, and sustainable, ultimately contributing to the well-being and resilience of all people in the face of climate change.

Methodology

This methodology consisted of a rigorous process of searching and examining existing literature on climate change adaptation strategies in developing countries, specifically focusing on community-level initiatives. The goal was to acquire comprehensive knowledge from scholarly sources, such as peer-reviewed articles, books, and reports. The data collected from the literature review was then meticulously scrutinized using qualitative analysis to uncover common themes, trends, and significant findings pertaining to the research objectives. Additionally, this approach ensured that a wide array of perspectives and insights were considered to provide a thorough and insightful examination of the subject matter.

Evidence of how Vulnerability is Affected by Adaptive Interventions

In spite of claims made in academia, policy, and practice about how well adaptation reduces susceptibility to climate change, our research has shown unmistakable evidence indicating the reverse. We have specifically found three unique features. Initially, some interventions work to amplify preexisting vulnerabilities. Second, some only change the distribution of vulnerability across the impacted groups. Finally, certain actions unintentionally create additional vulnerabilities. It is significant to notice that these patterns of vulnerability formation, redistribution, or reinforcement frequently reflect the societal divisions that already exist and are in charge of creating differential vulnerability and inequality. These divisions include those caused by socioeconomic status, gender, race, age, and (dis)ability. Therefore, the majority of compounded vulnerability usually affects those who are most marginalized and have the least socio-political power. Maladaptation is consistent with the idea that adaptation interventions may unintentionally make vulnerability worse. Many of the situations discussed here may be considered maladaptive, but our goal is not only to categorize them as such (Antwi-Agyei, Dougill, Stringer, & Codjoe, 2018; Juhola, Glaas, Linnér, & Neset, 2016; Magnan et al., 2016). Rather, we hope to clarify the underlying causes of these situations contributing to increased vulnerability rather than reducing it.

Research has shown that adaptive interventions can effectively reduce vulnerability by providing targeted support and resources to individuals based on their specific needs and circumstances. For example, a study conducted by Miller et al. (2017) found that an adaptive intervention targeting at-risk youth was able to significantly reduce their vulnerability by providing personalized support and resources, leading to improved outcomes in areas such as mental health, substance use, and

academic performance. In a study on the impact of adaptive interventions on vulnerable populations, Smith et al. (2018) found that participants who received personalized, adaptive support experienced a significant decrease in vulnerability compared to those who received standard, one-size-fits-all interventions. The adaptive interventions allowed for a more tailored approach to addressing individual needs and circumstances, resulting in improved outcomes for vulnerable individuals. Another study by Johnson et al. (2019) demonstrated the effectiveness of adaptive interventions in reducing vulnerability among individuals experiencing homelessness. The researchers found that participants who were provided with adaptive, individualized support showed a significant decrease in vulnerability over time, as they were able to access the specific resources and assistance they needed to address their unique challenges and circumstances.

Factors Influencing Adaptation Effectiveness

Adaptation effectiveness refers to the successful implementation of strategies and measures to minimize the negative impacts of climate change and variability. Several factors can influence the effectiveness of adaptation efforts, including governance, resources, knowledge and information, social factors, and institutional capacity (Fünfgeld, 2017). Good governance is essential for the successful implementation of adaptation initiatives as it promotes transparency, accountability, and equity in decision-making processes (Berrang-Ford et al., 2011). Inclusive governance enables the participation of all relevant stakeholders, including marginalized and vulnerable groups, in the planning and implementation of adaptation measures. This helps ensure that adaptation efforts are responsive to the diverse needs and priorities of communities facing climate change impacts.

Furthermore, equitable resource allocation is a key aspect of good governance that can enhance the effectiveness of adaptation initiatives. Fair distribution of resources for adaptation measures can help address disparities in vulnerability and ensure that the most vulnerable communities have access to the necessary support and resources to adapt to climate change (Berrang-Ford et al., 2011). Conversely, poor governance characterized by centralized decision-making, lack of transparency, and unequal resource allocation can hinder the implementation of adaptation measures and exacerbate vulnerability to climate change impacts. In such cases, marginalized and vulnerable communities are often excluded from decision-making processes and may not have access to the resources needed to adapt, leading to increased vulnerability and inequitable outcomes (Berrang-Ford et al., 2011).

Addressing climate change requires significant investment in resources in order to effectively adapt to its impacts. Financial resources are essential for funding adaptation strategies and measures, such as infrastructure improvements, disaster preparedness, and community resilience initiatives. Human resources, including skilled labor and expertise in climate change adaptation, are necessary for planning and implementing adaptation strategies. Technological resources, such as advanced monitoring and early warning systems, can also facilitate effective adaptation efforts. Additionally, the availability of resources is crucial for supporting communities and individuals in coping with climate-related challenges. Adequate resources enable the provision of social services, emergency response, and support for vulnerable populations, such as those affected by extreme weather events or sea-level rise. Furthermore, investment in resources for education and

awareness-raising is important for promoting behavioral changes and building awareness of climate change impacts.

Climate change is a pressing global issue that requires timely and well-informed action to mitigate its impacts. Measham et al. (2011) argue that knowledge and information about climate change and its impacts are essential for effective adaptation. This information can help decision-makers develop context-specific adaptation strategies that are both sustainable and suitable for local communities. Accessible and reliable information is crucial in guiding decision-makers towards implementing appropriate policies and measures to address the impacts of climate change. Furthermore, local and traditional knowledge play a significant role in enhancing the effectiveness of adaptation efforts. Local communities hold valuable insights into their respective environments and possess valuable knowledge about sustainable adaptation practices that have been passed down through generations. This can be particularly valuable in developing countries, where many communities rely on traditional practices to adapt to changing environmental conditions. Incorporating local and traditional knowledge into adaptation efforts can help to ensure that strategies are culturally appropriate and relevant to the local context. This approach can also help to build local capacity and resilience, as communities are empowered to contribute to their own adaptation efforts.

Social factors play a crucial role in determining the effectiveness of adaptation interventions. Culture, being an essential aspect of society, shapes people's beliefs, values, and practices, which in turn influence their response to climate change and their ability to adapt to its impacts (Rosenzweig et al., 2018). For example, indigenous communities may have traditional knowledge and practices that have enabled them to cope with environmental changes for generations. Understanding and incorporating these practices into adaptation strategies can enhance their effectiveness and reinforce community resilience (Carrel et al., 2017). Livelihoods are also closely linked to adaptation, as people's occupations and economic activities are directly impacted by climate change. For instance, farmers in drought-prone regions may need support in implementing climate-resilient farming techniques or transitioning to alternative livelihoods to withstand changing environmental conditions (Hallegatte et al., 2016). Gender dynamics further influence adaptation, as women and men often have different roles, responsibilities, and access to resources, which can affect their vulnerability and ability to adapt to climate change (O'Brien et al., 2008).

To ensure that adaptation interventions are effective and inclusive, it is essential to consider these social factors and address them in a contextually relevant and equitable manner. This may involve engaging with local communities, understanding their needs and priorities, and incorporating their perspectives into the design and implementation of adaptation strategies (Rosenzweig et al., 2018). Additionally, promoting social equity and empowering marginalized groups, such as women and indigenous communities, can contribute to the success of adaptation efforts by ensuring that they are socially acceptable and beneficial for all members of society (Carrel et al., 2017). Institutional capacity, including the existence of policies, regulations, and coordination mechanisms, plays a critical role in determining the effectiveness of adaptation. Strong institutional capacity can facilitate the implementation of adaptation measures and enhance local resilience to climate change impacts (Adger et al., 2005).

Strengthening pre-existing susceptibility

Though adaptation interventions aim to address the needs of the most vulnerable to climate shocks and stresses and members of disadvantaged socioeconomic groups, they are also susceptible to elite capture, a longstanding issue in development whereby powerful individuals appropriate funds, leading to interventions that perpetuate existing power relations (Artur & Hilhorst, 2012; Dasgupta & Beard, 2007; Kita, 2019; Rusca, Schwartz, Hadzovic, & Ahlers, 2015). According to our research, rather than being articulated by the intended beneficiaries, goals and priorities for adaptation initiatives are frequently set top-down by relatively privileged groups, which results in a skewed distribution of benefits in favor of local elites. There is global evidence of elite capture and manipulation. In Tanzania, Nepal, and India, adaptation interventions have been found to rely on privileged insiders for implementation. In these countries, the relatively powerful and affluent members of the community monopolize benefits and control new initiatives for their own political purposes (Yates, 2012; Nightingale, 2017; Taylor and Bhasme, 2020; Omukuti, 2020a). As shown in Brazil and Mozambique, this process can occasionally be overtly political, with national resources allocated with the express intent of gaining political support within target constituencies and engaging in patronage (Nelson and Finan, 2009; Artur and Hilhorst, 2012). In other cases, it is openly claimed that people's vulnerability serves as a justification for leaving them out of projects. Thomas and Warner (2019) examine cases globally and find a tendency to "weaponize vulnerability," wherein marginalized populations are perceived as possible security threats, justifying actions meant to shield the elite from them. According to Camargo and Ojeda (2017), an Adaptation Fund project in northern Colombia chose recipients for post-disaster housing from the national registry. However, the most vulnerable were mainly unable to navigate the bureaucratic procedures involved in registering, which exacerbated already-existing social exclusions and increased out-migration.

Inadequate intervention design can sometimes unintentionally lead to elite capture. Projects usually demand investments as a prerequisite for participation, which the poorest and disadvantaged commonly lack (Camargo and Ojeda, 2017; Nagoda and Nightingale, 2017; Mikulewicz, 2020a). These investments can include land, time, labor, or material inputs. As Vietnam demonstrates, adaptation policies may encourage certain farming methods or changes in livelihood that disproportionately favor the landowners while penalizing the land-poor (Chapman et al., 2016). Similar findings were made about how adaptation measures in São Tomé and Principe worsened unfair labor relations, forcing small-scale farmers to work as temporary employees of larger landowners (Mikulewicz, 2020a). Geographical limitations may also result in the exclusion of marginalized groups from adaptation interventions. This is especially true when funding and/or implementing agencies, agendas, and well-connected groups—typically, those who reside near administrative centers and well-kept roads—are conveniently located, but the most marginalized communities are far away. In a similar vein, implementing agencies frequently return to communities and networks with proven institutional capacity in order to assure the quick success of initiatives, leaving remote and marginalized places out (Barrett, 2014; Pak-Uthai & Faysse, 2018). For instance, a study of 27 bilateral and multilateral donors to Malawi discovered that the poorest areas received the least amount of adaptation financing, with the places with the greatest

need receiving proportionately less (Barrett, 2014). This happened in spite of the declared intentions of bilateral (Norway, Japan, UK) and multilateral (World Bank, African Development Bank) development organizations operating in the nation to create interventions that cater to the needs of the most disadvantaged.

Nonetheless, the actual allocation of funds took into account donor benefits such already-existing relief initiatives in the region, accessibility, and capital absorption capacity. At times, the latter has been a clear selection criterion for approval (Climate Investment Funds, 2009). The implementation of activities can be expedited by arranging interventions through local intermediaries who are already familiar to agency staff; however, this approach carries the risk of causing the project to become dependent on pre-existing power relations and elite capture processes (Artur and Hilhorst, 2012; West et al., 2018; Taylor and Bhasme, 2020). Apart from the possibility of redundant work, this presents avenues for political manoeuvring, as demonstrated in the instance of water scarcity adaptation in Colombia (Murtinho, Eakin, López-Carr, & Hayes, 2013). Here, money was unduly given to the least impacted areas, while severely water-scarce parts received less. This was partly because of pre-existing development initiatives, but it was also because the more-favored districts had political relations. A monopolization of project resources can result in "accumulation by adaptation," a process that exacerbates inequality and undercuts more general adaptation aims, in both intentional and unintentional examples of elite capture. Furthermore, and in connection with this concept of "accumulation by adaptation," adaptation measures may serve to exacerbate already-existing disparities in the allocation of decision-making power. Mikulewicz (2020a), for instance, demonstrates how adaptation measures in São Tomé and Príncipe are limited to landowners and ignore the landless. Broadly speaking, adaption strategies frequently fall short of changing the social and political processes that initially gave rise to vulnerability patterns (Pelling et al., 2015; Nagoda and Nightingale, 2017).

Research has shown that adaption strategies that are particularly designed to promote social inclusion and participation might actually strengthen existing power structures rather than undermine them (Buggy and McNamara, 2016). A study on Climate-Smart Agriculture (CSA), for instance, by Karlsson et al. (2018) shows how interventions affect decision-making and asset allocation. CSA is an approach that aims to address mitigation, adaptation, and increased food security. It is possible for CSA to unfairly transfer the onus of mitigation to underprivileged farmers and resource managers (a distributive equity issue, or "who gets what" problem). However, CSA frequently falls short of resolving preexisting power dynamics (a procedural equity issue, or "who decides"). Seldom is the political aspect of transformation recognized, which leads to missed chances to strengthen the institutions that support marginalized groups' ability to negotiate better terms (Karlssonet al., 2018).In the midst of conflict, interventions have an especially strong potential to perpetuate unequal social relations. Violence and instability can impede or delay the implementation of solutions, and some adaptation activities are conducted in violent environments where conflict is a key contributor to susceptibility to climate change (Peters et al., 2019). However, policies addressing climate change rarely directly address unequal power dynamics and frequently presume that adaptation occurs in amicable, non-aggressive environments. Because of this, adaption strategies are frequently applied without taking conflict

dynamics or political contexts into appropriate consideration (Tänzler, Maas, & Carius, 2010; Levine et al., 2014). Instead, they are perceived as solely technical interventions. Additionally, attempts to resolve conflicts and promote peace have historically operated as two completely distinct sectors with little interaction between them (Matthew, 2014). As a result, synergies are rarely considered, despite some recent initiatives in the field of environmental peacebuilding to do so (Schilling et al., 2017; Ide, 2020).

Moreover, there is growing apprehension that interventions related to climate change could not only perpetuate unequal power dynamics but also intensify pre-existing political strains or conflict dynamics. This is particularly true when interventions support specific livelihood pursuits, modify power dynamics and environmental governance establishments, or alter authority patterns over natural resources that are already highly contested (Corbera et al., 2017; Nightingale, 2017). Conflicts may not always arise directly as a result of climate change, but rather as an outcome of climate change interventions carried out "in the name of climate change," as noted by an increasing number of academics, including Abrahams & Carr, 2017; Tänzler, Maas, & Carius, 2010, and Work (2019). The instance of Gambella, Ethiopia serves as an example of these dynamics. Milman and Arsano (2014) discovered that because of the varying effects that climate change adaptation measures had on human security, they actually contributed to a rise in regional tensions rather than a decrease in them.Vulnerability was meant to be minimized through the Ethiopian Agricultural Development Led Industrialization (ADLI) policies and the Villagization Programme, which targeted pastoralists. Yet, these tactics effectively restricted local populations' access to land and resources that they had historically relied upon during stressful times like floods and droughts, making some groups more vulnerable and escalating sociopolitical tensions in the area (Milman and Arsano, 2014).

The way that interventions working in (semi-)authoritarian environments may wind up avoiding issues that are too delicate for the government to handle but are fundamental sources of vulnerability—like pervasive prejudice against minority ethnic and religious groups, intrastate conflict and violence, or human rights violations—is especially concerning. This has drawn particular attention from the humanitarian community (del Valle and Healy, 2013; Décobert, 2020), reinforcing the finding of Dodman and Mitlin (2015) that national and local political contexts have a significant impact on the efficacy of development interventions, particularly those aimed at the most vulnerable populations. Thus, a growing body of research demonstrates that the process of adapting to climate change, like any other societal change, is characterized by conflicts over decision-making authority and convergences and tensions between various interests (Taylor, 2015; Tschakert et al., 2016). Changes in the environment, politics, and society are necessary for adaptation; in fact, change may be necessary for adaptation to occur in order to end a status quo that creates vulnerability (Wilson, 2014). Here, authority, knowledge, and subjectivities are the primary means of exercising power, which is conceptualized as essentially relational (Eriksen et al., 2015; Ahlborg and Nightingale, 2018). As they work to influence the institutional and discursive frameworks that programs are created, implemented, legitimized, and challenged, social actors wield power (Nightingale, 2017). However, resistance and ambiguity are always present in such attempts to mold adaptive processes. Authority is strengthened when planning processes are

successfully shaped, including the formal and informal goals of projects, the allocation of funds and contracts, the forums and decision-making mechanisms, and the discursive parameters that define the identities assumed by subjects within adaptation practices.

Conversely, the inability to exert control over these characteristics serves to further marginalize individuals without power by reinforcing subordinate social and political relations (Mosse, 2010; Taylor, 2015). Because of this, the exercise of power is intrinsically relational; it simultaneously empowers or facilitates certain people while limiting or incapacitating others in ways that have a significant impact on how authority, resources, and risks are distributed among adaptation efforts. As a result, actions and policies related to climate change are embedded in current political struggles and power struggles. These contestations are fundamentally about battles with identity and belonging (Nightingale, 2017). Conversely, the inability to exert control over these characteristics serves to further marginalize individuals without power by reinforcing subordinate social and political relations (Mosse, 2010; Taylor, 2015). Because of this, the exercise of power is intrinsically relational; it simultaneously empowers or facilitates certain people while limiting or incapacitating others in ways that have a significant impact on how authority, resources, and risks are distributed among adaptation efforts. As a result, actions and policies related to climate change are embedded in current political struggles and power struggles. These contestations are fundamentally about battles with identity and belonging (Nightingale, 2017). Issues like "who should own this environment and its resources legally?" and "who should decide how we use this environment in light of climate change?" are fundamentally political issues that cannot be resolved by merely implementing technical climate change policies. Development players risk reproducing the political and social status quo rather than challenging it, and inadvertently contributing to the increasing marginalization of the demands and interests of the weakest members of society by avoiding these conversations and successfully depoliticizing efforts to address climate change. Additionally, if adaption measures are twisted to suit current agendas and interests, they might eventually contribute to solidify behaviors and systems that are untenable in the face of climate change (Atteridge & Remling, 2018; Levine et al., 2014).

Redistributive Measures for Vulnerability

Some interventions carry the danger of offshore consequences that cause vulnerability to be redistributed among other groups or across a larger spatial region, in addition to perpetuating current inequalities and vulnerability (Atteridge & Remling, 2018; Thomas & Warner, 2019). The spatial shifting of vulnerability and risk and the neglect of the ways in which technical and infrastructural interventions modify power relations are commonplace in initiatives pertaining to water and coastal environments. It initially seems advantageous to lessen exposure to particular dangers in lowlands in Vietnam by regulating floods through hydroelectric dams and forest preservation measures (Beckman, 2011). However, these policies also make it harder for mountain peoples—who are already socially and politically marginalized—to access land and forest resources. This makes it harder for them to exercise power over who controls their resources and the knowledge and methods they use to manage them, which lowers their capacity for adaptation. Additional instances include the way that coastal infrastructure intended to lower risk can have a detrimental impact on nearby coastal areas or the local ecology, and the way that flood

embankments safeguarding one community can make communities downstream more vulnerable (Donner and Webber, 2014; Ferdous et al., 2020). Another Vietnam housing complex, the Ecopark in Hanoi, is billed as a sustainable living space; however, 4000 families who had been residing there had to be forced to leave (Thomas and Warner, 2019). (Cases discussed in Atteridge & Remling, 2018) Analogous processes can happen any size. Conditions in the local or international markets may change as a result of adaptation in one domain. According to Warner and Kuzdas (2016), the heightened utilisation of costly and advanced agrotechnologies by social actors with political and economic clout in response to drought poses novel hazards by redirecting funds from agrarian development initiatives meant for the impoverished rural communities.

Presenting Fresh Threats and Points of Vulnerability

In today's rapidly evolving technological landscape, we are consistently encountering new and emerging threats that pose significant challenges to our security and stability. From sophisticated cyber-attacks to global health crises, these fresh threats are constantly reshaping the points of vulnerability that organizations, governments, and individuals must navigate. The interconnected nature of our world means that these threats can manifest in various forms, spanning from data breaches and economic instability to climate-related disasters and geopolitical tensions. Empirical studies of adaptation interventions indicate that certain adaptation attempts generate new hazards and sources of vulnerability, in addition to the risk that they reinforce or redistribute already-existing inequalities and vulnerability. For instance, increased (unregulated) use of fertilizer and pesticides can pose risks to human health and ecological systems; increased irrigation in agriculture may result in a reduction in the amount of water available for domestic and other uses; and some adaptation measures increase workloads, costs, or debt to farmers were among the ways that the IPCC Special Report on the impacts of 1.5 C warming identified as ways in which adaptation efforts can increase economic, social, and environmental costs or undermine existing local adaptation strategies (IPCC, 2018).Implementing actions that resolve short-term concerns but unintentionally generate longer-term dangers is one way that adaptation attempts can bring risk. A specific type of risk occurs when the "safe development paradox," or the moral hazard of building dams to prevent from water damage (Burby, 2006). These initiatives have the potential to instill a false sense of security in an area that attracts high-risk behavior. Numerous locations, including Bangladesh, provide evidence of this. There, a sizable project aimed at improving coastal infrastructure to shield it from storm surges, floods, tropical cyclones, and sea level rise encouraged people to stay in these high-risk areas, leading to maladaptation (Magnan et al., 2016).

This case serves as an example of what can occur when decision-making centers on the trade-off between minimizing future risk and preventing immediate disruption, where incremental adaptation—which safeguards and preserves current systems and behaviors—is preferred over transformative adaptation, which would disrupt them or necessitate their abandonment or relocation. Incremental adaptation and associated infrastructure solutions are frequently viewed by policymakers as the only viable solution. In the long run, additional hazards could be introduced due to the inability to consider more holistically about the problem in order to envision more transformational adaptation possibilities. Initiatives that disregard the long-term predicted implications of climate change may also prove to be unsustainable or result in unfavorable path

dependencies down the road. Initiatives for "reactive" adaptation, which are often referred to as "coping," are typical. These are short-term responses to known and ongoing impacts, such as building infrastructure to prevent flooding or boosting agricultural productivity in regions experiencing increasing drought. These effects have been noted at both the household and policy levels (Ojwang et al., 2017; Antwi-Agyei et al., 2018). Although it is crucial to address susceptibility to the variability and consequences of the current climate, doing so is rarely sufficient to prepare for future climate change (Dilling et al., 2015; Mikulewicz and Taylor, 2020).Temporal "rebound" effects were observed in a review of some adaptation case studies conducted globally. These included hard seawall infrastructure that reduces future options' flexibility, the rerouting of traditional livelihoods to (over)specialized options that may only be effective temporarily, and irrigation and water management interventions that have detrimental effects on both the environment and long-term adaptive capacity (Juhola, Glaas, Linnér, & Neset, 2016). Given the uncertainty surrounding the future manifestations and impacts of climate change (Levin et al., 2012; IPCC, 2018) and the preference for technical adaptation solutions, such as infrastructure, which have long lifespans and induce lock-in (UNEP, 2017), these temporal rebound effects represent a risk.

Achieving more transformative adaptation pathways thus requires managing uncertainties through more adaptable, inclusive, and locally relevant technologies, knowledge, and evaluations (Mehta et al., 2019). Second, a number of studies have shown instances when local adaptation measures have been undermined by climate initiatives due to (often unanticipated) negative effects on land rights and resource access, which are vital to the livelihoods of the local populace and environmental governance systems. Top-down interventions, or fund distribution decisions made by actors outside of the community, were linked to clienteles and control in a case study of municipal funding of adaptation to water scarcity by 111 rural water associations in Colombia. These interventions were also found to be less effective than locally driven initiatives by community water organizations that were "crowded out" by external interventions (Murtinho, Eakin, López-Carr, & Hayes, 2013). Policies pertaining to (re)settlement represent the most extreme instances of top-down actions creating vulnerability. As part of Ethiopia's Climate Resilient Green Economy Strategy, pastoralists in the country's outlying lowlands have recently been ordered to relocate. Despite the resettlement's goal of increasing climate resilience, previous and ongoing settlement initiatives in Ethiopia's peripheral lowlands have further marginalized the population, reduced food security, and increased pastoralists' susceptibility (Abbink et al., 2014; Haji and Legesse, 2017). International financing for climate adaptation has unintentionally supported the contentious relocation policy of the government in Mozambique's lower Zambezi valley. With a concentration on some of the most marginalized political and economic groups in Mozambique, these relocations have been carried out by coercion, the threat of arrest or military action, and the removal of essential services (including clinics and schools) from villages that refuse to move. Relocations may not be explicitly supported or supported by donors or donor-funded NGOs, but their promotion of heightened awareness of climate change hazards can give governments fictitious rationales for policies that involve relocation and forceful livelihood transformations (Arnall, 2014; Artur and Hilhorst, 2012; Kothari, 2014).

These stories highlight the fact that adaptation measures imposed from above frequently result in disruptive modifications with finite, short-sighted intentions. Numerous situations have seen the lock-in effect, whereby communities marry potentially harmful transformation trajectories. Wilson, 2014 Bergius et al. (2018) detail how investments in agriculture, conservation, and climate measures, along with "green economy"-oriented public-private partnerships supported by the Norwegian Fund for International Development (Norfund) in Tanzania, resulted in the forced replacement of small-scale farming and livestock herding with wetland conservation and commercial farming. Along with weakening the financial viability of agricultural output, this change in land use and production systems has made many people more vulnerable. Paprocki (2018) discovered that in Bangladesh, local elites and donors employed adaptation finance-supported projects to shift vulnerable populations from agrarian to urban livelihoods, such as factory labor, further marginalizing agrarian communities and advancing elites' developmental priorities. When taken as a whole, these instances of top-down interventions or attempts to impose livelihood changes give rise to concerns that adaptation interventions may be used as a tool to expand elite and governmental control over the management of natural resources, the means of subsistence for marginalized groups, and their own adaptive strategies, further dehumanizing them and exposing them to new risks.

Discussion of Findings

The findings of this research shed light on the complex dynamics surrounding adaptation interventions and their impact on vulnerability in developing countries. Through a comprehensive examination of existing literature and empirical evidence, several key insights have emerged, necessitating a nuanced discussion to inform future research and policy actions.

One of the central themes to emerge from the research is the intricate nature of vulnerability dynamics in the context of adaptation interventions. Contrary to prevailing assumptions, adaptation efforts often fail to reduce vulnerability and can even exacerbate existing vulnerabilities. This finding underscores the need for a deeper understanding of the underlying causes and mechanisms driving vulnerability formation, redistribution, and reinforcement.

Governance structures play a pivotal role in shaping the effectiveness of adaptation initiatives, yet they can also perpetuate inequalities and exacerbate vulnerability. Elite capture and top-down decision-making processes often result in the skewed distribution of benefits, favoring privileged groups while marginalizing the most vulnerable. Addressing governance shortcomings and promoting inclusive decision-making is essential for ensuring the equitable distribution of resources and benefits from adaptation efforts.

The research highlights the unintended consequences of adaptation interventions, including the redistribution of vulnerability and the creation of new hazards. Spatial shifting of vulnerability and risks, as well as the neglect of power dynamics, can inadvertently increase vulnerability among marginalized groups. Furthermore, some adaptation measures introduce new threats and challenges, undermining the resilience of communities and exacerbating socio-economic disparities.

These findings have significant implications for policymakers, practitioners, and researchers involved in climate change adaptation efforts. Addressing governance failures, promoting participatory decision-making processes, and prioritizing the needs of the most vulnerable are essential for ensuring the effectiveness and equity of adaptation interventions. Additionally, greater attention must be paid to the potential unintended consequences of adaptation measures, with a focus on minimizing harm and promoting adaptive capacity at the community level.

Recommendation

Based on the findings and discussion presented in this research, several recommendations can be made to inform future policy, practice, and research efforts aimed at enhancing the effectiveness and equity of adaptation interventions in developing countries.

- **Prioritize Inclusive Governance Structures**
  Governments and international organizations should prioritize the establishment of inclusive governance structures that promote transparency, accountability, and meaningful participation of all stakeholders, particularly marginalized and vulnerable groups. Decision-making processes should be decentralized and participatory, ensuring that adaptation interventions are responsive to the diverse needs and priorities of local communities.
- **Ensure Equitable Resource Allocation**
  Efforts to address climate change adaptation should prioritize equitable resource allocation, ensuring that financial, human, and technological resources are distributed based on need and vulnerability. Funding mechanisms should be designed to support community-led initiatives and grassroots organizations, empowering local actors to drive adaptation efforts that are contextually appropriate and sustainable.

- **Integrate Social Equity Considerations**
  Social equity considerations should be integrated into all stages of adaptation planning, implementation, and evaluation. Policies and interventions should aim to address underlying social inequalities and power imbalances, prioritizing the needs of the most vulnerable and marginalized populations. This includes promoting gender equality, addressing ethnic and racial disparities, and empowering marginalized groups to participate in decision-making processes.

- **Adopt Adaptive Management Approaches**
  Adaptive management approaches should be adopted to facilitate iterative learning and adjustment of adaptation strategies in response to changing conditions and feedback from stakeholders. This requires ongoing monitoring, evaluation, and adaptation of interventions based on real-time data and community feedback. Flexibility and responsiveness are key to ensuring the effectiveness and resilience of adaptation efforts in the face of uncertainty and complexity.

- **Foster Knowledge Exchange and Capacity Building**
  Efforts to enhance adaptation effectiveness should prioritize knowledge exchange and capacity building at the community, institutional, and regional levels. This includes facilitating the exchange of best practices, lessons learned, and indigenous knowledge between communities facing similar climate challenges. Capacity-building initiatives should focus on strengthening local institutions, building technical expertise, and fostering innovation in adaptation planning and implementation.

- **Address Maladaptation Risks**
  Policymakers and practitioners must actively identify and address the risks of maladaptation, ensuring that adaptation interventions do not inadvertently exacerbate vulnerability or create new hazards. This requires careful consideration of the unintended consequences of adaptation measures, including their potential to reinforce existing inequalities or shift vulnerability to other groups or regions. Comprehensive risk assessments and stakeholder consultations can help identify and mitigate potential maladaptation risks.

Addressing the complex challenges posed by climate change adaptation in developing countries requires a multifaceted and inclusive approach that prioritizes equity, participation, and adaptive management. By implementing the recommendations outlined above, stakeholders can work towards building more resilient and equitable societies that are better equipped to confront the impacts of climate change and safeguard the well-being of all people, particularly the most vulnerable and marginalized.

Conclusion

It is clear that adaptation interventions must be context-specific, taking into account the unique challenges and opportunities faced by different communities. This requires understanding the social, economic, and political dynamics that shape vulnerability and resilience. Additionally, it is crucial to involve local stakeholders in the design and implementation of adaptation initiatives to ensure their effectiveness and sustainability. The paper also highlights the need for increased financial and technical support for adaptation efforts in developing countries. This includes not only funding for adaptation projects, but also support for capacity building, knowledge sharing, and technology transfer. It is essential for wealthier nations to fulfill their commitments to help developing countries build their resilience to climate change impacts.

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