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Community Adaptation to Climate Change: A Sociological Analysis of the Madi Region, Chitwan, Nepal

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Abstract

Climate change brought about significant disruptions to local weather patterns, impacting communities worldwide. In Nepal, the Madi community of Chitwan district experienced these changes acutely, facing challenges that threatened livelihoods, agricultural productivity, and community well-being. Understanding the local dimensions of weather patterns (changing climate) and identifying effective adaptation strategies were crucial for building resilience at the grassroots level. While there was rising recognition of the global implications of climate change, localized studies focusing on specific communities, such as the Madi community, remained limited.

This research aimed to explore the constraints faced by the Madi community in Chitwan district due to changing weather patterns, and to evaluate the effectiveness of local adaptation strategies in mitigating these impacts. To gain the objective this research adopted a participatory action research (PAR) approach, using case study, field observation, focus group discussions (FGDs) and KII, with members of the Madi community. Participants actively involved themselves in data collection and analysis, ensuring the research was grounded in their lived experiences and local knowledge. The study also included interviews with key informants from local agricultural and community organizations.The study identified weather-related several challenges, including unpredictable rainfall, increased temperatures, and flooding, all of which severely impacted local agriculture, food security, and overall livelihood. Local adaptation strategies, such as diversifying crop types, adjusting planting seasons, and developing water management techniques, were effective in reducing vulnerability. By drawing on indigenous knowledge and practices, the Madi community developed innovative solutions that enhanced resilience.

Keywords
Climate change
Community adaptation pattern
Indigenous knowledge
Livelihood
Resilience

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THE COPENHAGEN AGREEMENT, which was adopted at COP-15, presented opportunities for significant progress on the climate change agenda and the establishment of a strong foundation for climate change adaptation (CCA). However, the true measure of success in adaptation was ultimately determined by its impact at the local level (IFRC, May 2009). It was argued that the effectiveness of climate change adaptation strategies was demonstrated through the enhanced resilience of communities most vulnerable to climate change impacts, such as those in Madi village, Chitwan, Nepal. The involvement of local authorities and community-based organizations in developing adaptation strategies was considered crucial. Additionally, risk reduction and risk management were regarded as essential components of successful adaptation.

Climate change represents a global challenge that affectes the natural environment, economies, and societies. Environmental impacts include alterations to the global water cycle, rising temperatures, and intensification of extreme weather events. Specifically, increased rainfall and extreme precipitation lead to floods and landslides, potentially destroying homes and posing significant risks to communities. Economic consequences included reductions in agricultural output and threats to human life and property. The social effects involved forced shifts in lifestyles, which required adjustments in public policies and the development of environmental education programs (Hsieh & Lee, 2021). Similarly, Chongbang (2022) explained that community support practices could significantly contribute to adaptation efforts, but achieving meaningful progress required more comprehensive actions than those previously in place to effectively reduce vulnerability to future climate change. Vulnerability to climate change was not solely determined by the extent of the climate change itself but was also shaped by existing social and natural stresses, which underscored the importance of following a "nature-based pathway." Sustainable development played a crucial role in deteriorating vulnerability by enhancing adaptive capacity and bolstering resilience. However, shifting weather patterns hindered progress toward sustainable development by escalating exposure to adverse impacts or eroding the ability to adapt. Consequently, it became essential for the agendas of sustainable development, climate change adaptation (CCA), and disaster risk reduction (DRR) to converge. This integrated approach aimed to maximize on-the-ground impact, reduce vulnerabilities, and fortify resilience within communities.

Community adaptation to changing weather patterns was most effectively achieved by building local capacities to reduce vulnerabilities to hazards. Experience demonstrated that safety and resilience were enhanced when communities focused on understanding and addressing the vulnerabilities that drove risk, rather than just the hazards themselves. Without reducing these vulnerabilities, it was not possible to sustainably lower community exposure to natural hazards in a way that contributed to long-term resilience (Chongbang, 2023). Furthermore, communities had to recognize the broader risk context in which they operated. For instance, building bio-damps, rainwater harvesting systems, drip-irrigation, or reservoirs to enhance the adaptive capacity of one community could unintentionally increase risks for neighboring communities. These lessons emphasized the need for climate change adaptation to be proactive and resilience-focused, aligning with broader risk reduction strategies and being deeply embedded within sustainable development goals.

Community-based adaptation adopted the approach of viewing adaptation as a form of development. It recognized that adaptation was inherently local and place-based, addressing the context-specific nature of climate change vulnerability. This approach focused on local levels, where people experienced climate impacts, built adaptive capacity, and acted. It emphasized that adaptation strategies should be developed through participatory processes (FGD), involving local stakeholders as well as development and disaster risk-reduction practitioners, rather than relying solely on impact-based scientific data. Consequently, expertise in vulnerability reduction stemmed from local case studies and indigenous knowledge, providing locally appropriate solutions to climate variability and extremes. Effective adaptation involved addressing both immediate and long-term vulnerabilities related to climate change and development, ensuring that adaptation efforts were grounded in local realities and needs. Community adaptation to changing weather patterns was most effectively achieved through community-based adaptation (CBA), which Reid et al. (2009) defined as a "community-led process, based on communities' priorities, needs, knowledge, and capacities, which should empower people to plan for and cope with the impacts of climate change." CBA brought climate change issues back to the local level, where communities played a central role in addressing challenges. Through adaptation efforts, local communities could rebuild not only cultural structures and lifestyles but also foster greater stakeholder involvement. This broader engagement, including inputs from ecosystem services and consumer groups, strengthened the capacity for adaptation and empowerment. The more stakeholders were involved, the greater the potential for sustainable, locally driven solutions that built resilience and adaptive capacity.

Climate change posed significant challenges to communities worldwide, impacting local weather patterns and threatening livelihoods dependent on natural resources. In the Madi community of Chitwan district, Nepal, changing weather patterns led to increased variability in rainfall, temperature extremes, and unpredictable growing seasons. These changes had profound implications for agriculture, water availability, and socio-economic stability. This paper aimed to explore how local adaptation practices and livelihood strategies developed through participatory approaches in the changing context of climate.

Review of Literature

The literature review examined previous studies on climate change impacts and community-based adaptation strategies globally and within Nepal. It discussed the vulnerability of rural communities to changing weather patterns, emphasizing the importance of localized responses that integrated traditional knowledge with scientific innovations. Key concepts included resilience-building, adaptive capacity, and the role of participatory action research in empowering communities to address climate-related challenges effectively.

Climate change, characterized by long-lasting shifts in weather patterns from the tropics to the poles, represented a global threat with far-reaching impacts across multiple sectors. This conceptual study, by Abbass et al. (2022), focused on how climate variability undermined the sustainability of various sectors worldwide, with particular attention to the agricultural sector. The vulnerability of agriculture was a significant concern, as fluctuating and unpredictable weather patterns threatened food production and global food security. This situation was especially critical in countries where agriculture played a central role in the

economy and overall productivity. Beyond agriculture, climate change endangered biodiversity by altering optimal temperature ranges for various species, accelerating biodiversity loss, and reshaping ecosystems. The study also highlighted the increased risks of food and water-borne diseases, as well as vector-borne diseases, with the coronavirus pandemic serving as a recent example of how climate variability exacerbated health crises. Furthermore, climate change accelerated the issue of antimicrobial resistance, creating new challenges for human health by fostering the spread of resistant pathogenic infections.

Since the IPCC's Fourth Assessment Report (AR4), the understanding of climate change adaptation had evolved, with a growing demand for strategies to manage climate risks. Klein et al. (2014) discussed the opportunities, constraints, and limits to adaptation in their contribution to the Fifth Assessment Report, emphasizing enabling conditions that facilitated adaptation and its potential benefits. They highlighted both biophysical and socio-economic constraints that hindered effective adaptation, suggesting that, in some cases, these constraints limited adaptive capacity. The authors argued that adaptation limits required transformational approaches to change social, economic, or environmental systems. They presented a framework that defined key adaptation concepts such as vulnerability and adaptive capacity, aligning with AR4 definitions. This framework integrated insights from different sectors and regions, offering a comprehensive view of adaptation complexities across time frames. The chapter called for flexible adaptation strategies that addressed uncertainties in climate models and potential irreversible changes, underscoring the need for both immediate and long-term adaptation responses from various actors, including governments, communities, and organizations.

Good adaptation involved addressing both immediate and long-term vulnerabilities in terms of climate change and development. It was essential to understand how social and economic trends contributed to vulnerability before considering how to adapt to likely climate risks. Without recognizing these underlying factors, the effectiveness of adaptation efforts could be limited. Development goals also had to integrate climate projections to ensure resilience. Community-based adaptation played a crucial role in this process if it remained a community-driven initiative. By aligning with the implications of climate change, these interventions formed part of a broader climate change adaptation strategy. This approach allowed for addressing specific, long-term climate impacts at various scales, ensuring the needs and priorities of the local community were incorporated into both immediate and future adaptation efforts (Ayers & Forsyth, 2009).

The growing application of an approach to adaptation was community-based adaptation. Community-based adaptation operated at the local level in communities vulnerable to the impacts of climate change. It identified, assisted, and implemented community-based development activities that strengthened the capacity of local people to adapt to living in a riskier and less predictable climate. Moreover, community-based adaptation generated adaptation strategies through participatory processes, involving local stakeholders, volunteers, local initiators, and development practitioners. It built on existing cultural norms and addressed local development concerns that made people vulnerable to the impacts of climate change in the first place. Bryan & Behrman (2013) explored that community-based adaptation (CBA) should prioritize local initiatives and collectivism, recognizing that adaptation to climate change required a

collective effort grounded in social capital. CBA was a group-based approach that emphasized collective action, where communities came together to address climate risks and build resilience. It integrated long-term climate change information into local planning, ensuring that communities were prepared for future impacts. Moreover, CBA incorporated local knowledge and perceptions of climate change, acknowledging the unique experiences and risks faced by each community. The approach placed importance on local decision-making, ensuring that solutions were rooted in the needs and priorities of the community. In doing so, CBA not only addressed climate challenges but also contributed to poverty reduction and enhanced livelihoods, promoting sustainable development. Relying solely on autonomous adaptation, where individuals independently adjusted their behavior, was insufficient to tackle the scale of climate change. Instead, a collective, community-driven approach was essential for fostering resilience and achieving meaningful change.

Community-based adaptation to climate change was an approach that prioritized local knowledge, needs, and capacities, empowering communities to manage the impacts of climate change. However, as Reid et al. (2007) noted, climate change was just one of several challenges faced by vulnerable populations, who also contended with issues such as unemployment, food insecurity, economic instability, and health problems. Therefore, focusing exclusively on climate-related risks did not address the broader concerns of these communities. To be effective, adaptation strategies had to integrate disaster risk reduction (DRR), livelihoods, and climate change adaptation, reflecting the interconnectedness of these issues and enabling communities to reduce vulnerability and strengthen resilience. This approach often involved co-learning, where both local and scientific knowledge were combined to better understand and mitigate the risks posed by climate change and other hazards (Reid et al., 2007).

Simon and Thomas (2020) emphasized two key insights for local government practitioners and decision-makers working to enhance climate adaptation and mitigation efforts. First, they argued that climate adaptation extended beyond infrastructure and engineering solutions and could not be addressed solely through one-time consultations. They stressed the importance of social learning in adaptation processes, aligning with those who asserted that sustainable climate responses required more than "one-time climate-proofing measures" (p. 17). Simon et al. (2020) suggested that local government planners engage professionals in community development, education, social services, and health when designing climate strategies. This approach ensured an understanding of ongoing community initiatives and encouraged meaningful dialogue with diverse community members.

Simon et al. (2020) criticized conventional planning engagement practices, which often excluded certain groups due to individualized formats and legal requirements. They pointed out that such practices separated marginalized people, such as incarcerated individuals, youth without voting rights, and those from collectivist cultures, which could play as effective governance mechanisms fostering social learning through collaboration, enhancing adaptive capacity. Additionally, the authors found that traditional planning approaches in Aotearoa New Zealand were often ineffective, as they suppressed social learning and led to costly, adversarial litigation. In contrast, the community-based initiative provided a successful model of community-based adaptation. The community-based adaptations focused on collective activities that promoted intergenerational connections and fostered joy, making climate

adaptation a more inclusive and less adversarial process. The initiative demonstrated that engaging communities around climate change did not have to center on property rights but could instead focus on shared concerns and collective actions, making the process more engaging and effective.

When comparing these findings with the beauty of community engagement, it became clear that fostering collaboration, social learning, and shared experiences provided a more holistic and inclusive approach to climate adaptation. This approach contrasted with traditional, individualized consultation methods, which often excluded significant portions of the population.

Siwi (2022) explored the impact of climate change on urban communities, particularly in relation to energy, food, and clean water crises.

While these community-based adaptation (CbA) measures proved beneficial at the local level, they often overlooked deeper socio-political factors, such as power dynamics and cultural structures, which limited their effectiveness. Traditional CbA strategies focused on addressing immediate environmental challenges but often failed to confront the underlying causes of vulnerability, such as unequal power relations and social exclusion.
In contrast, transformative community-based adaptation (TCbA), as discussed in Nath's (2024) findings, offered a more comprehensive approach. It incorporated the core characteristics of CbA but actively worked to empower communities by reframing decision-making processes, challenging power imbalances, and addressing the socio-political structures that shaped vulnerability.

The comparison between traditional community-based adaptation (CBA) and transformative community-based adaptation (TCbA) highlighted critical gaps in the current application of CBA, particularly in rural and marginalized communities. While CBA has shown promise in addressing immediate environmental challenges, it often overlooks socio-political factors such as power imbalances, economic instability, and the broader socio-economic structures that shape vulnerability. Despite the emphasis on local knowledge, its integration into scalable and sustainable adaptation practices remains uncertain, with insufficient empirical evidence on the long-term effectiveness of CBA.

Aforementioned literatures more emphasize environmental sustainability and governmental decision and focus to the out of context of inner terai related geographical region. Inner terai based climate change related issues and adopting pattern and livelihood strategies are still unanswered. Hence this research has been focused to identify the answer of the following question.
How people are adopted in the changing situation of climate in the specific area of Chitwan of Nepal?

Theoretical Underpinning

This study draws upon economic resilience theory, as conceptualized by Briguglio et al. (2006), to explore how communities adapt and transform in response to climate-induced disruptions. Economic resilience, as per this framework, involves three key components: absorptive, adaptive, and transformative capacities. Absorptive capacity enables communities

to withstand shocks, adaptive capacity allows them to adjust their practices to maintain core functions despite disruptions, and transformative capacity fosters long-term innovation, enabling communities to emerge stronger post-disruption. These capacities are influenced by factors such as economic diversification, social capital, market flexibility, and entrepreneurial activity. Social support mechanisms, as outlined in Briguglio's model, play an essential role in enhancing resilience by providing the necessary resources, financial aid, and emotional support during adverse events. This theoretical lens is particularly relevant when examining the role of green enterprises in fostering both community and economic resilience by integrating environmental sustainability and local knowledge. Green enterprises are seen as transformative agents, capable of driving innovation, creating jobs, and promoting long-term sustainability in the face of climate challenges. This research has been guided by this theoretical concept in study area.

The concept of community-based adaptation (CBA) serves as a critical bridge between theory and practice in climate change resilience capacities in different communities. CBA aligns with Briguglio's resilience framework, emphasizing the importance of local, local communities-based solutions tailored to the specific vulnerabilities and needs of communities. The participatory approach inherent in CBA ensures that adaptation strategies are grounded in local knowledge and priorities, empowering communities to lead their own adaptation processes. By focusing on local-level impacts, CBA fosters adaptive capacity and strengthens social cohesion, which are fundamental to both short-term survival and long-term resilience. The integration of durable solution in local level, climate change adaptation (CCA), and disaster risk reduction (DRR) within CBA ensures that adaptation strategies are not only reactive but proactive, mitigating future vulnerabilities while enhancing overall community resilience.

Theoretical Frame Work

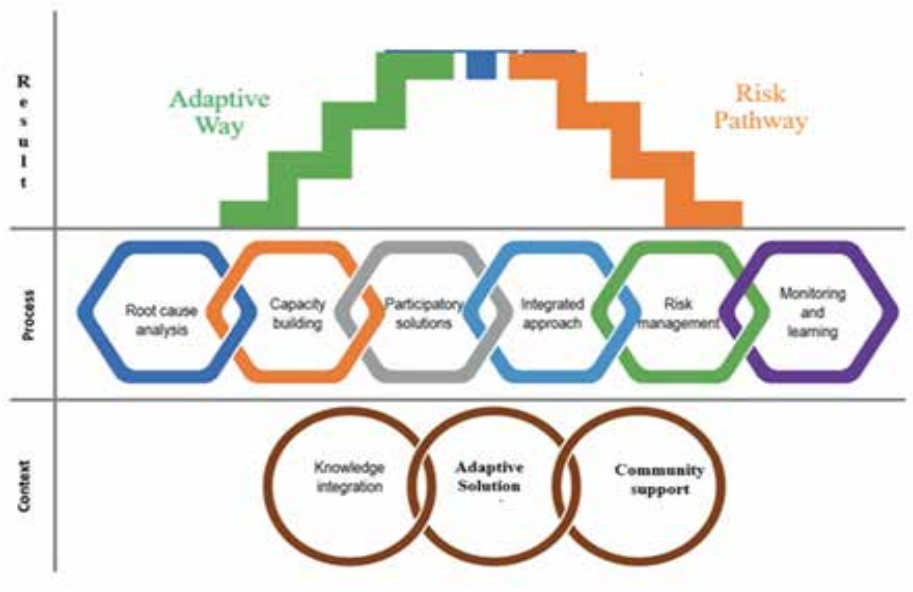
To build resilience in communities facing climate-induced disruptions, it is essential to integrate local, traditional, and scientific knowledge to craft effective adaptation strategies. This approach combines the lived experiences and coping mechanisms of community members with scientific insights, resulting in more comprehensive solutions to vulnerability. Adaptive strategies, such as sustainable farming practices and resource management, enable communities to not only survive but flourish in the face of environmental changes. Moreover, community support through social networks and green enterprises drives innovation, job creation, and long-term resilience by strengthening local economies and reducing climate vulnerability. This framework emphasizes the importance of knowledge integration, adaptive solutions, and community support in fostering resilience.

Building resilience is a dynamic and iterative process that involves several key steps: root cause analysis, capacity building, and participatory solutions. Root cause analysis allows communities to identify systemic barriers, such as over-reliance on unsustainable Agri-practices, thereby informing the development of targeted, context-specific interventions. Capacity building enhances communities' ability to absorb shocks, adapt effectively, and transform in response to climate challenges, ensuring greater preparedness for future disruptions. Participatory solutions and integrated approaches promote inclusivity, enabling communities to collaboratively design and implement adaptive strategies. Effective risk management, along with

continuous monitoring and evaluation, supports flexibility, progress assessment, and strategic refinement, ensuring long-term resilience in the face of evolving climate risks. This process ensures that resilience-building efforts are not only comprehensive but also adaptive and sustainable.

Figure 1

Theoretical Frame Work



Communities engaging in resilience-building efforts ultimately follow one of two pathways: an adaptive pathway or a risk pathway. The adaptive pathway represents a community's capacity to proactively respond to challenges, leveraging sustainable solutions and innovation to mitigate climate induced vulnerability and foster long-term resilience. In contrast, the risk pathway arises when communities fail to address underlying vulnerabilities or build necessary adaptive capacities, leading to persistent cycles of vulnerability and inadequate responses. This distinction underscores the importance of a balanced, integrated approach that supports both immediate adaptation and long-term transformation. Future research should prioritize strengthening local capacities, promoting inclusive strategies, and formulating policies that facilitate sustainable resilience, ensuring communities are equipped to navigate evolving climate challenges.

Objective and Methodology

This research has been focused on exploring how local adaptation practices build up to manage the livelihood in the changing context of climate in the specific area of Chitwan, Nepal. The ontological assumption of this research is that the livelihood of local people in the Madi community of Chitawan is influenced by climate change. It is concerned to the subjectivity and practices of the local people of the Madi community. The interpretive approach has been applied as the epistemology. The interpretive approach demands a qualitative research design. To gain this objective, a qualitative research approach has been applied. The qualitative research approach refers to case study, focus group discussions, observation etc methods

for the data collection (Adhikari, 2020a; Adhikari, 2020b; Adhikari et al., 2024d; Adhikari et al, 2024 c; Adhikari et al, 2024 a). The approach drew on the qualitative research design to capture the complex dynamics of climate change adaptation within the community. This research design allows for the exploration of the subjective experiences of community members and households while also offering measurable data on the success of these strategies. Fifteen cases have been selected based on a purposive sampling procedure. The research has investigated how house-led initiatives, rooted in local knowledge and priorities, contribute to the resilience of vulnerable populations in Madi (Chitwan) village.

Given the subjective nature of community responses to varying weather conditions, this study necessitates further qualitative research to gain a comprehensive understanding of local adaptation strategies. A participatory approach will be employed, engaging local stakeholders through focus group discussions (FGDs), semi-structured interviews, observation and participatory rural appraisal (PRA) methods. These methods have facilitated an in-depth exploration of community perceptions, indigenous knowledge, and socio-political factors shaping adaptation practices.

FGDs method has involved diverse community groups—such as farmers, women, youth, and elders—to explore their views on climate change impacts, adaptation measures, and empowerment, while also examining the role of local institutions, including community-based organizations (CBOs) and authorities, in adaptation planning. Semi-structured interviews with local government officials, CBO leaders, and key informants will provide insights into the challenges and effectiveness of current weather-related strategies. Additionally, PRA methods like participatory mapping, seasonal calendars, and vulnerability assessments will enable the community to identify climate-related risks, adaptive actions, and gaps in their coping capacities. Collectively, these qualitative approaches will yield context-specific insights into how local knowledge, community values, and power dynamics influence the adoption and effectiveness of climate adaptation practices.

The collected data was analyzed using a qualitative research approach. The content analysis method is a major method for analyzing qualitative data (Adhikari and Acharya, 2023; Adhikari, 2024a; Adhikari, 2024b; Adhikari et al., 2024b). Hence, the content analysis method has been used to analyze the gathered qualitative data approach to provide a comprehensive understanding of community-based adaptation strategies. This combination of data will offer a holistic view of the effectiveness of these strategies, identify key barriers like socio-political constraints, limited resources, and power imbalances, and explore how local adaptation practices intersect with broader climate change adaptation and disaster risk reduction frameworks.

Framed within an interpretive epistemology and a multiple reality ontology, the study recognizes the subjective nature of community members' experiences and acknowledges varying perspectives from different stakeholders. This qualitative research approach, combining empirical data and local narratives, offers a comprehensive, context-sensitive exploration of changing weather patterns, & climate change adaptation strategies in Madi village, Nepal, contributing valuable insights into the role of community-based adaptation in building resilience to climate change impacts

Results and Discussion

The study addressed the multifaceted impacts of climate change on the rural community of Madi village, Chitwan, where agricultural practices had long been the primary livelihood. As highlighted in an in-depth case study, key informant interviews (KIIs), and focus group discussions (FGDs), climate change had led to recurring droughts, erratic rainfall, and water scarcity, which drastically reduced crop yields, heightened food insecurity, and disrupted local water supplies. This situation forced many families to abandon farming, seeking alternative livelihoods through migration, both within urban centers and abroad, thus exacerbating economic instability and social fragmentation. Marginalized groups, already disadvantaged by limited access to land and caste-based discrimination, were disproportionately affected, making adaptation even more challenging for them. In response, the community emphasized the need for adaptive strategies, including water conservation techniques such as rainwater harvesting, groundwater recharge, and the adoption of eco-friendly agricultural practices to ensure long-term sustainability. Furthermore, the discussions underscored the importance of livelihood diversification as a crucial adaptive measure, though the shift to alternative forms of income, such as unskilled labor, often brought about economic instability. As climate change continued to disrupt traditional livelihoods, promoting resource management practices like forest restoration and sustainable agriculture offered potential for more resilient and sustainable solutions for the future. The findings highlighted several constraints faced by the Madi community due to changing local weather patterns, including:

Impact on Agriculture

The focus group discussions (FGDs) in Madi village, Chitwan, revealed the profound impact of climate change on local agriculture, which had been the primary livelihood for the community for generations. Participants, including case A: B:C, shared how recurring droughts and erratic rainfall patterns had drastically reduced crop yields, leading to severe food insecurity. Water scarcity, both for irrigation and drinking, exacerbated the situation, leaving many families unable to sustain their agricultural practices. This led to widespread migration, with families seeking alternative sources of income in urban areas or abroad. The migration, however, disrupted familial and community ties, leading to social fragmentation and perpetuating cycles of poverty. Furthermore, the encroachment of wild animals into farmlands and soil degradation compounded these challenges, making traditional farming methods increasingly ineffective.

The discussions also highlighted the vulnerability of marginalized groups, as pointed out by case A: B:C:D, who emphasized that climate change had intensified pre-existing social and economic inequities, particularly for those already burdened by limited access to land. The compounded effects of drought, heatwaves, and land degradation disproportionately affected these vulnerable groups, further restricting their ability to adapt and thrive. Participants stressed the need for adaptive strategies and resilient infrastructure to safeguard livelihoods and reduce vulnerabilities in rural communities. Additionally, they called for the promotion of eco-friendly agricultural practices, such as rainwater harvesting and groundwater recharge, as essential measures for mitigating the impacts of climate change on agriculture and ensuring long-term sustainability of local food systems.

Water Availability

During the focus group discussions (FGDs) in Madi village, Chitwan, participants highlighted the severe impact of changing climate patterns on water availability, which had become a critical issue for both agricultural and domestic needs. Many, including case A: B:C:D, discussed how recurring droughts and prolonged dry spells had drastically reduced the availability of water for drinking and irrigation. This scarcity had intensified food insecurity, as crops could no longer be reliably watered, forcing many families to abandon agriculture and consider migration to urban areas in search of better opportunities. This disruption of agricultural practices not only threatened the community's economic stability but also exacerbated social fragmentation, as families were often forced into labor migration, leading to the erosion of traditional community social structures and relationships.

In addition to the immediate strain on water resources, the FGDs also underscored the broader environmental impacts of water scarcity. Participants like case A: B:C:D pointed out that the depletion of local water sources had significantly worsened living conditions, particularly for marginalized groups who already faced challenges due to limited land access. These groups were disproportionately affected by water shortages, further deepening existing social inequities. Moreover, the discussions emphasized the urgent need for water conservation measures such as rainwater harvesting, groundwater recharge, and more sustainable agricultural practices to combat the ongoing water crisis. The participants stressed that these adaptive strategies were essential for maintaining community resilience in the face of climate change and safeguarding both water resources and livelihoods for the future.

Livelihood Diversification

The focus group discussions (FGDs) in Madi village, Chitwan, revealed that changing climate patterns had profoundly disrupted traditional livelihoods, especially those reliant on agriculture, forestry, and livestock. Many participants, including case A: B:C:D, emphasized that prolonged droughts and irregular rainfall had severely affected crop yields, leaving agricultural families struggling to maintain their income. The lack of water for irrigation and domestic use had forced many community members to abandon farming altogether. As a result, households increasingly turned to alternative forms of livelihood, such as unskilled labor, which led to greater economic instability and migration, particularly to urban areas. However, the shift to alternative livelihoods had not been without challenges, as it often involved low-paying, unstable jobs that did not provide the same level of security or community cohesion that traditional farming once did.

The discussions also highlighted the importance of livelihood diversification as a necessary adaptive strategy in the face of climate change. Participants, like case A:B:C:D, noted that while diversifying into non-agricultural activities such as construction or labor markets might provide temporary relief, it was not a sustainable solution for long-term community resilience. The compounded impacts of climate change, including livestock losses and the degradation of forests and water resources, had further strained the community's ability to diversify. Additionally, marginalized groups, already struggling with limited access to land and resources, faced even greater challenges in adapting to these changes. As case A: B:C:D suggested, local resource management practices, such as forest restoration and sustainable

agriculture, could offer more sustainable alternatives to diversify livelihoods and strengthen resilience in the face of a changing climate.

Crop Diversification

In response to the adverse impacts of climate change, particularly the increasing frequency of droughts and erratic rainfall patterns, the community in Madi village, Chitwan, began adopting crop diversification strategies to cope with the changing agricultural environment. During the focus group discussions, participants like case A: B:C:D highlighted the importance of shifting to drought-resistant and early maturing crop varieties. These crops not only offered resilience against erratic weather patterns but also helped ensure better yields during shorter, less predictable growing seasons. By diversifying crops, farmers could spread the risk of crop failure and mitigate the economic impacts of climatic variability, ensuring more reliable food production and income throughout the year. This approach became particularly crucial as traditional crops, which once thrived in the area, could no longer adapt to the changing weather conditions.

Additionally, the community recognized the necessity of integrating other climate-resilient practices alongside crop diversification. Case A: B:C:D's accounts of food insecurity and water scarcity emphasized the role of water management strategies in supporting agricultural adaptation. This included rainwater harvesting and better irrigation systems, which were critical for sustaining diversified crop systems during dry and changing weather periods. Furthermore, participants like Karuna BK noted the importance of combining agricultural adaptations with broader ecological restoration efforts, such as maintaining vegetation and promoting sustainable water use practices. Together, these community-based adaptation practices provided a multi-faceted approach to climate resilience, offering both immediate relief from the impacts of climate change and long-term solutions for ensuring the sustainability of livelihoods in the face of ongoing environmental challenges.

Water Management

In Madi village, Chitwan, local communities devised a range of adaptive water management strategies in response to the escalating challenges posed by recurrent droughts and unpredictable rainfall patterns, which significantly undermined agricultural productivity. Focus group discussions with community members, such as case A:B:C:D, highlighted the construction of small-scale water harvesting structures—such as ponds and reservoirs—as a pivotal intervention to mitigate water scarcity during dry spells. These structures functioned by capturing and storing rainfall during wetter periods, ensuring a continuous supply of water for both irrigation and potable purposes during droughts. According to case A:B:C:D, these water harvesting systems were essential for sustaining both domestic and agricultural water needs, thereby alleviating the growing pressure on already limited water resources. Such initiatives became fundamental to maintaining agricultural yields and supporting the livelihoods of farming families in the region, enhancing local resilience to climate change.

Moreover, the community engaged in the enhancement and modernization of irrigation systems, as noted by participants such as case A: B:C:D. Traditional irrigation methods had proven inadequate in the context of prolonged droughts and decreasing water availability. In response, the community adopted more water-efficient techniques, including drip irrigation,

to optimize water use for agricultural purposes. This shift toward precision irrigation ensured the more efficient distribution of water, conserving resources while sustaining crop production. Additionally, Soniya Gurung emphasized the importance of groundwater recharge efforts, particularly through ecological restoration activities such as tree planting in the Chure hills, which played a critical role in replenishing local water sources. Collectively, these water management practices—centered on efficiency, sustainability, and resource conservation—were integral to strengthening community resilience and securing water resources for future generations in the face of an increasingly uncertain climate.

Discussion

The findings from the Madi village focus group discussions aligned with the theoretical framework of economic resilience, as outlined by Briguglio et al. (2006). The community's efforts to adapt to climate-induced disruptions through water management strategies, livelihood diversification, and agricultural adaptation reflected the three core components of economic resilience: absorptive, adaptive, and transformative capacities. For instance, the construction of small-scale water harvesting structures, such as ponds and reservoirs, exemplified the community's absorptive capacity, enabling them to withstand the immediate shock of water scarcity during droughts. Similarly, adaptive capacity was evident in the adoption of water-efficient irrigation methods like drip irrigation and crop diversification, which allowed the community to adjust agricultural practices to changing climate conditions. The shift toward these practices indicated the community's ability to modify core activities to maintain food production and economic stability despite adverse environmental conditions. Furthermore, the emphasis on sustainable resource management, including forest restoration and groundwater recharge, illustrated the transformative capacity of the community, which not only sought to recover but also to innovate for long-term environmental and economic sustainability.

However, the findings also highlighted several challenges in achieving the full potential of these adaptive strategies, particularly in relation to marginalized groups. The vulnerability of these groups, compounded by caste-based discrimination and limited access to resources, reflected gaps in the absorptive and adaptive capacities of the community. While some households diversified their livelihoods by migrating for unskilled labor opportunities, this shift led to economic instability and weakened social cohesion, which directly affected the community's overall resilience. Briguglio's theory emphasized the importance of social capital and support mechanisms in enhancing resilience, yet the Madi community's experience revealed that migration and economic diversification into low-wage sectors did not necessarily foster long-term resilience. These challenges underscored the need for a more integrated approach to resilience-building, one that not only focused on economic and environmental adaptations but also strengthened social cohesion and reduced socio-economic inequalities. This gap called for further research and intervention to address the disparities faced by marginalized groups and ensure that adaptation strategies were inclusive and equitable, thus enhancing the overall resilience of the community.

Future research may focus on addressing the gaps related to the resilience of marginalized groups within the community, as highlighted in the findings. While Madi village made strides in enhancing absorptive, adaptive, and transformative capacities through various water

management and agricultural strategies, these efforts did not fully account for the socio-economic inequalities faced by marginalized groups, particularly those burdened by discrimination and limited access to resources. Future studies could explore how adaptation strategies could be tailored to inclusively address these disparities, ensuring that vulnerable groups were not left behind in resilience-building efforts. Additionally, there was a need for more in-depth analysis of the long-term impacts of livelihood diversification, especially in relation to migration for unskilled labor, which may have exacerbated economic instability and social fragmentation. Research should also investigate how social capital and community-based support mechanisms could be strengthened to promote cohesion and collective action, fostering a more holistic approach to resilience that integrated both environmental sustainability and social equity. These gaps pointed to the importance of developing adaptive strategies that were not only effective in environmental terms but also equitable and inclusive, ensuring sustainable community resilience across all segments of the population.

Conclusion

In The primary objective of this study was to explore the constraints faced by the Madi community in Chitwan district due to changing weather patterns and to evaluate the effectiveness of local adaptation strategies in mitigating these impacts. In conclusion, the community of Madi village demonstrated significant resilience in adapting to the increasing frequency and severity of climate extremes, largely through locally driven, community-based strategies. The findings aligned with the theoretical framework of economic resilience, emphasizing the community's ability to absorb, adapt, and transform in response to climate disruptions. Through practices such as water harvesting, adoption of efficient irrigation methods, crop diversification, and sustainable resource management, Madi villagers showcased their absorptive and adaptive capacities. These efforts allowed them to mitigate immediate shocks, adjust agricultural practices to shifting climatic conditions, and foster long-term sustainability in the face of uncertainty. However, the challenges faced by marginalized groups, particularly those affected by socio-economic inequities like socio-economic and natural resource-based discrimination, underscored the gaps in the community's resilience efforts. Economic diversification, while offering some relief, introduced instability and social support, highlighting the need for a more community based inclusive approach to adaptation that also strengthened social cohesion and addressed deep-rooted vulnerabilities.

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