

CLIMATE CHANGE, FOOD INSECURITY, AND ADAPTIVE STRATEGIES IN SOUTHERN MADAGASCAR

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ABSTRACT

Southern Madagascar has become a frontline of climate vulnerability, where recurring droughts, erratic rainfall, and land degradation have deepened chronic food insecurity. This study aimed to examine how climate change shapes rural livelihoods in the district of Ambovombe, Tsihombe, and Ford-Dauphin, in Androy and Anosy regions, and to identify the adaptive strategies that local communities employ under environmental and socio-economic stress. Using a qualitative design informed by interpretive phenomenology, data were collected through semi-structured interviews, focus group discussions, and field observations with 24 purposively selected informants, including smallholder farmers, female-headed households, community leaders, NGO staff, and agricultural extension officers. The findings reveal that climate-induced food insecurity is both an ecological and social crisis, exacerbated by poverty, gendered inequalities, weak institutional support, and cultural land practices. Communities rely on a mix of traditional coping mechanisms, such as food rationing, seasonal migration, and seed diversification, alongside externally supported interventions such as cash-for-work programs and drought-resistant crops. However, these measures often remain reactive, short-term, and unevenly accessible. The study concludes that community resilience is evident, but long-term adaptation remains constrained by structural barriers. Policy recommendations highlight the need for localized adaptation strategies, stronger agricultural extension services, and integration of indigenous knowledge into planning processes. By centering community voices, this study contributes to a more grounded understanding of the human dimensions of climate vulnerability in Southern Madagascar.

Keywords: Climate, Vulnerability, Food, Strategies, Madagascar.

INTRODUCTION

Southern Madagascar is increasingly defined by its fragile relationship with the environment (Fayad, 2023). Over the last two decades, prolonged droughts, erratic rainfall, and the encroachment of desertification have not only reshaped the landscape but also placed unbearable strains on rural communities' ability to secure food and maintain basic livelihoods (Gouvernement de Madagascar, 2015; Emynorane et al., 2025). In the arid and semi-arid districts of Androy, Anosy, and Atsimo-Andrefana, the cyclical nature of climatic stress has triggered repeated humanitarian crises, drawing global attention to the devastating consequences of slow-onset climate phenomena (Ayanlade et al., 2022). Local households, predominantly reliant on subsistence agriculture, livestock, and foraging now confront not only seasonal unpredictability but also a deep erosion of their socio-economic resilience. The severity of these environmental pressures reflects a wider pattern of climate stress experienced in the Global South, but in Madagascar's southernmost regions, the compound effects of geography, political

marginalization, and limited access to public services have created conditions that demand urgent scholarly and practical engagement (Harvey et al., 2014; Chigudu, 2024).

Existing academic inquiries into the dynamics of food insecurity in Madagascar have largely concentrated on macroeconomic frameworks, biophysical assessments, and humanitarian response mechanisms (Herrera et al., 2021). Quantitative climate models and satellite-based analyzes have proven invaluable in demonstrating trends in rainfall reduction, vegetation loss, and land-use changes (Powell et al., 2023). Yet, such methods often bypass the granular, lived experiences of the people most directly affected. Recent research in environmental anthropology and rural sociology has attempted to recenter communities in the narrative of environmental change, highlighting the significance of local knowledge, cultural beliefs, and social capital in coping and adaptive responses (Ayanlade et al., 2022; INSTAT, 2009). For example, studies conducted in East Africa and the Sahel have shown that farmers' perceptions of rainfall shifts, crop failure, and soil fertility degradation often precede formal meteorological alerts. These understandings are deeply intertwined with cosmological systems, ritual practices, and communal institutions. Nevertheless, in Madagascar, especially in its southern territories, these sociocultural dimensions remain insufficiently documented. This leaves a critical blind spot in how adaptive behavior is shaped and constrained by a spectrum of environmental and social variables (Eric et al., 2025; Golden et al., 2025).

The socio-political history of Southern Madagascar further complicates the region's vulnerability profile. Historically marginalized from national development plans and investment programs, communities in this area suffer from underdeveloped infrastructure, weak institutional presence, and poor connectivity with larger markets (Makoni, 2021; Asante et al., 2025). These conditions limit the scope and reach of both state-led and NGO-led interventions aimed at reducing hunger and building adaptive capacity. At the same time, traditional governance systems, based on clan elders and kinship networks, continue to mediate access to land, water, and agricultural inputs, often reinforcing hierarchies that hinder equitable resource distribution. In this context, adaptive strategies are rarely implemented in a neutral field (BNGRC, 2011). Rather, they emerge from negotiations between customary norms, development initiatives, and the exigencies of survival. Understanding these negotiations is crucial to uncovering how adaptation is practiced on the ground, not just planned in policy documents. The interplay between formal responses and informal coping practices therefore demands a more grounded and human-centered analysis.

Recent policy developments have introduced climate adaptation plans aligned with international frameworks such as the UNFCCC's National Adaptation Plans and the African Union's Agenda 2063 (Donatti et al., 2025). While commendable in ambition, the operationalization of these frameworks at the community level often fails due to bureaucratic inertia, language barriers, and cultural disconnects. Interventions tend to rely heavily on external expertise and imported technologies, sometimes overlooking the practical realities and ecological knowledge embedded within local systems (BNGRC & PNUD, 2012; Golden et al., 2025). For example, initiatives promoting drought-resistant seed varieties have failed in some communities where soil types, taste preferences, or storage methods differ from those envisioned by agricultural planners. Furthermore, communication between technical agents and rural communities is frequently hampered by literacy gaps, mistrust, and linguistic divides (Samputra, 2025).

These mismatches underscore the need to move beyond prescriptive solutions and to instead engage with the adaptive strategies that are already being enacted, however fragmented, informal, or underrecognized they may be.

The existing body of work on adaptation and food systems in Madagascar has produced valuable insights but has also tended to focus on externally driven responses and institutional capacities. Less attention has been given to the micro-level strategies adopted by households, the role of women and youth in managing food insecurity, and the relational dynamics that influence decision-making (Rafanomezantsoa et al., 2023; Delpy, 2024). For example, when faced with consecutive crop failures, some families opt for labor migration to coastal cities or mining areas, while others turn to debt arrangements, family-based food sharing, or informal trade. These actions, although individually rational, often carry social costs and can lead to longer-term vulnerabilities (Scholes et al., 2023). Moreover, certain groups, especially female-headed households, landless laborers, and disabled individuals may face greater barriers to accessing adaptive options. Capturing these differentiated experiences requires methodological approaches that are attentive to voice, narrative, and context.

By listening directly to the accounts of smallholder farmers, pastoralists, and local leaders in the southern regions, this study aims to reveal the complex, often contradictory nature of adaptation as it unfolds in daily life. Through in-depth interviews, focus group discussions, and ethnographic observations, this project seeks to map how people interpret climate risks, assess their coping options, and mobilize resources under conditions of uncertainty. Attention will also be given to the influence of social networks, cultural identity, gender roles, and institutional trust in shaping resilience. In doing so, this inquiry does not aim to romanticize local knowledge nor to dismiss scientific interventions. Rather, it advocates for a more dialogical approach, one that recognizes the value of hybrid strategies and multi-scalar responses that connect the local to the national and global.

This effort is characterized by a deliberate integration of diverse disciplinary and epistemological perspectives (Donatti et al., 2025). Rather than limiting its analytical lens to environmental science, economics, or development studies, it engages with frameworks from political ecology, rural sociology, and critical development theory. In doing so, it conceptualizes adaptation not as a series of technical fixes but as a socially embedded process shaped by power relations, historical trajectories, and ethical considerations (Emynorane & Arrive, 2024). This interdisciplinary orientation enables a deeper exploration of why particular adaptive strategies emerge, encounter resistance, or evolve over time (Powell et al., 2023). It further creates a platform for investigating how responses to climate challenges intersect with broader issues of justice, equity, and human dignity, issues that are especially pressing in Southern Madagascar, where environmental vulnerabilities are intensified by enduring structural marginalization and historical neglect.

Understanding the dynamics at play in Southern Madagascar is not only a matter of scholarly relevance. As global temperatures continue to rise and climate shocks intensify, the experiences of the region's rural communities serve as a bellwether for broader trends across sub-Saharan Africa (Bouley et al., 2018; Asante et al., 2025). The case of Madagascar, with its unique ecological systems, complex social fabric, and layered vulnerabilities, provides a crucial lens through which to examine the lived consequences of global environmental change. At the same time, the knowledge and resilience practices emerging from these communities offer insights that may inform

more sustainable, inclusive, and context-sensitive policies elsewhere (Betzabet et al., 2017; Ayanlade et al., 2022). Engaging with these realities requires moving beyond assumptions, investing in local voices, and reframing climate challenges as deeply human and fundamentally social.

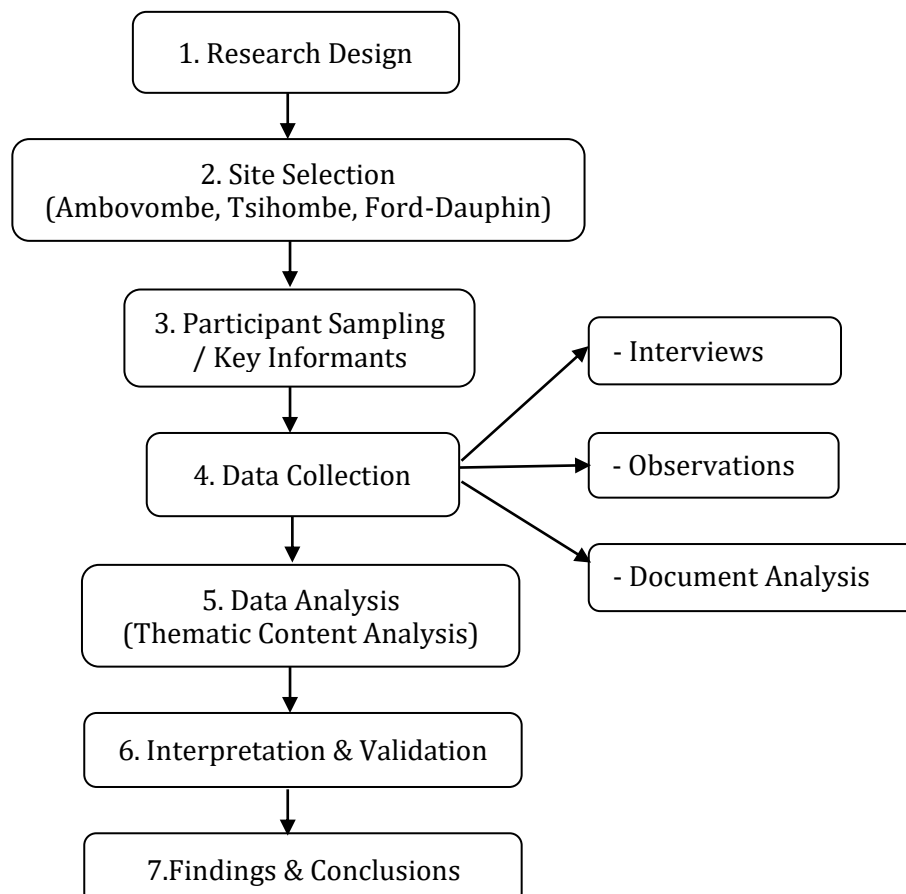
RESEARCH METHODS

This study used a qualitative research design to gain an in-depth understanding of how rural communities in Southern Madagascar, specifically in the districts of Ambovombe, Tsihombe, and Fort Dauphin (Androy and Anosy regions) perceive, experience, and respond to climate-induced food insecurity. The approach enabled close engagement with participants' voices, daily realities, and cultural meanings that are often overlooked by structured or quantitative tools.

A purposive sampling technique was applied to select 24 informants, including smallholder farmers, female-headed households, community elders, agricultural extension officers, and NGO staff, ensuring diversity in gender, age, and livelihood background. Data collection involved semi-structured interviews, focus group discussions, field observations, and document analysis of adaptation plans and NGO reports.

Thematic content analysis guided data interpretation, using inductive coding to identify patterns and themes. Triangulation was achieved through cross-checking interviews, observations, and documents, while member-checking with selected participants strengthened credibility. The overall research process is summarized in the methodological flow presented in Figure 1.

Figure 1. Research flow diagram of the study process



RESULTS AND DISCUSSION

RESULTS

The analysis of interviews, focus group discussions, observations, and supporting documents revealed recurring themes that capture how rural communities in the Androy and Anosy regions experience climate change and navigate food insecurity. These findings are synthesized below, highlighting perceptions, impacts, coping mechanisms, and adaptive practices.

The following table 1. presents a synthesis of the major findings from fieldwork, structured around central themes, illustrative quotes, and interpretive insights derived from thematic content analysis.

Table 1: Summary of Key Findings from Fieldwork

Theme	Sub-Themes	Illustrative Quotes	Interpretation
Perceptions of Climate Change	Unpredictable rain; Prolonged drought; Environmental degradation	"The rains used to come in November, but now we wait until January, and sometimes they don't come at all."	Farmers note shifting seasonal patterns, reinforcing awareness of climate disruption.
Impacts on Food Security	Crop failure; Livestock mortality; Food shortage	"Last year, we had to eat cactus fruit for weeks. There was nothing left in the field."	Recurrent food crises linked directly to environmental stress, reducing caloric intake and dietary diversity.
Coping Mechanisms	Food rationing; Migration; Borrowing food	"My son went to Fort Dauphin to work in a mine. That is how we managed to buy some rice."	Families engage in short-term coping strategies, often at social or economic cost.
Traditional Knowledge & Practices	Seed selection; Soil preservation; Rain rituals	"We still follow our ancestors' advice, some seeds are better when rain comes late."	Cultural knowledge sustains adaptive practices, though rarely supported by formal systems
External Support & Gaps	NGO programs; Limited access; Lack of follow-up	"They gave us drought seeds once, but no one came to show us how to use them properly."	Development programs are often short-lived or mismatched with local contexts, reducing long-term impact.
Gender and Vulnerability	Women's workload; Unequal resource access	"When food runs out, it's the mothers who go to look for wild tubers."	Women bear greater burdens in food crises yet remain central to household survival.
Local Adaptive Strategies	Crop diversification; Food preservation; Collective labor	"We started growing manioc and sweet potato, those survive even when rain is late."	Households innovate with available resources, showing resilience even in high-risk contexts.
Barriers to Adaptation	Poor infrastructure; Lack of information; Market inaccessibility	"We want to sell goats, but the road is broken. No one comes to buy them."	Isolation restricts economic opportunities and timely support.
Community Solidarity	Food sharing; Mutual aid; Local leadership	"Our chief organized a food collection for the elderly. Everyone gave a little."	Strong communal bonds provide resilience and act as informal safety nets.

DISCUSSION

Vulnerability Analysis

The concept of vulnerability is central to understanding the lived realities of communities in Southern Madagascar as they confront the compounded effects of climate change and food insecurity. Vulnerability in this context is not only about environmental exposure but is shaped by a complex intersection of socio-economic, political, and cultural factors (Powell et al., 2023). Households in regions such as Androy and Anosy are exposed to recurrent droughts, declining agricultural productivity, and soil degradation, but their ability to respond to these challenges is deeply influenced by structural inequalities, historical marginalization, and limited institutional support. In this study, vulnerability is interpreted through the lens of three interconnected components: exposure to climate risks, sensitivity to those risks, and the capacity to adapt.

Field findings illustrate that most rural households face high exposure to environmental stressors such as delayed rainfall, extreme heat, and crop failure. However, sensitivity to these climatic conditions varies based on livelihood dependence, access to land, and the nature of household assets. For example, families who rely solely on rain-fed agriculture are more acutely affected than those who engage in diversified income-generating activities such as livestock trading or petty commerce. Additionally, certain groups, including women, elderly individuals, and female-headed households experience heightened sensitivity due to their constrained access to natural resources, decision-making spaces, and economic capital. This differential vulnerability is embedded in traditional gender roles, labor divisions, and social hierarchies that often exclude marginalized voices from formal support systems.

Adaptive capacity, the third dimension, is equally uneven. While some communities have developed local coping mechanisms rooted in indigenous knowledge, such as food preservation, inter-household food sharing, and selective seed use, others remain heavily dependent on short-term humanitarian assistance (Rakotomavo & Rajaonarivony, 2015; Golden et al., 2025). The findings suggest that even when adaptation strategies are present, they are frequently reactive, fragile, and lack institutional reinforcement. Limited access to education, poor infrastructure, and weak market integration further erode resilience, leaving many communities trapped in cycles of dependency and food insecurity (Emynorane et al., 2025). Vulnerability in this context is therefore not simply a response to climate stimuli, but the result of systemic constraints that inhibit the capacity to absorb, respond to, and recover from shocks.

Recognizing these layers of vulnerability allows for a more critical understanding of climate risk in Southern Madagascar. It emphasizes the need for locally informed, socially inclusive adaptation strategies that address the structural dimensions of exposure and sensitivity, while strengthening the adaptive capacities of the most at-risk populations.

Socio-ecological Resilience

In the face of recurring climate shocks and chronic food insecurity, the ability of communities in Southern Madagascar to navigate environmental change is closely tied to the interconnectedness of their social and ecological systems. Resilience in this context refers to the capacity of these systems to absorb disturbances, adapt to shifting

conditions, and sustain essential functions over time (Rakotoarison et al., 2018). Findings from the field reveal that communities demonstrate various forms of resilience through traditional knowledge, diversified livelihood strategies, and collective action, even amid limited external support and persistent uncertainty.

Local agricultural practices provide key evidence of adaptive behavior. Farmers shift planting calendars based on observation of rainfall patterns and reliance on drought-tolerant crops such as cassava and sweet potatoes to ensure a minimum food supply (Ratsimamanga & Bettencourt, 2015). These ecological adjustments are supported by social mechanisms including shared labor systems, community-led food redistribution, and kinship-based migration arrangements (Donatti et al., 2025). Such interdependencies illustrate how social cohesion enhances the capacity of communities to manage natural resource scarcity and buffer the impacts of environmental variability.

However, the resilience of these systems is under strain. Overgrazing, deforestation, and soil exhaustion have reduced ecosystem services, while social cohesion is increasingly challenged by rising poverty, outmigration, and shifting cultural norms (World Bank, 2014). Interventions from NGOs and government agencies often focus on short-term relief rather than reinforcing the underlying systems that support resilience (WHO, 2015). Moreover, many external programs fail to recognize the importance of integrating ecological sustainability with social empowerment (Scholes et al., 2023).

Understanding resilience as both a social and ecological phenomenon allows for a more holistic view of adaptation. It shifts the focus from isolated interventions to long-term sustainability, where both the landscape and the community must be considered as co-dependent components. The persistence of Southern Madagascar's communities, despite severe constraints, underscores the need to support strategies that strengthen the adaptive capacity of both people and the ecosystems on which they rely.

Sustainable Livelihoods Approach

Addressing food insecurity in the drought-prone regions of Southern Madagascar requires an understanding of how households access, manage, and transform different forms of capital to sustain their well-being under pressure. The framework used in this analysis emphasizes five core asset categories, natural, financial, human, social, and physical capital, as essential building blocks for livelihood strategies (Delpy, 2024). Field data indicates that these assets are unequally distributed and highly vulnerable to environmental and socio-political shocks, influencing how communities respond to climate-induced challenges.

Natural capital, particularly land and water, remains central to survival in these regions (World Bank, 2014). Yet access is often constrained by land degradation, shrinking rainfall, and traditional inheritance systems that can marginalize women and youth. Financial capital is similarly limited; formal credit is scarce, and households frequently rely on informal lending or livestock sales during periods of food shortage. These reactive measures, although necessary, often deplete long-term assets and deepen vulnerability. Human capital, including education and agricultural skills, is unevenly distributed, with many youth lacking formal schooling and technical training that could support livelihood diversification.

Social networks also play a critical role in maintaining subsistence (WHO, 2015). Kinship ties, village-based savings groups, and religious associations often provide mutual aid during crises, filling gaps left by the absence of state support (Tirivangasi,

2018). Physical capital such as storage facilities, irrigation systems, or accessible roads is minimal or deteriorating, further limiting market access and post-harvest preservation (Chigudu, 2024). As a result, livelihood options remain narrowly focused on low-yield agriculture and risky seasonal migration.

An integrated understanding of these livelihood systems reveals that adaptation is not solely a matter of behavior change but also of structural empowerment. Supporting sustainable livelihoods in Southern Madagascar means enhancing access to all forms of capital, promoting inclusive development, and reducing barriers that prevent vulnerable groups from converting their resources into long-term resilience.

Gendered Dimensions of Adaptation

In Southern Madagascar, responses to climate stress are deeply shaped by gender roles, norms, and access to resources. Women are at the center of household food security, often responsible for food preparation, water collection, and small-scale gardening, yet they face systemic disadvantages in accessing land, credit, and decision-making spaces (World Bank, 2014). The burden of adaptation therefore falls disproportionately on women, who must navigate both ecological and social constraints while ensuring their families' survival.

Interviews revealed that when food supplies run low, it is women who travel long distances to forage for wild tubers or barter goods in nearby markets. They are also the first to reduce their food intake to prioritize children and elderly family members. Despite their central role in coping strategies, women are frequently excluded from formal adaptation programs or community leadership positions where key decisions are made about resource distribution and project planning. Traditional inheritance systems often deny women secure land rights, making it difficult for them to invest in long-term soil fertility or water management practices.

At the same time, women demonstrated remarkable innovation and resilience. Many have initiated small income-generating activities such as charcoal selling, food vending, or producing handmade goods, often using informal networks for support and knowledge-sharing (World Bank, 2014; Emynorane et al., 2025). Women's groups also serve as important platforms for mutual aid and information exchange during times of crisis. However, these efforts are often under-resourced and unsupported by external actors.

Recognizing the gendered nature of adaptation is essential for creating equitable climate responses (Rakotomavo & Rajaonarivony, 2015; Asante et al., 2025). Without addressing the structural inequalities that shape access to resources and decision-making, adaptation strategies risk reinforcing existing disparities. Empowering women through secure land tenure, access to credit, and inclusion in leadership can strengthen community-wide resilience and ensure that adaptation efforts reflect the needs and capacities of all members of society.

Institutional Trust and Governance Gaps

Local communities in Southern Madagascar often experience a profound disconnect between their lived realities and the institutions meant to support them. Many residents express skepticism toward government agencies and even international NGOs due to a history of short-lived projects, inadequate consultation, and unfulfilled promises (World Bank, 2014). This erosion of trust significantly influences the

effectiveness of adaptation efforts, as people are less likely to engage with programs they perceive as externally imposed or disconnected from local priorities.

Field accounts suggest that when external actors implement interventions such as distributing drought-resistant seeds or introducing new farming techniques, these efforts are often top-down and lack sustained follow-up. Beneficiaries report receiving tools or inputs without adequate training or support, leading to poor adoption or eventual abandonment. In some cases, project benefits are captured by local elites or misallocated due to favoritism, further deepening perceptions of injustice and institutional failure. The absence of transparent communication and inclusive decision-making processes has contributed to a cycle of disengagement and passive compliance, rather than genuine collaboration.

Additionally, state institutions are largely absent in remote rural areas, with limited presence of extension officers, agricultural advisors, or development planners (Rafanomezantsoa et al., 2023). This governance vacuum has left communities to rely heavily on traditional authorities or informal networks, which, while functional, may not always promote equitable access to resources (Rakotoarison et al., 2018). At the same time, communities have demonstrated a willingness to engage constructively with institutions when trust is built through participatory approaches, sustained presence, and culturally appropriate communication (Makoni, 2021).

Rebuilding institutional trust requires more than technical solutions; it calls for long-term engagement, local empowerment, and the decentralization of decision-making (World Bank, 2014). When governance systems are transparent, accountable, and responsive to community needs, adaptation initiatives are more likely to succeed. Bridging this gap between policy design and on-the-ground realities is essential for fostering meaningful and durable climate resilience in Madagascar's most vulnerable regions.

Local Knowledge Systems and Hybrid Practices

Communities in Southern Madagascar have long relied on indigenous knowledge to navigate the challenges of an unpredictable climate and fragile environment. Local farming practices, weather prediction methods, seed selection, and soil conservation techniques are rooted in generations of observation, experimentation, and oral transmission (Herrera et al., 2021). Elders in particular play a critical role in maintaining this knowledge, advising on when to plant based on the position of stars, animal behavior, or the timing of traditional ceremonies. These practices are deeply embedded in cultural identity and remain central to how rural households respond to drought and food insecurity (Harvey et al., 2014).

Despite their effectiveness in specific contexts, traditional strategies are increasingly under pressure. Environmental degradation, demographic change, and the influence of external actors are transforming the way knowledge is produced and shared. As modern technologies, new crops, and development interventions are introduced by NGOs and state programs, local communities often find themselves combining external inputs with indigenous techniques (World Bank, 2014). Farmers, for example, may adopt improved seed varieties while still using traditional soil-binding methods or consulting agricultural officers while adjusting advice based on ancestral experience. This blending of knowledge systems reflects a pragmatic and adaptive mindset rather than a rejection of new ideas.

However, external interventions often overlook or undervalue these local insights. Programs that fail to recognize the legitimacy of indigenous knowledge risk alienating communities and undermining participation (Fayad, 2023). On the other hand, initiatives that integrate local expertise with scientific approaches tend to enjoy greater acceptance and effectiveness (Eric et al., 2025). In many cases, hybrid practices, those that combine formal and informal knowledge, have proven more resilient and context-appropriate than standardized solutions.

Respecting and revitalizing indigenous knowledge systems, while fostering meaningful exchanges between local and scientific domains, can lead to more sustainable and inclusive adaptation outcomes. Recognizing that local communities are not passive recipients but active agents of innovation is crucial to strengthening resilience in a changing climate.

CONCLUSION

This study examined how climate change intensifies food insecurity in Southern Madagascar and how rural communities respond through diverse coping and adaptive strategies. Findings show that adaptation is shaped not only by environmental pressures but also by poverty, gender inequality, weak institutions, and cultural practices. Communities display resilience through traditional and hybrid strategies, yet long-term adaptation remains hindered by structural barriers such as limited assets, poor infrastructure, and inadequate institutional support. The qualitative scope, centered on selected districts of Androy and Anosy, provides rich contextual insights but does not capture the full diversity of Southern Madagascar. Even so, the findings highlight patterns of vulnerability and resilience that carry broader relevance. Policymakers and development actors are encouraged to design locally embedded and participatory adaptation strategies, strengthen agricultural extension and rural infrastructure, and integrate indigenous knowledge with scientific innovation. Particular attention should be given to empowering women and youth, whose roles are central in sustaining household resilience. Future research should expand to other regions, adopt longitudinal approaches, and explore cross-generational changes in adaptation to capture evolving patterns of resilience. By addressing structural inequities and centering vulnerable voices, adaptation in Southern Madagascar can become more effective, just, and sustainable.

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