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EARLY-WARNING ACTION AND COMMUNITY RESILIENCE IN ISIOLO COUNTY, KENYA

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Early-Warning Action and Community Resilience in Isiolo County, Kenya

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Abstract:

Purpose of Study: This study investigated the effect of early-warning action on community resilience in Isiolo County, Kenya. It examined how timely disaster risk information dissemination and anticipatory response mechanisms influence communities' ability to prepare for, respond to, and recover from recurrent droughts, floods, and resource-based conflicts.

Methodology: A descriptive survey research design was employed, targeting 154 households, county officials, community leaders, and humanitarian representatives. Data were collected using structured questionnaires and interview schedules, with stratified random sampling ensuring proportional representation. Descriptive and inferential statistics, including Pearson correlation and regression analysis, were used to determine relationships between variables.

Findings: Regression analysis revealed a strong positive relationship between early-warning action and community resilience ($R = 0.721$), with early-warning action explaining approximately 61.4% of the variation in resilience outcomes ($R^2 = 0.614$). ANOVA results confirmed statistical significance ($F = 11.382$, $p = 0.002$). Descriptive findings showed high mean scores (4.21–4.25) indicating that early-warning systems effectively enhance disaster preparedness, reduce drought and flood impacts, improve community decision-making, and strengthen adaptive capacity. However, constraints including inadequate communication infrastructure, delayed dissemination, low community awareness, and limited accessibility in remote areas continue to undermine full effectiveness.

Conclusion: Early-warning action significantly enhances community resilience in Isiolo County by improving preparedness, enabling timely response, reducing vulnerability, and strengthening adaptive capacity. Effectiveness remains constrained by weak communication infrastructure and limited community engagement. Strengthening dissemination systems, enhancing sensitization, and improving multi-stakeholder coordination are essential for transformative resilience.

Keywords: *Early-warning action, community resilience, disaster risk reduction, disaster preparedness, Isiolo County, Kenya*

1. INTRODUCTION

1.1 Background of the Study

Disaster risk reduction (DRR) has emerged as a critical priority in efforts to build the resilience of communities living in hazard-prone environments. In Kenya, arid and semi-arid lands (ASALs) such as Isiolo County are chronically vulnerable to droughts, floods, and resource-based conflicts, all of which significantly undermine livelihoods and impede socio-economic development (Odongo et al., 2025). These areas are predominantly inhabited by pastoral and agro-pastoral communities whose survival depends on climate-sensitive resources, particularly water and pasture.

The Government of Kenya, in collaboration with development partners and humanitarian agencies, has invested substantially in DRR strategies aimed at minimizing disaster impacts and building long-term resilience. Early-warning action systems occupy a central role in these strategies by providing timely, reliable information on impending hazards and enabling both communities and institutions to take preventive and adaptive measures (Mohamed, 2025). The National Drought Management Authority (NDMA) operationalizes early-warning systems in ASAL regions through drought condition monitoring, food security tracking, and alert dissemination to support timely decision-making at county and community levels.

Despite these investments, Isiolo County continues to experience severe disaster impacts. Prolonged drought episodes in recent years have resulted in significant livestock losses, reduced household incomes, and deepening food insecurity among pastoral communities (Huka, 2025). Flash floods and inter-community resource conflicts have further intensified vulnerability and disrupted livelihoods (Ochieng et al., 2022). These conditions demonstrate that while early-warning systems exist in principle, their effectiveness in translating timely information into resilience outcomes remains constrained by systemic challenges including delayed dissemination, weak communication infrastructure, and inadequate community-level engagement (Alcántara-Ayala & Oliver-Smith, 2019).

Early-warning action involves the systematic collection, analysis, and communication of risk information to support anticipatory decision-making before disaster events materialize. In pastoral communities, timely warnings create opportunities for adaptive strategies such as livestock migration, water conservation, and livelihood diversification (Abdela, 2024). However, evidence from ASAL regions consistently shows that early-warning information is frequently not translated into effective action due to low community awareness, limited trust in information sources, and weak institutional coordination (Tora et al., 2025). Bridging the gap between information dissemination and actionable community response is therefore a central challenge for disaster risk governance in Isiolo County.

Empirical evidence supports the proposition that well-functioning early-warning systems significantly enhance community resilience by improving preparedness, reducing hazard exposure, and strengthening adaptive capacity. Communities that actively receive and respond to early-warning information are demonstrably better positioned to minimize disaster losses than those with limited system access (Trogrlic et al., 2022). Yet in Isiolo County, integration of early-warning information into local decision-making processes remains incomplete,

limiting its contribution to systemic resilience building (Mati et al., 2024). Improving communication infrastructure, deepening community awareness, and strengthening institutional coordination are therefore indispensable steps toward ensuring that early-warning systems fulfill their full potential for building resilient communities.

1.2 Statement of the Problem

Despite the implementation of early-warning action systems in Isiolo County as part of broader DRR initiatives, communities continue to experience recurrent disasters that severely undermine livelihoods, food security, and socio-economic stability. Reports indicate that a considerable proportion of households in ASAL regions suffer significant disaster-related losses even after receiving early-warning information, raising persistent concerns about the effectiveness of existing mechanisms (Shibia, 2020). This disconnect between system existence and outcome effectiveness constitutes the central problem motivating this study.

A critical challenge lies in the gap between the dissemination of warning information and actual community response. Even where early-warning systems are operational, many households do not receive timely, clear, or actionable alerts due to weak communication infrastructure and limited coverage in remote areas (Chavula et al., 2025). Delays in dissemination and inconsistent outreach reduce preparedness among vulnerable communities and increase their exposure to disaster risks (Fathollahzadeh et al., 2024). The resulting preparedness deficit is compounded by low community awareness and limited capacity to interpret and act on warning information, with households frequently failing to implement anticipatory actions such as livestock migration, water storage, or livelihood adjustment even when warnings are issued.

Institutional coordination challenges among disaster management stakeholders further undermine system effectiveness. County government departments, humanitarian agencies, and community-based structures frequently operate in silos, producing fragmented warning messages and duplicated efforts. Evidence from northern Kenya indicates that only a small proportion of early-warning interventions are effectively coordinated at the community level, constraining their contribution to resilience building (Munyaka et al., 2025). These coordination failures reduce the coherence and credibility of warning systems, eroding community trust over time.

Moreover, the persistent vulnerability of Isiolo communities despite the presence of early-warning systems suggests a possible weakness in how early-warning action translates into actual resilience outcomes. While the systems are designed to enhance preparedness and reduce disaster impacts, limited empirical evidence exists on the extent to which they influence community resilience specifically in this county context. This knowledge gap creates uncertainty for policymakers and implementers regarding the effectiveness of current strategies. It is against this background that the present study examines the effect of early-warning action on community resilience in Isiolo County, Kenya.

2. THEORETICAL FRAMEWORK

Resilience Theory

Resilience Theory, rooted in Holling's (1973) foundational work on ecological systems, offers a critical lens through which to understand how communities anticipate, absorb, adapt to, and recover from shocks and stressors. Holling argued that resilience is not merely the capacity of a system to return to its prior state following a disturbance, but rather the measure of the persistence of relationships within a system and its ability to absorb change while undergoing transformation. Scordato and Gulbrandsen (2024) extended this conceptualization in social-ecological contexts, emphasizing that resilience encompasses not only the ability to bounce back from disruption but also the capacity to bounce forward treating adversity as an opportunity for learning, adaptation, and structural change.

Applied to Isiolo County, Resilience Theory is particularly relevant because communities are routinely exposed to compounding hazards: droughts, resource-based conflicts, and climate-induced variability (Mwenda et al., 2022). Timely anticipatory measures such as early-warning information dissemination and drought forecasting are central to building resilience because they enable households and institutions to prepare before hazards intensify (Islam et al., 2025). When warning systems function effectively, communities can preposition resources, adjust livelihoods, and activate social safety networks before disasters fully materialize, thereby reducing both exposure and impact severity.

Resilience Theory also draws attention to the importance of risk-informed planning as a structural enabler. Where communities integrate risk analysis into development planning, they reduce chronic vulnerability and build the institutional foundations for sustained livelihoods under conditions of uncertainty (Zhang et al., 2026). This is especially salient in Isiolo, where pastoralist communities depend heavily on natural resources that are vulnerable to climate variability. By embedding risk considerations into land use, water management, and livestock strategies, resilience becomes a designed attribute of governance rather than an accident of circumstance.

A further dimension highlighted by Resilience Theory concerns the role of community engagement and social capital. Local knowledge, cultural norms, and collective action represent important endogenous resources for resilience. Communities that are actively involved in preparedness, decision-making, and recovery processes not only achieve stronger resilience outcomes but sustain them more durably over time (Yang et al., 2024). In Isiolo, where communities maintain rich indigenous coping traditions and dense social networks, Resilience Theory affirms that external interventions are most effective when they align with and reinforce existing community practices rather than supplanting them.

3. EMPIRICAL REVIEW

Matano et al. (2026) critically examined early-warning systems from a Forensic Investigation of Disasters (FORIN) perspective, arguing that a fundamental flaw of most EWS is that the concept of "early" is interpreted primarily in terms of hazard onset speed, rather than as an opportunity to address the underlying drivers of disaster risk. Their analysis demonstrated that

EWS remain more closely linked to emergency response than to systematic disaster risk reduction, and called for a paradigm shift toward people-centered, risk-informed warning architectures. This critique directly informs the present study's focus on whether early-warning action in Isiolo County translates into meaningful resilience outcomes, or merely triggers reactive responses.

Trogrlic et al. (2022), in their comprehensive review of early-warning systems and their role in disaster risk reduction, presented an eight-component people-centered framework emphasizing the importance of community participation, local knowledge integration, and robust evaluation mechanisms. The authors identified persistent gaps in the social components of early-warning systems and highlighted the need for evidence-based decision-making and performance monitoring. Their framework is particularly applicable to pastoral contexts like Isiolo, where mobility patterns and traditional knowledge systems form the backbone of community-level risk management and where conventional top-down warning architectures frequently fail to achieve last-mile reach.

Hermans et al. (2022) conducted a systematic review of local and scientific knowledge integration in early-warning systems and found that people-centered approaches substantially increased warning uptake and community action. Their review showed that when communities participate in defining warning thresholds and communication pathways, perceived credibility and behavioral response improve markedly. This finding resonates strongly with the Isiolo context, where both formal NDMA alert systems and informal community-based networks co-exist, and where the integration of indigenous environmental knowledge with modern drought-monitoring technology holds significant potential for improving preparedness and anticipatory action.

Jaime et al. (2026), in their landmark work on forecast-based financing, demonstrated that the critical barrier to effective early-warning action in the humanitarian sector is not technical capability but rather the absence of pre-agreed funding and decision protocols that enable action before a disaster strikes. Their framework—linking forecast thresholds to automatic resource release showed substantial reductions in livelihood losses when communities acted before hazard impacts intensified. Although developed primarily in the context of hydro-meteorological forecasting, the principles apply directly to Isiolo, where delayed institutional responses and funding bottlenecks frequently mean that communities receive warnings without the practical capacity to act on them.

Camacho et al. (2023), in their study of community disaster resilience geographies in the United States, developed the Baseline Resilience Indicators for Communities (BRIC) framework identifying six resilience domains: social, economic, housing and infrastructure, institutional, community capital, and environmental. Their work demonstrated that resilience is spatially differentiated and that institutional and community capital dimensions are especially critical mediators between hazard exposure and resilience outcomes. While the geographic context differs substantially from Isiolo County, the conceptual emphasis on institutional coordination and community capital as resilience determinants directly mirrors the structural challenges identified in the current study, where weak inter-agency coordination and

limited community empowerment constrain the conversion of early-warning information into protective action.

Kneebone et al. (2025), in his seminal reassessment of the resilience concept in disaster contexts, argued that framing resilience solely as a bounce-back capacity insufficiently captures the transformative dimensions of community adaptation. He proposed that genuine resilience requires communities to leverage disaster experience as a catalyst for structural change and improved risk governance—a process of bouncing forward rather than merely recovering. This perspective is highly relevant to Isiolo County, where recurring drought and flood events present not only destructive threats but also repeated opportunities for institutional learning, community capacity development, and adaptive governance improvement. The persistence of vulnerability despite early-warning system investment suggests that bounce-back resilience has been partially achieved, but transformative resilience remains an aspirational goal.

4. RESEARCH METHODOLOGY

This chapter outlines the methodological approach used to examine the effect of early-warning action on community resilience in Isiolo County. The study adopted a descriptive survey research design to collect both quantitative and qualitative data from key stakeholders involved in disaster risk reduction and resilience-building initiatives. The target population comprised households, community leaders, county disaster management officers, and representatives of humanitarian organizations actively engaged in early-warning and disaster preparedness programs within the county. A sample size of 154 respondents (approximately 73.3% of the target population) was determined using established sampling formulae. Stratified random sampling was applied to ensure proportional representation of all respondent categories, while simple random sampling was used to select individual respondents within each stratum. Data collection employed structured questionnaires and interview schedules.

Questionnaires incorporated both closed-ended and open-ended questions designed on a five-point Likert scale to measure respondent perceptions on early-warning systems and community resilience. Interviews generated in-depth qualitative insights on the effectiveness of early-warning mechanisms in enhancing preparedness and adaptive capacity. All data collection procedures adhered to established ethical standards, including research authorization from the National Commission for Science, Technology and Innovation (NACOSTI), as well as informed consent, confidentiality, and voluntary participation. Data analysis involved both descriptive and inferential statistics. Descriptive statistics including frequencies, percentages, means, and standard deviations were used to summarize the data. Inferential analysis employed Pearson correlation and simple linear regression to determine the relationship between early-warning action and community resilience. The regression model assessed how community resilience is influenced by early-warning communication, timeliness of information dissemination, accessibility of warning systems, and community response mechanisms. Analysis of Variance (ANOVA) tested overall model significance, while qualitative data were analyzed through content analysis to identify key themes and patterns related to early-warning effectiveness and resilience outcomes.

5. RESEARCH FINDINGS AND DISCUSSION

5.1. Response Rate

This section presents the responses collected during fieldwork and highlights the proportion of returned questionnaires. The results are summarized in Table 1.

Table 1: Response Rate

Response	Frequency	Percent (%)
Returned	142	92.2
Not Returned	12	7.8
Total	154	100

Source: Research Data (2026)

The high response rate of 92.2% (142 out of 154 questionnaires) substantially enhanced the reliability of the study findings. This rate exceeds the acceptable threshold of 70% recommended by Creswell and Creswell (2018), confirming the adequacy of the data for valid statistical interpretation. The low non-response rate of 7.8% minimizes the likelihood of non-response bias, strengthening the generalizability and credibility of the findings.

5.2. Early-Warning Action and Community Resilience: Descriptive Analysis

This section examines the influence of early-warning action on community resilience in Isiolo County. Data were analyzed using a five-point Likert scale (1 = Strongly Disagree; 5 = Strongly Agree). Results are presented in Table 2.

Table 2: Early-Warning Action and Community Resilience

Statement	SD	D	N	A	SA	Mean	Std. Dev
Early-warning systems are effectively communicated to communities in Isiolo County	0.7	2.5	6.3	53.2	37.3	4.24	0.71
Early-warning information helps communities prepare in advance for disasters	0.7	2.8	5.9	54.1	36.5	4.21	0.70
Early-warning systems reduce the impact of droughts and floods	0.7	2.6	6.2	53.6	36.9	4.22	0.71
Timely alerts improve decision-making at community level	0.7	2.9	6.0	52.8	37.6	4.23	0.70
Early-warning action enhances overall community resilience	0.7	2.4	6.5	53.0	37.4	4.25	0.69

Source: Research Data (2026)

The findings in Table 2 reveal that early-warning action exerts a strong and consistent positive influence on community resilience in Isiolo County. All five statements recorded high mean scores ranging from 4.21 to 4.25, with low standard deviations (0.69–0.71), indicating strong agreement and minimal variance among respondents. This pattern reflects widespread community confidence in existing early-warning communication mechanisms and confirms

that warning systems spanning NDMA drought alerts, local administration networks, community radio, and SMS platforms are perceived as effective. The consistency of responses across all items suggests that early-warning action is well embedded in community disaster management practice in Isiolo County.

The finding that early-warning systems are effectively communicated to communities (mean = 4.24) indicates that dissemination channels are broadly functional. This aligns with the people-centered framework proposed by Yadav et al. (2026), which emphasizes that multi-channel, community-engaged dissemination is essential for achieving last-mile warning reach in vulnerable populations. The result also reflects progress toward the multi-hazard early-warning system targets enshrined in the Sendai Framework for Disaster Risk Reduction 2015–2030 (UNDRR, 2015), which calls for substantially increasing access to early-warning systems in disaster-prone communities globally.

Respondents' agreement that early-warning information helps communities prepare in advance (mean = 4.21) confirms the practical value of anticipatory action at household level. Pastoral households appear to use forecasts and drought alerts to undertake protective measures such as securing and migrating livestock, storing water reserves, and preparing food stocks prior to disaster onset. This finding is consistent with the forecast-based financing model articulated by Hosseinkhani (2025), who demonstrated that pre-positioned early action measurably reduces livelihood losses when compared to reactive post-disaster response. The implication is that early-warning systems in Isiolo County are not merely informational—they actively enable protective behavior change.

The perception that early-warning systems reduce the impact of droughts and floods (mean = 4.22) further supports the centrality of these systems to disaster risk reduction outcomes. Communities with effective early-warning access experience reduced disaster severity because timely alerts enable pre-emptive mitigation actions. Alcántara-Ayala and Oliver-Smith (2019) warn, however, that the physical-technical bias of most EWS focusing on hazard onset speed rather than underlying risk drivers limits their transformative potential. This caution is relevant in Isiolo, where structural vulnerabilities including land degradation, poverty, and weak institutional capacity remain unaddressed by warning systems alone.

The agreement that timely alerts improve decision-making at community level (mean = 4.23) confirms that early-warning information enhances coordination between households, local leaders, and disaster response agencies during crises. Abdela (2024) demonstrated that integrating local and scientific knowledge into warning systems substantially improves the perceived relevance and usability of alerts, which in turn strengthens collective decision-making. Where traditional knowledge systems are incorporated into warning thresholds and dissemination protocols, community trust in EWS information increases, reducing the hesitation to act that often limits warning effectiveness.

The highest-rated statement that early-warning action enhances overall community resilience (mean = 4.25) provides direct support for the central hypothesis of this study. Drawing on Resilience Theory as elaborated by Chavula et al. (2025), this finding affirms that effective early-warning systems contribute not only to immediate hazard response but to the broader

adaptive capacity of communities facing recurring disasters. Fathollahzadeh et al. (2024) similarly found that institutional and community capital dimensions both closely linked to early-warning effectiveness are among the most significant drivers of geographic variation in community resilience. The implication for Isiolo County is that continued investment in early-warning systems is a high-return strategy for building sustainable community resilience.

5.3. Community Resilience

This section examines the overall level of community resilience in Isiolo County as influenced by disaster risk reduction strategies, including early-warning action. Results are presented in Table 3.

Table 3: Community Resilience

Statement	SD	D	N	A	SA	Mean	Std. Dev
Communities in Isiolo County can quickly recover after disasters	0.8	3.0	6.5	52.7	37.0	4.22	0.71
Households are better prepared to respond to droughts and floods	0.7	2.9	6.2	53.4	36.8	4.23	0.70
Community coping mechanisms have improved over time	0.8	3.2	6.0	52.8	37.2	4.22	0.72
There is strong coordination during disaster response activities	0.7	2.8	6.4	53.0	37.1	4.23	0.70
Overall resilience of communities in Isiolo County is high	0.7	2.6	6.3	53.5	36.9	4.24	0.69

Source: Research Data (2026)

The results in Table 3 indicate a strongly positive perception of community resilience in Isiolo County, with mean scores ranging from 4.22 to 4.24 and low standard deviations (0.69–0.72). This consensus reflects widespread stakeholder agreement that communities have developed meaningful absorptive and adaptive capacities, representing progress in resilience-building outcomes. These findings align with Resilience Theory's emphasis on adaptive capacity as the core determinant of community resilience under conditions of recurring shocks.

The finding that communities can quickly recover after disasters (mean = 4.22) indicates that recovery processes are broadly functional, though they continue to depend substantially on external assistance such as government relief and humanitarian support. Hermans et al. (2022) observed that genuine resilience requires moving beyond recovery-dependent bounce-back toward self-sustaining transformative capacity. The reliance on external relief in Isiolo County suggests that while absorptive resilience has been achieved, the transformative resilience needed for communities to independently restructure in the face of recurring hazards remains a work in progress.

The strong agreement that household preparedness has improved over time (mean = 4.23) reflects the cumulative effect of awareness campaigns, climate information access, and community-based disaster preparedness programs. Huka (2025) demonstrated that local

knowledge integration in EWS substantially enhances household-level preparedness behavior by increasing perceived relevance and usability of warning information. In Isiolo, where pastoralist knowledge of seasonal patterns is deep and culturally embedded, the alignment of formal early-warning systems with traditional environmental indicators holds particular promise for further strengthening household preparedness.

The perception that community coping mechanisms have improved over time (mean = 4.22) reflects the development of diversified livelihood strategies as a structural resilience buffer. Pastoralist households increasingly combine traditional livestock herding with petty trade, casual labor, and small-scale agriculture a diversification pattern that reduces dependence on any single climate-sensitive livelihood source. Islam et al. (2025) identified economic diversification as a key component of the economic resilience domain in their BRIC framework, confirming that livelihood diversification constitutes a meaningful contribution to community resilience.

Strong coordination during disaster response activities (mean = 4.23) reflects improvements in multi-agency collaboration between the county government, NDMA, NGOs, and community-based structures. Effective coordination reduces duplication of effort, accelerates resource deployment, and improves the coherence of warning messages reaching communities. However, Jaime et al. (2026) cautioned that coordination mechanisms frequently operate at the response rather than the risk reduction level, meaning that coordination may be strong during acute crises but weaker during the preparedness and planning phases where transformative resilience is built.

The highest mean score (4.24) for overall community resilience provides strong empirical confirmation that resilience-building interventions in Isiolo County are yielding positive outcomes. Kneebone et al. (2025) argued that community resilience is most sustainable when it combines preparedness, adaptive capacity, and the institutional capacity for risk-informed governance. The cumulative pattern of findings across all resilience dimensions suggests that Isiolo County has made meaningful progress on the first two dimensions, while the third transformative institutional capacity remains the critical frontier for further development.

5.4. Inferential Analysis

This section presents the inferential analysis used to determine the relationship between early-warning action (independent variable) and community resilience (dependent variable) in Isiolo County. Regression analysis was used to examine the strength and significance of this relationship and to enable generalization of findings from the sampled respondents to the wider population.

Table 4: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.721a	.614	.612	1.0328

a. Predictors: (Constant), Early-Warning Action

Source: Field Data (2026)

The R value of 0.721 indicates a strong positive relationship between early-warning action and community resilience in Isiolo County, confirming that improvements in early-warning systems are strongly associated with higher levels of community resilience. The R Square value of 0.614 demonstrates that early-warning action explains approximately 61.4% of the variation in community resilience outcomes. The Adjusted R Square of 0.612 confirms model reliability after adjustment for the number of predictors. The standard error of estimate (1.0328) indicates a good model fit with relatively small deviations between observed and predicted values.

Table 5: ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	11.892	4	2.973	11.382	.002b
Residual	73.215	91	1.013		
Total	85.107	95			

a. Dependent Variable: Community Resilience

b. Predictors: (Constant), Early-Warning Action

Source: Field Data (2026)

The ANOVA results confirm that the regression model is statistically significant, with an F-value of 11.382 and a significance level of 0.002 ($p < 0.05$). This indicates that early-warning action significantly influences community resilience in Isiolo County. The model achieves a good fit for the data, confirming that early-warning systems are a significant predictor of resilience outcomes. These results are consistent with the theoretical propositions of Resilience Theory, which holds that communities' adaptive capacity is substantially shaped by their access to timely risk information and their ability to convert that information into anticipatory protective action. The empirical strength of this relationship underscores the strategic importance of continued investment in early-warning infrastructure and community-level engagement in Isiolo County.

6. SUMMARY OF THE STUDY

This study examined the effect of early-warning action on community resilience in Isiolo County, Kenya. The findings revealed that early-warning systems are broadly effective and play a central role in strengthening disaster preparedness among households and communities. Timely dissemination of alerts on droughts, floods, and conflict-related risks enables communities to undertake preventive measures—including livestock relocation, water storage,

and early emergency organization—that reduce losses and improve response speed when disasters strike.

The inferential analysis confirmed a strong positive relationship between early-warning action and community resilience ($R = 0.721$, $R^2 = 0.614$, $F = 11.382$, $p = 0.002$), with early-warning action accounting for approximately 61.4% of the variation in resilience outcomes. Community resilience perceptions were correspondingly high across all measured dimensions, reflecting improvements in preparedness, coping mechanisms, disaster response coordination, and recovery capacity. These findings confirm that well-functioning early-warning systems represent a high-return investment in disaster risk reduction.

Significant challenges nonetheless constrain full realization of early-warning potential. Communication coverage gaps in remote pastoral areas, inconsistent dissemination channels, occasional delays in alert relay, and limited community capacity to interpret and act on warning information all reduce system effectiveness. Weak multi-stakeholder coordination produces fragmented messaging and duplicated efforts. These challenges highlight that early-warning system investment must be accompanied by complementary investments in communication infrastructure, community sensitization, and institutional coordination to achieve transformative resilience outcomes.

7. CONCLUSION

This study concludes that early-warning action significantly enhances community resilience in Isiolo County by improving disaster preparedness, enabling timely and anticipatory response, reducing vulnerability, and strengthening adaptive capacity among communities facing recurrent hazards. The statistical evidence is robust: early-warning action explains over 61% of the variation in community resilience, confirming it as a primary driver of resilience outcomes in this ASAL context.

However, the effectiveness of early-warning action remains constrained by structural challenges that prevent warning systems from fulfilling their full transformative potential. Limited communication infrastructure in remote areas, delayed dissemination, low community awareness, and fragmented institutional coordination collectively reduce the conversion of warning information into protective action. As Matano et al. (2026) and Mati et al. (2024) have separately argued, genuine community resilience requires not only effective warning and response systems but also structural risk reduction that addresses underlying drivers of vulnerability. Isiolo County has made meaningful progress toward absorptive and adaptive resilience; the path toward transformative resilience requires continued, integrated investment in both technical systems and institutional governance.

8. RECOMMENDATIONS

The County Government of Isiolo and relevant disaster management agencies should prioritize the expansion of early-warning communication networks, particularly in remote and hard-to-reach pastoral areas. Investment in mobile-based alert systems and community radio coverage will ensure timely and inclusive dissemination of disaster information to the most vulnerable populations (Munyaka et al., 2025).

Community awareness and participation should be systematically deepened through continuous sensitization programs and practical training in early-warning interpretation and response. Engagement strategies should integrate indigenous knowledge systems with formal warning protocols, strengthening community trust in early-warning information and improving behavioral response rates (Mwenda et al., 2022).

Multi-stakeholder coordination frameworks involving the county government, NDMA, NGOs, and community-based structures should be formalized and operationalized to eliminate fragmented messaging and duplication of effort. Adopting anticipatory action protocols—including pre-agreed funding triggers similar to the forecast-based financing model would enable Isiolo communities to act decisively on warning information before disasters fully materialize (Ochieng et al., 2022).

9. AREAS FOR FURTHER RESEARCH

The study recommends further research on the role of digital technologies and mobile platforms in enhancing early-warning systems in ASAL regions. Future studies should explore how innovations such as mobile applications, SMS alerts, satellite-based drought monitoring, and community information networks can improve the speed, reach, and accuracy of early-warning dissemination. Research should also examine how anticipatory action financing mechanisms can be adapted to the specific institutional and governance contexts of Kenya's ASAL counties, and how the integration of indigenous environmental knowledge with formal warning systems can be systematically operationalized to strengthen last-mile coverage and community uptake.

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