Climate Variability, Gendered Indigenous Ecological Knowledge, and Health Inequalities in Western Kenya

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ABSTRACT

Climate variability is increasingly reshaping socio-ecological systems, livelihoods, and public health outcomes across Sub-Saharan Africa. In Western Kenya, shifts in rainfall patterns, prolonged droughts, and ecological degradation are closely associated with rising health inequalities, including malnutrition, waterborne diseases, and other climate-sensitive illnesses. While Indigenous Ecological Knowledge (IEK) is widely recognized as a key resource for climate adaptation, its gendered dynamics and implications for public health remain insufficiently integrated within climate-health policy frameworks. This study examines how gendered power relations influence the production, transmission, and application of IEK, and how these dynamics shape environmental processes and health outcomes. The analysis is based on a systematic qualitative synthesis of 45 peer-reviewed studies, policy documents, and regional case analyses published between 2015 and 2025, identified through structured database searches and analyzed using thematic content synthesis. The findings show that women play a central role in soil management, water conservation, and crop diversification practices that enhance environmental resilience, food security, and disease prevention. However, structural constraints, including unequal land tenure systems, limited access to resources, and exclusion from decision-making processes, restrict the translation of this knowledge into equitable health outcomes. The study further demonstrates that climate variability affects health primarily through environmentally mediated pathways and that IEK functions as a gendered adaptive system within these processes. The study concludes that integrating IEK into climate–health governance while addressing gender inequalities is essential for strengthening resilience and reducing health disparities.

Keywords: Climate variability; Indigenous Ecological Knowledge; Gendered adaptation; Health inequalities; Socio-ecological systems; Western Kenya

INTRODUCTION

Climate variability is increasingly reshaping socio-ecological systems across Sub-Saharan Africa, with far-reaching consequences for livelihoods, environmental sustainability, and public health. Over the past decades, shifts in rainfall regimes, prolonged drought episodes, rising temperatures, and the intensification of extreme weather events have disrupted agricultural systems and undermined ecosystem stability (Gebrechorkos et al., 2020; Mbow et al., 2019; IPCC, 2022). In predominantly agrarian regions such as Western Kenya, where livelihoods are closely tied to rain-fed agriculture and natural resource systems, these climatic disruptions directly affect food security, water access, and disease exposure.

The impacts of climate variability on human health are neither direct nor uniform, but are mediated through environmental and socio-economic pathways. Climatic stressors alter ecological conditions such as soil fertility, water quality, and vector habitats, which in turn shape patterns of disease and nutritional outcomes. For example, erratic rainfall can result in flooding and contamination of water sources, increasing exposure to waterborne diseases such as cholera and diarrhea (Levy et al., 2016). Conversely, prolonged drought reduces agricultural yields, constrains food availability, and contributes to malnutrition and related health complications (Romanello et al., 2023). These processes highlight that climate variability operates through environmental systems to produce differentiated and unequal health outcomes.

Within this nexus, Indigenous Ecological Knowledge (IEK) emerges as a vital resource for climate adaptation. IEK encompasses locally developed systems of knowledge, practice, and belief that guide interactions between communities and their environments. These knowledge systems are adaptive and context-specific, informing practices such as agroforestry, terracing, crop diversification, seed selection, and water conservation, which enhance ecological stability and buffer communities against climatic shocks (Leal Filho et al., 2022; Mugi-Ngenga et al., 2021; Zougmoré et al., 2023). By sustaining soil fertility, improving water retention, and stabilizing food systems, these practices contribute to environmental resilience and improved public health outcomes.

Despite growing recognition of IEK within climate adaptation discourse, its internal dynamics remain insufficiently examined. Existing literature often treats IEK as a homogeneous and gender-neutral resource, overlooking the social relations that shape its production and application. In reality, access to and control over IEK are embedded in gendered divisions of labor, cultural norms, and institutional arrangements. Women and men possess distinct forms of ecological knowledge reflecting their roles in agricultural production, natural resource management, and household care (Agarwal, 2018; Jost et al., 2020).

In many rural contexts, women are central to soil management, water collection, food processing, and small-scale farming. These roles position them as key actors in practices that directly influence environmental conditions and health outcomes. For instance, decisions about crop diversity affect household dietary diversity and nutritional outcomes, while water management practices influence exposure to waterborne diseases. However, women face structural constraints that limit their ability to apply their knowledge effectively, including restricted land ownership, limited access to financial resources, and exclusion from decision-making processes. As a result, those most actively engaged in sustaining ecological and health systems are often the least empowered to benefit from them.

This paradox is particularly evident in Western Kenya, where socio-ecological vulnerability is intensified by high population densities, land fragmentation, and environmental degradation. In regions such as Kisii, Nyamira, and Mount Elgon, smallholder farming systems are under increasing pressure from declining soil fertility, reduced land availability, and climate-induced hazards such as landslides and flooding (Ngetich et al., 2019; Mugagga et al., 2012). These stressors interact with socio-economic inequalities to produce uneven patterns of risk and resilience. Consequently, climate variability amplifies existing social inequalities, particularly along gender lines.

Despite growing research on climate adaptation, gender, and Indigenous knowledge systems, important gaps remain. Existing studies often examine these domains separately, with limited integration of environmental, social, and health dimensions. While some research explores the role of IEK in agricultural resilience, fewer studies link these practices directly to public health outcomes. Similarly, although gender is recognized in climate vulnerability, there is limited attention to how gendered knowledge systems mediate environmental processes that shape health risks. This fragmentation limits the development of holistic and effective policy responses.

This study addresses these gaps by advancing an integrated approach linking climate variability, gendered IEK, environmental processes, and public health outcomes. It examines how gender shapes the production and application of IEK, how these knowledge systems influence ecological conditions, and how these conditions translate into health outcomes in Western Kenya.

The study is guided by three research questions: How is Indigenous Ecological Knowledge distributed along gender lines in rural communities of Western Kenya? How do these gendered knowledge systems influence environmental processes such as soil fertility, water quality, and agricultural productivity? How do these environmental processes translate into differentiated public health outcomes?

By addressing these questions, the study contributes to a more context-sensitive understanding of climate adaptation. It also provides practical insights for policymakers, development practitioners, and public health professionals by emphasizing the importance of integrating local knowledge systems, addressing structural inequalities, and linking environmental management to health outcomes.

In sum, addressing climate-induced health inequalities requires more than technical interventions. It requires attention to how knowledge, power, and resources are distributed within socio-ecological systems. Recognizing and supporting gendered Indigenous Ecological Knowledge is therefore a strategic pathway toward achieving climate resilience and health equity.

Theoretical and Conceptual Framework

This study is anchored in a multi-theoretical, integrative framework that synthesizes Socio-Ecological Systems (SES) Theory, Resilience Theory, and Feminist Political Ecology (FPE), while incorporating insights from Planetary Health, One Health approaches, and Intersectionality Theory. These perspectives provide an analytical lens for explaining how climate variability, gendered Indigenous Ecological Knowledge (IEK), and environmental systems interact to produce differentiated health outcomes in Western Kenya (Ostrom, 2009; Folke et al., 2016; Agarwal, 2018; Rocheleau et al., 1996).

Within this framework, Socio-Ecological Systems (SES) theory conceptualizes human and ecological systems as interdependent and co-evolving, with climate variability acting as a stressor that propagates through ecological subsystems including soil, water, biodiversity, and agroecosystems, ultimately shaping food security, disease exposure, and nutritional health outcomes. Indigenous Ecological Knowledge (IEK) is therefore understood as a living adaptive system embedded within socio-ecological feedback processes that influence system stability, resilience, and recovery capacity (Ostrom, 2009).

Resilience Theory strengthens this analysis by explaining how communities absorb, adapt to, and respond to climate shocks (Folke et al., 2016). This study extends resilience thinking by emphasizing that adaptive capacity is shaped by unequal access to land, knowledge, credit, and institutional support. IEK enhances resilience through practices such as crop diversification, agroforestry, soil regeneration, and water harvesting, but its effectiveness is constrained by gendered power relations and institutional exclusion, resulting in uneven adaptive capacity across social groups.

Feminist Political Ecology (FPE) provides a critical lens for examining these power asymmetries by highlighting how gendered divisions of labor, resource access, and decision-making shape environmental practices and health outcomes (Agarwal, 2018; Rocheleau et al., 1996). Within this perspective, IEK is understood as a gendered knowledge system rather than a homogeneous cultural resource. Women's ecological knowledge in soil management, food production, and water governance is central to climate adaptation and public health protection. However, women experience structural constraints including limited land ownership, restricted access to financial resources, and exclusion from governance processes, resulting in unequal adaptive capacity.

To strengthen the health dimension, this framework incorporates Planetary Health and One Health perspectives, which conceptualize human health as inseparable from ecosystem integrity. Climate variability is therefore understood as a systemic health risk mediated through ecological disruption. Water contamination, soil degradation, and biodiversity loss function as upstream determinants of disease emergence and nutritional decline, while IEK operates as a preventive public health mechanism that reduces risks associated with cholera, diarrhea, and malnutrition. Further analytical depth is provided through Intersectionality Theory. Intersectionality explains how gender interacts with land ownership, class, geography, and institutional exclusion to produce differentiated vulnerability and adaptive capacity.

The integrated conceptual framework therefore links climate variability, gendered IEK, environmental change, institutional structures, and health outcomes in a multi-layered system. Climate variability acts as the primary stressor influencing environmental systems such as soil fertility, water availability, and ecosystem stability, which in turn shape health outcomes including malnutrition, waterborne diseases, and climate-sensitive illnesses. IEK functions as an adaptive mediation mechanism within this system, while its effectiveness is moderated by gendered and institutional structures such as land tenure, policy recognition, and resource access. Feedback processes are also recognized, where environmental degradation weakens IEK transmission, while effective IEK practices strengthen ecological stability and long-term health resilience.

Building on this synthesis, the study advances three analytical propositions: (i) climate variability influences health outcomes primarily through environmentally mediated pathways rather than direct causation; (ii) IEK functions as a gendered adaptive system that enhances environmental and health resilience; and (iii) the effectiveness of IEK is shaped by intersecting structures of gender, power, and institutional recognition. This framework shifts analysis from a linear climate–health model to a dynamic socio-ecological and political system model, demonstrating that climate-induced health inequalities are produced through both ecological processes and gendered power relations (Agarwal, 2018; Rocheleau et al., 1996; Folke et al., 2016; Ostrom, 2009).

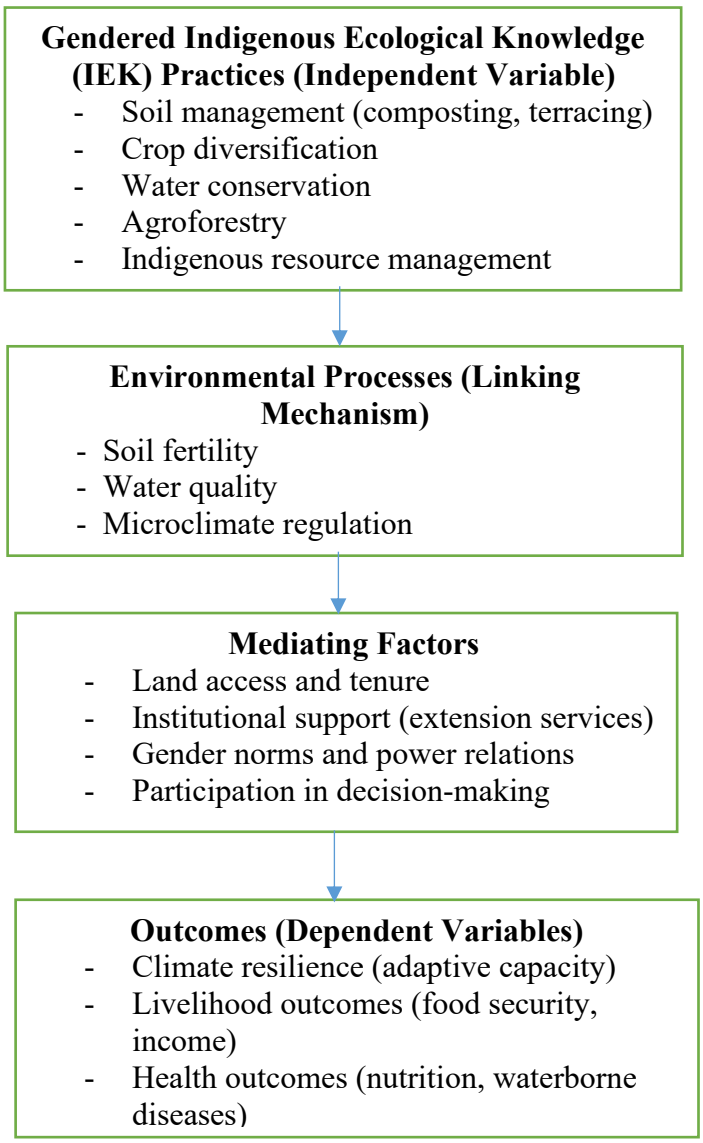

Figure 1: Conceptual framework illustrating pathways linking climate variability, gendered Indigenous Ecological Knowledge (IEK), environmental processes, socio-institutional factors, and health outcomes in Western Kenya

Source: Author's Conceptualization (2026)

METHODOLOGY

This study adopts a systematic qualitative synthesis design to examine the interconnections between climate variability, gendered Indigenous Ecological Knowledge (IEK), environmental processes, and public health outcomes. This approach is appropriate for analyzing complex socio-ecological systems where relationships are indirect, context-dependent, and mediated through environmental and institutional pathways. The synthesis integrates evidence from peer-reviewed literature, policy documents, and regional case studies to develop an analytical framework linking climate, environment, and health systems. A structured search and screening process was applied to ensure transparency and reproducibility, while qualitative appraisal criteria were used to

assess methodological rigor. The analytical process employed thematic synthesis to identify patterns and relationships across contexts.

A PRISMA-guided protocol (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) was applied to enhance transparency and analytical rigor in the identification, screening, and selection of studies, thereby reducing selection bias and strengthening methodological credibility (Page et al., 2021).

Search Strategy and Data Sources

A systematic literature search was conducted across Scopus, Web of Science, and Google Scholar to ensure broad disciplinary coverage across environmental science, climate studies, public health, and development research. A Boolean search string was used to capture the intersection of key variables: "Indigenous Ecological Knowledge" OR "Indigenous knowledge" and "gender" OR "women" and "climate variability" OR "climate change" and "health" OR "health inequalities" and "Western Kenya" OR "East Africa". The search string was refined during preliminary scoping to balance sensitivity and specificity, while the inclusion of regional identifiers ensured geographic relevance without restricting the dataset.

To ensure relevance, the search was limited to studies published between 2015 and 2025, capturing recent developments in climate-health discourse, including global frameworks such as the IPCC assessments and the Lancet Countdown (IPCC, 2022; Romanello et al., 2023). Only English-language studies were included to maintain consistency in analysis.

Inclusion and Exclusion Criteria

Studies were included if they addressed at least two of the four core variables, namely IEK, gender, climate variability, and health; provided empirical evidence, policy analysis, or case-based insights; and focused on Sub-Saharan Africa, particularly East Africa.

To strengthen methodological rigor, selected studies were appraised using the Critical Appraisal Skills Programme (CASP) qualitative checklist, which evaluates research design, data collection, analytical rigor, and validity of conclusions. Only studies meeting acceptable quality thresholds were retained.

Screening and Selection Process

The initial search yielded 120 records. After removing duplicates, 100 records remained. A two-stage screening process was applied. First, titles and abstracts were reviewed, reducing the dataset to 80 studies for full-text assessment. Second, full-text screening using the inclusion criteria resulted in 45 studies for final synthesis. This process enhances internal validity and aligns with systematic review best practices (Page et al., 2021).

Data Extraction and Analytical Framework

Data extraction was guided by an analytical matrix capturing three domains: gendered IEK practices such as soil management, water conservation, and crop diversification; environmental outcomes such as soil fertility, water quality, and ecosystem stability; and public health impacts including malnutrition, waterborne diseases, and climate-sensitive illnesses. This structure enabled systematic comparison and identification of cross-cutting patterns.

The analysis employed thematic content analysis following Braun and Clarke (2006). The process involved initial coding, development of thematic categories, and iterative refinement through comparison. A two-stage coding process was used, where descriptive codes were first assigned and then grouped into higher-order themes representing broader socio-ecological processes.

Reliability and Verifiability

Reliability and verifiability were ensured through the use of a standardized coding framework and documentation of coding decisions and thematic development. Although interpretive, analytical rigor was

strengthened through clear procedures and decision rules. Frequency-based content analysis was used to indicate thematic prevalence rather than statistical significance. Triangulation enhanced robustness through the integration of peer-reviewed studies, policy documents, and case studies. Bias was minimized through the inclusion of gray literature, cross-validation across sources, and careful geographic filtering, reinforcing internal validity and credibility.

Limitations of the Study

This study is based on a systematic qualitative synthesis of published literature, policy documents, and regional case studies. Consequently, its findings are dependent on the quality, scope, and geographical distribution of existing evidence. Although the review provides valuable insights into climate variability, gendered Indigenous Ecological Knowledge, and health inequalities, some local variations and emerging experiences may not have been fully captured. The findings should therefore be interpreted within the context of the reviewed literature.

RESULTS

Overview of Synthesized Evidence

This study synthesizes evidence from 45 peer-reviewed articles, policy documents, and regional case studies to examine how gendered Indigenous Ecological Knowledge (IEK) shapes responses to climate variability and related health inequalities in Western Kenya. Four main themes emerge: gendered ecological practices, environmental outcomes under climate stress, livelihood and health outcomes, and institutional constraints influencing exposure to health risks.

The findings show that climate adaptation is shaped by social relationships, particularly gender roles and access to resources. IEK reflects local realities and is influenced by labor divisions, resource control, and participation in decision-making (Zougmoré et al., 2023; Eriksen et al., 2021). Women play a central role in soil management, crop diversification, and water regulation, activities that directly affect household nutrition and health (Mango et al., 2017; Ngetich et al., 2019). Environmental practices also function as practical public health measures by reducing disease risks and improving nutrition, highlighting the need to link environmental and health perspectives (Romanello et al., 2023; IPCC, 2022).

Summary and Regional Distribution of Reviewed Studies

The reviewed studies include peer-reviewed research, policy documents, and regional case studies, providing both academic depth and policy relevance as presented in table 4.1 below.

Table 1: Summary of Reviewed Studies (n = 45)

Category	**Number of Studies (n)**	**Percentage (%)**
Peer-reviewed journal articles	32	71.1
Policy documents	7	15.6
Regional case studies	6	13.3
Total	**45**	**100.0**

Source: Author's synthesis (2026).

Note: Frequencies represent occurrence across reviewed studies, not statistical sampling.

This diversity strengthens the analysis by combining empirical evidence with real-world insights. Most studies focus on Western Kenya, ensuring contextual relevance, while evidence from Sub-Saharan Africa situates

findings within broader regional patterns related to water access, sanitation, and disease exposure (WHO, 2021; IPCC, 2022).

Climate Variability and Environmental Impacts

The findings show that Western Kenya is experiencing multiple, overlapping climate challenges, including erratic rainfall, prolonged droughts, rising temperatures, and unpredictable seasons. Table 4.2 below presents the major climate variability patterns and their environmental effects.

Table 2: Major Climate Variability Patterns and Environmental Effects

Climate Variable	Frequency (%)	Key Environmental Effects
Erratic rainfall	78	Flooding, water contamination, soil erosion
Prolonged drought	65	Water scarcity, reduced crop yields
Temperature increase	59	Heat stress, increased evapotranspiration
Seasonal unpredictability	54	Disrupted planting cycles

Source: Author's synthesis (2026).

Note: Frequencies represent occurrence across reviewed studies, not statistical sampling.

These changes interact and reinforce one another, increasing pressure on environmental and livelihood systems. For example, erratic rainfall leads to flooding and water contamination, increasing diseases such as cholera and diarrhea (Levy et al., 2016; WHO, 2021). Drought reduces water access and increases reliance on unsafe sources, raising infection risks (Bain et al., 2014; Romanello et al., 2023). These findings confirm that climate variability affects health indirectly through environmental systems such as water quality and food production (IPCC, 2022; Romanello et al., 2023).

Gendered Indigenous Ecological Practices under Climate Variability

The study reveals clear gender differences in how IEK is practiced. Women are mainly involved in soil conservation, crop diversification, and water management, while agroforestry is often shared and climate forecasting tends to be male-dominated. Table 4.3 below presents the gendered distribution of IEK practices.

Table 3: Gendered Distribution of Indigenous Ecological Knowledge Practices (n = 45)

Practice	Frequency (n)	Percentage (%)	Dominant Gender Role
Agroforestry	38	84.4	Shared
Soil conservation	35	77.8	Female-dominated
Crop diversification	33	73.3	Female-dominated
Water management	29	64.4	Female-dominated
Climate forecasting	27	60.0	Male-dominated

Source: Author's synthesis (2026).

Note: Frequencies represent occurrence across reviewed studies, not statistical sampling.

These roles reflect household responsibilities where women manage food production, water, and family care. Practices such as composting, mulching, intercropping, and water management maintain productivity under climate stress while reducing risks of food insecurity and unsafe water. Women's ecological knowledge therefore supports both environmental stability and public health (Agarwal, 2018; Nyantakyi-Frimpong & Bezner Kerr, 2015). However, women's contributions remain under-recognized in formal systems, creating a gap between local practice and institutional support.

Environmental Outcomes under Climate Stress

The findings show that IEK practices play a major role in protecting the environment under climate stress. Activities such as improving soil fertility, reducing soil erosion, and increasing water retention help stabilize local ecosystems. Table 4.4 below summarizes environmental outcomes associated with IEK practices.

Table 4: Environmental Outcomes Associated with Indigenous Ecological Knowledge Practices

Outcome	**Frequency (%)**	**Gender Contribution**
Improved soil fertility	86.7	Female-driven
Reduced soil erosion	80.0	Female-led
Enhanced water retention	75.6	Female-dominated
Biodiversity conservation	68.9	Shared
Microclimate regulation	62.2	Shared

Source: Author's synthesis (2026).

Note: Frequencies represent occurrence across reviewed studies, not statistical sampling.

These outcomes improve soil fertility, reduce erosion, enhance water retention, and support ecosystem stability. Improved soil fertility increases crop yields, while better water retention supports production during dry periods. These environmental improvements are closely linked to public health by reducing risks of malnutrition and disease (Altieri & Nicholls, 2017; Zougmoré et al., 2023; IPCC, 2022).

Climate-Health Linkages

The study clearly shows that the effects of climate variability on health are indirect and mediated through environmental changes. Table 4.5 illustrates the relationship between climate variability, environmental change, and health outcomes.

Table 5: Climate Variability, Environmental Change, and Health Outcomes

Climate Stressor	**Environmental Change**	**Health Outcome**
Erratic rainfall	Water contamination	Diarrhea, cholera
Drought	Water scarcity	Poor hygiene, infections
Temperature rise	Heat stress	Respiratory illness
Food insecurity	Reduced yields	Malnutrition

Source: Author's synthesis (2026).

Flooding leads to water contamination and disease outbreaks, while drought reduces water availability and hygiene, increasing infections (Levy et al., 2016; Romanello et al., 2023). Reduced agricultural yields contribute to food shortages and malnutrition. These findings demonstrate that environmental conditions form the key link between climate variability and health outcomes, requiring integrated environmental and health responses.

Livelihood Outcomes and Health Inequalities

The findings indicate that IEK contributes significantly to improved food security, enhanced adaptive capacity, and reduced vulnerability, all of which are associated with better health outcomes (Place et al., 2018; Mango et al., 2017). Table 4.6 below presents livelihood outcomes associated with IEK practices.

Table 6: Livelihood Outcomes of Indigenous Ecological Knowledge Practices

Outcome	**Frequency (%)**	**Gender Implication**
Improved food security	82.2	Female-driven
Enhanced adaptive capacity	80.0	Women central
Reduced vulnerability	75.6	Female-led
Income diversification	71.1	Male-controlled

Source: Author's synthesis (2026).

However, benefits are unevenly distributed. Women contribute significantly to food production and environmental management, while men often control income and financial resources. This imbalance limits women's ability to access healthcare and improve nutrition, reinforcing gender inequalities in health outcomes.

Mediating Factors and Constraints

The effectiveness of IEK is constrained by several structural challenges, including land fragmentation, limited land ownership, particularly among women, erosion of traditional knowledge, and weak policy support. Table 4.7 outlines key constraints affecting IEK systems.

Table 7: Gendered Constraints Affecting Indigenous Ecological Knowledge Systems

Constraint	**Frequency (%)**	**Impact**
Land fragmentation	84.4	Limits IEK application
Limited land ownership	77.8	Affects women disproportionately
Knowledge erosion	73.3	Reduces adaptive capacity
Policy marginalization	68.9	Limits integration into formal systems

Source: Author's synthesis (2026).

Land fragmentation limits the application of ecological practices, while women are disproportionately affected by limited land access (FAO, 2021; IPCC, 2022). At the same time, erosion of traditional knowledge reduces long-term adaptive capacity, and weak policy recognition limits integration into formal systems.

Synthesis of Key Findings

Overall, the findings show that gendered IEK plays a central role in shaping climate resilience and public health outcomes in Western Kenya. Practices such as soil conservation, crop diversification, agroforestry, and water management stabilize environmental systems and reduce health risks.

A key insight is that IEK acts as a bridge between environmental management and public health. Women are the primary drivers of these practices, yet they face structural barriers that limit their ability to benefit from them. This creates a paradox in which those who contribute most to resilience are often the least empowered to benefit. Addressing this challenge requires policy support, equitable access to resources, and inclusive decision-making systems to strengthen both climate resilience and health equity.

DISCUSSION

This study positions Indigenous Ecological Knowledge (IEK) as a living system that shapes how communities in Western Kenya respond to climate variability and related health impacts. IEK operates within social structures where gender, land access, and decision-making power influence who benefits and who is left behind. Across Kisii, Nyamira, and the Mount Elgon region, the findings show that climate adaptation is shaped not only by environmental conditions but also by power, recognition, and inequality (IPCC, 2022; Leal Filho et al., 2022; Zougmoré et al., 2023). These findings support the analytical framework by demonstrating that climate variability operates through environmentally mediated pathways, while gendered IEK functions as a gender-responsive adaptive system influencing resilience and health outcomes.

IEK is not a fixed set of traditions but a dynamic system shaped by interactions between people, ecosystems, and institutions. Its effectiveness depends on control over resources such as land and water, recognition of knowledge, and participation in decision-making. As a result, climate resilience and health outcomes are uneven and reflect existing social inequalities.

The study establishes a clear connection between climate variability, environmental change, and public health outcomes. Environmental systems such as water sources, soil quality, and local microclimates act as the main pathways through which climate affects health (Romanello et al., 2023; WHO, 2023).

Rainfall variability leads to flooding, water contamination, and increased diseases such as cholera and diarrhea (Bain et al., 2014; Levy et al., 2016). Local knowledge practices such as water protection, agroforestry, and soil conservation help reduce these risks by improving environmental conditions (Watts et al., 2021; Haines & Ebi, 2019).

A similar pattern is observed in food systems. Practices such as agroforestry and soil conservation improve agricultural productivity and support better nutrition (Altieri & Nicholls, 2017). Improved soil fertility and crop diversity contribute to more stable diets and reduced malnutrition (Myers & Frumkin, 2020; IPCC, 2022).

The study highlights a strong gender dimension within IEK systems. Women are primarily responsible for soil management, water use, and crop diversification, directly influencing food availability, water safety, and household care (Agarwal, 2018; Nyantakyi-Frimpong & Bezner Kerr, 2015). Despite this central role, women face constraints including limited land access, lack of control over income, and exclusion from decision-making. This creates an imbalance where women carry responsibility for adaptation but receive fewer benefits. These findings align with broader research showing that gender inequality increases vulnerability to climate-related health risks (Sorensen et al., 2018; Tschakert & Machado, 2012).

Local examples further illustrate these dynamics. In Kisii and Nyamira, farmers rely on composting, mulching, and intercropping to maintain productivity under land pressure. In Mount Elgon, terracing and vegetation management reduce soil erosion and landslide risks (Mango et al., 2017; Ngetich et al., 2019; Kansiime et al., 2014; Mugagga et al., 2012).

From a socio-ecological perspective, environmental and social systems are closely interconnected. Improvements in soil quality, water retention, and microclimate regulation reduce exposure to hazards and improve health outcomes (IPCC, 2022; Zougmoré et al., 2023).

At the household level, IEK improves food security and adaptive capacity, but benefits are unevenly distributed. While women's work supports resilience and nutrition, men often control income (Agarwal, 2018; Place et al.,

2018). This limits women's ability to access healthcare and respond to health needs, reinforcing health inequalities.

Structural challenges further constrain IEK effectiveness. Land fragmentation, insecure land ownership, and weak extension services limit the adoption of sustainable practices (FAO, 2021; IPCC, 2022). In densely populated areas, small land sizes reduce long-term investment in soil and water conservation, while land insecurity discourages environmental protection. These constraints increase vulnerability to climate risks (Eriksen et al., 2021; Romanello et al., 2023).

Another concern is the gradual erosion of Indigenous knowledge due to urbanization, education systems, and changing livelihoods (Zougmoré et al., 2023). This threatens long-term adaptive capacity.

From a feminist political ecology perspective, climate adaptation is shaped by whose knowledge is recognized, whose labor is valued, and who has access to resources (Agarwal, 2018; Robbins, 2012). The marginalization of IEK in formal systems reflects broader patterns where scientific knowledge is prioritized over local experience, limiting the effectiveness of interventions.

Overall, climate-related health outcomes such as malnutrition, waterborne diseases, and heat stress are shaped by environmental change and reinforced by social inequality (IPCC, 2022; WHO, 2023; Romanello et al., 2023). Addressing these challenges requires not only technical solutions but also equitable access to resources, recognition of local knowledge, and inclusive decision-making. Strengthening climate-health resilience therefore depends on integrating Indigenous knowledge with scientific approaches while addressing social and gender inequalities that shape adaptive capacity.

Policy Implications for Climate and Public Health

The findings point to a clear need for integrated policy reforms that treat climate change, public health, and Indigenous Ecological Knowledge (IEK) as interconnected rather than separate domains. In Western Kenya, climate variability is both an environmental challenge and a driver of health inequalities through its effects on water, food systems, and ecosystem stability (IPCC, 2022; WHO, 2023; Romanello et al., 2023). Policy responses must therefore move beyond fragmented sectoral approaches toward coordinated climate–health governance systems.

A central implication is that Indigenous Ecological Knowledge should be formally recognized as a strategic component of national climate and public health policy. IEK functions as a practical system of environmental management that supports disease prevention and health promotion. Practices such as soil conservation, agroforestry, crop diversification, and water protection reduce exposure to climate-sensitive diseases by stabilizing ecosystems and improving food and water quality (Altieri & Nicholls, 2017; Zougmoré et al., 2023). Policy frameworks should institutionalize IEK within climate adaptation plans, agricultural extension services, and primary healthcare strategies.

Environmental interventions should also be reframed as preventive public health tools. Investments in water management, soil restoration, and ecosystem protection should be treated as frontline health interventions that reduce disease burdens. Improving water quality reduces cholera and diarrheal disease outbreaks, while diversified cropping systems reduce malnutrition and related health risks (Levy et al., 2016; WHO, 2021).

A second major implication concerns gender-responsive climate and health governance. Women are central to the application and transmission of IEK, particularly in soil management, water use, and food production (Agarwal, 2018; Nyantakyi-Frimpong & Bezner Kerr, 2015). However, their contributions are constrained by unequal access to land, financial resources, and decision-making structures. Policy reforms must therefore prioritize gender equity through strengthened land rights, improved access to agricultural inputs, and inclusion in governance processes. These measures enhance household nutrition, water safety, and caregiving capacity.

The study also highlights the need for locally grounded climate–health interventions. IEK practices are highly place-specific and tailored to local ecological conditions in regions such as Kisii, Nyamira, and Mount Elgon,

yet they remain underutilized in formal systems (Mango et al., 2017; Ngetich et al., 2019). Integrating IEK into extension services, local planning, and health outreach programs would improve the relevance and sustainability of adaptation strategies.

Structural barriers must also be addressed. Land fragmentation, insecure land tenure, and weak institutional support systems undermine long-term ecological management (FAO, 2021; IPCC, 2022). Policy interventions should therefore include land governance reforms that secure tenure rights, particularly for smallholder farmers and women. Without addressing these constraints, adaptation efforts will remain uneven.

Another key implication is the need to support intergenerational knowledge preservation. The erosion of IEK due to urbanization and changing livelihoods threatens long-term adaptive capacity. Educational programs, community knowledge systems, and participatory documentation can support knowledge transmission and strengthen resilience.

Finally, the findings call for integrated climate-health governance frameworks. Current policy systems treat climate change and public health as separate sectors, resulting in fragmented interventions. Effective responses require coordination between environmental agencies, health ministries, and local governance structures to improve efficiency and address climate-induced health risks comprehensively.

In conclusion, climate resilience and health equity in Western Kenya require structural transformation that recognizes IEK as a core development resource, strengthens gender equity, and integrates environmental management into public health planning. Aligning climate, health, and knowledge systems within a unified framework can reduce health inequalities and strengthen long-term resilience.

CONCLUSION

This study examined how climate variability, gendered Indigenous Ecological Knowledge (IEK), and environmental processes interact to shape health inequalities in Western Kenya. Drawing on a systematic qualitative synthesis of 45 studies, the analysis shows that climate variability is a socially mediated process that produces uneven health outcomes through its effects on ecosystems and livelihoods. Erratic rainfall, prolonged droughts, rising temperatures, and seasonal unpredictability were identified as key drivers of environmental disruption, leading to soil degradation, water contamination, reduced agricultural productivity, and increased exposure to climate-sensitive diseases such as cholera, diarrhea, and malnutrition.

A central finding is that IEK plays a critical mediating role in buffering these impacts. Practices such as soil conservation, crop diversification, agroforestry, and water management enhance environmental stability by improving soil fertility, increasing water retention, reducing erosion, and sustaining biodiversity. These ecological benefits translate into improved food security and reduced disease risk, confirming that environmental management functions as a form of preventive public health intervention. However, the effectiveness of IEK is uneven and shaped by gendered social relations.

Women emerge as the primary custodians of IEK, particularly in soil management, food production, and water use. Their knowledge is central to household nutrition, water safety, and disease prevention. Despite this role, women face structural constraints including limited land ownership, restricted access to financial resources, and exclusion from decision-making. This creates a paradox in which those who contribute most to resilience are least able to benefit from it.

The findings also show that climate-induced health inequalities are reinforced by institutional, socio-economic, and gendered power structures. Land fragmentation, erosion of traditional knowledge, and weak policy integration of IEK reduce adaptive capacity and limit the scalability of effective practices. These constraints highlight the need to understand climate adaptation as both an ecological and social process shaped by power relations.

Overall, addressing climate-related health inequalities requires an integrated approach linking environmental management, public health, and gender equity. Strengthening gendered IEK systems is essential for building resilient socio-ecological systems, but this must be supported by reforms that ensure equitable access to resources and inclusive governance. Without addressing these inequalities, adaptation efforts will remain incomplete and continue to reproduce health disparities. Integrating IEK into policy frameworks while addressing structural inequalities can support more effective and equitable strategies for managing climate-related health risks and strengthening long-term resilience.

POLICY AND PRACTICE RECOMMENDATIONS

Integrate IEK into Climate-Health-Agriculture Policy Architecture

National and county governments should formally institutionalize Indigenous Ecological Knowledge (IEK) within policy frameworks such as County Integrated Development Plans (CIDPs), National Climate Change Action Plans (NCCAPs), and Public Health Strategic Plans. IEK should be recognized as a co-equal knowledge system alongside scientific knowledge, supported by implementation mechanisms, budget allocations, and measurable indicators. Governments should establish IEK integration units within county administrations to ensure incorporation of local knowledge into planning, early warning systems, and climate-health interventions.

Strengthen Gender-Transformative Climate Governance

There is a need to move from gender inclusion to gender-transformative governance that redistributes power, resources, and decision-making authority. This includes securing women's land tenure and inheritance rights, expanding access to agricultural inputs and credit, and ensuring representation of women in governance structures. These reforms are essential for strengthening food systems, water management, and household health resilience.

Reframe IEK as Preventive Public Health Infrastructure

Public health systems should recognize IEK as part of preventive environmental health infrastructure. IEK-based practices should be integrated into Water, Sanitation, and Hygiene (WASH) programs, nutrition initiatives, and vector control strategies. Agroecological practices such as mulching, intercropping, water harvesting, and watershed protection should be classified as nature-based public health interventions, positioning environmental management as a first-line disease prevention strategy.

Develop Integrated Knowledge Co-Production Systems

Extension systems should shift from top-down models to co-production approaches. This includes expanding Farmer Field Schools, using Participatory GIS (PGIS) for mapping climate risks, and establishing community climate-health innovation hubs that connect local communities, researchers, and extension officers. These platforms strengthen knowledge exchange and ensure that interventions reflect local ecological conditions.

Scale Up Ecosystem-Based Infrastructure Investments

Governments and development partners should prioritize ecosystem-based adaptation as a cost-effective and health-sensitive strategy. Key investments include rainwater harvesting systems, terracing and landscape restoration, agroforestry, and climate-resilient irrigation. These interventions should target high-risk areas such as Kisii, Nyamira, and Mount Elgon, where climate stress and population pressure intersect.

Establish Systems for IEK Preservation and Transfer

Institutional mechanisms are needed to preserve and transmit Indigenous knowledge. These include community knowledge archives, integration of IEK into education systems, intergenerational mentorship programs, and legal frameworks to protect knowledge rights. Such systems are essential for maintaining long-term adaptive capacity.

Institutionalize Cross-Sectoral Climate-Health Governance

Governments should establish formal coordination mechanisms across health, agriculture, water, and environmental sectors. This includes joint planning, integrated surveillance systems, and shared early warning systems for climate-sensitive diseases. Such coordination supports proactive and integrated responses to climate-health risks.

Develop Climate-Health Resilience Financing Mechanisms

There is a need for locally governed climate-health resilience funds at county level. These should support women-led and IEK-based adaptation initiatives, finance community innovations, and provide rapid-response funding for climate-related health emergencies. Such mechanisms strengthen local capacity and ensure equitable adaptation outcomes.

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