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A Systematic Review of Indigenous Ecological Knowledge for Climate Change Adaptation in East Africa

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Abstract

Rationale of study - Climate change adaptation has been a global priority in recent years, with governments, the private sector, the international community, and individuals focusing their available resources on these challenges. Indigenous ecological knowledge has been a strategic resource for climate change adaptation among people living in limited-resource environments, such as farmers and pastoralists. Therefore, this study was conducted to systematically review the indigenous knowledge used in the efforts to adapt to the climate change impacts in East Africa.

Methodology - The study followed the PRISMA protocol and included articles published between 2009 and 2023. Only articles published in the English language were included in the study. The data were analysed through thematic analysis.

Findings - The study revealed that farmers and pastoralists in East Africa use indigenous knowledge based on ecological indicators, such as observing changes in the behaviour of insects, birds, plants, and animals, as well as celestial bodies and wind directions, to predict weather and climate patterns. The use of indigenous water resource management and traditional irrigation practices is key to surviving droughts and dry seasons. However, the sharing and adoption of indigenous knowledge remain challenges due to contextual differences across tribes and cultural practices in East Africa.

Implication of the study - The study suggests that climate change adaptation strategies in East Africa must move beyond functional resilience to climate change to indigenous-ecological relational continuity strategies, building on what already exists among smallholder farmers and pastoralists across the region. Furthermore, climate change intervention must align with the community's perception of indigenous ecological knowledge, incorporate it into the strategy, and not rely entirely on the scientific resilience system.

Originality - The study calls for more research on gender and the social effects of using indigenous ecological knowledge in climate change adaptation. It includes testing the framework of relational continuity, understanding its community-based conceptualisation, and its impact on climate adaptation in East African communities.

Keywords

Indigenous ecological knowledge, climate change adaptation, East Africa, climate knowledge.

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1 Introduction

Climate change impacts have significantly affected pastoralists' and farmers' agricultural practices due to the unpredictability of rainfall, crop seasons, and animal diseases, as well as prolonged drought, environmental degradation, and pollution. This is influenced by overdependence on natural resources and agriculture for a living, especially among people living in low-resource environments (Basiru et al., 2022; Sherpa, 2023). There have been global efforts to enhance adaptation to climate change impacts, including the adoption of climate-smart agricultural practices, environmental conservation, green energy policies, tree planting, marine resource protection, and knowledge management. However, the knowledge management strategy has focused too much on scientific knowledge, which is scarce among indigenous communities, marginalising indigenous ecological knowledge, which is abundant among indigenous communities, farmers, and pastoralists.

Indigenous ecological knowledge, which is made of skills, understanding, information, and experience that a certain distinguished ethnic group of people living in a certain area for a long period of time, interacting with the environment, understanding the weather patterns, indicators, seasons, animal and plant behaviours, has been a strategic resource for climate change adaptation. In response to climate change, farmers are relocating farms near water sources for local irrigation, based on their indigenous knowledge (Nkurunziza et al., 2023). Indigenous communities prefer to use both indigenous knowledge and exogenous knowledge of weather forecasting and climate change adaptation. Both kinds of knowledge were used and preferred by the indigenous community, indicating that it is very necessary to have both kinds of knowledge at the community's disposal to ensure communities' access to and use of the knowledge for climate change adaptation (Irumva et al., 2021). Mahoo et al. (2015) argue that indigenous knowledge has proven relevant to weather forecasting and yields reliable results comparable to those of scientific knowledge. Indigenous ecological knowledge built on interaction between paper and their environment has been essential for climate change resilience among indigenous communities such as farmers, agro-pastoralists and pastoralists across the global which people use knowledge accumulated over generations to interpret signs happening in their environment and use the existing resources in their vicinity to respond to climate changes like climate change, environmental changes, this knowledge is not just personal experience but the time tested resource that people has been able to use to live in a certain environment for generations.

Unlike the Western knowledge system, the indigenous ecological knowledge embraces a knowledge worldview. It explains that

knowledge is transferred relationally from generation to generation and is interconnected with nature, emphasising the role of the natural environment in climate change adaptation through strategies such as protecting natural forests, reforestation, and managing water resources. Use of signs from plants, sky bodies, wind directions, animals, insects, birds, and amphibians to predict climate changes (Ali et al., 2025).

However, Indigenous ecological knowledge has not been fully integrated into climate adaptation strategies in developing countries due to limited documentation and its relevance to specific, local contexts. There has been limited recognition among the scholarly community and a lack of government support (Filho et al., 2023). Previous studies consider indigenous knowledge as a local adaptation tool, marginalising it on the pretext of its limited contribution to climate change, with insufficient assessment of how communities' indigenous worldviews shape the ecological meaning, interpretation, and application of indigenous knowledge in climate adaptation. Few studies systematically assess how indigenous ecological knowledge contributes to climate change adaptation. The study was conducted to investigate indigenous ecological knowledge for climate change adaptation in East Africa. The following objectives guided it:

i. To determine Indigenous ecological indicators for climate change adaptation among East African communities,
ii. To assess indigenous ecological-based knowledge for climate change adaptation practices among East African communities
iii. To find out the challenges of using indigenous climate knowledge among East African communities

2 Literature Review

The literature was reviewed as follows.

2.1. Indigenous ecological knowledge for climate change adaptation

Globally, indigenous ecological knowledge has been used to predict weather and climate change long before the emergence of modern scientific knowledge and technology, such as meteorological instruments. For example, in the Middle East, people of the first century were able to predict the changes in weather patterns based on the appearance of the sky. *(Matthew 16:2-3, NIV)* One day, Jesus told the Pharisees and Sadducees, *"When evening comes, you say, it will be fair weather, for the sky is red", and in the morning, "Today is stormy, for the sky is red and overcast..."* This indicates how ancient indigenous climate knowledge is useful to human development, as it serves as an early warning system for farmers and pastoral communities. Knowledge resources have been sustainable and are expected to be used continuously to predict climate and weather events, such as the onset of rain, storms, and

droughts, as well as animal and plant diseases. Such predictions play a key role in addressing climate variability among people living in resource-constrained areas (Filho et al., 2023).

The study conducted in Europe by Harnesk et al. (2025) revealed that people used indigenous ecological knowledge as early warning systems, such as keeping an eye on the environment for signs of landslides, and constant observations of dikes for field protection. This is done especially by farming communities. Furthermore, Harnesk et al. (2025) stressed that indigenous knowledge was passed down from generation to generation; community members learned from childhood to interpret environmental signs and to respond appropriately. Indicating how the deep root of the indigenous ecological knowledge is important to people living in a certain environment, and its importance in their adaptation to climate change.

In Asia, the study conducted by (AIPP, 2012) revealed that indigenous communities have depended on the weather and climate patterns for the agricultural activities built on their ecological understanding of their environment and the interdependent nature between people and their environment. Furthermore, the lunar cycle plays a key role in rice farming as the appearance of the moon during August indicates the beginning of the farming season, which people in Asia depend on for preparing for planting rice (Hosen et al., 2019).

African communities use signs and indicators from their surroundings, including swarms of insects, bird migration, wind direction, frog calls, the appearance of the same animals, changes in the positions of the stars, and birds' songs. To predict and prepare for weather and climate changes, and make adjustments to the farming calendar, prepare responses to climate impacts such as outbreaks of animal diseases, floods, and droughts. These are the results of long-term interaction between Africans and their environment, indicating the significant role of indigenous ecological knowledge in climate change adaptation (Nyadzi et al., 2021).

Indigenous ecological knowledge have help the indigenous communities to develop several adaptation strategies against climate change, for example due to the risks of floods destroying gardens and crops, the people living in Asia developed and adopted the floating vegetable gardens strategy to protect their crops, people planting windbreaks along the cost to control tropical storm, increase height houses from the ground in areas vulnerable to flood, adoption of food preservation techniques like dry and smoking to be used during the time of scarcity (AIPP, 2012). In Africa, farmers are adapting to crop failures by changing planting dates and adopting early-maturing crops, while pastoralists are adapting to drought and pasture scarcity through rotational grazing and seasonal migration (Filho et al., 2023). The study by David et al.

(2020) found that factors influencing the adoption of indigenous-based climate adaptation practices included farming experience, household size, age, and gender, highlighting the role of sociodemographic characteristics in the use of indigenous ecological knowledge for climate change adaptation.

2.2 Knowledge gap

Indigenous ecological knowledge is contextual, as are the associated climate change adaptation practices, and varies from continent to continent and region to region, depending on regional climates. The reviewed studies have shown that due to changing climate and weather patterns and increasing unpredictability of rainfall and the seasons, indigenous ecological knowledge is less reliable (AIPP, 2012). In addition, there is a limited number of cross-country studies on indigenous ecological knowledge for climate change adaptation that consider the Indigenous worldview and social-ecological resilience theory, and examine how they shape climate change perception and adaptation. Furthermore, the study conducted by Nyinondi and Sospeter, (2023) found that most studies on public perception of climate risks and adaptation used a mixed-methods approach. The trend shows a significant gap in comprehensive studies conducted across multiple countries, as identified through a systematic review.

3 Theoretical Framework.

Various theories and models have explained climate change, helping people adapt, transform, and become resilient to its impacts. This study integrates social ecological resilience theory and knowledge worldview theory. The Social ecological resilience theory operationalises resilience as the interconnection between human beings and the environment through which shocks and changes are absorbed, recognise vulnerability, and develop adaptation strategies while still fully functional and operating (Folke, 2016). It mirrors the capacity of people and communities in both developed and developing countries, rural and urban areas, and resource-rich and resource-constrained environments to adjust and cultivate sustainable development capacity in the face of climate, environmental, and ecological changes. The theory recognises the ability to predict climate change using ecological indicators and uses available ecological resources to respond to its impacts. Through resilience theory, people can learn to adapt to climate change without collapse. Adaptive practices include managing water resources through pits and artificial dams, afforestation, and reforestation (Ifejika et al., 2009).

However, social-ecological resilience theory pays limited attention to local and traditional knowledge embedded in people's cultures, which shapes climate-change adaptive behaviours, perceptions, and interpretations of

events in particular environments. Knowledge worldview addresses these limitations (Cobern, 1994). Worldview theory explains the perspectives of people and society. It is cognitive-based, offering a comprehensive way to understand why people, such as the indigenous community, view the world and situations the way they do. The theory stresses that indigenous communities interpret phenomena such as climate change impacts through their culture and traditional beliefs. This theory is the lens that brings these aspects into focus, which other theories have ignored (Chakkarath, 2013).

The Indigenous worldview is built upon the interaction between people and their ecological surroundings; how local people perceive and interpret ecological changes over time, which is passed down intergenerationally. The worldview is changing over time because it is based on two knowledge systems: scientific and indigenous. Indigenous knowledge systems work within certain boundaries, while scientific knowledge is used globally (Guto, 2020). However, due to colonialism and the perceived superiority of scientific knowledge over local knowledge systems, African local knowledge has been marginalised at the global stage. Hence, sidelined by many theories and in policies, education curricula, and strategic plans (Ezeanya-esiobu et al., 2021). By integrating the two theories, the review uncovers the significance of indigenous climate knowledge as a key component for adaptation capabilities, enhancing local communities in East Africa, especially smallholder farmers and agro-pastoralists who are more vulnerable to climate change impacts, to anticipate climate variability, adjust their livelihood strategies, and maintain balanced social-ecological stability under increasing climate change pressure.

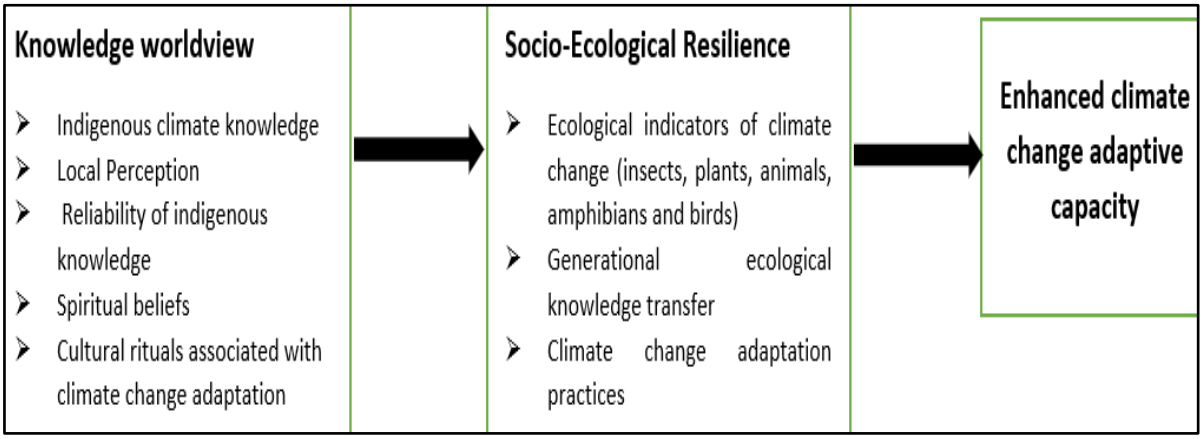

Figure 1: The conceptual framework was developed by the authors (2026) based on insights from the Indigenous worldview and social-ecological resilience theory.

4 Methodology

The Study adopted the Preferred Reporting Items for Systematic reviews and Meta-Analyses approach. This approach enabled the researchers to systematically synthesise the available evidence on the topic. Studies have shown that systematic reviews are an effective way to report robust, reliable evidence on the topic, ensuring comprehensive information is available with the available evidence. The study focused on open-access, peer-reviewed articles, reports, conference papers, book chapters, theses, and dissertations accessed through Google Scholar that addressed indigenous knowledge for climate change adaptation. The period for inclusion was from January 1, 2009, to December 31, 2023. For indigenous climate knowledge, which has not been well researched in developing countries like Tanzania, Uganda, Kenya, Rwanda, and Burundi (Nyadzi et al., 2021). The selected papers were published in the English language. The search was conducted using keywords and phrases (including 'indigenous knowledge', 'climate change', 'climate change impacts', 'indigenous ecological knowledge, and 'ecological knowledge AND Climate change'), truncations, and Boolean operators to identify relevant studies. The techniques mentioned enabled the researchers to identify the maximum number of relevant studies while narrowing the search to articles covering all relevant topics. The search yielded 1,241 articles; after a selection process, only 43 studies were included.

A standardised extraction sheet was developed to collect data on the following: study Authors and Year of publication, geographical area of study, title, study methodology, and key findings relevant to the study objective. The study adopted thematic analysis, guided by qualitative research principles, to analyse the findings from the included studies. Both authors conducted repeated readings of the included studies for familiarisation, identified trends, similarities, and differences across East African countries. They developed themes based on the research objective, which guided the presentation of findings. Descriptive statistics, including frequencies and percentages, bar charts, and pie charts, were used to present findings on geographical coverage, temporal distribution, and methods adopted by studies.

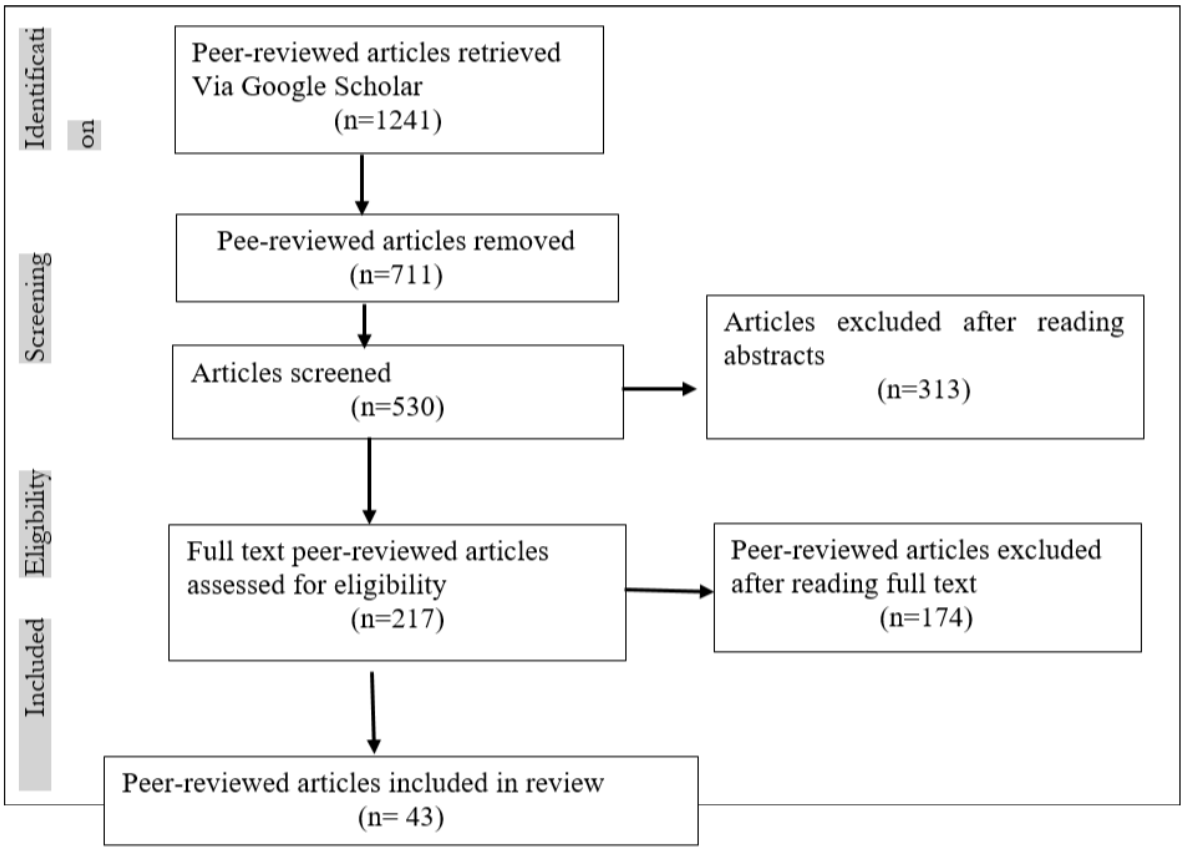

Figure 2: The flow chart of the selection process of articles for systematic review

5 Findings

The study findings are presented in accordance with the study's objectives.

5.1 Geographical coverage of the study

The geographical coverage of the study is shown in Figure 3.

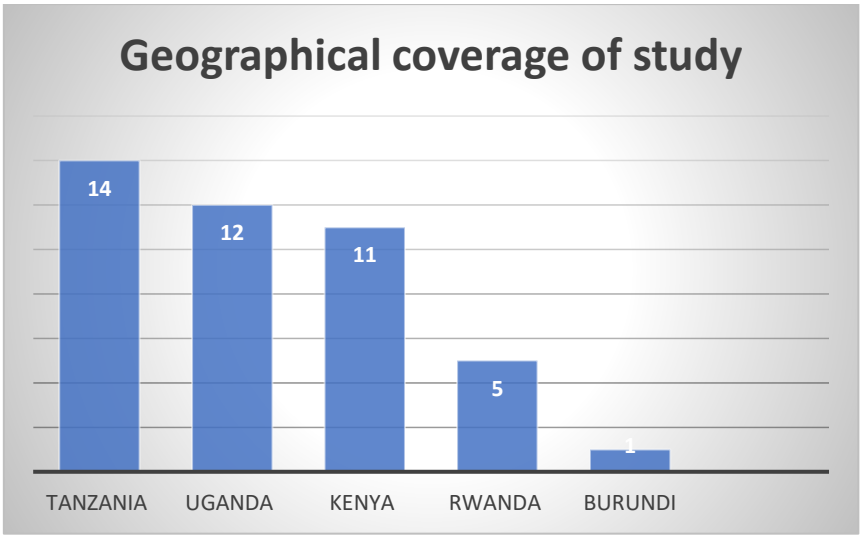

Figure 3: Geographic coverage of the study

From Figure 3, the review revealed that (32.5%) of studies on indigenous climate knowledge in East African states were conducted in Tanzania, followed by 27.9%

Uganda and Kenya with 25.6%. This rate indicates a relatively equal focus on indigenous climate knowledge in the region, suggesting limited coverage of the topic across the member states. This could impact the decision on comprehensive strategies and policies for climate change adaptation.

5.2 Research methods applied in IK for Climate change adaptation in East Africa

The study's research methodology is shown in Figure 4.

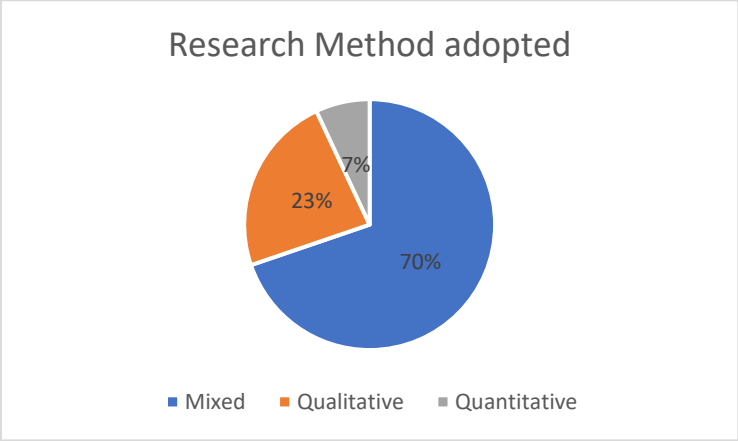

Figure 4: Research method adopted

From Figure 4, the review revealed that 30 (70%) of the studies on indigenous knowledge for climate change adaptation in East Africa adopted a mixed-methods approach, 10 (23%) used a qualitative approach, and 3 (7%) used a quantitative approach.

5.3 Temporal distribution of IK studies in East Africa

The temporal distribution of Ik studies in East Africa is shown in Figure 5.

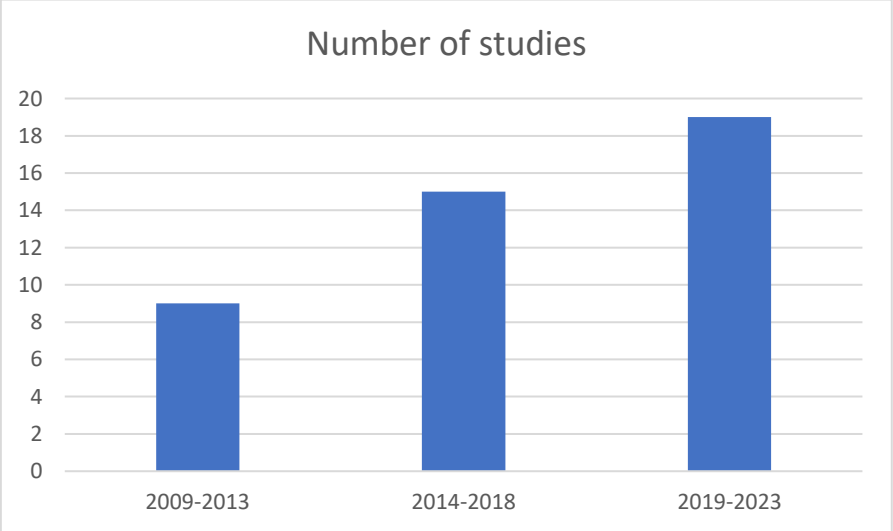

Figure 5: Temporal distribution of IK studies in East Africa

From figure 5, the finding revealed that many 19(44%) studies were conducted from 2019 to 2023, followed by 15(35%) conducted in 2014-2018 and 9(21%) conducted in 2009-2013. This indicates growing recognition of the potential of indigenous ecological knowledge to address climate change challenges. Furthermore, it indicates the commitment of researchers, funders, and stakeholders to make research-based informed decisions regarding climate change adaptation.

5.4 Indigenous ecological knowledge of animal and amphibian behaviours

The review revealed that indigenous people relied heavily on their knowledge to interpret animal signs and predict changes in the climate and weather in their particular place. Studies conducted by (Elia et al., 2014) In Tanzania, it was revealed that the appearance of amphibians, such as frogs, and making certain sounds during the dry season, indicates that the rain is on its way; frog behaviours were interpreted similarly in Kenya (Apraku et al., 2021). In Tanzania, when frogs start to make noise consistently, it indicates the near rainfall onset (Chang'a et al., 2010). In Tanzania, Bulls and cows cry when they smell raindrops (UNESCO, 2018)

5.5 Indigenous ecological knowledge of Birds and insect behaviours in relation to climate change

Indigenous people in East African communities use various birds and insects to detect changes in climate and weather conditions. In Uganda, the movement of some insects, such as butterflies, red caterpillars, and the appearance of migratory birds known as cattle egrets and black eagles, indicate the beginning of the dry seasons (Okonya & Kroschel, 2013). In Tanzania, the emergence of many butterflies, termites, and ants during the dry season indicates an early onset of the rainy season. Yangi yangi birds in October and November signal the onset of rainfall and a good rainfall season (Chang'a et al., 2010). In Tanzania, the singing of birds known as *Oltilo, Olube, and Inekipiriak* flying over the sky, among the Maasai community

5.6 Observation of celestial bodies, plant behaviour and wind direction

Based on the indigenous knowledge of the Ugandan people, when the wind blows from the east to the west and the sky appears very clear, it indicates the beginning of the dry season. Winds blowing from west to east, a bright moon, and thunderstorms indicate the onset of the rainy season (Okonya & Kroschel, 2013). In Tanzania, the Maasai interpreted the following signs: rain clouds with thunder and lightning, a rain star known as Olokira le Nkakenya, and the moon bending to the right (UNESCO, 2018). According to Ugandan indigenous knowledge, when trees shed their leaves, it signals the start of the dry season (Okonya & Kroschel, 2013). In Tanzania, high yields from Mikusu fruits *(Uapaca kirkiana)*

indicate drought in the upcoming season (Chang'a et al., 2010).

5.7 Reliability of indigenous ecological knowledge for weather and climate change forecasts

The review found that indigenous knowledge's predictions of climate change were reliable, as the study conducted in Tanzania by Mahoo et al. (2015) revealed that the majority (56%) of respondents found indigenous knowledge's predictions of weather and climate changes reliable. The study conducted in Uganda indicated that the majority of the respondents relied on both Indigenous knowledge and official weather and climate change forecasts, finding that combining the two brought more accurate and reliable results (CTA, 2017). The study conducted in Kenya revealed that integrating scientific and indigenous knowledge is paramount, as indigenous knowledge helps farmers forecast seasons and prepare for farming. In contrast, scientific knowledge helps them understand the rate of change (Kipkorir et al., 2011). The study conducted in Tanzania by Chang'a et al., (2010) found that the majority (64%) of respondents found indigenous weather and climate forecasts reliable. In Tanzania, the majority (92%) of respondents use indigenous knowledge for climate and weather change forecasts.

5.8 Indigenous ecological knowledge-based climate change adaptation strategies and their associated challenges

The review found that indigenous communities have developed several climate change adaptation strategies, as studied by (Malekani et al., 2015; Mussa & Mjemah, 2015; Theodory, 2020). In Tanzania, the following strategies were identified: intercropping; preservation of planting materials for extended periods through traditional facilities; hunting; temporary migration; diversification of economic activities beyond farming, including worship and prayer; and growing early-maturing crops. In Kenya, domestication of wild plants, planting of resistant crops, and weeding were practised much earlier, and food storage and diversification of crop cultivation were adopted. In Uganda, mulching was observed, along with indigenous agroforestry, changes in planting time, diversification of economic activities, and a reduction in the number of cattle. In addition, Rwanda and Burundi revealed that the adoption of early-maturing crops, protection of soil from erosion, changes in farm location, and early sowing of seed. Challenges associated with indigenous ecological knowledge for climate change adaptation include, but are not limited to, lack of documentation, contextual nature, policy issues and religious beliefs (Nyadzi et al., 2021)

6 Discussion of the Findings

6.1 Indigenous ecological indicators in relation to climate change predictions and adaptation

The review found that indigenous communities' ecological understanding has been the key enabling factor for weather and climate change predictions and adaptation. The communities observe indicators of weather and climate change in their surroundings and prepare to respond based on pre-established interpretations and adaptation strategies. Ecological indicators, such as frogs making certain sounds during the dry seasons, indicate that rain is on its way. This is a common indicator and is interpreted similarly across the East African region (Elia et al., 2014; Apraku et al., 2021). In addition, insects behavior interpretation, such as the movement of some insect species, red caterpillars, and the appearance of migratory birds known as cattle egrets and black eagles, indicates the beginning of the dry season (Okonya & Kroschel, 2013). The appearance of many butterflies, termites, and ants during dry seasons indicates an early onset of the rainy season. *Yangi yangi* birds in October and November signal rainfall onset (Chang'a et al., 2010). The flowering of vegetation and new leaf growth on certain plants signal that the rainy season is about to begin. People can understand plant signs and make decisions, such as preparing farms for farming seasons, which helps them be prepared for environmental changes and benefit from their knowledge of the surrounding climate (UNESCO, 2018). Observing and interpreting ecological signs in relation to climate change and weather predictions is a common practice among indigenous communities worldwide. Harnesk et al. (2025) revealed that people living in European areas prone to landslides used ecological knowledge of their environment as an early warning sign of landslides. The agricultural system among indigenous communities is built on the weather and climate patterns interpreted through ecological knowledge (AIPP, 2012). This indicates that indigenous ecological knowledge of climate change and weather indicators is an important factor in the decision-making and actions of indigenous communities in their daily lives. It is important to reconsider the role of this knowledge in policies and strategies for climate change adaptation and mitigation,

6.2. Reliability of indigenous ecological knowledge for weather and climate change forecasts

Indigenous climate knowledge is embedded in people's culture; they can predict and interpret signs from plants, animals, birds, amphibians, and the sky. This makes it easy to access and use this knowledge when facing the impacts of climate change. It is more contextual and ecologically connected to people living in a certain environment. In Tanzania, the study conducted by Mahoo et al. (2015). Found that over (90%) of farmers were familiar with indigenous climate change forecasts, and they used ecological indicators to predict weather

and climate changes. In addition, indigenous ecological knowledge serves as the primary source of traditional medicines used to treat livestock among agro-pastoral and pastoral communities. In a study, Ezeanya-esiobu et al. found that 6/6 of experienced farmers and ¾ of less-experienced farmers used indigenous medicine to treat animal diseases. This indicates that indigenous ecological knowledge is a common resource that smallholder farmers, agro-pastoralists, and pastoralist communities possess and can use in daily climate change predictions. This creates a strong foundation for climate change adaptation strategies and policies, ensuring resilience in a resource-constrained environment.

6.3 Indigenous ecological knowledge-based climate change adaptation strategies

Indigenous people adapted different means in response to the changing climate. In Tanzania, indigenous people have long practised intercropping and preserved planting materials through traditional facilities (Malekani et al., 2015b). In Kenya, indigenous people adapted by domesticating wild plants, planting resistant crops, and weeding much earlier (Wekesa et al., 2015). In Tanzania, expanding farm size to increase yields and diversifying crops, such as potatoes and cassava, was adopted (Theodory, 2016). In Uganda, Tumwesigye et al. (2023) found that farmers adopted early planting, timely weeding, and the use of thorny trees to scare pests in response to climate change. In Rwanda and Burundi, farmers adopted early-maturing crops, irrigation, and diversified economic activities (Nkurunziza et al., 2023). Water scarcity is one of the impacts of climate change on agricultural activities. Due to its importance, farmers across the region have been adopting irrigation strategies to ensure agricultural productivity. This strategy is built on indigenous ecological knowledge to predict the nature of the upcoming seasons and prepare for dry seasons (Zvobgo et al., 2022). These adaptation strategies have been key to the survival of East African farmers and pastoralists amid climate change impacts; it is possible to integrate these already time-tested indigenous climate change adaptation practices into science-based climate resilience practices, which together are expected to ensure climate change resilience among agriculturally dependent communities.

6.4. Constraints of indigenous ecological knowledge for climate change

The review found that indigenous climate knowledge faces several challenges, including a lack of documentation. This makes it difficult for scientists, scholars, politicians, and stakeholders to use it when making decisions about climate adaptation strategies, thereby affecting the efforts and capacity of indigenous communities to adapt to climate impacts (Kihila, 2020). Lack of policy enforcing indigenous climate knowledge, policies are very important as the guiding tool for governments and individuals to make

decisions and take actions, for example, protection of natural resources, reforestation, grazing practices and farming practices are influenced by the policy available in place with indigenous climate knowledge there is lack of comprehensive policy in East Africa for use of indigenous climate knowledge. Indigenous knowledge is largely qualitative and context-dependent, making it difficult to share and preserve (Nyadzi et al., 2021). emergence of new, more resistant diseases, availability of modern knowledge, rural-urban migration, and Christianity, as some people do not believe in the application of indigenous knowledge because of their Christian beliefs (Kimani et al., 2014).

7 Conclusions

A review of indigenous climate change knowledge in East Africa revealed a significant concentration of studies in three countries: Tanzania, Kenya, and Uganda. This leaves significant gap of the indigenous climate knowledge among east African member states, this make it difficult to obtain comprehensive understanding of indigenous knowledge for climate change in east African states and make it difficult to capitalize on this strategic resource in response to climate change impacts, despite the availability and easily accessibility of this knowledge among people living rural areas who are largely affected by climate change impacts. Indigenous climate knowledge strongly influences the understanding and action taken by indigenous people to adapt to the impacts of climate change. Indigenous people relied on both indigenous and scientific knowledge to adapt to climate change, as some communities relied solely on indigenous knowledge due to limited access to meteorological information.

8 Recommendations

The study recommends integrating indigenous and scientific knowledge to adapt to climate change, thereby enhancing the effective utilisation of the knowledge management strategy in resource-constrained environments. The study recommends further research on Gender and the social influence of using indigenous ecological knowledge for climate change adaptation. Testing the framework of relational continuity of indigenous ecological knowledge for climate change adaptation and its conceptualisation across communities, and its influence on climate change adaptation in East African communities.

9 Implications of the Study

The findings from the review imply that climate change adaptation strategies in East Africa must move beyond functional resilience to climate change to indigenous-ecological relational continuity strategies, thereby facilitating the use of indigenous climate change knowledge already held by smallholder farmers and pastoralists across the region. Furthermore, climate change interventions must align with the community's perception of

indigenous ecological knowledge, incorporate it into the strategy, and not rely entirely on the scientific resilience system. Furthermore, climate change adaptation interventions that do not take into consideration the indigenous knowledge worldview risk poor or low adoption, and hence, they could weaken climate change adaptation efforts due to differences in perception between scientists, stakeholders, and indigenous communities, as the indigenous community finds their local knowledge and practices contextually usable compared to general intervention means introduced from outside their community.

Several scholars have ignored the knowledge worldview, and resilience theory has been used as the functional system in climate change adaptation and mitigation. However, this systematic review contributes to theories by reconceptualising resilience from a functional system perspective to relational continuity, a shift from Western resilience conceptualisation (Folke, 2016), which views resilience as grounded in adaptive practices, transformation, and feedback loops. Integrating the indigenous knowledge worldview, which is built on relationships between people and their environment, with interpretations of environmental change indicates that resilience capacity is embedded in this worldview. Contrary to theories and models that consider indigenous knowledge as a contextual tool in resilience theory, this presents an alternative resilience perspective: it views it as an independent system with a different view of resilience and as part of that system. Furthermore, the study conceptualises climate change adaptation. Resilience is the relational continuity that smallholder farmers and pastoralists draw on, using indigenous knowledge passed down from one generation to the next. To them, this is generational, and the ecological knowledge of the land, trees, changes, weather, planting seasons, water resource management, interpretation of sky signs, and food preservation methods has been passed down through family culture and communities in general. Hence, this uncovers that resilience is relational continuity, not a functional system; this is what defines climate change adaptation and resilience among people in East Africa.

10 Study limitations

The study was limited to English-language articles, excluding those published in local languages across East African communities. Unpublished and documented local knowledge reports were not assessed. The concept of relational continuity in indigenous ecological knowledge can be understood differently across communities and can be influenced by factors such as government policy. Gender and social influence of indigenous ecological knowledge on climate change adaptation.

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