Keraton: Journal of History Education and Culture
Vol. 7., No. 2, December 2025, pp. 195-206
ISSN 2685-9114 (print), 2686-0082 (online)
http://journal.univetbantara.ac.id/index.php/keraton

The Critical Role of Local Wisdom In Supporting Water Sustainability and Climate Crisis Mitigation

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Received 04 Desember 2025; accepted 18 Desember 2025; published 30 Desember 2025

ABSTRACT

The escalating global environmental crises, particularly water scarcity and the pervasive impacts of climate change, necessitate a re-evaluation of conventional management strategies and an urgent search for sustainable solutions. This systematic literature review investigates the profound, yet often overlooked, contributions of local wisdom and Indigenous Knowledge to achieving water sustainability and mitigating the effects of climate crises. Local wisdom, defined as basic knowledge gained from living in balance with nature, accumulated and passed on through generations, integrates the body, spirit, and environment, emphasizing respect for ecological balance and community well-being (Musi et al., 2022). The purpose of this study is to systematically review and synthesize existing academic literature to elucidate how these traditional knowledge systems provide effective and culturally appropriate strategies for environmental resilience. Employing the Preferred Reporting Items for Systematic Reviews and Meta-Analyses methodology (Abas et al., 2022; Dorji et al., 2024; Sahani et al., 2025), this review analyzes a comprehensive body of research to identify key themes and empirical evidence. Findings highlight the efficacy of local wisdom in various aspects, including traditional water conservation practices (e.g., rainwater harvesting, terracing, wetland management) and enhancing climate resilience through adaptive farming techniques and weather prediction (Sahani et al., 2025). Furthermore, indigenous knowledge systems contribute significantly to nature conservation, sustainable water management, and climate change adaptation efforts (Abas et al., 2022; Zvobgo et al., 2022). These insights underscore the critical need to integrate local and Indigenous Knowledge with modern scientific approaches to foster robust, sustainable, and equitable responses to contemporary environmental challenges. The implications of this study suggest that recognizing and leveraging local wisdom can provide innovative and context-specific pathways toward global water security and climate stability.

KEYWORDS

Local Wisdom; Indigenous Knowledge; Water Sustainability; Climate Change Mitigation; Systematic Literature Review.

1. Introduction

The world faces unprecedented environmental challenges, with global water scarcity and the pervasive impacts of climate change emerging as defining crises of our era. Water scarcity, affecting billions worldwide, is exacerbated by anthropogenic factors and increasingly erratic climate patterns (Hasan et al., 2023; Quandt et al., 2022). The global climate is undergoing rapid transformations, marked by rising temperatures, altered precipitation patterns, and accelerating glacier melt, threatening ecosystems and human societies alike (Khan et al., 2024; Organization, 2024). The State of Global Water Resources 2023 report underscores this urgency, revealing five consecutive years of below-normal river flows, significant ice loss, and the designation of 2023 as the hottest year on record, intensifying the likelihood of severe water stress globally (Organization, 2024; Ravinandrasana & Franzke, 2025).

While conventional scientific and technological approaches have made strides, their limitations in addressing the multifaceted nature of these crises are becoming increasingly apparent. There is a growing recognition that diverse knowledge systems, particularly local wisdom and Indigenous Knowledge, hold immense potential for developing more effective, sustainable, and culturally appropriate solutions. These traditional knowledge systems, often overlooked in mainstream environmental discourse, embody centuries of empirical observation, adaptive practices, and holistic understandings of human-environment interactions.

The role of local wisdom and Indigenous Knowledge in environmental stewardship is deeply rooted in various grand theories that bridge social and ecological sciences. Central to this understanding are concepts such as Traditional Ecological Knowledge and Indigenous Knowledge, which originate from literature on international development and adaptive management (Whyte, 2013). These knowledge systems are not static but are recognized as dynamic and adaptive, continually shaped by long-term interactions between communities and their heterogeneous environments (Silva-Ávila et al., 2025).

The broader theoretical frameworks underpinning the integration of local wisdom into environmental governance and sustainability studies often incorporate complex systems thinking. This approach emphasizes concepts like resilience, ecosystem services, social-ecological systems, and overall sustainability, advocating for multiple ways of knowing and bridging the divide between social and natural sciences (Partelow et al., 2020). A "relational approach" further enriches this theoretical landscape, positing that sustainability outcomes are inherently tied to the quality of interactions among communities, ecosystems, and governance structures. Within this framework, Indigenous relational ontologies view humans as integral parts of ecosystems, fostering stewardship practices that sustain both biodiversity and cultural identity (Silva-Ávila et al., 2025). Essentially, local wisdom functions as a foundational basis for environmental management, guiding ethical considerations and practical solutions towards sustainable development principles (Saptenno & Timisela, 2024).

Empirical evidence consistently highlights the practical effectiveness of local wisdom in addressing water sustainability and climate change impacts. For instance, Indigenous Knowledge and local knowledge are extensively relied upon by African communities for climate adaptation, particularly within the water sector (Zvobgo et al., 2022). Case studies from various regions demonstrate the direct application and success of these traditional practices. In Iran, ethnographic research has explored water management practices, underscoring the applicability of indigenous knowledge for resource governance in arid regions (Ghorbani et al., 2021). Similarly, in hilly areas prone to drought, the "Jamban systems" exemplify local water conservation strategies that enhance community resilience and water availability in the face of climate change impacts (Kristiyanto, 2020).

Further research identifies recurring patterns in Traditional Ecological Knowledge practices related to water management, agroecology, community resource governance, and cultural heritage, showcasing its inherent adaptability and capacity to integrate with scientific frameworks to achieve culturally relevant adaptation (Silva-Ávila et al., 2025). The value of traditional ecological knowledge is also evident in traditional Chinese villages, where practices utilizing ponds, canals, and permeable pavement effectively contribute to stormwater management (Li et al., 2024). These examples underscore that local wisdom provides concrete, on-the-ground solutions for pressing environmental challenges.

Despite increasing calls for the incorporation of Indigenous Knowledge into climate adaptation planning, this field remains nascent, with a limited number of studies comprehensively reporting findings and systematically improving scientific understanding and delivery (Ciocco et al., 2024). While the role of indigenous and local people in climate change mitigation and adaptation is gaining recognition, the precise methods and pathways for effectively integrating Indigenous and Local Knowledge into climate action remain fragmented (Chanza et al., 2024). There is a recognized limitation in fully understanding the effectiveness of indigenous knowledge for climate change adaptation across diverse global contexts (Zvobgo et al., 2022).

Current research indicates a persistent need for more focused studies on IK and climate change, emphasizing diverse approaches and, critically, the bridging of traditional knowledge with modern

scientific understanding (Dorji et al., 2024). For example, a systematic literature review on "local wisdom, sustainability, and education" revealed that research collaboration in this interdisciplinary area remains predominantly local, signaling a gap in international research focus and synthesis (Lestari et al., 2024). This fragmented landscape highlights the pressing need for comprehensive systematic reviews that consolidate existing knowledge and illuminate pathways for future research and practical application.

The critical state of global water resources and the accelerating climate crisis demand a departure from siloed approaches towards integrated, holistic solutions. Given the recognized fragmentation in methods and the limited systematic understanding of how Indigenous and Local Knowledge effectively contributes to climate adaptation and water sustainability (Chanza et al., 2024; Zvobgo et al., 2022), a comprehensive systematic literature review is unequivocally justified. Such a review is essential to synthesize the existing body of knowledge, identify patterns, and evaluate specific practices through which local wisdom supports water sustainability and mitigates climate crisis impacts (Abas et al., 2022).

This study is driven by the urgent need for effective, sustainable, and equitable solutions to these global environmental challenges. By systematically exploring all available knowledge systems, particularly local wisdom, which has consistently demonstrated its capacity to offer viable alternatives or complements to modern scientific and technological interventions (Saptenno & Timisela, 2024; Silva-Ávila et al., 2025), this research will contribute to a more inclusive and robust framework for environmental management.

This systematic literature review distinguishes itself by specifically bridging the intricate relationship between local wisdom, water sustainability, and climate crisis mitigation in a comprehensive and integrated manner. While existing reviews often focus on isolated aspects, such as nature conservation or specific adaptation strategies (Abas et al., 2022; Lestari et al., 2024), this study offers a holistic synthesis of evidence across both water sustainability and climate mitigation domains.

Its novelty lies in providing a structured and systematic assessment of the multifaceted role of local wisdom, moving beyond general discussions to identify concrete practices, underlying principles, documented effectiveness, and the critical challenges and opportunities for integrating these traditional systems into broader environmental governance and policy frameworks. This approach aims to yield a more nuanced and actionable understanding than previously available, highlighting the unique contributions and potential of Indigenous Knowledge in addressing contemporary global environmental dilemmas.

This systematic literature review is specifically focused on identifying, analyzing, and synthesizing peer-reviewed academic articles that elucidate the role of local wisdom and Indigenous Knowledge in fostering water sustainability and mitigating the impacts of climate change. The study will thoroughly explore the diverse types of local wisdom practices employed globally, the fundamental principles that underpin these practices, their demonstrated effectiveness in various socio-ecological contexts, and the existing challenges and promising opportunities for their meaningful integration into contemporary environmental governance and policy frameworks.

2. Research Methods

This study employed a systematic literature review (SLR) approach to comprehensively identify, evaluate, and synthesize existing evidence on the critical role of local wisdom in supporting water sustainability and climate crisis mitigation. An SLR provides a rigorous and transparent method to minimize bias, enhance the reliability of findings, and enable replication of the research process, thereby ensuring the academic rigor required for publication in reputable international journals (Meliante et al., 2025; Page et al., 2021). Accordingly, the review adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines (Moher et al., 2009; Page, McKenzie, et al., 2021; Page, Moher, et al., 2021), which were applied to ensure transparent and complete reporting of both the methodology and the findings of this study.

3. Results

The systematic literature review, encompassing a qualitative synthesis of 150 articles, revealed a robust and multifaceted role of local wisdom and Indigenous Knowledge in addressing water sustainability and mitigating climate crises. Three overarching themes emerged as central to understanding these contributions: The Efficacy of Traditional Water Management Practices Local Wisdom as a Foundation for Climate Change Adaptation and Mitigation, and The Enhancement of Community-Based Governance and Resilience through Local Knowledge Systems. Each theme is explored in detail below, highlighting specific practices, their underlying principles, and documented outcomes.

3.1 The Efficacy of Traditional Water Management Practices

The review consistently demonstrated that local wisdom underpins a diverse array of traditional water management practices that are highly effective in ensuring water sustainability, particularly in regions prone to scarcity or facing the impacts of climate change. These practices often involve low-cost, environmentally sustainable, and culturally integrated approaches that modern systems can complement or learn from (Sahani et al., 2025). Many resource-poor communities depend on Indigenous Knowledge for water security, and organizations like the IPCC have recommended its exploitation in water conservation and management (Getyengana et al., 2023).

Table 1: Examples of Traditional Water Management Practices Informed by Local Wisdom

Practice	Description	Region/Context	Contribution to Water Sustainability	Key References
Rainwater Harvesting	Collection and storage of rainwater for various uses.	South Africa, Africa	Addresses water scarcity, provides water for agriculture and domestic use.	(Sahani et al., 2025; Zvobgo et al., 2022)
Terracing	Modifying land to create stepped fields for water retention and erosion control.	South Africa	Reduces runoff, improves soil moisture, supports agriculture.	(Sahani et al., 2025)
Wetland Management	Traditional practices for maintaining and utilizing natural wetlands.	South Africa	Natural water purification, flood control, biodiversity conservation.	(Sahani et al., 2025)
"Jamban Systems"	Community-scale water management model for utilizing scarce water in hilly, drought-prone areas.	Rural Hilly Areas	Enhances water availability, improves community resilience during drought.	(Kristiyanto, 2020)
Traditional Irrigation	Indigenous irrigation techniques adapted to local hydrological conditions.	Africa	Efficient water distribution, supports crop production in arid regions.	(Zvobgo et al., 2022)
Water Ponds & Rainmaking Ceremonies	Traditional water storage and ritual practices linked to water abundance.	Various (e.g., Africa)	Provides water for livestock and communities, reinforces cultural connection to water.	(Getyengana et al., 2023)
Social Contracts for Water	Community-defined rules and roles governing equitable	Jiroft County, Iran	Ensures fair access, reduces conflict, supports sustainable	(Ghorbani et al., 2021)

Distribution	water sharing.		resource governance.	

Despite their proven effectiveness, indigenous Rainwater Harvesting systems have seen a decline due to factors like increased groundwater use, rural-urban migration, and policy changes (Aklan et al., 2024). However, revitalized indigenous RWH systems, especially when combined with traditional knowledge and modern technologies, can play a crucial role in alleviating water scarcity and sustaining livelihoods, making them more resilient, efficient, and productive (Aklan et al., 2024). The ethnographic case study in Iran further discusses the applicability of indigenous knowledge in regional water management for arid regions globally, emphasizing the relationship between community social structure, indigenous knowledge, and water governance rules under climate change (Ghorbani et al., 2021).

3.2 Local Wisdom as a Foundation for Climate Change Adaptation and Mitigation

Local wisdom provides critical strategies for communities to adapt to the adverse effects of climate change and, in some cases, mitigate its impacts. These knowledge systems often integrate deep ecological understanding with practical coping mechanisms, developed over generations of living in close harmony with specific environments.

Table 2: Local Wisdom Contributions to Climate Change Adaptation and Mitigation

Strategy	Description	Region/Context	Role in Climate Action	Key References
Adaptive Farming Techniques	Traditional agricultural methods adjusted to changing climate patterns.	South Africa, Africa	Enhances food security, reduces vulnerability to climate-induced yield losses.	(Sahani et al., 2025)
Weather Prediction	Indigenous knowledge-based forecasting using natural signs and observations.	South Africa	Enables timely decision-making for farming and disaster preparedness.	(Sahani et al., 2025)
Agroforestry	Integrating trees and shrubs into agricultural systems.	Africa	Improves soil health, sequesters carbon, enhances ecosystem resilience.	(Zvobgo et al., 2022)
Indigenous Climate Governance	Traditional systems of rules and practices for managing resources in response to climate variability.	Rural Zimbabwe	Supports sustainable land and water management, fosters community resilience.	(Mugambiwa & Makhubele, 2021)
Contextualized Adaptation Plans	Local reports informing specific, locally relevant climate adaptation strategies.	Indigenous Peoples and local communities globally	Provides actionable insights for localized and effective adaptation measures.	(Reyes-García et al., 2024)
Partnership-Based Approaches	Collaborative efforts incorporating Indigenous knowledge for environmental management.	Aotearoa-New Zealand	Increases efficiency in mitigating climate change impacts and social cohesion.	(Awatere et al., 2023)
Ethnopedagogical	Incorporating traditional narratives and arts into	Jombang, Indonesia	Strengthens environmental awareness and promotes	(Anggraeni et al.,

Integration	education.		cultural values for sustainability.	2025)

African communities, in particular, rely heavily on Indigenous Knowledge and Local Knowledge for climate adaptation, especially in the water sector, with evidence of its influence on adaptation responses in Southern, West, and East Africa (Zvobgo et al., 2022). This knowledge extends to identifying economic and non-economic loss and damage related to climate change impacts, providing crucial data beyond scientific monitoring (Reyes-García et al., 2024). The concept of "Cultural Water and Indigenous Water Science" emphasizes the need to learn from Indigenous approaches to water management (O'Donnell et al., 2023). Efforts like the Bugis community's "SIPA principles" illustrate how local wisdom fosters mutual respect, assistance, and protection, contributing to harmonious human-environment interactions that are vital for resilience (Musi et al., 2022). Furthermore, local wisdom, often transmitted through folklore and daily activities, plays a significant role in educating younger generations about environmental values and cultural preservation, which indirectly supports climate change mitigation by fostering stewardship (Ali et al., 2022; Marwany et al., 2021).

3.3 The Enhancement of Community-Based Governance and Resilience through Local Knowledge Systems

Beyond specific technical practices, local wisdom profoundly influences community-based governance structures and enhances overall resilience to environmental shocks. These systems are characterized by collective decision-making, shared responsibilities, and a deep understanding of local social-ecological dynamics.

Table 3: Local Wisdom's Role in Community-Based Governance and Resilience

Aspect	Description	Outcomes for Governance and Resilience	Key References
Social Contracts for Resource Access	Community-defined roles and agreements for equitable access and distribution of natural resources.	Ensures fair access to water resources, minimizes conflict, promotes community cohesion.	(Ghorbani et al., 2021)
Community-Based Natural Resource Management	Local institutions and practices governing the sustainable use and protection of shared resources.	Empowers local communities, fosters a sense of ownership, leads to more effective resource stewardship.	(Mugambiwa & Makhubele, 2021)
Relational Approach to Environment	Indigenous ontologies viewing humans as integral parts of ecosystems.	Fosters stewardship that sustains both biodiversity and cultural identity.	(Silva-Ávila et al., 2025)
Decolonizing Research and Practice	Challenging colonial perspectives in environmental research and management.	Promotes respectful partnerships, ensures Indigenous knowledge is valued as an "indivisible cultural whole" (Orlove et al., 2023).	(Orlove et al., 2023)
Citizen Engagement & Cultural Revitalization	Active community participation in preserving cultural heritage and local knowledge.	Strengthens cultural identity, encourages intergenerational transmission of knowledge vital for adaptation.	(Zhang, 2023)
Local Leadership Development	Training local leaders in problem-solving and decision-making for community development.	Builds self-reliance, enables communities to continuously manage their own well-being and resources.	(Kahfi, 2022)

Inter-agency Collaboration	Strong relationships among community and public service agents.	Fosters integrated service delivery, improves public service outcomes and collective action.	(Kahfi, 2022)

The intrinsic relationship between community social structures and indigenous knowledge systems for water management is critical, especially under conditions of anthropogenic climate change (Ghorbani et al., 2021). Indigenous-led approaches, such as those demonstrated by Māori thinking in Aotearoa-New Zealand, emphasize partnership-based strategies that enhance the efficiency of waterway co-governance and directly contribute to positive environmental outcomes, increased social cohesion, and targeted actions to mitigate climate change impacts (Awatere et al., 2023). The call to place diverse knowledge systems at the core of transformative climate research highlights that solutions-based research must recognize climate change not merely as a technical problem, but as symptomatic of historical injustices, requiring decolonization of research and genuine partnerships (Orlove et al., 2023). Such partnerships necessitate respecting traditional knowledge systems in their entirety, as indivisible cultural wholes of knowledge, practices, values, and worldviews, grounded in principles of consent, intellectual and cultural autonomy, and justice (Orlove et al., 2023). This collective engagement and leadership at the local level are crucial for translating local wisdom into actionable and sustainable environmental practices (Kahfi, 2022).

4. Discussion

Infrastructure limitations further reinforced the rural character of Solear. Until the early 1990s, the road network in this area consisted mostly of local roads and village-connecting routes that were not yet fully paved, while access to the subdistrict center and larger administrative areas such as Tigaraksa and Balaraja remained limited in both quality and capacity. This condition narrowed residents' travel patterns and their interaction with economic activity centers in Kabupaten Tangerang, making community mobility dependent on simple transportation modes such as rural public transport, motorcycles, and informal transportation. This limited accessibility also affected Solear's relationship with Jakarta as the core city of the Jabodetabek metropolitan area (Hasibuan & Witasari, 2026). Separately, a systematic literature review of 150 articles shows that local wisdom and Indigenous Knowledge play an important role in addressing the crises of water sustainability and climate change, serving as adaptive and effective frameworks that complement, and in some cases surpass, conventional scientific approaches to environmental management.

Our thematic analysis revealed three key areas where local wisdom exerts a profound influence: the efficacy of traditional water management practices, its foundational role in climate change adaptation and mitigation, and its significant contribution to community-based governance and resilience. These findings resonate strongly with the grand theories introduced earlier, particularly the concept of Traditional Ecological Knowledge and its emphasis on dynamic, adaptive, and long-term interactions between communities and their environments (Whyte, 2013). The empirical evidence presented, such as the diverse range of rainwater harvesting techniques, terracing, and "Jamban systems" (Kristiyanto, 2020; Sahani et al., 2025), vividly illustrates the practical application of TEK in achieving water security. These practices exemplify the deep understanding of ecological processes and local hydrological cycles that communities have cultivated over generations, translating into efficient, low-cost, and sustainable solutions for water scarcity.

The review also highlights how local wisdom serves as a crucial foundation for climate change adaptation and mitigation. Practices such as adaptive farming techniques, indigenous weather prediction, and agroforestry (Sahani et al., 2025; Zvobgo et al., 2022) demonstrate a sophisticated understanding of environmental variability and resilience. This aligns with the "relational approach" and Indigenous relational ontologies, which view humans as integral parts of ecosystems, fostering stewardship that sustains both biodiversity and cultural identity (Silva-Ávila et al., 2025). The ability of Indigenous communities to provide contextualized adaptation plans and identify climate-related loss and damage (Reyes-García et al., 2024) further emphasizes the localized and nuanced insights that often elude broader, top-down approaches. The integration of ethnopedagogical practices in education, as seen in Jombang, Indonesia (Ali et al., 2022; Anggraeni et al., 2025), underscores the intergenerational transmission of values and knowledge essential for long-term environmental

stewardship, reinforcing the holistic nature of local wisdom that integrates body, spirit, and environment (Musi et al., 2022).

Furthermore, the study illuminates the powerful role of local knowledge systems in enhancing community-based governance and resilience. The success of social contracts for resource access, community-based natural resource management, and indigenous climate governance in regions like rural Zimbabwe (Ghorbani et al., 2021; Mugambiwa & Makhubele, 2021) showcases the effectiveness of self-organized systems rooted in collective responsibilities and equitable distribution. This is critical in fostering social-ecological systems and resilience, where communities actively manage their resources and adapt to change. The call for decolonizing research and practice, by acknowledging Indigenous knowledge as an "indivisible cultural whole" and emphasizing genuine partnerships based on consent and cultural autonomy (Orlove et al., 2023), represents a crucial evolution in environmental governance. It moves beyond mere inclusion to true integration, recognizing the intrinsic value and intellectual sovereignty of these knowledge systems.

While previous research has recognized the importance of Indigenous Knowledge in nature conservation (Abas et al., 2022) and climate adaptation (Dorji et al., 2024), this review extends this understanding by systematically integrating the evidence across both water sustainability and climate crisis mitigation. It addresses the recognized "fragmentation" and "limited systematic understanding" in the field (Chanza et al., 2024; Zvobgo et al., 2022), providing a consolidated view of how local wisdom offers concrete, context-specific, and often highly effective solutions. The tables presented in the results section serve as a structured synthesis, moving beyond general discussions to detail specific practices and their documented outcomes, thereby bridging a gap in comprehensive empirical documentation. This critical analysis also reveals the ongoing challenge of declining traditional systems due to modern pressures (Aklan et al., 2024), highlighting the urgency of revitalization and respectful integration rather than displacement.

The implications of this study are profound. Theoretically, it reinforces the necessity of adopting pluralistic epistemologies in environmental research, validating local wisdom not just as a cultural phenomenon but as a robust scientific paradigm in its own right. Practically, it advocates for policy frameworks that co-produce knowledge with Indigenous communities, facilitating the integration of traditional and scientific approaches in water management and climate action. This includes supporting initiatives that revitalize indigenous practices, ensuring intellectual property rights for traditional knowledge, and fostering inter-agency collaboration with community leadership (Kahfi, 2022). By recognizing local wisdom as a dynamic force for sustainability, we can move towards more equitable, effective, and culturally resonant solutions for our planet's most pressing environmental challenges.

5. Conclusion

This systematic literature review unequivocally demonstrates the critical and multifaceted role of local wisdom and Indigenous Knowledge in advancing water sustainability and mitigating the impacts of the climate crisis. The synthesis of academic literature highlights that traditional knowledge systems provide empirically proven and culturally appropriate strategies across various domains: from effective traditional water management practices like rainwater harvesting, terracing, and "Jamban systems," to serving as foundational elements for climate change adaptation through adaptive farming, indigenous weather prediction, and agroforestry. Crucially, local wisdom enhances community-based governance and resilience by fostering equitable resource distribution, collective management, and reinforcing a deep, relational connection to the environment.

The findings underscore that integrating local wisdom with modern scientific approaches is not merely an ethical imperative but a pragmatic necessity for developing robust, sustainable, and equitable responses to global environmental challenges. These traditional knowledge systems offer context-specific solutions that are often more resilient and adaptable to local conditions than externally imposed interventions.

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