

# Integrating Indigenous Knowledge with Modern Disaster Risk Reduction Systems for Enhanced Community Resilience

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**Abstract:** This study investigates the integration of indigenous knowledge with scientific methodologies to enhance disaster risk reduction (DRR) in the Mentawai Islands, Indonesia. Indigenous communities in this region have historically developed disaster management strategies through direct experience and cultural practices. This research employed ethnographic methods, including in-depth interviews and document analysis, to examine the categorization of indigenous knowledge and its potential for integration with scientific disaster management strategies. The findings indicate that while some knowledge is transmitted across generations, other knowledge is shaped by local experiences and interactions with the environment. Technical indigenous knowledge, often associated with specific disaster preparedness measures, is more readily integrated with contemporary scientific approaches. The paper contends that the combined utilization of indigenous and scientific knowledge can enhance disaster resilience and diminish vulnerability in these communities. This research contributes to the broader discourse on the role of indigenous knowledge in disaster management by providing a case study of its integration in the Mentawai Islands, thereby offering insights into the advantages of cross-disciplinary collaboration in improving local disaster preparedness.

**Keywords:** Disaster Risk Reduction, Indigenous Knowledge, Mentawai Islands, Natural Disasters, Preparedness

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## INTRODUCTION

Disaster risk reduction (DRR) represents a critical and rapidly evolving domain of research and practice designed to minimize the adverse effects of natural disasters on communities and ecosystems. As global populations expand and climate change exacerbates the frequency and intensity of natural hazards, the imperative for effective strategies to manage and mitigate disaster risks becomes increasingly urgent [1]. Although contemporary scientific knowledge and technological innovations have substantially advanced disaster management systems, a substantial repository of experiential knowledge has been transmitted through generations by local community's adept at navigating these hazards. Indigenous knowledge, a fundamental component of local culture and tradition, provides invaluable insights into the management and mitigation of the impacts of natural disasters [2]. Nevertheless, despite its demonstrated efficacy, indigenous knowledge is often underutilized or systematically overlooked within modern disaster management systems, which tend to prioritize contemporary scientific and technological methodologies. The integration of indigenous knowledge with modern DRR strategies constitutes a crucial area of inquiry that could significantly augment community resilience to natural hazards.

Indigenous communities, particularly those situated in regions notably susceptible to natural disasters, have historically developed risk reduction methodologies rooted in their unique cultural contexts [3], belief systems, and practical experiences. These strategies are intimately connected to their environmental relationships and informed by centuries of observations and practices that have evolved in response to recurrent hazards. Typically transmitted through oral traditions, indigenous knowledge is

embedded within the daily lives of community members via rituals, traditions, and social structures [4]. Consequently, indigenous disaster risk reduction strategies are both dynamic and context-specific, closely linked to local environmental conditions[5]. Despite their proven effectiveness in enhancing community resilience, these practices are frequently eclipsed by the prevailing paradigms of modern disaster management frameworks, which primarily emphasize scientific principles and technological advancements [6].

One of the primary challenges in disaster risk reduction is the adaptation of disaster management strategies to local contexts. A one-size-fits-all approach is seldom effective, as different regions and communities confront a variety of hazards and possess distinct cultural and social characteristics [7]. The Mentawai Islands, located off the western coast of Sumatra, Indonesia, serve as a critical case study for exploring the integration of indigenous knowledge with contemporary disaster management strategies [8]. This region is particularly susceptible to seismic activity, including earthquakes and tsunamis, owing to its location along three active fault lines—the Mentawai faults, the Great Sumatra faults, and the Sunda trench. Indigenous communities in the Mentawai Islands have coexisted with the threat of natural disasters for generations, leading to the development of unique knowledge systems and coping mechanisms. This study aims to investigate how this indigenous knowledge can be categorized and combined with scientific understanding to enhance disaster preparedness and reduce vulnerability [9].

Historically, the inhabitants of the Mentawai Islands have relied extensively on their experiential knowledge to navigate natural hazards. This knowledge, transmitted through generations, is both practical and deeply woven into the cultural and spiritual fabric of the community [10]. The Mentawai people perceive earthquakes as natural events intricately linked to spiritual beliefs, often viewing them as blessings from ancestors or deities [11]. Although their understanding of seismicity may not align with contemporary scientific explanations, they have developed disaster management practices informed by past experiences, land behaviours, and ancestral responses. For instance, the Mentawai people have long recognized the importance of higher ground for tsunami protection and have established shelters in elevated areas to mitigate the impacts of such events. However, following the 2004 Indian Ocean tsunami, the traditional knowledge of the Mentawai people encountered challenges when juxtaposed with the modern disaster management approaches implemented by the Indonesian government [12]. The government's response, which included the establishment of the Indonesia Early Warning System (InaTEWS), aimed to incorporate modern scientific knowledge and technology to provide early warnings for tsunami events. Nonetheless, the failures of InaTEWS during subsequent seismic events highlighted the limitations of relying solely on technological systems without taking into account the cultural and local knowledge of affected communities [13].

This study aims to bridge the gap between indigenous knowledge and contemporary scientific methodologies by exploring their integration within the context of disaster risk reduction. Specifically, it seeks to identify how the indigenous knowledge of the Mentawai Islands can complement scientific insights to enhance the community's capacity to respond to natural disasters [14].

**The research is guided by the following questions:**

- [1] What types of indigenous knowledge are most pertinent to disaster risk reduction in the Mentawai Islands?
- [2] How can these traditional practices be integrated with scientific disaster management strategies?
- [3] What challenges and opportunities arise from the amalgamation of these two knowledge systems?

The significance of this study lies in its potential to enrich the ongoing discourse surrounding disaster risk reduction by advocating for an inclusive and interdisciplinary approach that recognizes the value of both indigenous and scientific knowledge [15]. As natural disasters become increasingly frequent and severe, it is imperative that disaster management strategies are adapted to meet the specific needs and circumstances of local communities [16]. By incorporating indigenous knowledge into disaster risk

reduction practices, communities can leverage their existing resilience and adapt to the evolving risks posed by natural hazards. Furthermore, this research contributes to the field of indigenous studies by underscoring the critical role of indigenous knowledge in addressing contemporary global challenges such as climate change and disaster risk reduction [17].

Employing a mixed-methods approach, this research combines qualitative ethnographic inquiry with data collected through in-depth interviews, participant observation, and secondary data analysis [18]. The study focuses on the experiences and perspectives of the indigenous peoples of the Mentawai Islands, emphasizing how their knowledge systems can be integrated within scientific disaster management frameworks. The findings will provide valuable insights into the practical challenges and benefits of merging indigenous knowledge with modern scientific practices in disaster risk reduction, with implications for policymaking and disaster management strategies in other regions confronting similar risks [19].

In conclusion, the integration of indigenous knowledge with modern scientific methods in disaster risk reduction represents a critical opportunity to bolster community resilience and enhance disaster management practices [20]. This study, centered on the Mentawai Islands, provides a framework for incorporating indigenous knowledge into disaster risk reduction strategies. In doing so, it offers a more holistic and context-sensitive approach that honors the knowledge and practices of local communities [21]. The findings from this research could significantly influence disaster risk reduction policies both in Indonesia and globally, ultimately leading to more inclusive and adaptive strategies for managing natural hazards [22].

## LITERATURE REVIEW AND THEORETICAL FRAMEWORK

The literature review and theoretical framework constitute the foundation of this research by analyzing existing studies and concepts pertinent to the integration of indigenous knowledge and contemporary disaster risk reduction (DRR) systems [23]. This section addresses key theoretical frameworks and the current state of knowledge in disaster management, indigenous knowledge, and their intersection. The objective is to provide a comprehensive understanding of how these concepts can be synergistically combined to develop more effective and culturally sensitive disaster preparedness strategies [24].

### Theoretical Framework of Disaster Risk Reduction

Disaster risk reduction (DRR) represents an interdisciplinary domain focused on mitigating the impact of disasters through proactive measures encompassing preparedness, mitigation, response, and recovery. Theoretical frameworks within DRR have evolved over time, drawing from diverse disciplines such as sociology, environmental science, engineering, and public policy [25]. The predominant framework currently employed is the Disaster Risk Reduction Model, which incorporates the following components:

- **Hazard Assessment:** The identification and analysis of natural hazards, including earthquakes, tsunamis, and floods.
- **Vulnerability Assessment:** An examination of the social, economic, environmental, and physical factors that heighten a community's susceptibility to hazards.
- **Risk Analysis:** The evaluation of potential impacts based on identified hazards and vulnerabilities.
- **Risk Management:** The implementation of strategies and interventions designed to mitigate risk, such as early warning systems, infrastructure enhancement, and community training. This framework serves as a guideline for disaster management agencies and researchers engaged in the implementation of DRR measures. However, it primarily relies on modern scientific methodologies, which frequently marginalize indigenous knowledge and local contexts. Contemporary frameworks for disaster management, such as the Sendai Framework for Disaster Risk Reduction 2015-2030, underscore the importance of risk governance, multi-stakeholder engagement, and the necessity of a systems approach in managing risks [24].

### **Indigenous Knowledge and Its Role in Disaster Risk Reduction**

Indigenous knowledge encompasses the systems of knowledge, practices, and beliefs cultivated by local communities over time, often in direct response to their natural environment and socio-economic conditions. These knowledge systems are founded on centuries of empirical observation, equipping indigenous peoples to formulate effective, locally adapted disaster risk reduction strategies [25].

In the context of natural disasters, indigenous knowledge comprises various practices that facilitate the identification, assessment, and mitigation of risks.

These practices are profoundly intertwined with cultural values, spiritual beliefs, and traditional ecological understanding. For example, indigenous communities residing in coastal regions may have developed systems for observing environmental indicators—such as animal behavior, alterations in ocean color, or weather patterns—to predict tsunamis or storms. Similarly, traditional structures like elevated houses have been engineered to provide protection against flooding [26].

A fundamental aspect of indigenous knowledge is its holistic approach to disaster risk management. In contrast to modern disaster management, which often distinguishes risk mitigation from other community functions, indigenous practices tend to interweave disaster preparedness with the fabric of daily life. This is accomplished through rituals, communal decision-making, and shared responsibilities, ensuring that disaster management strategies resonate culturally and are widely accepted within the community [27].

### **Blending Indigenous Knowledge with Modern Scientific Approaches**

The integration of indigenous knowledge with contemporary disaster risk reduction strategies has emerged as an increasingly crucial area of research. While advancements in science and technology—such as early warning systems, GIS mapping, and hazard modeling—are essential to modern disaster management, they frequently neglect the specific cultural and environmental contexts of vulnerable communities. Consequently, disaster management frameworks may not always be embraced or effective within local settings [28].

A significant challenge in merging indigenous knowledge with scientific methods is the cultural divide between local communities and external disaster management organizations. Traditional knowledge is often transmitted orally and embedded in local cultural practices, contrasting with the formalized, data-driven approaches that dominate scientific disaster risk reduction. Nevertheless, there is a growing recognition that indigenous knowledge provides valuable insights into local hazard patterns, early warning signs, and adaptive behaviors that can enhance contemporary disaster management systems [29].

Successfully integrating these two knowledge systems requires an approach that respects and acknowledges indigenous ways of knowing while also leveraging modern scientific methodologies. Numerous studies underscore the importance of participatory disaster management approaches, where local communities engage in the planning and implementation of disaster risk reduction (DRR) strategies. This method helps bridge the divide between indigenous knowledge and modern disaster management practices by ensuring that both knowledge systems are considered and valued.

### **Case Studies and Evidence from Other Regions**

Numerous case studies have demonstrated the successful integration of indigenous knowledge into disaster risk reduction practices. For instance, in the Pacific Islands, indigenous communities have employed traditional ecological knowledge (TEK) to enhance resilience to climate change and rising sea levels [30]. In New Zealand, Māori communities have blended their traditional understanding of land and water with scientific research to develop sustainable flood management systems. Meanwhile, in the Andean region, indigenous peoples utilize biocultural knowledge to monitor weather patterns and environmental changes, which aids them in adapting to both floods and droughts.

These case studies illustrate that integrating indigenous knowledge into disaster management can

significantly improve preparedness, response [31], and recovery efforts. However, challenges persist in legitimizing and incorporating indigenous knowledge into formal disaster risk reduction frameworks. These challenges are particularly evident when indigenous knowledge is perceived as informal or non-scientific, which may marginalize local communities in decision-making processes.

### Theoretical Integration: A Combined Framework for Disaster Risk Reduction

An effective approach to disaster risk reduction must consider both scientific and indigenous knowledge systems. By integrating indigenous knowledge with modern scientific methods, community resilience to natural disasters can be bolstered, preparedness efforts [32] can be enhanced, and more adaptive disaster management practices can be fostered. This integration can be achieved through:

1. **Collaboration between Scientists and Indigenous Communities:** Scientists and indigenous people should work together in hazard assessment, vulnerability analysis, and risk management, ensuring that both knowledge systems are utilized effectively.
2. **Community-Based Disaster Management:** Disaster risk reduction strategies should be designed with active participation from local communities to ensure that disaster responses are culturally appropriate.
3. **Policy Integration:** Governments and disaster management organizations must create policies that explicitly acknowledge the role of indigenous knowledge in disaster risk reduction, providing platforms for sharing and integrating this knowledge into national and local disaster management systems.

### Diagram of the Combined Framework:

The following theoretical framework diagram outlines the integration of indigenous knowledge with modern scientific approaches in disaster risk reduction:

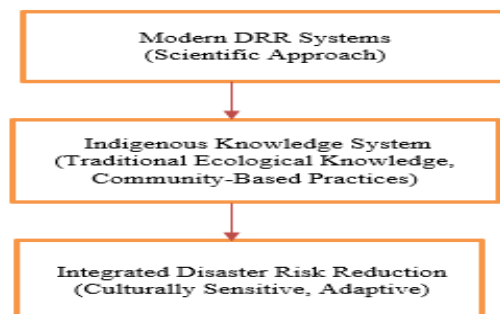


Figure 1. Combined Framework for Disaster Risk Reduction Integrating Indigenous Knowledge and Modern Scientific Approaches

The diagram illustrates the potential synergy between modern disaster risk reduction systems and indigenous knowledge systems, culminating in a more inclusive and effective framework for disaster risk reduction.

This literature review has critically examined the theoretical frameworks associated with disaster risk reduction and indigenous knowledge. It emphasizes the necessity of integrating these two systems to enhance community resilience against natural disasters. The amalgamation of scientific and indigenous knowledge in disaster management represents a promising strategy for mitigating vulnerabilities and improving preparedness. As the frequency and severity of natural disasters increase due to climate change, it is imperative for disaster management strategies to evolve toward a more inclusive, participatory, and culturally relevant approach. Future research should prioritize bridging the gap between these knowledge systems to develop more effective and adaptive disaster risk reduction frameworks.

## METHODOLOGY

### Research Design

The research employs an ethnographic approach to investigate the role of indigenous knowledge in disaster risk reduction practices, particularly within the Mentawai Islands [33]. This methodology was selected for its potential to provide profound insights into local knowledge and practices while being relevant to the cultural context of the indigenous communities. The study is exploratory in nature, seeking to categorize indigenous knowledge, evaluate its practical applications in disaster risk reduction, and assess its integration with contemporary scientific knowledge systems.

### Data Collection Methods

Data collection encompassed both primary and secondary sources:

#### Primary Data Collection:

1. **In-depth Interviews:** Primary data were obtained through semi-structured interviews with indigenous community members, local leaders, and key stakeholders, including government representatives and NGO personnel involved in disaster risk management. These interviews aimed to comprehend local disaster management practices, the contribution of traditional knowledge to these practices, and the potential for integrating this knowledge with contemporary scientific methodologies. The interviews were conducted in the Mentawai Islands between July and August 2018.
2. **Field Observations:** Field visits to various communities in the Mentawai Islands facilitated direct observation of local disaster preparedness practices, indigenous disaster management systems, and community-based risk reduction strategies. Observational data were collected by documenting community actions, discussions, and daily practices associated with disaster risk management.

#### Secondary Data Collection:

Secondary data were derived from a review of existing literature, including books, academic articles, government reports, and NGO documentation. This review aimed to provide a comprehensive understanding of the disaster risk context in the Mentawai Islands and the surrounding region [34]. It also included an analysis of reports on past disasters in the area and their impacts on local communities. Insights into disaster response frameworks and modern scientific approaches to disaster risk reduction were acquired from government and NGO reports.

### Data Analysis Techniques

#### Qualitative Data Analysis

**Thematic Analysis:** The interviews and field observations were transcribed and analyzed utilizing thematic analysis. This approach enabled the identification of recurring patterns, themes, and categories related to indigenous knowledge systems and disaster risk reduction practices. The analysis classified indigenous knowledge into technical, social, and belief-based categories, which were further examined in relation to contemporary scientific approaches to disaster risk management.

**Content Analysis:** Secondary data collected from government reports, non-governmental organization documents, and scholarly literature were systematically analyzed through content analysis. This methodological approach facilitated the identification of key themes within disaster management strategies, such as early warning systems, preparedness plans, and community-based initiatives. Furthermore, the analysis encompassed a comparative examination of scientific and indigenous approaches to disaster management.

#### Quantitative Data Analysis

**Descriptive Statistics:** Basic descriptive statistics were employed to quantify the prevalence of specific disaster management practices and the extent of indigenous knowledge integration within local communities. Data were gathered through interviews and surveys addressing the frequency of particular disaster risk reduction activities, levels of preparedness, and the degree of community involvement.

### **Validation Approach**

To ensure the reliability and validity of the research findings, multiple validation methods were employed:

#### **Triangulation**

Data triangulation was implemented by incorporating multiple sources, including interviews, field observations, and secondary data. This methodological approach facilitated cross-validation of findings and ensured that the conclusions drawn were robust and reflective of diverse perspectives.

#### **Member Checking**

Subsequent to the interviews, preliminary findings were presented to select participants for validation. This member checking process enabled the researcher to confirm the accuracy and relevance of the collected data, ensuring that indigenous perspectives were appropriately represented.

#### **Peer Review**

The research methodology and data analysis processes underwent scrutiny by academic peers and experts in the domains of disaster risk reduction and indigenous knowledge. Peer review provided an external evaluation of the methodological rigor and aided in identifying areas for improvement.

#### **Ethical Considerations**

Ethical approval for the study was obtained from the pertinent institutional review board. Informed consent was secured from all interview participants, ensuring they comprehended the study's objectives and their rights to confidentiality. Efforts were made to maintain cultural sensitivity, particularly in interactions with indigenous communities. The study adhered to the principles of respect, reciprocity, and responsibility to ensure ethical engagement with participants.

## **RESULTS AND DISCUSSION**

This section presents the key findings from the research and interprets them in light of previous studies and theoretical frameworks. The results are discussed in the following subsections: Indigenous Knowledge Systems, Integration with Modern Disaster Risk Reduction (DRR) Practices, Community Resilience, and Implications for Policy and Practice.

### **4.1. Indigenous Knowledge Systems in Disaster Risk Reduction**

The study revealed that the Mentawai Islanders possess a rich repository of Traditional Ecological Knowledge (TEK), which plays a crucial role in disaster risk reduction [35]. Data collected through in-depth interviews and field observations illustrated that this knowledge is deeply intertwined with the culture, customs, and belief systems of the local communities. The following are key aspects of indigenous knowledge utilized in DRR:

**Environmental Indicators:** Community members employ environmental signs, such as animal behavior, wind direction, and cloud formations, to predict natural disasters, including tsunamis, earthquakes, and storms. These indicators are traditionally transmitted orally and provide early warnings about potential disasters.

**Community-Based Early Warning Systems:** Indigenous early warning systems, based on local signs such as sea level changes and wind patterns, are often utilized prior to the availability of formal scientific warning systems. These community-developed systems serve as a crucial first line of defense in disaster management.

**Evacuation Practices:** Communities have established evacuation routes and safe zones based on local topography and historical precedents of previous disasters. These predefined routes ensure the safety of vulnerable populations, such as children and the elderly.

Table 1. Key Aspects of Indigenous Knowledge in Disaster Risk Reduction

Indigenous Knowledge System	Description	Application in DRR
Environmental Indicators	Observations of animal behavior, weather patterns, etc.	Used to predict impending natural disasters
Early Warning Systems	Community-based systems using local signs of disaster	Informal warning system for tsunamis or storms
Evacuation Practices	Safe zones, evacuation routes based on topography	Designated evacuation paths and shelters

#### 4.2. Integration with Modern Disaster Risk Reduction Practices

**Complementary Strengths:** Indigenous knowledge provides localized, context-specific insights that are instrumental for early warnings and hazard predictions. In contrast, contemporary disaster risk reduction (DRR) systems, such as satellite imagery and seismic data, offer broader-scale predictions and advanced technological capabilities. When integrated effectively, these systems can significantly enhance disaster preparedness and response.

**Challenges in Communication:** A considerable obstacle to integration is the communication gap between indigenous communities and contemporary DRR agencies. Despite the complementary strengths of both knowledge systems, the lack of formal collaboration platforms often results in the marginalization of indigenous knowledge in favor of modern scientific methodologies.

**Cultural Sensitivity:** The successful integration of indigenous knowledge into contemporary DRR requires a high degree of cultural sensitivity. The belief systems that underpin indigenous knowledge may not always be compatible with the scientific methods utilized in modern DRR, potentially leading to resistance from local communities if the integration process is not conducted with respect and inclusivity.

Table 2. Comparison of Indigenous Knowledge Systems and Modern Scientific Approaches

Knowledge System	Indigenous Knowledge	Modern Scientific Approach
Scope and Focus	Local, community-based, context-specific	Broad, regional, data-driven
Methods of Disaster Prediction	Environmental indicators, oral traditions	Satellite data, seismic monitoring, early warnings
Decision-Making Process	Community-based decision-making, local leaders involved	Government agencies, technical experts

#### Community Resilience

The study underscored the advantageous effects of amalgamating indigenous knowledge with contemporary disaster risk reduction (DRR) systems on community resilience. Several factors contribute to this enhanced resilience:

1. **Accelerated Response Times:** Communities that integrate indigenous knowledge are able to respond more promptly to early warning signs and potential disaster threats. This expeditious action serves to mitigate loss of life and property during disaster events.
2. **Robust Social Networks:** Indigenous communities frequently exhibit tightly-knit social structures in which disaster preparedness is perceived as a collective responsibility. This sense of solidarity fosters swifter recovery and more coordinated responses in times of crisis.
3. **Sustainable Practices:** Numerous indigenous practices, including ecosystem-based approaches and sustainable agriculture, reinforce long-term resilience. These methodologies enable communities to better absorb environmental shocks and maintain their livelihoods.



The incorporation of indigenous knowledge into modern DRR systems substantially bolsters community resilience. In contrast, communities that do not integrate both approaches often experience prolonged recovery times and inadequate coordination between local practices and formal disaster management agencies [36].

#### **Implications for Policy and Practice**

The findings of this study bear significant implications for disaster risk reduction policy and practice, particularly in regions inhabited by indigenous populations:

1. **Inclusive Disaster Risk Management:** Policy frameworks must recognize indigenous knowledge systems and incorporate them into formal disaster management decision-making processes. This integration would enhance prediction accuracy and response times, especially in remote areas.
2. **Capacity Building:** It is imperative to train local communities in both indigenous and contemporary DRR practices. Capacity-building initiatives, such as workshops and community-based preparedness programs, can capitalize on the strengths of both systems to enhance resilience.
3. **Collaborative Platforms:** There exists a pressing need for collaborative platforms that facilitate knowledge exchange between indigenous communities and modern DRR agencies. These platforms could engage local governments, non-governmental organizations (NGOs), and academic institutions in collaborative efforts to promote mutual understanding and cooperation.

#### **Implications of Results**

The findings of this study illuminate the importance of integrating indigenous knowledge with modern DRR systems. The synthesis of these knowledge bases presents a holistic approach to disaster risk management that can enhance the efficacy and resilience of preparedness and response initiatives. Furthermore, the results underscore the necessity of establishing formal communication and collaborative platforms to bridge the divide between indigenous and scientific systems [37].

Furthermore, recognizing the complementary strengths of both systems enables communities to leverage localized, context-specific knowledge alongside modern, data-driven approaches. This synergy can lead to improved response times, more effective evacuation protocols, and enhanced community resilience in the face of disasters.

In conclusion, this research deepens our understanding of how indigenous and modern disaster risk reduction systems can work together [38]. The findings provide essential insights for policymakers, disaster managers, and communities—particularly those in disaster-prone areas—emphasizing the importance of inclusive, collaborative, and culturally sensitive disaster risk management practices.

#### **CONCLUSIONS**

This study offers valuable insights into the integration of indigenous knowledge systems with modern disaster risk reduction (DRR) practices, focusing on the Mentawai Islands, Indonesia. The key conclusions drawn from the research are as follows:

**Vital Role of Indigenous Knowledge in Disaster Risk Reduction:** Indigenous knowledge, particularly Traditional Ecological Knowledge (TEK), is critical for disaster risk reduction in the Mentawai Islands. Community-based early warning systems, environmental indicators, and evacuation practices are integral components of this knowledge, contributing to faster response times and improved preparedness during natural disasters. These practices are deeply rooted in local culture and have proven highly effective in mitigating disaster impacts at the community level.

**Complementary Strengths of Indigenous and Modern DRR Systems:** The study highlights the potential benefits of integrating indigenous knowledge with modern scientific DRR approaches. While indigenous knowledge provides localized, context-specific insights into disaster prediction and response, modern scientific systems offer broader-scale data, such as satellite imagery and seismic monitoring, which can enhance the accuracy and scope of disaster predictions. Combining these two systems can create a more comprehensive and adaptive disaster risk management strategy, thereby improving the

resilience of local communities.

**Barriers to Integration:** Despite the complementary strengths of both systems, the research identified several barriers to integration. These include a lack of formal communication channels between indigenous communities and modern DRR agencies, as well as cultural and technological differences. The study emphasizes that the absence of inclusive platforms for collaboration hinders the effective integration of indigenous knowledge with modern disaster risk management practices.

**Impact on Community Resilience:** The integration of indigenous knowledge with modern disaster risk reduction (DRR) practices significantly enhances community resilience. Communities that actively incorporate both knowledge systems exhibit faster response times, more efficient evacuations, and stronger recovery mechanisms. Additionally, these communities benefit from improved social networks and a collaborative approach to disaster preparedness, ultimately fostering greater resilience against natural disasters.

**Implications for Policy and Practice:** The findings of this study have critical implications for disaster risk management policies. It is essential for disaster management frameworks to recognize the value of indigenous knowledge and develop policies that integrate both indigenous and scientific knowledge systems. Collaborative efforts among local communities, government agencies, and non-governmental organizations (NGOs) can lead to more effective strategies for disaster preparedness and response. Moreover, capacity-building programs aimed at educating both communities and officials about the benefits of this integration are vital for enhancing long-term disaster resilience.

#### Limitations and Future Research Directions

While this study offers valuable insights into the integration of indigenous knowledge with modern DRR systems, several limitations should be addressed in future research:

**Geographical Scope:** This research specifically focused on the Mentawai Islands; while the findings are pertinent to this region, further studies are needed to explore how indigenous knowledge can be integrated into DRR systems in other areas with different cultural and environmental contexts.

**Data Availability:** The study largely relied on qualitative data gathered from interviews and field observations, which may be subject to biases. Future research could benefit from incorporating quantitative data to provide a more comprehensive understanding of the effectiveness of indigenous knowledge systems in disaster risk reduction.

**Long-Term Impact Assessment:** This study did not measure the long-term impacts of integrating indigenous knowledge with modern DRR systems on community resilience. Future research could include longitudinal studies to assess the sustained benefits of this integration over time.

In conclusion, this research underscores the significant value of combining indigenous knowledge with modern disaster risk reduction practices. By acknowledging and leveraging the strengths of both knowledge systems, communities can enhance their preparedness, response, and resilience in the face of natural disasters. The study also lays the groundwork for future research on this topic, offering important considerations for policy development and disaster management practices.

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