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Strengthening Risk Communication in Disaster Management Based Religion and Local Wisdom in North Sumatra

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ABSTRACT

North Sumatra is a region with a high level of disaster vulnerability, particularly the eruption of Mount Sinabung and flash floods in Langkat. The government's risk communication remains technocratic and one-way, making it less suited to the community's perspective, which is heavily influenced by religious values and local wisdom. Consequently, some residents rely more on natural signs, kinship networks, and the authority of religious figures in responding to disaster threats. This situation highlights the importance of integrating cultural and spiritual values into mitigation strategies. This study aims to analyze the forms of risk communication occurring in the community, identify relevant religious values and local wisdom, and formulate strategies to strengthen risk communication based on the local context. A qualitative case study approach was used in Karo and Langkat Regencies through in-depth interviews, observation, and documentation, which were then analyzed using an interactive analysis model. The results indicate that risk communication occurs through three channels: formal government channels, culture-based communication, and religious communication. Values such as mutual cooperation, traditional taboos, natural signs, and religious moral messages strengthen information acceptance and enhance community preparedness. This research implies the need for an integrative risk communication model involving religious leaders, traditional leaders, and the government to build more effective and sustainable disaster resilience.

***Keywords**: Community resilience; disaster management; local wisdom; religion; risk communication.*

INTRODUCTION

Indonesia, located in the *Ring of Fire,* is highly vulnerable to various natural disasters, particularly earthquakes, volcanic eruptions, floods, and landslides. North Sumatra is one of the provinces most affected by these risks, as evidenced by the eruption of Mount Sinabung, earthquakes, flash

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floods, and landslides that occur almost annually. Several areas, such as Karo Regency, Langkat, Mandailing Natal, and Deli Serdang, face a combination of geological and hydrometeorological threats on a recurring basis. This situation underscores the importance of strengthening disaster risk mitigation and communication at the local level.

Disaster management efforts have tended to rely on a top-down and technocratic approach, resulting in a one-way communication process from the government to the community. This mismatch in the socio-cultural context has resulted in a low level of public understanding of risks and minimal public involvement in disaster mitigation. Yet, the people of North Sumatra possess significant cultural richness, such as the Dalihan Na Tolu philosophy of the Batak people, the social values of the Karo, Mandailing, and Nias communities, and various forms of local wisdom related to knowledge of natural change. Furthermore, religion plays a central role in community life; religious leaders wield strong social legitimacy in shaping public attitudes, behavior, and opinion.

The enormous potential of religious and cultural values has not been optimally utilized in disaster risk communication strategies. Various government communication programs remain generic and lack context, making them difficult for the public to accept. This highlights the need for a more participatory, culturally and spiritually based risk communication approach to enhance community preparedness. The involvement of religious and traditional leaders is crucial given their emotional closeness to the community and their ability to convey meaningful messages in symbolic and moral language. Values such as mutual cooperation, taboos, disaster myths, and natural symbols can be more effective risk communication tools.

The national regulatory framework also emphasizes the importance of education-based mitigation. Law No. 23 of 2007 states that mitigation is a series of actions to reduce disaster risk through community awareness and capacity building. Article 47 paragraph 2(c) explains that mitigation can be carried out through education, outreach, and training, both conventional and modern. Similarly, Pramana et al. (2024) emphasize that integrating the character of the disaster-affected community with government regulations can only be achieved through cohesive communication that fosters shared understanding. However, in emergency situations, establishing effective communication is challenging due to rigid government bureaucracy and the community's tendency to

rely on local values or unvalidated information.

The high disaster risk in North Sumatra is increasingly evident in data from the North Sumatra Regional Disaster Management Agency (BPBD). The Head of BPBD, Tuahta Ramajaya Saragih, reported that throughout 2024, 677 disasters occurred, impacting 33 districts/cities. Forest and land fires were the dominant disaster, with 237 incidents affecting 2,638,265 hectares, followed by landslides, floods, extreme weather, tidal waves, drought, and disease epidemics. The damage impacted settlements, education, health facilities, places of worship, bridges, and even community kiosks. Data from the BPBD's Operational Operations Center (PUSDALOPS) shows that throughout 2024, there were 63 deaths, 176 injuries, 4,878 refugees, and 297,241 people affected. This situation demands a more responsive and adaptive risk communication system to minimize casualties in subsequent disasters.

Risk communication in a disaster context is the process of exchanging *real-time information* between experts, officials, and affected communities (R. D. Lestari, 2022; Syuryansyah & Habibi, 2024). The goal is to support decision-making and reduce the threat of hazards (Kar & Cochran, 2019; Maarif, 2012; Sutton et al., 2020) . In various countries, effective risk communication has been shown to increase resilience and mobilize communities. However, in Indonesia, its effectiveness is heavily influenced by the cultural context and unique social relations.

In the past two decades, local knowledge has been recognized as a crucial resource in multilateral agreements on disaster risk reduction. Numerous studies confirm that local wisdom has significantly contributed to saving lives, from the past to the present (Fakhruddin & Elmada, 2022; Lambert & Scott, 2019; Lusia et al., 2025; Makondo & Thomas, 2018; Okorafor, 2010). Local wisdom encompasses knowledge and skills developed through adaptation to the environment and passed down across generations. Cultural transmission, belief systems, and customary institutions form effective collective mechanisms for mitigating risk. Kinship networks and the collective values of indigenous communities are important strategies for strengthening collective action while reducing dependence on external assistance (Berkes & Berkes, 2009; K Kosim et al., 24 C.E.; Mailin et al., 2023; Rozi et al., 2021; Rumbach & Foley, 2014; Suciani et al., 2018).

These studies highlight how belief systems, customary institutions, and kinship networks function as collective mechanisms that strengthen

social responses to disasters and reduce dependence on external assistance. They highlight the importance of traditional aspects in building disaster resilience through the transmission of experiential knowledge from generation to generation.

However, this study differs significantly in its approach, particularly in the integration of formal risk communication with local knowledge based on religion and culture. While previous studies focused more on the role of local wisdom in the context of unstructured knowledge and the social experience-based knowledge of indigenous communities, this study emphasizes the collaboration between scientific knowledge from the government and cultural and religious knowledge, a factor often overlooked in similar research.

Unlike previous studies that focused on local wisdom mechanisms in isolation or within the context of general policies, this study proposes a culturally and spiritually based risk communication model that involves religious leaders, traditional figures, and the government to create a more integrated and adaptive communication approach for local communities. This study also focuses on the crucial role of religious leaders in conveying mitigation messages, an area understudied in the context of risk communication, particularly in areas with strong religious and traditional values. Thus, this study contributes to developing a risk communication model that does not only rely on local knowledge or scientific knowledge, but rather emphasizes the importance of collaboration between the three to build a more inclusive and sustainable mitigation system, which is an element that has not been widely found in previous studies.

This research uses a qualitative approach with a case study method because it aims to understand the phenomenon of religion-based risk communication and local wisdom in disaster management in depth and holistically in communities in disaster-prone areas in North Sumatra. A qualitative approach is deemed appropriate because it allows researchers to understand the meaning, perspectives, and patterns of social interaction in the community naturally, as emphasized. Moleong (2019) states that qualitative research seeks to understand phenomena contextually through the presentation of descriptive data. Sugiyono (2020) explains that qualitative research positions researchers as key instruments directly involved in data collection, thus providing flexibility in capturing social dynamics in the field. The case study method was chosen because the research focused on a specific situation that is bound by space and

time, namely the practice of risk communication in disaster management in Karo Regency (Mount Sinabung Eruption) and Langkat Regency (Flash Flood) North Sumatra. Creswell (2013) states that case studies aim to explore in depth a system that is bound through various data sources so that researchers can uncover social patterns, practices, and experiences comprehensively.

The research location is in Karo Regency (Mount Sinabung Eruption) and Langkat Regency (Flash Flood) North Sumatra. The duration of this research lasted for six months, from January to June 2024. The determination of respondents was carried out purposively which can be done by determining their characteristics as explained by Sugiyono (2020), namely selection based on the consideration that the informant understands the phenomenon being studied. The number of informants in this study was 30 people, consisting of 10 religious leaders, 5 traditional leaders, 5 BPBD officials, 5 disaster volunteers, and 5 disaster-affected communities who have direct experience in the risk communication process and the use of local wisdom in dealing with disasters. This informant selection aims to obtain rich and relevant data from various perspectives so that the findings obtained reflect the overall social reality.

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Data collection was conducted through in-depth interviews, participant observation, and documentation studies. In-depth interviews were used to explore informants' experiences, knowledge, and perspectives on risk communication and local religious and cultural

practices used in disaster mitigation. Moleong (2019) stated that interviews in qualitative research are directed conversations to uncover the meaning behind informants' actions and thoughts. Observations were conducted to capture social dynamics and community interactions in the context of everyday life, including how religious symbols, customs, and local rituals are used in responding to disaster threats. Bungin (2019) emphasized the importance of observation in qualitative research as an effort to understand empirical data directly from the natural context. Documentation was used to obtain written data such as BPBD reports, disaster archives, recordings of traditional and religious activities, and statistical data. Zed (2018) stated that documents are important sources that complement field data and strengthen the interpretation process.

The collected data was analyzed using an interactive analysis model that includes data reduction, data presentation, and conclusion drawing. This process continues from data collection until the final report is written. Data reduction is carried out by filtering relevant information, grouping, and organizing data according to the research theme. The data presentation is arranged in a systematic narrative to facilitate researchers in understanding the flow of findings. Conclusions are drawn by examining patterns of relationships between data, emerging themes, and the social meaning of risk communication practices. Sugiyono (2020) emphasizes that qualitative data analysis is cyclical, continuous, and evolves according to the dynamics of field data. Creswell (2013) also emphasizes the importance of the codification process in identifying the core themes of case studies.

Data validity was examined through credibility, transferability, dependability, and confirmability tests as described (Moleong, 2019). Credibility was achieved through source and time triangulation. Transferability was achieved through compiling a detailed description of the research context so that the findings could be applied in similar contexts. Dependability was achieved by conducting a thorough audit of the research process, while confirmability ensured that the findings were truly derived from the data, not from researcher bias. Nazir (2014) explained that research procedures are necessary to maintain the systematic and accurate scientific process. Yusuf (2019) emphasized that research ethics are important to maintain research integrity and protect informants. This approach was chosen because it can reveal the role of religion, customs, and local wisdom in strengthening risk communication

and community resilience to disasters, thus providing theoretical and practical contributions to the development of disaster management strategies based on cultural and spiritual values in North Sumatra.

RESULTS AND DISCUSSION

This study found that disaster risk communication in North Sumatra, particularly in Karo and Langkat Regencies, took place through three main channels: formal communication delivered by the government, culture-based communication carried out by the community, and religious communication delivered by religious leaders.

Forms of Disaster Risk Communication

Research on disaster risk communication in North Sumatra, particularly in Karo and Langkat Regencies, shows that the process of exchanging information about hazards and mitigation measures occurs through complex patterns and is influenced by geographic, social, cultural, and religious factors. The two research areas have different risk characteristics. Karo faces the threat of Mount Sinabung eruptions, while Langkat faces flash floods originating from upstream areas and changing hydrometeorological conditions. Despite these differences in threats, risk communication mechanisms in both regions show relatively similar patterns, in which technical information from the government interacts with local knowledge systems and religious authorities deeply rooted in community life.

Government risk communication primarily focuses on conveying technical information regarding hazard status, early warnings, and evacuation instructions. Local governments, through the Regional Disaster Management Agency (BPBD), sub-district officials, village heads, the Indonesian National Armed Forces (TNI) and the Indonesian National Police (POLRI), and the Mount Sinabung Observation Post (PVMBG), are the primary sources of official messages. Information is disseminated through village loudspeakers, WhatsApp groups, radio communications, patrol cars, warning banners, and government social media accounts.

In the context of Sinabung, information on the volcano's status is routinely disseminated based on reports from the Center for Volcanology and Geological Disaster Mitigation (PVMBG), which updates the volcano's activity level. In Langkat, early warnings regarding rising water

levels or potential flash floods are delivered through village heads and volunteer teams. However, this formal communication is not always optimally effective, as communities often perceive government messages as overly technocratic, irrelevant to local perspectives, and using language they don't fully understand. People often find the messages too technocratic and difficult to understand. A Karo informant, Mrs. S, stated, " *Government messages are often difficult to understand, especially when they are delivered only through village loudspeakers. We trust what our family or religious leaders say more* ." Furthermore, several informants stated that information regarding the danger zone or the level of volcanic activity was difficult to interpret without explanation in the context of their daily lives. This led some residents to rely more on direct observation of natural signs or informal messages circulating within the community.

Despite limitations in formal communication, culturally based risk communication plays a crucial role in shaping community responses. Karo sociocultural structures, such as rakut si telu (traditional community gatherings) and inter-clan kinship networks, serve as channels for the rapid and reliable dissemination of information. Information about eruption threats, wind direction, potential pyroclastic flows, and evacuation route conditions is often reinforced through conversations in jambur (designated areas) or through small family gatherings. Karo people also utilize natural signs as a form of early warning, such as changes in the sound of Mount Sinabung, animal behavior, or ground vibrations. This pattern is not simply a traditional practice, but rather an adaptive mechanism passed down from generation to generation. A similar pattern is found in Langkat, where people pay attention to changes in river water color, rumbling sounds from upstream, or certain odors believed to be signs of impending flash floods (Simon Hutagalung & Himawan Indrajat, 2020). This local knowledge system has been shown to increase community awareness, and in some cases, information spreads faster than official government communications.

Religious Values and Local Wisdom for Risk Communication

Religious values and local wisdom in North Sumatra have significant potential to support disaster risk communication, particularly in areas facing recurrent disasters, such as Karo and Langkat Regencies. Field findings indicate that communities in both regions use value systems, kinship structures, and religious teachings as a foundation for

understanding, responding to, and disseminating information related to disaster threats. In this context, cultural and religious values are not only social elements but also function as communication mechanisms that strengthen community awareness, social cohesion, and preparedness.

Among the Karo people living around Mount Sinabung, local wisdom is reflected in their ability to read natural signs, interpret changes in animal behavior, and understand sound patterns from within the volcano as warning signs of danger. This knowledge has been passed down from generation to generation and has become part of the highland community's habitus. Traditional Karo values, such as strengthening kinship networks through rakut si telu (traditional gatherings), provide a fast, accurate, and reliable channel for disseminating information. When volcanic activity increases, informal communication between families and clans plays a crucial role in conveying warning messages, determining evacuation procedures, and distributing aid. These mechanisms demonstrate that customary structures are not merely symbols but social infrastructure that can expedite the flow of information in emergency situations.

In Langkat Regency, the local wisdom of communities living along rivers exhibits a similar pattern. Knowledge of changes in water color, roaring sounds from upstream, pungent odors, and wildlife movements are often early indicators of potential flash floods. This knowledge is enriched by stories passed down through generations about past floods, which inform current decision-making. Furthermore, the deeply rooted value of mutual cooperation within the Langkat Malay community provides a collective foundation that accelerates coordination, evacuation, and post-disaster response. Field findings indicate that communities will immediately contact each other, knock on neighbors' houses, and even use traditional musical instruments like gongs to warn of danger, even before an official government warning is received.

Furthermore, local wisdom values such as taboos, myths, and natural symbols play a role in shaping risk perceptions. In the Karo community, there is a taboo against approaching certain areas when the mountain shows signs of increased activity, which are believed to be forbidden areas for ancestors. Although rooted in traditional beliefs, this taboo is actually in line with modern mitigation principles regarding danger zones. In Langkat, the myth of "the water rises three times before a major flood" is often used by residents to guide evacuation times.

Although not based on scientific data, this myth serves a social function in preparing the community before critical conditions occur. Other local wisdom such as the use of gongs (kentongan), night patrols, and social calls between neighbors demonstrate that traditional mechanisms are still highly relevant in supporting risk communication (Novitasari et al., 2025; Permatasari & Sinduwiatmo, 2024).

Furthermore, religious values also play a similar role. In Karo Regency, which is predominantly Christian, religious values have a significant impact on preparing communities for disasters. Religious leaders, such as pastors, often link disaster preparedness with moral teachings about personal responsibility and efforts to keep themselves and others safe. These messages are delivered in Sunday services and congregational meetings, providing mental strength for the community to face the threat of disaster. " *We always remind the congregation to maintain their own safety, strive to be prepared, and leave the results to God. This is part of our moral responsibility* ," said Pastor J. Furthermore, the Karo people also utilize local wisdom passed down through generations to read natural signs. They rely heavily on changes in volcanic sounds, animal behavior, and weather changes as early indicators of danger. This knowledge is maintained through oral tradition and has become part of the community's habitus. " *Before an eruption, we can already hear different sounds from the mountain. We also see signs from animals; these are danger signs we have learned from generation to generation* ," said Mr. R, a Karo resident. The value of kinship in Karo culture, known as rakut si telu (traditional gathering), also accelerates the flow of information about disasters through informal communication between families and clans.

In Langkat Regency, which is predominantly Muslim, Islamic values are the main foundation for dealing with disasters, especially flash floods. Ustaz and ulama in Langkat play a crucial role in conveying messages of preparedness through Friday sermons and other religious gatherings. " *We always remind the congregation that disasters are tests from Allah. We must be patient and ready to face them with maximum effort, but still leave the outcome to God* ," explained Ustaz H. This approach frames disasters as life's tests that must be faced with patience, while still striving to prepare physically and mentally. Furthermore, the Langkat community utilizes local wisdom related to changes in river water color, rumbling sounds from upstream, and wildlife behavior as warning signs of impending flash floods. " *We know the river water is rising when the color turns cloudy and the smell from upstream*

begins to be felt. That's a sign that a flood is coming, " said Ibu F, a housewife in Langkat. This local wisdom is enriched by flood stories passed down from generation to generation, which form the basis for decision-making in dealing with the threat of flooding. Furthermore, the strong value of mutual cooperation (gotong royong) within the Langkat Malay community expedited coordination during evacuations and post-disaster response. Communities immediately contacted each other, knocked on neighbors' houses, and even used traditional musical instruments like gongs to warn of danger, even before official government warnings were received.

However, although religious values and local wisdom play a crucial role in building disaster preparedness, this study shows that they have not been fully integrated into the government's official communication strategy. Government mitigation programs tend to be general and do not sufficiently involve social authorities with an emotional connection to the community, such as religious leaders and traditional figures. This often leads the community to perceive government messages as overly technical and not reflecting their social context. "We trust church leaders or religious leaders more because they understand us better. *If they were the ones telling us to evacuate, we would act more quickly* ," said Mr. M, a Langkat resident. This situation demonstrates the importance of integrating religious values and local wisdom into risk communication, so that the messages conveyed are more easily accepted and implemented by the community. Integrating these two aspects religion and local wisdom can strengthen community resilience, accelerate information dissemination, and encourage collective action in the face of disasters. This ensures that risk communication is not only conducted technocratically but also takes into account the cultural roots and spiritual foundations of the community (Herningtyas et al., 2023).

Effective Strategies for Strengthening Disaster

Strategies for strengthening disaster risk communication in North Sumatra require a participatory and contextual approach rooted in the socio-cultural structures of local communities. Field findings in Karo and Langkat Regencies indicate that government-implemented risk communication tends to be one-way and technocratic, resulting in it failing to fully capture the perspectives, collective memory, and customary norms within the community. Therefore, an effective strategy

for strengthening risk communication must involve figures with social legitimacy, such as religious leaders, traditional leaders, and indigenous groups with moral authority, as their involvement has been shown to increase public trust in risk information and mobilize collective action in emergency situations.

In Karo Regency, communities have a value system rooted in extended family solidarity known as senina, kalimbubu, and anak beru, which serve as the basis for community organization in disaster situations. During the repeated eruptions of Mount Sinabung since 2013, these customary structures played a crucial role in establishing informal communication networks used to disseminate initial information, provide warnings, and coordinate evacuations. Research has found that messages delivered through customary channels are more readily accepted by communities because they contain symbolic and moral dimensions relevant to their historical experiences with volcanic disasters. Narratives about "changing natural signs" passed down from previous generations are often combined with technical data from the Regional Disaster Management Agency (BPBD), creating more comprehensive and understandable risk communication. This integration of modern science and local knowledge is a key strategy that strengthens the effectiveness of risk communication in eruption-prone areas like Karo.

Meanwhile, in Langkat Regency, which frequently experiences flash floods, the dynamics of risk communication are slightly different than in Karo. The Langkat community, which is predominantly Muslim, has demonstrated that mitigation messages are more effective when linked to religious values, particularly regarding the mandate to protect the environment and the prohibition against damaging nature. Religious leaders in villages along the river basin (DAS) play a crucial role in conveying mitigation messages, such as sermons on the dangers of illegal logging, the importance of river protection, and the moral obligation to participate in prevention efforts. Strengthening risk communication through mosques has proven effective because it provides spiritual legitimacy to technical instructions from the government. Research has noted that religious study groups, mosque youth groups, and religious study groups serve as highly effective community spaces for disseminating risk-related information. These groups serve as informal communication channels through which communities can share experiences, validate information, and formulate collective actions in emergency situations.

In addition to the role of religious leaders, the Langkat community also possesses local wisdom related to knowledge of water flow patterns and flood warning signs passed down from generation to generation. The community uses specific terms to describe changes in water flow, river color, and sounds from upstream, all of which are used as indicators of flood threat. Research shows that when these natural indicators are confirmed with information from the Regional Disaster Management Agency (BPBD), community preparedness levels increase significantly. Integrating local knowledge with technology-based early warning systems is one of the most recommended strategies for strengthening risk communication. Many residents expressed greater trust in information combined with natural signs they have known since childhood, creating a bridge of trust between scientific knowledge and local knowledge.

Field findings also indicate that the value of mutual cooperation (gotong royong) is a very strong social capital in both research areas. In Karo, mutual cooperation is manifested in activities such as building posts, public kitchens, and extended family-based evacuation networks. In Langkat, mutual cooperation is evident in efforts to clean rivers, build emergency embankments, and provide assistance to affected families. Activating the value of mutual cooperation in risk communication has been shown to accelerate community response, as decisions to act are no longer individual, but collective. Mitigation messages packaged as calls to uphold customary honor or as a form of social worship are more easily accepted than messages that are technical or administrative in nature.

This research also shows that effective risk communication strategies must avoid overly general and centralized approaches. Risk communication is better when delivered by trusted individuals who understand the emotional language of the community. When religious and traditional leaders are involved from the planning through to the implementation of mitigation programs, the messages delivered are more contextual and rooted in the community's values. This research found that communities are more compliant with evacuation instructions when the messages come from figures with whom they have an emotional connection. Therefore, the most effective strategy is to build a coherent partnership between the government, traditional leaders, religious institutions, and local communities within a mutually reinforcing risk communication framework.

Overall, this study concludes that strengthening disaster risk

communication in North Sumatra can only be achieved through a strategy that integrates modern science, religious values, and local wisdom. Integrating these three strategies results in a more adaptive and socially acceptable risk communication model capable of encouraging collective action in the face of recurring disaster threats. This approach not only increases the effectiveness of information dissemination but also strengthens social resilience and builds long-term awareness of the importance of living in harmony with the natural environment.

Based on research findings, disaster risk communication in North Sumatra occurs through two main channels: formal government-managed communication and informal communication rooted in social, religious, and customary networks. Formal communication generally follows a top-down model widely described in modern disaster communication literature, in which the government, the Regional Disaster Management Agency (BPBD), and technical institutions are the primary producers of risk information, as noted by Nurdin (2015) and Lestari (2022) . This model is influenced by the principles of *Crisis and Emergency Risk Communication* (CERC), which emphasize speed, accuracy, and consistency of messages (Reynolds & W. Seeger, 2005) . However, research shows that the effectiveness of this technocratic model is heavily influenced by public trust in the message source, resulting in many rural areas where risk messages become merely "passive knowledge" that does not trigger concrete action.

In the context of North Sumatra, both in the Sinabung eruption area in Karo and the flash floods in Langkat, risk communication often occurs through socio-cultural mechanisms that are not formally recorded. This finding aligns with studies by Aziz (2023) and Fahrimal & Husna (2023), which emphasize that community-based risk communication is more effective when it involves social actors trusted by the community. In Karo society, informal communication occurs through the customary *senina–kalimbubu–anak beru structure* , which serves as a channel for the rapid, multi-layered, and emotional distribution of information. In Langkat, mosques and religious study groups (Majelis Taklim) serve as arenas for the production and transmission of risk messages, particularly during the pre-crisis and emergency response phases. This communication pattern intersects with the findings of Heath & O'Hair (2020), who stated that social cohesion and emotional relationships influence the effectiveness of risk information reception.

This study found that communities do not solely rely on official agency messages, but combine them with natural indicators such as river water color, sounds from upstream, sulfur odors, wind changes, and volcanic signs passed down through generations. This practice aligns with the concept of *holistic indigenous knowledge* described by Berkes & Berkes (2009), which shows that local communities interpret the environment in an adaptive manner based on collective experience. This integration of modern messages and reading natural signs forms *a hybrid risk communication model* , as has been seen in other cases around the world (Makondo & Thomas, 2018). Thus, the form of risk communication in North Sumatra is a combination of a technocratic model (government) and a cultural-communitarian model (religion and customs), which complement each other but are not yet fully strategically connected (Andreastuti et al., 2023; Hermawan et al., 2024).

Research shows that both religious values and local wisdom not only have potential support but are the main foundations for successful mitigation efforts in communities. In the Karo community, local wisdom related to eruption signs, eruption history, wind patterns, and traditional rituals plays a crucial role in building risk awareness, as explained in a study (Erni, 2020). Traditional values such as *rakut sitelu solidarity* and mutual cooperation provide a collective strength for evacuation, refugee management, and recovery. This cohesive traditional structure also aligns with findings by Berkes & Berkes (2009) and Lambert & Scott (2019) that traditional institutions can enhance community resilience through strong social networks and internalized knowledge systems.

In Langkat Regency, Islamic religious values serve as a significant medium for risk communication. Strengthening mitigation through sermons, lectures, religious studies, and local fatwas provides moral legitimacy to government messages regarding environmental protection, preparedness, and prohibitions against environmental damage. This strategy has proven effective because religious leaders possess significant moral authority, as noted by Lestari (2022), who stated that faith-based risk communication strengthens public trust and reduces resistance to mitigation policies.

The local wisdom of the Langkat community regarding river patterns, customary prohibitions on indiscriminate logging, and collective memories of major floods contribute to the knowledge base of location-based risk. From the perspective of Putri's (2022) research, this local

wisdom is part of *local genius* that can become the foundation of modern mitigation when combined with technology and science. This also aligns with research by Pramana et al. (2024), which shows that the use of local symbols in mitigation communication increases emotional engagement and community compliance.

Overall, religious values and local wisdom in North Sumatra contain three main strengths: (1) a mechanism for rapid and reliable information dissemination; (2) moral legitimacy that strengthens calls for mitigation; and (3) the ability to build collective action. All three constitute social capital that aligns with the concept of *community resilience* as proposed (Abid et al., 2025; Ali et al., 2021; Kar & Cochran, 2019).

Based on research findings, strategies for strengthening disaster risk communication in North Sumatra must simultaneously integrate modern approaches, religious values, and local wisdom. First, a participatory risk communication model is needed that involves religious leaders, traditional leaders, and community groups from the mitigation planning stage. P. Lestari et al., (2019) and Barata et al., (2018) show that collaboration between actors can increase knowledge cohesion and encourage active community participation. In the context of North Sumatra, this strategy includes involving churches, mosques, Karo traditional structures, and informal institutions such as youth groups and community organizations as *co-producers of risk information* , not simply recipients of information.

Second, communication strategies need to utilize symbolic language, moral narratives, and spiritual messages that are already part of people's lives. Aziz (2023) explains that messages linked to religious values are more easily internalized because they are seen as part of a moral obligation. This aligns with Reynolds & W. Seeger's (2005) integrative model , which emphasizes that risk communication is effective when messages address the cognitive, affective, and social aspects of society. In the Karo community, integrating traditional narratives about natural signs with BPBD data can increase message credibility. In the Langkat community, delivering mitigation messages through sermons and religious studies has been shown to reduce misinformation and increase compliance.

Third, strengthening risk communication must be done through *a community-based early warning system* that combines technology with local knowledge. The research findings are consistent with the recommendation of Makondo & Thomas (2018) that the best adaptations

emerge when *indigenous knowledge* is combined with modern science. In North Sumatra, natural indicators known to the community can serve as the first layer of risk detection before being verified by technical data. This system is also relevant to Sutton et al. (2020), who emphasized the importance of community retransmission to accelerate information dissemination.

Fourth, mitigation strategies need to develop culturally based training mechanisms, such as *tabletop exercises*, traditional simulations, or religious activities that convey preparedness messages. Lestari et al. (2019) showed that a community-based training approach makes communities more prepared because they understand their role in crisis situations. Local adaptations such as the use of kentongan (a wooden drum), certain traditional rituals, or communal prayers can be part of an early warning system that is more acceptable to the community.

Fifth, the strengthening strategy must strengthen the local knowledge documentation system, as Okorafor (2010) noted . Much local knowledge in North Sumatra remains oral and at risk of being lost if not documented. Collaboration between local governments, academics, traditional leaders, and religious institutions is necessary to ensure that this knowledge can be integrated into the disaster mitigation curriculum.

Overall, the strategy for strengthening disaster risk communication in North Sumatra must be directed at integrating four pillars: modern science, religion, local wisdom, and community participation. This approach not only increases communication effectiveness but also builds long-term resilience rooted in the cultural identity of the North Sumatran people. Thus, disaster mitigation becomes not only a technical obligation of the government but also a socio-moral movement carried out collectively by the community.

CONCLUSION

This research confirms that communities in both study areas do not passively receive risk information, but interpret it through collective experience, kinship relationships, and spiritual beliefs. In Karo, the traditional structure of rakut si telu (rakutu si telu), clan networks, and the ability to read natural signs serve as sources of validated information that can accelerate community awareness, often faster than formal government channels. Meanwhile, in Langkat, communities rely on local

wisdom in the form of natural indicators and collective memory of flash floods, which strengthens community-based early detection processes. Both cases demonstrate that local knowledge systems are not merely traditions but effective adaptive tools in dealing with recurring risks. Religion has been shown to play a significant role in shaping risk perceptions, strengthening preparedness, and increasing community compliance with mitigation messages.

Religious leaders, including priests, pastors, and ulama, act as message mediators, translating technical information into moral, ethical, and spiritual language that is more easily accepted by the community. Values such as ikhtiar (independence), tawakkal (relief), patience, moral responsibility, and solidarity provide a framework of meaning that strengthens the legitimacy of safety messages. In many cases, information delivered by religious leaders is more credible than official government messages due to its emotional immediacy and high symbolic relevance. This study also concluded that the three forms of communication—formal, cultural, and religious—often operate in parallel but are not integrated with each other. The absence of a mechanism to align government messages with customary and religious authorities creates a communication gap between scientific knowledge and public understanding. This gap results in low compliance with evacuation instructions, slow emergency responses, and a high reliance on informal information. When the government began involving customary and religious leaders in messaging, communication effectiveness increased significantly, demonstrating that successful risk communication relies heavily on social and cultural integration.

The main conclusion is that strengthening disaster risk communication in North Sumatra can only be achieved through a synergistic integration of modern science, religious authorities, and local wisdom. An effective risk communication model must be participatory, dialogic, contextual, and delivered through trusted figures who understand the social structure of the community. An approach that combines technical messages with traditional and spiritual language not only improves the accuracy of information received but also fosters solidarity, accelerates evacuations, and strengthens long-term community resilience. Thus, risk communication is not simply a process of conveying data, but a social practice rooted in the culture, morality, and spirituality of local communities. This dissertation emphasizes that the success of

disaster mitigation will be largely determined by the extent to which communication strategies are able to bridge modern science with the living value systems believed in by the community.

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