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The Integration of Indigenous Knowledge for Disaster Risk Reduction Practices through Scientific Knowledge: Cases from Mentawai Islands, Indonesia

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***Abstract*—** This study explores the importance of indigenous knowledge for everyday practices of disaster risk reduction and response. Many existing studies have highlighted the need to integrate such knowledge with modern science. Based on ethnographic research in indigenous communities in the Mentawai Islands of Indonesia, this study explores the categorization of indigenous knowledge in the integration process. To that end, primary data were collected through in-depth interviews while secondary data were collected from relevant documents, including books, articles, websites and government and NGO reports. The findings indicate that indigenous knowledge is acquired through long observation and interaction with disasters. Although some of this knowledge is based on successes in other localities, some indigenous knowledge is completely local, homogenous and shared among community members. It was also established that indigenous knowledge can be meaningfully organized into a number of categories, and that indigenous knowledge of a technical nature is more likely to be integrated with scientific knowledge. The research was exploratory and approached indigenous knowledge issues from the point of view of indigenous communities themselves. This approach should be replicated and expanded in other indigenous communities.

Keywords—*:* *Indigenous peoples; knowledge; natural disaster; cultural behavioral; local wisdom; tacit knowledge.*

I. INTRODUCTION

The widely publicized recovery of Simeulue on Aceh and Moken society on Thailand following the 2004 Indian Ocean earthquake and tsunami prompted a substantial increase in studies of indigenous knowledge and its role in disaster management. The knowledge that helped those communities to survive demonstrates the importance of local and indigenous knowledge (in the form of written and oral stories) for disaster risk reduction. Reports of the use of indigenous knowledge in this context can be traced back to a time long before these events. For example, Dekens (2007) reported evidence from the 1970s that local knowledge and practices could improve preparedness for natural disasters. However, it is only in recent years that practitioners have integrated such resources and in policy-making and planning (McAdoo et al., 2009).

Various strategies for disaster preparedness, mitigation, and rehabilitation by public or non-governmental agencies have failed to reduce vulnerability significantly. Successful disaster management requires a high level of adaptability to local conditions, taking account of the cultural context of affected localities (Kusumasari & Alam, 2012). In other words, the customs, traditions, practices and ethnic composition of an area should be factored in when devising an appropriate package for effective and easy implementation (Gopalakrishnan & Okada, 2007). According to Ellis and West (2000), local knowledge is embedded both in historic understandings of natural hazards and disasters and in current actions and events. Local social history is important because it is likely to influence how people perceive and respond to natural hazards.

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II. METHOD

This paper discusses the classification of indigenous knowledge and practices in the context of the Mentawai case study. This research site was chosen mainly because the area has experienced several major disasters. Based on ethnographic research in indigenous communities, the study draws on primary data from in-depth interviews and secondary data from relevant documents, including articles, books, websites and government, and NGO reports. This research was conducted on July – August 2018. The research was exploratory and approached indigenous knowledge issues from the point of view of indigenous communities themselves. This approach should be replicated and expanded in other indigenous communities. The process of integrating indigenous and scientific knowledge involves several phases: preparation, data gathering, analysis, validation, integration, and utilization. The first of these (preparation) involves finding out as much as possible about indigenous knowledge in the area of study and categorizing each item of knowledge. In the second phase (data gathering), the researcher observes and records any indigenous knowledge related to disaster risk reduction. In the third phase (analysis and validation), data are interpreted, analyzed and validated in focus groups discussion. In the integration phase, the researcher is not pursuing new knowledge but identifying existing knowledge that can potentially be integrated to enhance the community's capacity to reduce their vulnerability to natural hazards.

For centuries, indigenous communities in the Mentawai islands have coped with environmental events caused by themselves or by external factors that shift and reshape their society and environment. This paper explores how these communities deal with disaster and examine the nature and role of indigenous knowledge in that context.

III. INDIGENOUS KNOWLEDGE

Depending on the field of study, there are many definitions of indigenous knowledge; in general, it can be said to be (a) locally bound; (b) context-specific; (c) non-formal and (d) dynamic (Shaw, Sharma, & Takeuchi, 2009). Indigenous knowledge develops through ongoing experimentation and is usually handed down from one generation to the next through oral histories, myths, songs, and legends. In some regions, this kind of knowledge is handed down through oral and written stories to a key member of the society and is not widely shared. As such, this information may be considered sacred and taboo, retained only in the memory of key persons in the community such as clan leaders or elders. This practice makes such knowledge less accessible. Indigenous communities have a unique way of transferring this knowledge, usually through direct face-to-face contact. Unlike more formal education systems, children learn from family members at home and by observation in the field or at their place of work. The following are some typical definitions of indigenous knowledge.

1) "The unique, traditional, local knowledge existing within and developed around the specific condition of women and men indigenous to a particular geographic area" (Grenier, 1998).
2) "The knowledge that people in a given community has developed overtimes, and continues to develop. It is based on experience, often tested over centuries of use, adapted to local culture and environment, dynamic and changing" (IIRR, 1996).
3) "The information base for a society, which facilitates communication and decision making. Indigenous information systems are dynamic and are continually influenced by internal creativity and experimentation as well as by contact with external systems" (Flavier et al., 1995).
4) Local knowledge consists of knowledge and practical capabilities which emerged from local conditions and natural and social surroundings, and which have often been tested over a long period of time and are integrated into a larger cultural context (Schroder, 1995).
5) Knowledge essentially transmitted by oral face-to-face communication (and therefore rather localized), the encoding of this knowledge into an oral discourse (not in literary language), and

the use of sensual (especially visual) demonstration distinguish local knowledge from scientific or technical knowledge (Elwert et al., 1999).

TYPES OF INDIGENOUS KNOWLEDGE

For present purposes, indigenous knowledge is classified in terms of how it is acquired and practiced by the community or selected members, and whether this knowledge is visible or invisible. However, this classification of indigenous knowledge is not comprehensive, as the study involved only two communities. The classification is an attempt to simplify reality as a rough dichotomy of types that, in the context of local knowledge, are not separate but closely intertwined. The important point here is the diversity of local knowledge, most of which remains undocumented despite growing evidence of its vital role, directly or indirectly, in disaster risk reduction policy.

Table 1. Categorization of indigenous knowledge

How it is gained (X)	**Aspects (Y)**	**Practises (Z)**
Transmitted **(X_a)**	Technology **(Y_a)**	Common **(Z_a)**
Experienced **(X_b)**	Belief System **(Y_b)**	Specialist **(Z_b)**

(Source: Thrupp, 1989; Berkes, 1999; Dekens 2007; Mercer 2012)

1) *How it is gained*: Indigenous knowledge can be classified into two types: experiential knowledge (Dekens, 2007) and transmitted knowledge (Berkes, 1999). While experiential knowledge is acquired through direct experience, transmitted knowledge is handed down from one generation to the next. In many cases, experiential knowledge has greater problems of legitimacy than transmitted knowledge because the former has been culturally internalized. As such, local knowledge is not easy to document because it is often invisible.

2) *Based on their aspects*: Indigenous knowledge that relates to physical features can be regarded as technical knowledge. Conversely, invisible knowledge related to social systems, traditions, religion, and local culture is understood as a belief system. Thrupp (1989) found that local knowledge is often associated with technical knowledge, which is the most visible and concrete aspect of indigenous knowledge. In contrast, belief systems correspond to tacit knowledge (Mercer, 2012). During field observation, the researcher observed a variety of strategies that can be characterized as methods for coping with a disastrous event that none of the respondents thought worthy of mention as part of their indigenous knowledge.

3) *Based on practices*: Indigenous knowledge related to practices can again be divided into two types: common knowledge, which informs the everyday activities of the whole community, and specialist knowledge, which is retained by selected members of the community such as elders or the shaman. This explains why some community members lack some of their community's knowledge.

INDIGENOUS KNOWLEDGE IN THE MENTAWAI ISLANDS

The Mentawai Islands archipelago is located in western Sumatra. Consisting of 323 islands and islets, it belongs to West Sumatra Province (Badan Perencanan Pembangunan Daerah Kabupaten Kepulauan Mentawai, 2004). The four main islands are Siberut, Sipora, North Pagai, and South Pagai. At 4,480 square kilometers, Siberut is the largest island. While 90% of the population is indigenous, the remaining 10% includes Minangkabau (a clan from West Sumatra), Javanese people and Batak (a clan from North Sumatra) (Bastide, 2008). In this paper, the term *indigenous people* refer to those of Mentawai origin. The islands lie on three highly active fault lines: the Mentawai faults, the Great Sumatra faults, and the Sunda trench. Prior to the great Indian Ocean tsunami, local inhabitants of the

Mentawai Islands were unaware of the threat of earthquake and tsunami despite movement of the tectonic plate. They were accustomed to earthquakes and believed them to be a blessing in disguise, bringing them luck especially at harvest time.

The Mentawai Islands people are a good example of a community with experiential knowledge of how to deal with the threat of earthquakes and tsunamis. For their livelihood, most of Mentawai's indigenous people live deep in the forest, mainly in upstream areas, while outsiders or "mainland people" tend to be concentrated in the capital city on the coast. Although they are considered "Island People," only a small percentage of the population depends on fishing for a livelihood. Most local people depend on coconut farming and on resources found in the forest. They earn a living by selling rattan (Calamus sp), eaglewood (yielding fragrant oil), sago palm (Metroxylon sago), coconut, Dipterocarpaceae and mangrove.

CULTURAL REVOLUTION IN MENTAWAI

Mentawai experienced two stages of civilization, which can be characterized as cultural and disintegration phases. The cultural phase commenced with the early settlement of the islands by the Mentawai people, and the disintegration phase began in the 1950s with the abolition of Arat Sabalangun, the local religion (known as Arat in Mentawai language), and local community ritual traditions.

Figure 1. Map of Mentawai Islands (Gispedia, 2018)

In 1971, the central government also implemented a new program called Pemukiman Kembali Masyarakat Terasing (PKMT) or Resettlement for Indigenous People (Henri, 2012). The government built a new settlement and constructed houses that all shared the same design on the riverbank or along the coast. At the same time, the indigenous people were banned from practicing their culture and were forced to abandon ancestral traditions such as Uma. After five years, responsibility for this program was delegated to local authorities. At this time, logging companies began to take over the forests that the indigenous communities had left.

In the late 1980s, some clans that had been overlooked by the government project and were still pursuing traditional practices became a tourist attraction (Henri, 2012). For this reason, the government relaxed their resettlement program. This was a blessing for indigenous Mentawai people, as they found themselves free to engage in their own cultural activities in areas far from modern settlements. However, the number actively practicing their culture remains limited and most live in the deep forest on Siberut, since not many of the young generation interested on their own culture and fell that their culture are out of date. (Henri, 2012).

This integration and resettlement of locals diminished their understanding of their native culture, and their knowledge of their environment is almost nonexistent (Henri, 2012). The government program made them more vulnerable to disaster because they lacked experience of earlier disasters such as tsunami. They were also poor in economic terms and were forced to cultivate build rice without the benefit of a proper education. Henri (2012) showed that 90% of this population could not survive without access to sago, which is the main food source.

Those who continue to live as indigenous people still consider earthquakes a blessing and a gift from God. This remains in their collective memory of earthquakes as indicating that the spirit of their ancestors will bless them with a plentiful fruit harvest. Although further research is needed, this belief is apparently held by those who have adopted a modern way of life as well as by indigenous people.

After the Great Indian Ocean Tsunami of 2004, they realized that they were living in a danger zone. They became frightened by the disaster and began to prepare for similar future events. Those living in the coastal area who had agricultural fields in the forest began to build shelters on high ground and stocked these shelters with food. At first, they stored food in these small houses in agricultural areas for practical reasons, as they spent more time there and returned to their other house only at weekends. However, they still needed some kind of early warning system. Some villages already had the simpler Tuddukat tool used by their ancestors. Their activities confirm that their knowledge of disasters comes both from their own predecessors and from the experiences of others. The success story of Simelue Island has had a great impact, encouraging many coastal communities on the Indian Ocean and in western parts of Sumatra to internalize their cultural tradition of disaster management. They learned about the need for community early warning systems from existing knowledge and did not depend only on modern technology.

In the wake of the Great Indian Ocean Tsunami, the government, supported by foreign donors, built an early warning system called InaTEWS (Indonesia Early Warning System), mainly on Sumatra's west coast. This system is intended to reduce the impact of a disaster, primarily by saving human lives. However, on 25 October 2010, the system failed to work properly. Although it transmitted information to the institutional interface and to the central government that the earthquake had tsunami potency, there was no warning for local government or for people living in that area because the Internet connection was lost. Additionally, the tsunami buoy sirens failed to work. Officials said that tsunami buoys had been stolen, showing that community awareness of disaster management remains low. At that time, the loss of connection between local and provincial government in Padang meant that no one knew that the tsunami had struck Mentawai, causing hundreds of casualties. Two days after those events, one of the local newspapers was able to send a message to their contributor via satellite phone. No cellular phone could operate at that time, and the situation was exacerbated by bad weather, high waves and tropical cyclones at the same time, which meant that small ships could not reach the island.

Figure 2. Tuddukat (Source: Author)

Experience and Transmitted knowledge

One of the traditional technologies that each clan should have is Tuddukat, a wooden drum used by indigenous Mentawai to spread news of a death or to tell other clan members that a group of hunters caught their prey. Tuddukat is made from kulip (Nephelium Sp) or from hairy fruit, and Tektektek (the stick) is made from Lakoba (Garciana Mangostana). Each set of Tuddukat consists of three different sizes. When struck, these produce coded sounds that can be interpreted by community members. Beyond its function as a communication tool, Tuddukat is also a sacred tool and symbol of pride. It is known to be an effective instrument that can transmit sounds over long distances to clan members going to their agriculture field or to the forest. It is a tradition for clan members to gather in Uma when they catch their prey or when a clan member dies. As well as reporting clan success in hunting, it is also used to mock other clans for their failure. These activities are called Pako, or social competition among clans. Nowadays, however, Uma and their communication technology are rarely seen in modern Mentawai communities. Those who left their original clan to move to another place adopted a modern lifestyle and may be unable to interpret the Tuddukat sound code. This traditional tool is an example of transmitted knowledge that has been passed down from one generation to the next.

In 2010, when the tsunami struck several places in the Mentawai Islands, the head of a local community in Pagai Island reported that all the people in one village survived the tsunami because of their local knowledge. This villager struck the small Tuddukat to tell others that a tsunami was imminent; based on their experience and that of the Simeulueans, they knew that the seafloor on the beach had subsided, threatening their lives. Hearing the alert, everyone (with the exception of one person who ran in the opposite direction and was later found dead) went directly to higher ground and sheltered while waiting for the waves to come. As they had already stocked their shelters with food, they were able to remain there for a couple of days. This success story will be passed on to the next generation and will endure in those places, based on their own experiences and those of others in the past.

Technical knowledge and belief system

The sociocultural characteristics of Mentawai are unique. The basic unit of traditional society is the household or "Uma.” This does not necessarily refer to a nuclear family but may include a number of families of the same kin sharing a traditional house (19). All members of the Uma are blood relations through the patrilineal line, in contrast to the matrilineal lineage of Minangkabau on the main island. In Mentawai, this family relationship is called Pusarainaan, meaning brotherhood. The members of the Uma may be regarded as a clan, which is itself named after their Uma.

Uma also may be seen as indigenous building methods and systems, representing the society's architectural heritage as wisdom embodied in knowledge related to technique, material, and skill. Technical knowledge includes architecture, methods of construction and the use of specific materials for traditional buildings. This form of building has existed for centuries, informed by experiences of nature's toughest tests. According to Guitierrez (2004), this can be characterized as vernacular building, as it is not based on engineering theory but transferred through tradition, readily accepted by local people and capable of withstanding local environmental challenges that include earthquakes, flooding, and climate change. Schefold (1991) saw Uma as proof of the Mentawai people's skill and technique, as they use not a single nail when building, relying instead on a specially crafted joint.

Before an Uma is built, there are several considerations regarding location. First, it must be built close to water sources, known in Mentawai language as Batsopak, meaning small river. Second, a flat surface area is required for building Uma and Sapou (a small house). Third, it must have a basin area for sago plantation. Fourth, it must have a hilly surface for other commodities. Finally, it should have some historical connection with their ancestors. As well as socioeconomic and cultural factors, Uma construction is influenced by climate and the availability of materials locally. This practice plays a significant role in improving community resilience in relation to natural disasters, especially floods and earthquakes.

Figure 3. Traditional Mentawai house (Uma)(Source: Author)

When building an Uma, Mentawai people always work together as a lot of resources are needed, including money and food supplies. Workers receive no money but work voluntarily, usually coming from the same clan or invited by a clan leader to help with the building process.

Common and specialist knowledge

One observed phenomenon was that, prior to the tsunami, the community exhibited no anxiety about earthquakes, which they believed to signify the presence of their ancestor's spirit. There is a legend that highlights the metaphysical relationship between people and earthquakes, providing a detailed account of the first ever earthquake. The following is a version of the legend as heard in Muntei, a small village in southern Siberut. The story tells of murdering someone who was disliked by placing him in the first pillar of a longhouse (*uma*) during construction. When the Uma was complete and a

ceremony was held to inaugurate the house, the spirit of the victim became very angry with the owner of the house and those participating in the feast. Before the celebration, he came to warn his family not to participate in the party. Rather than eating in the uma, they should hide under a banana tree when they felt a quake. When the feast started, the ground began to shake violently, and a thundering noise erupted from under the ground. The newly built house collapsed, and everyone other than the spirit's family was killed. The earthquake was the spirit's revenge, and from that day on, according to Bajak encu (Sakukuret clan leader), the Mentawaians named the earthquake "Grandmother" (teteu). Another commonly shared belief is that whenever an earthquake occurs, certain mushrooms will grow in certain places, and people pick these to eat.

However only key members of the community retain the knowledge of an earthquake's meaning. If the earthquake happens in the morning, they believe that the harvest will yield plenty of fruit. However, if the earthquake is at night, that means they must prepare for an enemy's arrival.

INTEGRATING INDIGENOUS AND SCIENTIFIC KNOWLEDGE

Mercer et al. (2012) argued that for more effective disaster risk reduction, indigenous knowledge should be integrated with modern technology, moving beyond the dichotomy to bridge the gap between them. This integration of traditional and modern systems demands a mutual understanding of the cultural and material basis of each (Agrawal, 1995). Table 2 below classifies types of indigenous knowledge that relate to disaster risk reduction in the Mentawai Islands.

Table 2. Indigenous Knowledge Classification

Combination	Type of knowledge	Code	Indigenous knowledge
$\mathbf{X_a, Y_a, Z_a}$	Transmitted, Technical, Common	C1	Sago storing
$\mathbf{X_a, Y_a, Z_b}$	Transmitted, Technical, Specialist	C2	*Uma* / Traditional house
$\mathbf{X_a, Y_b, Z_a}$	Transmitted, Belief System, Common	C3	*Panaki*/ Mutual assistance
$\mathbf{X_a, Y_b, Z_b}$	Transmitted, Belief System, Specialist	C4	Forecasting
$\mathbf{X_b, Y_a, Z_a}$	Experience, Technical, Common	C5	*Tuddukat* / Drum
$\mathbf{X_b, Y_a, Z_b}$	Experience, Technical, Specialist	C6	Use of medicinal plants
$\mathbf{X_b, Y_b, Z_a}$	Experience, Belief System, Common	C7	Observe cloud, wave and Wind
$\mathbf{X_b, Y_b, Z_b}$	Experience, Belief System, Specialist	C8	Observe celestial body

(Source: Author)

In the present study, when reviewing indigenous knowledge, the community worked alongside scientists and experts to identify indigenous strategies used in the past and present to deal with natural disasters. The data were then triangulated to identify useful strategies or methods that may not have been known to the community. FGD was used to engage the Muaro Siberut community and conducted on June 17, 2017, in Muaro Siberut, along with several NGOs including YCMM and Arbiter Samaritan Bund and local experts and government officials, community leaders, religious leaders, and community members, ensuring that all indigenous knowledge was covered. This was an essential process in giving the community a sense of belonging, ensuring that the outcomes could be successfully implemented (Mercer et al., 2010).

During this discussion, the authors guided and listened rather than directing, thus enabling the community to analyze their indigenous knowledge. Along with the experts, the community then identified and ranked the types of indigenous knowledge that could potentially be integrated with

scientific knowledge. Table 3 summarizes the results, based on the possibility of integration with scientific knowledge from the community's perspective.

Table 3. Pairwise Ranking Process for Indigenous Knowledge

CODE	C1	C2	C3	C4	C5	C6	C7	C8
C1	**N/A**	C1	C1	C1	C5	C6	C7	C8
C2	C1	**N/A**	C2	C2	C5	C6	C7	C8
C3	C1	C2	**N/A**	C3	C5	C6	C7	C8
C4	C1	C2	C3	**N/A**	C5	C6	C7	C8
C5	C5	C5	C5	C5	**N/A**	C5	C5	C5
C6	C6	C6	C6	C6	C5	**N/A**	C6	C6
C7	C7	C7	C7	C7	C5	C6	**N/A**	C7
C8	C8	C8	C8	C8	C5	C6	C7	**N/A**
Total	**6**	**4**	**2**	**0**	**14**	**12**	**10**	**8**

(Source: Author)

In this FGD every participant contributed to ranking indigenous knowledge based on the possibility of integrating it with modern technology. To assist the participants in this process, pairwise ranking was used, according to Kumar (2002) pair wise ranking is a process of comparison between each of the factors. To simplify the process, the name of every form of indigenous knowledge was replaced with a number (Table 3). The participants then went through the grid and compared two forms of indigenous knowledge at a time, and discussed which one in the pair was more likely to be able to be integrated with modern technology. Table 4 below shows the final results.

Table 4. Ranking of IK Based on Likelihood of Integration with Scientific Knowledge

Ranking	Code	Combination	Type of knowledge	Indigenous knowledge
1	**C5**	$\mathbf{X_b, Y_a, Z_a}$	Experience, Technical, Common	*Tuddukat* / Drum
2	**C6**	$\mathbf{X_b, Y_a, Z_b}$	Experience, Technical, Specialist	Use of medicinal plants
3	**C7**	$\mathbf{X_b, Y_b, Z_a}$	Experience, Belief System, Common	Observe cloud, wave and Wind
4	**C8**	$\mathbf{X_b, Y_b, Z_b}$	Experience, Belief System, Specialist	Observe celestial body
5	**C1**	$\mathbf{X_a, Y_a, Z_a}$	Transmitted, Technical, Common	Sago storing
6	**C2**	$\mathbf{X_a, Y_a, Z_b}$	Transmitted, Technical, Specialist	*Uma* / Traditional house
7	**C3**	$\mathbf{X_a, Y_b, Z_a}$	Transmitted, Belief System, Common	*Panaki*/ Mutual assistance
8	**C4**	$\mathbf{X_a, Y_b, Z_b}$	Transmitted, Belief System, Specialist	Forecasting

(Source: Author)

From the above results, it can be concluded that experiential knowledge is more likely than transmitted knowledge to be integrated with science, and that technical knowledge is more easily integrated than a belief system. The possible explanation for these findings is that most experiential knowledge is gained through assimilation of external factors such as other communities' success stories, new knowledge, new inventions or other factors such as nature and climate change. On the other hand, technical knowledge is more likely to integrated with scientific knowledge because it can be explained scientifically.

LESSON LEARNED, CHALLENGES AND POLICY IMPLEMENTATION

Indigenous knowledge related to earthquake, tsunami and flood resistance is available in various parts of Indonesia. This derives from past experiences that have been adopted and handed down to the next generation as part of an evolutionary process. With the passage of time, however, much of this

knowledge vanishes with modernization, lifestyle changes, and inadequate policies for preserving such knowledge, as well as economic pressures and globalization.

With decentralization, government policy has undermined the sustainability of indigenous knowledge—for example, by banning traditional cultural practices and rituals in indigenous communities. Relocation without due regard to local knowledge and forcing communities to abandon their roots has also played a significant role in the decline of disaster-related resilience. Clearly, then, there is a need to consider indigenous knowledge when implementing programs or strategies within a community or society.

The study identified some interesting features of Mentawai houses and traditions that can be utilized in disaster management. The traditional house reflects a bond with nature in the ability to withstand flood, climate, and earthquake that is still useful today. Traditional instruments play a significant role as an early warning system for any disaster. The tradition of storing food in agricultural shelters adds further to disaster-related resilience. Other techniques such as observing animal behavior and celestial bodies to predict hazards remain in limited use, mostly among elders; it seems unfortunate that younger people assume that such activities are "out of date."

Those with less experiential or transmitted knowledge of natural disasters are more likely to become casualties, and the people interviewed in Sipora and Pagai regularly referred to the need for more government information about such hazards.

CONCLUSION

As an indigenous community, the Mentawai people already have their own ways of coping with disaster threats. First, their traditional house (the Uma) is earthquake resistant, and none has ever collapsed as a result of the 2010's earthquake. Second, their predecessors have already taught them where to live and to avoid coastal areas because of tsunami risk. Third, their villages are usually close to the water but not on the river bank in order to avoid floods. Fourth, the community has its own traditions of storing food for times of drought or flooding. Finally, people use Tuddukat to disseminate news that is of importance in their community.

Those who do not live in the forest live on the riverbank and in coastal areas. The decision to keep their communication tool as an early warning system is not based on ancestral knowledge but on their experience of daily life and success stories from other areas such as Simeuleu Island, encouraging them to develop new strategies in the face of incoming disaster, especially tsunami.

From the above discussion, it can be concluded that beyond the transmitted knowledge inherited from predecessors, indigenous knowledge may also come from direct or experienced knowledge. A further distinction can be drawn between technical knowledge and belief system. More concrete and "visible" indigenous knowledge is often associated with technical knowledge while belief system can be characterized as "invisible" because it is embedded in the society. Another characteristic of indigenous knowledge relates to whether it is shared by the community or only by selected persons. These distinctions help to simplify indigenous knowledge related to disaster risk reduction. The validation and integration process established that indigenous knowledge based on experience is more likely to be integrated with scientific knowledge.

Further research is needed to quantify the potential impact of this integrated knowledge on disaster risk reduction programs. Any such intervention must promote the use of indigenous knowledge, empowering communities to utilize this in combination with external knowledge. This integration will hopefully inform policymaking in the interests of local communities in Mentawai. If possible, this

integrated approach to disaster risk reduction adaptation should be extended to other environments facing similar challenges elsewhere.

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