



The role of traditional ecological knowledge in the disaster risk management strategies of island communities in Cat Hai, Vietnam

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Abstract

The very real threat of climate change requires effective disaster risk management (DRM), especially in highly vulnerable ecosystems such as island communities. Past disaster experiences in different parts of the world have revealed the importance of integrating traditional ecological knowledge (TEK) with scientific findings in managing disaster risk. Hence, this study assessed the role of TEK in the DRM strategies of communities in Cat Hai Island, Vietnam. Participatory Rural Appraisal techniques such as key informant interviews, household survey, and focus group discussion were used to collect primary data. The survey was administered to 50 residents of three communes in Cat Hai Town. Results showed that the respondents use their TEK together with information from the mass media in predicting, preparing for and coping with the impacts of weather-related disasters such as floods and storms. The results of this study could be used in creating an effective community-based DRM program for the above mentioned communities. The lessons from this study could serve as a reference and guide for other coastal communities that are vulnerable to weather-related disasters and climate change.

Keywords: traditional ecological knowledge · community perception · disaster risk management · climate-related disaster · Cat Hai Island

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Introduction

The frequency and intensity of extreme events are going to change as climate change affects the environment and systems in which they occur (Banholzer, Kossin, & Donner 2014). For example, the increased moisture content in the atmosphere, due to increased greenhouse gases in the air, could fuel more extreme precipitation events (Kunkel et al., 2013). Over the last twenty years, water-related disasters have caused over 600,000 deaths and affected more than 4.1 billion people across the world (Centre for Research on the Epidemiology of Disasters [CRED] & United Nations Office for Disaster Risk Reduction [UNISDR], 2015). Because of this, the impacts of climate change are becoming more pronounced.

The need to strengthen disaster risk management (DRM) is more evident now than ever. Several studies argued that science-based DRM could be improved and communicated effectively by integrating it with local knowledge since the latter is readily acceptable to the community (Ikeda, Narama, & Gyalson, 2016). Because of this, the local, traditional, and indigenous knowledge are important in reducing disaster risk (International Strategy for Disaster Reduction [ISDR], 2005, 2008a, 2008b; Kelman, 2010).

The terms “local”, “traditional”, and “indigenous” are sometimes differentiated in disaster management and climate change adaptation studies (Etkin & Stefanovic, 2005; Lebel, 2013; Codjoe, Owusu, & Burkett, 2014), and at other times considered similar or overlapping in others (Tearfund, 2008; Mercer, Kelman, Suchet-Pearson, & Lloyd, 2009; Kelman, Mercer, & Gaillard, 2012; Hiwasaki, Luna, Syamsidik, & Shaw, 2014). Although both indigenous and traditional knowledge are passed down from generation to generation (Materer, Valdivia, & Gilles, 2002; Hiwasaki et al., 2014), indigenous knowledge is only held by people who identify themselves as indigenous (Lebel, 2013). It encompasses knowledge about cultural traditions and worldviews of the indigenous people, whereas traditional knowledge indicates knowledge about the economic, political, and spiritual relationships with the land of local people (Brockman & Legat, 1995 as cited in Brockman, Masuzumi, & Augustine, 1997).

Traditional ecological knowledge (TEK) is identified as a cumulative body of knowledge, practices, and beliefs that is evolving by adaptive processes through generations, and is about the relationship of living beings (including humans) with other individuals and with their environment (Berkes, Colding, & Folke, 2000). Scholars find it difficult to distinguish among these three terms because their definitions are abstract (McGregor, 2006). The similarity of these terms is that they are defined by many generations who not only managed to survive but also live in harmony under harsh conditions of nature (Hiebert & Van Rees, 1998). Therefore, in this paper, the term TEK is used to refer to the environmental knowledge that was derived from experience and traditions (Greneir, 1998; Leonard, Parsons, Olawsky, & Kofod, 2013) of a non-indigenous rural community in Cat Hai Island, Vietnam.

In recent years, weather-related hazards in Vietnam are becoming more severe in terms of magnitude, frequency, and volatility (Huy & Shaw, 2010). During a period of twenty years from 1993 to 2012, Vietnam was exposed to 213 weather-related disasters and was considered as one of the six worst affected countries by climate change (Kreft & Eckstein, 2013). Moreover, majority of its population are residing in coastal areas and small islands making them more vulnerable to the impacts of weather-related hazards, such as storms and floods (Dat & Thu, 2012; Hiwasaki, Luna, Syamsidi, & Marcal, 2015). To cope with these events, the country established its DRM strategy. The TEK or indigenous knowledge was mentioned in Decision 2139 QD-ttg of the Vietnamese Prime Minister (2011) approving the national strategy for climate change. However, TEK was not captured in the regional or provincial strategies. Meanwhile, the locals in coastal areas have a rich culture and traditional knowledge, which they use to adapt to the changing environment (Thinh, 2010) and to mitigate disaster risk (ISDR, 2008b; United Nations Educational, Scientific and Cultural Organization [UNESCO], 2014). Hence, this paper assessed the potential role of TEK in improving the island's DRM strategy, as well as the present coping strategies to flood and storms employed by the community. Based on the research results, this paper recommended methods to preserve valuable TEK for use in DRM.

Materials and Methods

Study Area

The study was conducted in Cat Hai Island, one of the two main islands of Cai Hat district in Hai Phong province in North Vietnam. It is a flat sand island covering a total land area of about 40 km². The island is 24 kms away from the center of Hai Phong City and is located between Cat Ba Island and Do Son Peninsula. Its climate is characterized by two distinct seasons: cold and dry northeastern monsoons (winter) from November to April, and cool and fresh southeastern monsoons (summer) from May to October. Its average annual rainfall ranges from 1,600 mm to 1,800 mm, while the average monthly temperature varies from 20 to 23°C. The island is considered as one of the most vulnerable areas to storm in Vietnam with 28 percent of the storms in the country crossing the island (Thung, 2014).

Cat Hai Town, located on the northeast side of the island, suffers most from the impacts of storms, waves, and floods (Thung, 2014; Cat Hai Town People's Committee, 2015). With six communes, it covers 4.92 km² land area, wherein 0.023 km² is classified as forestland. In 2015, the town had a population of 6,700 belonging to 1,670 households. Most of the residents rely on fishing, aquaculture, and seafood processing (salt making, fish sauce making) to earn a living. The town has a high literacy rate since most of the families send their children to school. According to reports of Cat Hai Town People's Committee (2013, 2014, 2015), the three communes in Cat Hai namely, Tien Loc, Hai Loc, and Dong Luong were

ranked as the most vulnerable to storms and floods. Their flood level and economic damage are always higher than other communes. In these areas, most of the settlements are either located in the lowest regions of the island or alongside the embankment (Cat Hai Town People's Committee, 2015).

Data Collection and Analysis

Primary data was collected using Participatory Rural Appraisal (PRA) methods such as key informant interviews (KII), household survey, and focus group discussion (FGD). PRA method is effective at the community level because communities usually respond well and openly during the conduct of PRA (Ramasubramanian, Seeralan, & Sekar, 2010). It is an effective tool in capturing the community perception (Cornwall & Pratt, 2011). The study used PRA to elicit the community perception on the immediate disaster impacts and disaster risk management practices in Cat Hai Island, as well as their TEK in storm and flood prediction.

The household survey was written and recorded in Vietnamese language and conducted between the 26th and 30th of April 2015. It determined the experiences and perception of households on disaster risk. Because the location of the target respondents was pre-identified through KII, the study employed purposive sampling to guarantee that the respondents could provide valuable and relevant information.

A total of 50 households were surveyed, wherein 25 came from Tien Loc Commune while 15 and 10 were residents of Hai Loc and Don Luong Communes, respectively (Table 1). The distribution of respondents was determined based on the level of vulnerability of the commune, with the highest sample size allocated to the most vulnerable area (Tien Loc) (Cat Hai Town People's Committee, 2015, 2014, 2013). Households

Table 1. Socio-economic characteristics of the respondents in Cat Hai Island, 2015

Characteristics		Tien Loc Commune n=25	Hai Lo Commune n=15	Don Luong Commune n=10
Age (years)				
Mean		47	49	53
Range		14-60	40-57	37-70
Annual gross income per household				
Mean*	USD	2,108	1,646	1,902
*1 USD= 21,610 VND (Vietcombank, April 2015)	VND	45.56 million	35.56 million	41.11 million
Primary source of livelihood (%)				
Farming		4	0	40
Fishing		32	60	30
Non-resource –based		63	40	30
Average number of household members		4	5	4

present during the time of fieldwork were included in the survey. The survey questionnaire with 41 questions was designed to capture the socio-economic characteristics of the respondents and their perception on the three main topics: (1) local perception on DRM, (2) role of TEK in DRM (TEK on storm and flood prediction; local practices to cope with flood and storm; and integrating TEK in DRM), and (3) measures to preserve and improve the contribution of TEK in DRM.

An FGD was conducted to validate the survey results and to gather information on the DRM of the island. Authorities in Cat Hai Town (representatives of Commune Committee for Natural Disaster Prevention and Control and Search and Rescue [CCNDPC and S&R], Cat Hai Town People's Committee, Cat Hai Town Military Affairs, and Cat Hai Town Veteran Affairs) were invited to participate in the activity.

Results and Discussion

Local Perception on Disaster Risk Management

In this study, weather-related hazards or disasters pertained to storms and floods since these were the most common hazards experienced in the study area. All of the household survey respondents observed an increased intensity and magnitude of recent storms. This observation was consistent with the results of the FGD and findings of other scientific studies in Vietnam (Huy & Shaw, 2010). All of the interviewees claimed that they had knowledge of the disaster risks including storm surge and flooding in their vicinity.

The FGD results indicated that the provincial government was funding the construction of a dyke and drainage system and mangrove protection activities. Dyke construction was noted in several studies as one of the national government's main strategy in reducing the impacts of floods and storms (Phuc, 2011; Reynaud, Aurbert, & Nguyen, 2013; Casse, Milhoj, & Nguyen, 2015), with mangrove protection activities mainly available in Cat Ba Island – the other island of Cat Hai district and the center of Cat Ba National Park. Every year, the authorities at the provincial level take the main responsibility of repairing and strengthening the dyke and drainage systems in Cat Hai Island. On the other hand, the 'Four on-the-spot motto', which has been documented in legal documents since 2006 by Vietnam's Government (Decree No. 8/2006 / ND-CP), was the main DRM strategy employed by the locals of Cat Hai Island. The program name was coined from its four objectives—leadership on-the-spot, human resources on-the-spot, means and materials on-the-spot, and logistics on-the-spot. The implementation of this program in Vietnam has been a successful example of community-based disaster risk reduction and management strategy (Shaw, 2012).

For the island, an annual budget of 30 million VND (~1,388 USD¹)

¹ USD=21,610 VND (Vietcombank, April 2015)

was regularly allocated for activities comprising both proactive and reactive measures to reduce disaster risk at commune level, following the Four on-the-spot motto. Proactive strategies mainly focused on early warning mechanisms and disaster risk prevention activities prior to storm landfall, such as strengthening of houses, anchoring of boats, cutting down and trimming of trees, and early evacuation of vulnerable people like elders, pregnant women, and children (Cat Hai Town People's Committee, 2015).

The role of the mangrove and dyke drainage systems on DRM in this island is still an ongoing debate. The ability of mangroves to protect coastal communities against natural hazards such as storms, tsunamis, and coastal erosion has been widely promoted around the world (Spalding, McIvor, Tonneijck, Tol, & van Eijk, 2014). However, in this island, survey results revealed that there seemed to be some misconception about the role of mangroves in disaster risk reduction since 66% of the respondents believed that mangroves could not reduce the impacts of flood and storms. Most (94%) of the mangrove area in this island has been replaced with infrastructures (dyke system, road, etc.) and shrimp farms.

In comparison, 70% of the interviewees believed in the reliability of the dyke system around the island in protecting them from impacts of storms. All respondents believed in the reliability of the new two-kilometer concrete dyke system from K0+000 (Got Berth) to K3+094 (Cai Vo). It was upgraded to withstand even level 10 storms, but interviewees were doubtful of the remaining 20.6 km dyke system of the island, which was still made of stones, thinking it could easily be damaged by storms and needed repairs almost every year.

Majority (74%) of the survey respondents perceived that their present drainage systems had low draining capacity, increasing their exposure to flood, particularly in low-lying communes like Hai Loc and Tien Loc. Meanwhile, 34% of interviewees noted that the newly built dyke replacing the mangroves system slowed down the flood receding rate. Some people shared that it took about two to four hours longer than in the

past for floods to recede in Tien Loc and Hai Loc communes. Some interviewees further explained that in the past, when they used mangrove systems and/or the stone dyke system to protect them from storms, flood could recede via the drainage systems and through the holes in the stone dyke. After the authorities upgraded the dyke systems without the drainage systems, the flood could not recede through the new concrete dyke.

Role of Traditional Ecological Knowledge in Disaster Risk Management

Traditional Ecological Knowledge on Storm and Flood Prediction

Several studies have confirmed the role of TEK in the prediction of natural hazards such as floods and storms. TEK of this kind was developed through detailed observation of the environment including the behavior of animals, changes in morphology and physiology of plants, cloud patterns, and the appearance of moon and other celestial bodies (Woodley, 1991 as cited in Materer et al., 2002; Enock, 2013; Rivero-Romero, Moreno-Calles, Casas, Castillo, & Camuo-Guerro, 2016). Communities in Zimbabwe predicted natural hazards by observing the behavior of animals, insects, and plants (Kihupi et al., 2002; Mhita, 2006; Huy & Shaw, 2008; Enock, 2013; Hiwasaki et al., 2015). Storm prediction through observing cloud direction was also documented in some studies with the appearance of cumulonimbus clouds signalling heavy rainfall or storm (Barry & Chorley, 1998; Hiwasaki et al., 2015).

Similar to these studies, the local people in Cat Hai have been predicting the occurrence of storms and floods by using TEK and observing their environment. Most of them could predict these events by simply looking at the changes in the sky, plant growth, and animal behavior (Table 2). About 60% of the survey respondents, all of whom were fisher folk, said that they were knowledgeable in the traditional practices of predicting storm and flood. They explained that these beliefs were already embedded in their livelihood because their

Table 2. Traditional ecological knowledge of the respondents in predicting storm

Signs	Belief	Number of users* (%) n = 50	Number of holders* (%) n=50
Sky Cloud	There will be a storm once a cumulonimbus cloud (dense towering vertical cloud) appeared. If the clouds are moving from the sea to the land, the island will not be affected. If the direction of the clouds is from inland to sea, the storm will definitely hit the island. If clouds are moving fast, the storm will also move fast.	28	44
Lightning and thunder	If there is rain, thunder, and lightning above the sea, incoming storm will be very violent (Ancient local people refer to it as "Bão đồ đĩnh").	24	74

(Continued) Table 2. Traditional ecological knowledge of the respondents in predicting storm

Signs	Belief	Number of users* (%) n = 50	Number of holders* (%) n=50
Rainbow	A storm will come shortly once a rainbow appeared in the east.	20	64
Plants	If bamboo shoots grow toward the land instead of ponds, lakes, and rivers, it will be a stormy year.	12	36
	A strong storm is possible if the yield of Longan (<i>Dimocarpus longan</i>) fruit is more than the usual.	8	30
Animals			
Insects	There will be a storm once the ants move their eggs into elevated areas and termites leave their nest.	70	84
Marine Species	A strong storm is coming if many mullets appeared on the sea surface.	28	74

*Users are those who actually use the information to predict the onset of disasters, while holders are those who have mastered how to interpret the signs

ancestors, who were also fisher folk, used them for centuries. However, these traditional practices are becoming unpopular at the study site in recent years because of modern technology. Despite knowing about these practices, 90% of the sampled households indicated that they relied mostly on weather updates from the agency of hydro-meteorological forecasting. This was manifested in the difference between the number of holders of the TEK (those who have mastered how to interpret signs) and the number of users (those who actually use that information to predict the onset of disasters) (Table 2). FGD participants also noted that most of the local inhabitants, especially the youth, relied on the more accurate weather forecasting that reached them through the mass media. The elderly and fisher folk combined both TEK and updates from the media to determine weather forecast. This result is similar to several studies in other countries (Rivero-Romero et al., 2016).

On the other hand, all respondents were still using their TEK and experience in terms of flood prediction. The community was able to preserve their knowledge on the tide calendar, which is their main tool for predicting flood and determining the best time to catch fish (This knowledge is similar to TEK of other coastal regions in Vietnam). Locals predicted the level of the tide according to the lunar calendar. If a storm happened on a high tide day, the level of flooding would be higher than normal. This knowledge was passed on from a long history of fishing tradition. Although all of the respondents were familiar with the tide calendar, only 20% (mainly fisher folk and elders) mastered the flood predictions; hence, other residents depended on them for this kind of information. The respondents perceived that the information generated from the tide calendar was relatively precise.

Local Practices to Cope with Flood and Storm

All of the respondents have developed coping strategies using their experience and TEK. Table 3 summarizes these strategies, classified into proactive strategies (done before the

Table 3. Local practices to cope with flood and storm

Coping Strategies	Respondents (%)
Proactive	
Installing small concrete walls at the bottom of the doors or around the water tanks and wells to block flood water	34
Renovating house	18
Moving elderly and children to relatives' houses or public shelters	68
Moving properties to elevated areas of the house or to set up scaffolds and float	94
Reactive	
Relying on the immediate and extended families and other community networks	100
Repairing houses and clearing debris from the houses immediately after the flood	100
Travelling by boats in Tien Loc commune	40

natural hazard occurs) and reactive strategies (done after). The most commonly practiced proactive strategies mentioned by survey respondents are moving their properties to elevated areas one to two days before storms (94%) and evacuating their elders and children either to their relatives' houses or to public shelters, like schools and hospitals, a couple of days before the storm (68%). Combined with weather forecast data, TEK helped habitants to predict when flooding would occur. From this, the locals could proactively come up with short-term strategies (two to three days before a storm occurs) to deal with flood (Young, 1998). Moreover, 34% of the respondents installed small concrete walls at the bottom of their doors or

around their water tanks and wells to block out floodwater. Interestingly, five interviewees responded that TEK sometimes helped them to predict the possibility of storms, which could cause flood for a few months (in the average term), by looking at signs of plants. As a response, they built small concrete walls at the bottom of their doors or around their water tanks and wells months before the storm season. In addition, some households elevated their floors from an average of 1.5 to 2.0 m to avoid flood inundation. This strategy of elevating houses was also documented as one of the coping strategies to flood impacts in central Vietnam (Reynaud et al., 2013).

After the storm and flood, all of the respondents relied on their social networks to easily cope with the losses and damages. They claimed that disasters have strengthened the social networks in their community. In addition, all of the respondents cited that these events temporarily disrupted the transportation system for two to three days both in and out of the island. Ferries and boats could not navigate around the area. Even the locals, especially those in Tien Loc commune, the lowest area of the island, could not travel across the island by land because roads were mostly inundated. They had to use floats or boats to travel from one place to another. About 40% of total respondents (20 of the 25 interviewees in Tien Loc commune) noted that they traveled by boats for half a day to as long as two days after a flood, noting that the newly built dyke had reduced the drainage rate.

Integrating Traditional Ecological Knowledge in Disaster Risk Management

The FGD and KII participants emphasized the importance of integrating TEK into the current DRM of Cat Hai Island. Current practices showed that the level of preparation before the storm was mostly based on the early warning information from the hydromet agencies. The weather-forecasting programs try to provide the most accurate forecasts in terms of storm track, wind direction, and storm level. However, there are uncertainties in the climate system that affect the accuracy of the storm forecasts. Moreover, the flood risk in the study area is affected by the tide level. At times, although the storm level is low, the flooding level remains high due to the high tide level. Hence, disaster preparation activities in Cat Hai are sometimes perceived to be ineffective when they have been based on weather-forecasting information alone.

Accounts from the interview and FGD noted that there were instances when the local authorities and communities did not prepare as there were no forecasted storms, but due to high-tide level, their areas were seriously flooded. Only those households which used both TEK (the tide calendar) and information from the local authorities were able to proactively mitigate the impact of extreme events, especially flooding, by building small concrete walls at the bottom of the doors and moving their furniture to higher places. Thus, some FGD and KII participants emphasized that the current DRM of Cat Hai Island could still be improved through better TEK integration.

This integrated approach has been suggested in several studies as it enables the communities to formulate and implement the most appropriate coping strategies to weather-related hazards (Lucio, 1999; Krishnamurthy, Fisher, & Johnson, 2011; Hiwasaki et al., 2014). Several studies recommended ways that could be used for that purpose (Botterill & Wilhite, 2005; Baumwoll, 2008; Tran, Shaw, Chantry, & Norton, 2009; Krishnamurthy et al., 2011; Gaillard & Mercer, 2013). For instance, the locals could use TEK as part of the early warning system such as anticipating the intensity of storms and making necessary preparations few months before the storm season to reduce storm and flood impacts. Similarly, if the signs of storms and flood prediction are recognized several days before those events occur, short-term strategies can be formulated to cope with disaster risk.

Given the importance of TEK, governments, institutions, and/or networks need to strengthen and encourage cross-disciplinary TEK research (Etkin & Stefanovic, 2005) and TEK documentation. FGD and KII participants noted that since TEK presentation or transfer could be in the form of storytelling and idioms attached directly to the local livelihoods and their environment, island inhabitants, especially children, could easily acquire knowledge on DRM through TEK or combination of TEK and scientific knowledge rather than relying on scientific knowledge alone. Therefore, disaster managers should use both TEK and scientific knowledge to enhance local awareness and capacity to cope with weather-related disasters. For instance, governments and institutes could provide the scientific basis of TEK (Enock, 2013) and collect TEK information via open discussion with the locals. They can work with the locals in documenting the TEK and information on disaster risks, then transform them into a mapping tool such as through Geographic Information System (GIS). This can be used in mobilizing available human and technical resources and also in strengthening the partnership between local communities and institutions (Tran et al., 2009). The locals could also be encouraged to proactively be involved in DRM activities.

Measures to Preserve and Improve the Traditional Ecological Knowledge in DRM

At the local level, people should preserve TEK. The FGD participants enumerated three main strategies in preserving TEK: (1) identifying local leaders who could promote the integrated TEK and scientific findings, (2) developing oral narratives, and (3) using the extended family model (“mô hình dòng họ”).

Ikeda et al. (2016) emphasized the importance of determining and developing local leaders who could promote both local and scientific knowledge in DRM. The FGD participants believed that the elderly people were in the position to do that as they could attest to the effectiveness of TEK in reducing disaster risk. At the same time, the TEK could be presented through oral narratives in the form of storytelling,

poems, idioms, and cultural and art performance, among others. All the respondents of the survey also supported this recommendation. The importance of oral traditions has been established in several disaster-management studies (Syafwina, 2014; Ikeda et al., 2016). Lastly, FGD participants and 74% of the respondents argued that the extended family model could also be used to disseminate TEK between clans effectively. Through this method, TEK can be documented in a written report by the locals (e.g., leaders of communes, families). Then, reports can be passed on to the next generation of extended families and communities who could also revise or improve its application via oral narratives. The extended family model method could be effective in reducing disaster risk since increasing human interaction and communication between family generations are important in enhancing community-based disaster prevention strategies (Nakamura, Umeki, & Kato, 2016).

Conclusion and Recommendation

The residents of Cat Hai Island, especially the elders and fisher folk, were able to preserve their TEK on storm and flood prediction. This body of knowledge has been passed on from generation to generation by word of mouth. They were able to predict storms by observing the changes in the sky (i.e., clouds, lightning and thunder, rainbow), plant growth, and animal behavior. In recent years, they have been relying both on their TEK and on weather forecasts delivered through the mass media. When it comes to flood prediction, they were still using their TEK of the tide calendar. Although TEK was widely used by the residents, currently, the young generation and local authorities in the island are likely to omit TEK in their DRM strategy. The local authority in the island, in terms of DRM strategy, is mainly focused on strengthening infrastructure (dyke and drainage systems).

This study concludes that the residents of Cat Hai Island have a rich body of TEK that could be used in improving the island's current DRM program. Through an open discussion with the local people, the disaster managers could understand and document disaster risk and TEK in the island. Using the documented TEK, they could establish better medium- and short-term strategies to reduce disaster impacts in the island. However, this study also recognized the need to evaluate the TEK and determine which of them could be integrated with science-based DRM strategies.

Having demonstrated the potential role of TEK in DRM, this study suggests integrating relevant TEK in the DRM activities of Cat Hai Island such as in early warning system and awareness raising activities so the community can better prepare in addressing the impacts of future storms and floods. The integration of TEK and DRM activities could lead to an effective community-based DRM program. Both the government and local people should preserve, document and improve TEK. The documented TEK in Cat Hai Island

on flood and storm prediction and the lessons to integrate TEK and DRM activities in the island could also be applied to reduce disaster risks in other coastal areas not only in Vietnam but in other parts of the world.

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