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Local Community Knowledge for Flood Resilience: A Case Study from East Coast Malaysia

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ABSTRACT

Malaysia as a tropical climate country is vulnerable to dreadful climate change events; particularly floods. These frequent occurrences of floods severely affect one or other parts of the country. In reducing disaster risk and strengthening local initiatives towards climate adaptation, vulnerable communities particularly in rural areas have developed valuable local knowledge for flood resilience. This local knowledge is continuously practiced in facing disasters and it is passed down to the next generations. This study aims to examine measures taken by communities based on local knowledge they possessed from the three stages of disaster management cycle namely, before, during and after disaster. Local knowledge as asserted by scholars could complement scientific knowledge and build a comprehensive disaster risk reduction approach for local context implementation. A mixed method approach was adopted; case study method and household survey involving 90 respondents for quantitative data collection and field observation for collecting qualitative data. Three case study areas in East Coast of Malaysia have been selected for further observation including; 1) Lubok Setol village in Kelantan state; 2) Teladas village in Terengganu state; and 3) Gajah Mati village in Pahang state. Findings from this study indicated that all study cases have developed and adopted local knowledge strategies for flood preparedness and responses including; 1) agriculture techniques and livestock trading; 2) stock piling of food and other necessities; 3) marking flood level as historical record; 4) floodproofing animal shelter; 5) constructing overhead storage cabinet and outdoor hut, and; 6) saving boats for emergencies. As a conclusion, it is proven that local community knowledge plays crucial roles in reducing disaster risks hence contributing towards building a resilient community.

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1. Introduction

Since the last few decades, the advancement of multi-hazards and risks has significantly changed the environment and its ecosystem. Since climate change events particularly floods, have affected many parts of the country; hampering the socioeconomic growth and undermining sustainable development of the nation, it become obvious for the government of Malaysia to play a more proactive role in translating global disaster risk reduction (DRR) strategies into national policy framework (Omar Chong and

Kamarudin, 2018). The continuous process of mainstreaming DRR into national and local policies and strategies is unarguably in line with UNISDR (2005) statement that calls for states and local authorities to collaborate with local communities for the systematic development and application of DRR policies and strategies to minimise vulnerabilities, hazards and the unfolding disaster impacts, hence to achieve a resilient community agenda. According to Omar Chong and Kamarudin (2018), it is common for any policies related to disaster risk management to be bestowed to relevant authorities including of army force or civil protection institution of a country. Under military chain of command, disaster is treated as an enemy in the battle field, which raises issues among scholars particularly on tendency for development of command and control (top-down), and challenge in building trust between policy makers and local community. As a result, communities which are the most impacted victims by natural hazard or the marginalised and economically unequal groups (Fastiggi et al., 2020) might become more disintegrated from the disaster risk reduction system. Furthermore, the marginalised local communities that pose specific knowledge suitable for resilience to disasters might find their local knowledge and practices to be neglected from overall DRR process (Cuaton and Su, 2020; Dennis et al., 2019). On another paper, Pelletier (2017) stressed that local knowledge is vital in DRR decision making and action coordination particularly at local level. This is regardless of local knowledge or scientific knowledge, or combination of both type of knowledge.

This study aims to identify the construct of local knowledge and practices related to DRR and the extent to which this knowledge has been integrated by respondents before, during and after disaster. Specifically, the study intended to link between adoption of local knowledge with local capacity building; science in DRR and resilience through disasters impact reduction whilst improving recovery period. Local knowledge has been described using various terms by different researchers. According to Lejano et al. (2013: 61), local and/or traditional knowledge is often described as knowledge which is 'passed on within a community as part of its cultural heritage', while, science is assumed to be a 'continuous testing, refutation or confirmation, and improvement of knowledge'. Other researchers such as Cuaton and Su (2020); and Hooli (2016) are using the term traditional knowledge or local people knowledge. Regardless of differences of the term they have been used, local knowledge implies to a set of knowledge owned and developed based on local people experience and learning from long term interaction with their surrounding environment. Since the meaning of local knowledge could cover a wider range of knowledge and discipline of studies, there were also some efforts for integrating local knowledge interpretation into the context of disaster-related research (Table 1).

Interestingly, generation of a word cloud using the definition of local knowledge offered by the scholars shows that the most frequently used word is 'through' (Figure 1). According to the Cambridge Dictionary, 'through' means from one end or side of something to the other, or beginning to the end of a period of time. For the purpose of this paper, 'something' should refer to a group of people inhabiting within the same geographical area. This is taking into account that natural disaster is disruption resulting from a physical agent; which is also termed as community (Cuaton and Su, 2020). 'Something' also refers to the understanding of a particular event in a particular area. In conclusion, local knowledge here is an understanding of flood gathered through experience, accumulating and snowballing through generations within a community. In a more recent study by Omar Chong (2020), adoption of local knowledge in DRR reflected the four stages of community resilience strategies; prevention, prediction, preparation and coping mechanisms. For instance, local people improved their building techniques and/or using floodproofing materials for construction as prevention measures. In some communities, their prediction on future flooding is based on observation of animal behaviour and environmental changes etc. Other than physical elements, local people are also using spiritual and religious, dream and ritual to guide their preparation for disaster. As for coping mechanisms, they make sure to provide safe storage for rice and other staples, trading livestocks for cash during emergency, etc.

Table 1 Local knowledge defined by scholars

Term	Field	Definition	Reference
Local indigenous knowledge	Disaster	Traditional knowledge is regarded as a sort of a collectively spoken and articulated narrative that is shared by everyone in a community	Cuaton and Su (2020)
Indigenous and local knowledge	Ecosystem services	The multi-faceted arrays of knowledge, know-how, practices and representations that guide societies in their innumerable interactions with their natural surroundings. A body of different types of knowledge and practices of societies accumulated through a continuous interaction with their natural surroundings.	Sin and Månsson (2017)
Indigenous knowledge	Disaster	Heterogeneous combination of different knowledge and it varies between different localities. It is also accumulated from the observation, experimentation, beliefs, behaviours, and the holistic worldviews of local people.	Hooli (2016)
Local and indigenous knowledge	Development practice	Understandings, skills and philosophies developed by societies with long histories of interaction with their natural surroundings	Hiwasaki *et al.* (2014)
Indigenous knowledge	Agriculture	Unique, traditional, local knowledge existing within and developed around the specific conditions of people indigenous to a particular geographic area.	Derbile (2013)

Term	Field	Definition	Reference
Indigenous knowledge	Disaster	A body of information passed down through generations in a given locality and acquired through the accumulation of experiences, relationships with the surrounding environment, and traditional community rituals, practices and institutions.	Kelman *et al.* (2012)

Figure 1 Review of literature on definition of local knowledge word cloud

1.1 Integration of Local Knowledge into the Building of Community Resilience

As mentioned by Fastiggi et al. (2020), local knowledge was given low priority for local/practical applications by community due to larger influence by scientific knowledge, hence restricting its full potential in DRR. In this light, strengthening of local knowledge adoption into DRR requires firstly, a clear understanding on the concept of resilience community, particularly on how the four stages of local knowledge on DRR (Omar Chong, 2020) can be mapped and synergised with the four stages of disaster management cycle (DMC); prevention/mitigation, preparedness, response and recovery (Chen and Quan, 2021). Many researchers in the field of resilience study explains the level of resilience with specific reference to capital/resources component (vertical axis) and time component (horizontal axis) (see Omar Chong, 2020; Akter and Mallick, 2013; Wilson, 2012 and others) (refer to Figure 2). The capital/resources axis represents community's economic, social and environment components. The notion of this model is that the more capital a community possess; the more resilient that said community will become in the event of a disaster (Wilson, 2012). These capitals can be developed through the process of mitigation and preparedness in disaster management cycle (Cuaton and Su, 2020). Meanwhile, the horizontal axis represents the time consumed by the community to get back to the original state or build back better prior to the disaster.

With reference to Figure 2, there are four (4) possible scenarios which can be assessed in relation to the concept of community resilience (Chen and Quan, 2021; Omar Chong, 2020) namely: (1) 'bounce back better' which refers to community's ability to absorb disturbances and improve most of its functions as compared to before the disaster; (2) 'bounce back' refers to community's ability in getting back and restore its original state and main functions similar to its condition before the disaster; (3) 'recover, but worse than before' means the community still shows some sign of disaster recovery but at a slower phase and with decreasing of local capacity to carry out the recovery tasks: and (4) 'collapse' indicates community's failure in managing the disaster risks including failure in post-disaster process and unable to restore community's basic functions needed for rebuilt of their livelihood. As defined by Hayashi (2017), damage is equal to the sum of hazard, exposure, and vulnerability (Figure 2). Damage that resulted from disaster could be reduced by implementing suitable prevention/mitigation and preparedness measures (in pre-disaster stage). The triangle shape marked in blue represents the ideal situation for disaster resilient progress where the vertical axis shows the implementation of prevention/mitigation measure to alter hazard and reduce vulnerability.

Meanwhile, the horizontal axis indicates any appropriate activities which carried out to speed up recovery process after disaster and to initiate community 'bounce back process' or in a more ideal situation, shall increase community's ability to bounce back better (Omar Chong et al., 2018). With reduction of hazard and vulnerability, and improvement of community's capacity building would increase the chances for community to be more resilient hence to reduce future disaster risk (Chen and Quan, 2021; Omar Chong et al., 2018). The process for obtaining and cultivating the bounce back process also would require strategic adoption of

community resources including local knowledge in nurturing and building a resilience community.

This study aims to examine measures taken by communities based on local knowledge they possessed from the three stages of disaster management cycle namely, before, during and after disaster. This study has been carried out in three rural settlements in East Coast of Malaysia during 2016 to 2019.

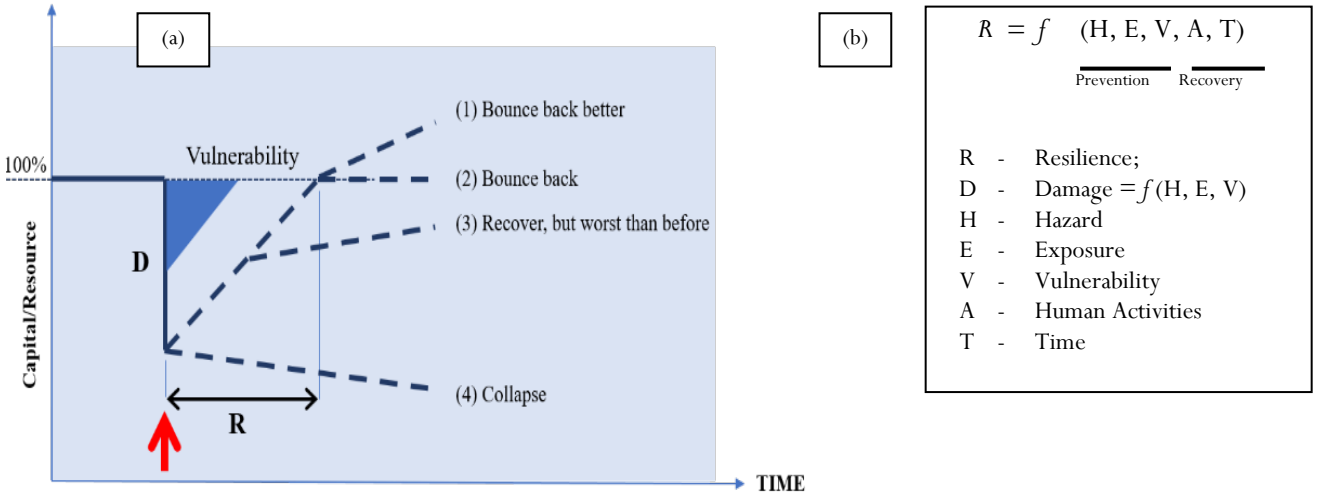


Figure 2 (a) Resilience towards disaster illustrated in lifeline (Chen and Quan, 2021; Omar Chong, 2020; Hayashi, 2017; Wilson, 2012; Akter and Mallick, 2013); (b) The resilience towards disaster as illustrated in Mathematical Model (Hayashi, 2017)

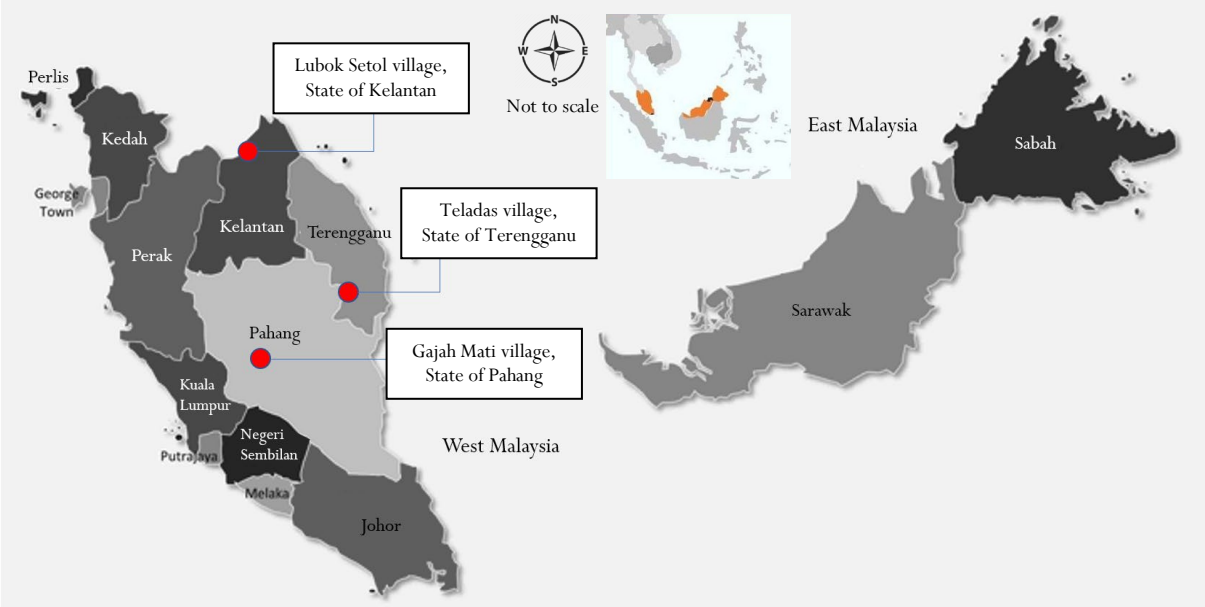
2. Methodology

2.1 Description of Study Area

According to the National Rural Physical Planning Policy 2030 (NRPPP 2030) (PLANMalaysia, 2016) report, the east coast region of Malaysia has the highest number of disaster risk villages. Based on similar report, Kelantan is the leading state with the highest number of 1,472 disaster risk villages, followed by Pahang (1,434 villages) and Terengganu (1,319 villages). Cross examines of data from the Social and Welfare Department, SWD (Malaysia Social and Welfare Department, 2015), indicated flood as the most common disaster which dominantly impacting people as compared to other types of disaster particularly in East-Coast region. Using latest information from NRPPP report and SWD, then it would be more appropriate for the study to focus only on flood risk villages in the East-Coast region of Malaysia. Selection of suitable study cases shall be based on the following five criteria, namely:

a) The case must be the traditional village(s) with disaster risk as identified by NRPPP 2030 report (C1);
b) Village(s) located in East Coast region which frequently experienced disaster occurrences based on record provided by the Malaysia Social and Welfare Department (JKM) (C2);
c) Village(s) with own disaster response team established under Village Development and Security Committee (JKKK) (C3);
d) Village(s) which has Standard Operating Procedure (SOP) for disaster response endorsed by Disaster Management agencies (C4); and
e) Village(s) that participated in Community Based Disaster Risk Management (CBDRM) Program conducted by MERCY Malaysia (C5).

A total of three villages with flood disaster risks have been identified as the most suitable candidates for further study. These villages are; 1) Kampung Lubok Setol in the State of Kelantan; 2) Kampung Teladas in the State of Terengganu; and 3) Kampung Gajah Mati in the State of Pahang (Figure 3).



State	Village	Comments of Assessment Criteria				
		C1	C2	C3	C4	C5
Kelantan	Lubok Setol	Listed as traditional village with disaster risk	Experienced most frequent flood occurrence in Pasir Mas	Have established disaster response team sub-committee	Coordination meeting lead by evacuation center manager (JKM officer)	Not available
Tereng-ganu	Teladas	Listed as traditional village with disaster risk	Experienced most frequent flood occurrence in Kemaman	Have established disaster response team sub-committee	With SOP acknowledge by NADMA	Not available
Pahang	Gajah Mati	Listed as traditional village with disaster risk	Experienced most frequent flood occurrence in Temerloh	Have established disaster response team sub-committe	Coordination meeting lead by evacuation center manager (JKM officer)	Participated in CBDRM by MERCY

Figure 3 Location and distribution of selected case study areas based on selection criteria (C1-C5)

2.2 Data Collection

This study utilises a mixed method for data collection including household survey using questionnaire (quantitative approach), followed by several qualitative approaches including partial-participatory observation, interviews with key informants, photograph and content analysis (reviews of relevant documents and reports related to topics researched). 'Partial-participatory observation' is an operational term which derived from the original term 'field observation'. Due to time and financial constraints, as well as the long distance/location to commute to each study area, forcing researchers to conduct structured field observation within the limited period of time (i.e. partially observed the community's daily activities and DRR-related practices) (Saunders and Luck, 2014; Kamarudin, 2013). This approach seems more appropriate under current limitations and the data gathered from the field study will be combined with inputs from questionnaire survey and review of relevant documents for analysis of findings. Kamarudin (2013) has applied the participant observation technique to verify and cross reference with data collected through questionnaire interview. For instance, during the pilot study, the local community was given a set of questionnaires about their knowledge and experience during flood including the severity of flood occurrences, highest flood water level they have experiences over few years and strategies undertaken to reduce losses or damages from the flood.

It was noted that many respondents have recorded flood water level on the wall or pillars of their houses. In order to record these observations, researchers are using photographs to capture and store images for further analysis. Other than taking photos, informal interviews with key informants including the village heads and house owners in the study areas have been conducted to gather detail and/or in-depth information regarding local knowledge and practices related to DRR. Documentary resources or known as the secondary resources are also important source of data. According to Deschilder-Omoro (2013), documentary sources include book, journal, governmental report, village profile report, thesis and publications by agencies. Deschilder-Omoro (2013) asserted that documents are able to provide guideline and information to assist researcher in cross-checking information from other source of field data. In this context, researcher shall review various documents to extract relevant information relating to historical background of floods in east coast region. Previous studies done are also reviewed in order to understand the disaster risk and formulation of actions for resilient rural society.

3. Results and Discussions

3.1 Background of Respondents

A total of 90 respondents from the Malay race group had participated in the survey using questionnaire-guided interview. Distribution of sample size of all three study cases is shown in Table 2.

Table 2 Distribution of sample size (by village)

Village	Number of families	Each village (%)	Sample size *(n=90)*
Lubok Setol	131	40	37
Teladas	121	37	32
Gajah Mati	70	23	21
Total	322	100	90

As illustrated in Table 3, in terms of respondents' types of employment, a majority of respondents in Lubok Setol are (30%) currently working in agricultural-related sectors as rubber tappers or as land owner rubber plantations. Employment as manual workers was ranked in second place (19%), followed by working in government sectors (14%), businessman/entrepreneur and retiree (8% respectively), followed by unemployed and housewife (3% respectively) and others (15%). For Teladas, majority of respondents are currently working as self-employed person to carry out local and odd-jobs or wage earner (transportation driver, shop assistant, and babysitter) (35%). In the second rank is manual workers (22%), agricultural-related (16%), businessman/ entrepreneur (9%), government and housewife (6% respectively), unemployed and retiree (3% respectively). In Gajah Mati, majority of respondents are retiree (33%) followed by workers in agricultural-related sectors (24%). In terms of age structure, majority of respondent from all three villages are above 50 years old with Lubok Setol (62%), followed by Teladas (59%) and Gajah Mati (57%). According to a study conducted by Hooli (2016), community with many older respondents could provide more inputs due to the notion they have been living and interacting within their community for a long period and therefore might possess vast amount of local knowledge. In this light, this study assumes older respondents within these three communities would possess unique local knowledge in relation to DRR.

Table 3 Profile of respondents (n=90)

No.	Information	Answers	Study areas					
			Lubok Setol		Teladas		Gajah Mati	
			Frequency	%	Frequency	%	Frequency	%
1	Ethnic group	Malay	37	100.0	32	100.0	21	100.0
2	Types of occupation	Unemployed	1	2.7	1	3.1	0	0.0
		Retiree	3	8.1	1	3.1	7	33.3
		Businessman/entrepreneur	3	8.1	3	9.4	2	9.5
		Professional	2	5.4	0	0	2	9.5
		Government	5	13.5	2	6.3	1	4.8
		Housewife	1	2.7	2	6.3	0	0.0
		Manual worker	7	18.9	7	21.9	2	9.5
		Agriculture-related	11	29.7	5	15.6	5	23.8
		Others	4	10.8	11	34.4	2	9.5
		Total	37	100.0	32	100.0	21	100.0
3	Religion	Islam	37	100	32	100	21	100
4	Age category	<30 years	2	5.4	4	12.5	4	19.0
		31-34 years	3	8.1	2	6.3	0	0.0
		35-39 years	3	8.1	2	6.3	1	4.8
		40-44 years	4	10.8	5	15.6	2	9.5
		45-49 years	2	5.4	0	0.0	2	9.5
		50-54 years	6	16.2	3	9.4	2	9.5
		55-59 years	7	18.9	4	12.5	3	14.3
		60-64 years	5	13.5	1	3.1	5	23.8
		>65 years	5	13.5	11	34.4	2	9.5
		Total	37	100.0	32	100.0	21	100.0
5	Marital status	Single	2	5.4	3	9.4	3	14.3
		Married	32	86.5	29	90.6	17	81.0
		Others	3	8.1	0	0.0	1	4.8
		Total	37	100.0	32	100.0	21	100.0
6	Level of Education (highest education	No formal education	4	10.8	4	12.5	1	4.8
		Primary school	11	29.7	12	37.5	1	4.8

No.	Information	Answers	Study areas					
			Lubok Setol		Teladas		Gajah Mati	
			Frequency	%	Frequency	%	Frequency	%
	received)	Secondary school	15	40.5	15	46.9	17	81.0
		Certificate/Diploma	5	13.5	1	3.1	1	4.8
		Degree an above	2	5.4	0	0.0	1	4.8
		Total	37	100.0	32	100.0	21	100.0
7	Monthly household income (in US Dollars)	Below 200	19	51.4	15	46.9	3	14.3
		201-250	5	13.5	7	21.9	4	19.0
		251-750	12	32.4	9	28.1	13	61.9
		751-1250	1	2.7	1	3.1	1	4.8
		1251-1750	0	0.0	0	0.0	0	0.0
		>1751	0	0.0	0	0.0	0	0.0
		Total	37	100.0	32	100.0	21.0	100.0

In terms of level of education, majority of respondents from all three villages received up until the secondary education. However, there are few respondents from Lubok Setol village (19%) which received up until tertiary education. It is also worth to highlight the relationship between level of education and respondents' types of job in study areas because majority of them did not participate in professional work; i.e. many are working in agriculture-related sectors, operating local business and other works which might not require higher academic qualification. This situation is also reflected in the assessment of household income whereby majority of them are living below the poverty line (<USD200/month).

3.2 Background of Floods in the Study Areas

3.2.1 Lubok Setol village, Kelantan

Lubok Setol village is located in the district of Rantau Panjang, Jajahan of Pasir Mas, Kelantan, about 8 km from the nearest town (Rantau Panjang) and 30 km from the town of Pasir Mas (Figure 3). The village is stated in National Rural Physical Planning Policy 2030 report as one of the disaster-risk villages (PLANMalaysia, 2016). The village is administered by the Neighborhood Watch (Rukun Tetangga) under the Department of National Unity and Integration. Kampung Lubok Setol was established as a linear village along the road within an area of 576 hectares.

The village is located adjacent to Sungai Golok (the Golok River) (national boundary for Thailand and Malaysia), which is considered the main contributor to the flood in the monsoon season. During the field study, information from local leader on flood inundated areas were transferred into base map. Almost 93.00% of Kampung Lubok Setol was inundated during ordinary floods, and the portion of the inundated area can reach as high as 97.38% during severe flooding e.g. major flood in 2014. During ordinary floods, the areas safe from flood are Kasban Road, the main road, the police station, and the evacuation centre. Whereas during a severe flood, only the evacuation centre and the police station were inundated.

3.2.2 Teladas village, Terengganu

Teladas village is located in Mukim Tebak, Kemaman District, State of Terengganu. The village is about 28km from the town of Kemaman, 150km from Kuala Terengganu. The village has been identified in the NRPPP 2030 as one of the disaster-risk villages (PLANMalaysia, 2016). Administered by the Village Development and Security Committee (MPKK) of Kampung Teladas, the village has a population of 774 people (121 households), all of whom are Malays (100%). From the field observation of physical element, it was noted that Kampung Teladas is characterised by scattered dwellings stretched in an area of 762 hectares.

The village is located adjacent to the Kemaman River, which is considered the main contributor to the flood in the monsoon season. Based on the interview with key informants during the field study, only 0.11 % (9.24 hectares) of the areas were inundated at two different areas within the village: one is the area close to the river and bridge which connects Kampung Teladas with Air Putih village, and another is at the centre of the village. Both areas were inundated due to the low elevation of the lands. During the severe flood in 2013, 96% of Kampung Teladas was inundated, including the evacuation centre and the surau, leaving only a small area spared from flooding.

After the flood event in 2013, the existing standard operating procedure (SOP) for flood management has been improved with the support from Kemaman's member of parliament, YB Datuk Sri Ahmad Sabery Chik. The improvements include (1) completion of the inventory of village population for immediate registration at the evacuation center in the flood event, (2) development of Flood Management System (SPB) software developed for flood management in Kemaman only, and (3) forming the evacuation center committee. The SOP had been awarded the Gold Medal for the best SOP in 2014.

3.2.3 Gajah Mati village, Pahang

Kampung Gajah Mati is located in Mukim Mentakab, Temerloh District, in the state of Pahang, approximately 125 km away from Kuantan, the capital state of Pahang. The population of

Kampung Gajah Mati in 2017 was 554 people (75 households). However, no information was obtained regarding the land size of the village due to an incomplete village profile. Kampung Gajah Mati is a link village (or Kampung Rangkaian) currently administered by MPKK Sungai Buloh (as a main/core village). MPKK Sungai Buloh is responsible for managing seven other villages, namely Lubuk Kechemas, Batu Hampar, Sungai Buloh, Batu Kapur Sekolah, Sungai Buloh Seberang, Bukit Netas, and Bukit Intan.

Among these villages, Kampung Gajah Mati was identified as a traditional village with a disaster risk, as stated in the NRPPP 2030 Report. Kampung Gajah Mati experienced series of major floods including in 2013 whereby almost 72.7% of the village area was inundated, and the most severe flood occurred in 2016 when 460 victims were forced to leave their homes and transferred to an evacuation center. Few residents were also left stranded at their houses due to logistic issues. According to the JKM officer, Kampung Gajah Mati is severely impacted by annual flood. The exposure to high intensity of disaster could have become one of the main criteria for the village community being selected for the disaster relief programs organized by MERCY (such as training for disaster preparedness, health and medication, logistic equipment/boat and etc.).

3.3 The Impacts of Floods to Community

According to the results from household survey, majority of respondents (approximately 87%) from all three villages indicated a high vulnerability to flood. Respondents in Teladas is the most vulnerable to annual floods with 97% mentioned they have suffered several losses, followed by Lubok Setol (84%) and Gajah Mati (76%). A total of 87% of respondents also agreed the annual floods that occurred during monsoon season (November to February) have affected their livelihoods including damaging properties and disturbance of local jobs and loss of income particularly among farmers and rubber tappers. Field observations have been carried out to assess physical quality of each village. The result indicated that components of property owned by community that were seriously damaged by floods included houses with wooden structure and soil erosion involving agriculture land adjacent to the main river. Since most of the respondents experienced work and income disruptions for almost three months prior to the flood, they faced financial burden after flood since more money was needed to reconstruct damaged houses and slope maintenance works, with addition to the daily living costs (Figure 4).

Figure 4 Physical damages caused by flooding. (Photo, from left) wooden house structure damage by flood, debris in the river and main road in the village was covered by thick mud after flood receded

3.4 Disaster Risk Reduction

Table 4 indicates more than 81% of respondents have been living for more than 20 years in their villages. Based on the interview, many of them were born in the village and it is also common for some of them to inherit properties from their parents including house, farm land, local businesses, etc. As mentioned by the literature review, local knowledge is an accumulation of knowledge and practices by local community prior to the long engagement and/or interaction with nature and surrounding environments (Cuaton and Su, 2020). This knowledge has been tested and modified through various trial-and-error processes over the years. With advancement of disasters and introduction of modern mitigation approach to DRR, local community still rely on local knowledge to enable them in managing disasters together with assistance from agencies. Having said that, local knowledge is often not applicable to immigrant groups; as these groups are lacking in experience of managing local disasters as well as they lack of integration with the local community for information sharing (McAdoo et al., 2009).

Table 4 Information related to respondents' length of stay in the village (n=90)

No.	Information	Answer	Study Area					
			Lubok Setol		Teladas		Gajah Mati	
			Frequency	%	Frequency	%	Frequency	%
1	Length of stay in the village	<2 years	3	8.1	1	3.1	1	4.8
		2-5 years	4	10.8	2	6.3	0	0.0
		6-10 years	0	0.0	1	3.1	0	0.0
		11-15 years	2	5.4	1	3.1	0	0.0
		16-20 years	0	0.0	0	0.0	2	9.8
		>21 years	20	75.7	27	84.4	18	85.7
		Total	37	100.0	32	100.0	21	100.0

Based on the survey, almost all respondents (99%) did mention they have direct experience in local disasters. Only one respondent that also a housewife (age 30 years old) from Teladas village mentioned she did not experience the flood because she got married in 2017 (field work was carried out in 2018) and moved into the village after the flood occurred. Table 5 (based on research fieldwork in 2018) presents the results from assessment of respondents' awareness and preparedness towards floods in case study areas using mean value and standard deviation analysis. A total of eleven questions or statements using Likert Scale of 1 to 5 were constructed. The value of 1 denoted 'strongly disagree' and value of 5 denoted 'strongly agree'. Results with mean value of 4.0 and above will indicate high level of awareness and preparedness among respondents.

Table 5 Assessment of respondents' awareness and preparedness towards flood in case study areas (n=90)

No.	Statement	Minimum	Maximum	Mean	S.D.
1	I am able to predict flood occurrences (using local knowledge)	2	5	4.48	0.796
2	I am fully aware that flood occurrences cannot be avoided	3	5	4.83	0.404
3	My house was built to withstand flood	2	5	4.29	0.753
4	I have prepared an emergency bag	1	5	4.31	1.056
5	I know the location of evacuation centres	3	5	4.67	0.519
6	I am aware that sharing of experience about DRM is essential	3	5	4.51	0.623
7	I think humanitarian aids provided by government is sufficient	2	5	3.92	0.851
8	I think government will assist in recovery process	1	5	3.41	0.911
9	I know which agency to refer for assistance during disaster	1	5	3.96	0.833
10	I think my community still rely on government and NGO assistance in facing floods	1	5	3.41	1.048
11	I am aware the importance of practicing DRR among member of community	2	5	3.96	0.616

The above table indicates utilisation of local knowledge in flood prediction among respondents remains high with mean value of 4.48 (i.e. from agreed to highly agreed). Based on interviews, many respondents are using local knowledge to alert them about the flood water level from nearby river (by marking the water level at the pillar in their houses). Marking of water level will enable the community to decide for evacuation strategies later on. Having local knowledge in flood early warning is helpful, however, many of respondents also agreed flood occurrences are unavoidable (mean value = 4.83) and therefore, they have to accept any consequences living in flood-prone areas. Many respondents also agreed their houses were constructed using appropriate building materials to withstand flooding (mean value = 4.29).

Majority of respondents also mentioned they prepared an emergency bag where they put important documents, flashlight, medicine, water and food supply in small quantity (mean value = 4.31). The respondents are also aware of the location of nearby evacuation shelter (mean value = 4.67). In terms of knowledge and experience sharing, the respondents agree that experience sharing is important (mean value = 4.51). The remaining five questions with moderate consensus (i.e. mean value <4.0 and above 3.0) among respondents included "sufficient humanitarian aids by government" (3.92), "government will assist in recovery process" (3.41); "aware of agencies to be contacted for assistance" (3.96), "rely on government and NGO in facing floods" (3.41), and "aware of the importance of practicing DRR among community members" (3.96).

3.5 Adoption of local knowledge for flood preparedness and response

3.5.1 Agricultural Techniques and Livestock Trading

Occurrences of flood in all case study areas as discussed in previous section has impacted the wellbeing of respondents since many of them are actively engaged in agricultural-related activities; as rubber tappers they need to halt their work at the plantation during monsoon season (normally for more than three months). Usually, local community will spend all their annual savings during the monsoon season to buy food and other necessities. For those whose livelihood is damaged by flood, selling assets (including jewelries and livestock) is a normal solution to raise fund for reconstruction and damage repair. This is also the reason for local community to safeguard their livestock (cows or goats) during flood by keeping it in higher shelter.

3.5.2 Stock Piling of Food and Other Necessities (Clean Water, Construction Materials, etc.)

Based on series of interviews with local leaders from three villages, it is a common practice for local people to create stock pile of food and materials supplies as preparation for flood. According to Omar Chong (2020), stock piling of food and materials also termed as "stock up on provision" and become a normal practice by other communities in flood-prone areas in Malaysia. Safeguarding other necessities including clean water however, becomes a huge issue for respondents in Lubok Setol since they are largely dependent on local wells as the main source of water (Figure 5). This is because supply of water by state water agency often disrupted during flooding due to low water pressure. Local community has voiced out their concern

with water contamination issue (water in wells mixing with flood water) after flood receded as this might result in the spread of water-related diseases. In this light, local community needs to stock up clean water for the usage during flood together with sufficient food supply for some period of time. Currently, among strategies to store clean water is to purchase packed reverse osmosis water from local shops. During field study in 2018, it can be observed that many respondents have purchased few bottles of RO water in jumbo size of 10 liters as early preparation. Respondents also raise the barricade surrounding their well to prevent flood water penetration. On top of the well, respondents constructed a high platform to place a water pump. After flood receded, the officers from District Health Department will conduct water treatment process to ensure local communities received clean and safe water for everyday consumption.

Figure 5 (from left) Water supply from local well is an important source for clean water among residents in Lubok Setol village; (right) Local community stock up "RO water" (reverse osmosis water) that they purchased from local shops for their usage during flood season

3.5.3 Marking of Flood Water Level and Construct Higher House Elevation (Raising the Floor Level)

After the devastating tsunami strike in 2004, a research team for Japan has initiated DRR practices suitable for local community i.e. through construction of higher poles and, marking of water level during tsunami (as documentation). This knowledge transfer approach had begun since 1854 in Japan called "height pole" (Sugimoto et al., 2010).

Figure 6 (from left) Marking flood water level on the house pillar; Local leader standing beside house pillar with marking of flood water level showing the highest water level is above his head; Marking of water level on the wall beside staircases

Interestingly, in Lubok Setol, marking of flood level (for documentation of each flood event and to share their story with future generations) served as a physical record and it has been initiated by local communities (similar to Japanese approach). The oldest record on flood water level in Lubok Setol is dated back to 6th Jan 1967 (Figure 6). Based on field observation, every respondent marked the annual flood level at different places in their house such as on the wall, house pillar, main entrance staircase and staircase to kitchen area. During the visit, the head of the village pointed one flood height pole that measured water level of 2014 major flood that went above his head i.e. approximately 1.6-meter height. Based on the interview, the height pole became a vital indicator as to guide every owner of the house (many of respondents inherit house from their late parents) that wanted to renovate or extending their houses (Figure 7).

Figure 7 (from left) Valuable asset store in the new; (right) House elevation is raised to a new level to surpass the highest flood water level recorded over the years

Materials for housing construction as observed during the fieldwork also gradually changed from traditional timber and wooden houses to the use of mix building materials i.e. concrete and timber and entirely concrete. There is a strong perception among respondents that concrete building is stronger and may provide better protection during flood. Using concrete materials also could reduce structure vibration caused by strong water current hence will reduce missing sections. This is because previous construction using timber/woods often missing or severely damaged by the floods. Changes in construction materials also mentioned in research carried out by Chan and Khan and Ahmad (2017) using the term 'permanent flood proof building'. This measure also adopted by local communities in all three cases through integration of local knowledge. The owners will urge the constructor/builder to increase or raise the height of the new section to be above the highest marking of flood water level. Using this marking system also helps residents to arrange home furnishings and install higher storage cabinet sets.

3.5.4 Constructing Higher Structure for Animal Shelter

Buildings for livestock or animal shelters in all three villages also have been constructed at higher elevation to provide better protection for animals during flood. Keeping their livestock safe is important to local residents considering the potential income to be generated from selling of animals that could be used to fund reconstruction process after the flood. Evacuation of livestock is considered a costly process hence it is more

sustainable solution to construct higher structure for animal shelters.

3.5.5 Placing valuable items/goods on a higher overhead storage cabinet

Research field work recorded that every house in all three villages has installed the overhead cabinet functioned for additional storage spaces. The main purpose of constructing an overhead storage cabinet is to place valuable items including furniture, electrical appliances, motorcycle and valuable assets away from the water line. Hooli (2016) in her study in Northern Namibia offered similar observation when local community in flood-prone areas often constructed overhead storage as a mean to protect their valuable items and goods from floods.

3.5.6 Keeping a Boat for Emergency Use and Mobility during Flood and Building Outdoor Hut for Extra Storage

Based on the field observation, local community in Gajah Mati obtained more storage space for their household items by constructing an outdoor hut. An outdoor hut is also a practical approach to secure valuable assets during the flood. Based on the interview, residents who are stranded during flood (i.e. their houses were spared from flood but somehow unable to reach local facilities because the road was submerged), they were survived even staying at their own house because of sufficient storage of food and other needed supplies in huts and overhead storage cabinet. It is also a common sight to see residents store boats under the huts for emergency and mobility during flood (to get food supply and other necessities). It is also a common sight to see residents store boats under the huts for emergency and mobility during flood (to get food supply and other necessities) (Table 8).

Figure 8 Keeping boat for emergency use and mobility during flood is a common sight at all three villages

As majority of members of the community are still living in poverty, there is a little doubt that living in flood prone areas makes the community to be more vulnerable and becoming less resilient to flood. Despite economic disadvantages, all three communities have managed to utilise their local knowledge and experience to reduce flood risk. As explained in section 3.5.1 to 3.5.6, the communities have also demonstrated strong will and ability to adapt to occurrences of flood and changing environment. Meanwhile, assessment of respondents' level of awareness and preparedness towards flood in case study areas as presented in Table 5 also provided crucial insights regarding high level of communities' utilisation of local knowledge in flood prediction. Results from interviews indicated many respondents are using local knowledge to alert them about the flood water level from nearby river (by marking the water level at the pillar in their houses). Marking of water level enables the community to decide for evacuation strategies in times of the flooding. Although majority of respondents are aware that flood is an inevitable event however, through utilisation of local knowledge that they gathered through long term engagement and learning from their surroundings, combined with modern approach (based on scientific knowledge) from training and awareness programs by agencies and NGOs, they can adapt to the changing environment while minimising negative impacts from flood to livelihood and surrounding environment. This situation has in turn enriched their awareness and preparedness about local flood phenomena by constructing appropriate DRR strategies.

This study finding was indeed in-line with previous studies on community-lead DRR by Fastiggi et al. (2020) and Cuaton and Su (2020) as discussed in subsection 1.1 of this article on the importance for integrating both strands (i.e. local knowledge and scientific knowledge). Figure 9 presents the overall findings of this paper that emphasis on combination of these two knowledge strands supported by elements of flood resilience practices from data analysis in section 3.4 and 3.5, as well as inputs from literature review in section 1.1. It is worth mentioned that in the case of the three communities, local knowledge is applicable for disaster prediction, prevention, preparation and coping purposes and also concurrent with existing DRR measures stipulated by scholars in both strands (see Omar Chong, 2020; Cuaton and Su, 2020 for details). Therefore, the best wisdom for flood mitigation and preparedness must require an integration of local knowledge application with scientific knowledge with reference to disaster management cycle prevention / mitigation, preparedness, response and recovery (see Omar Chong, 2020; Fastiggi et al., 2020 for detail discussions).

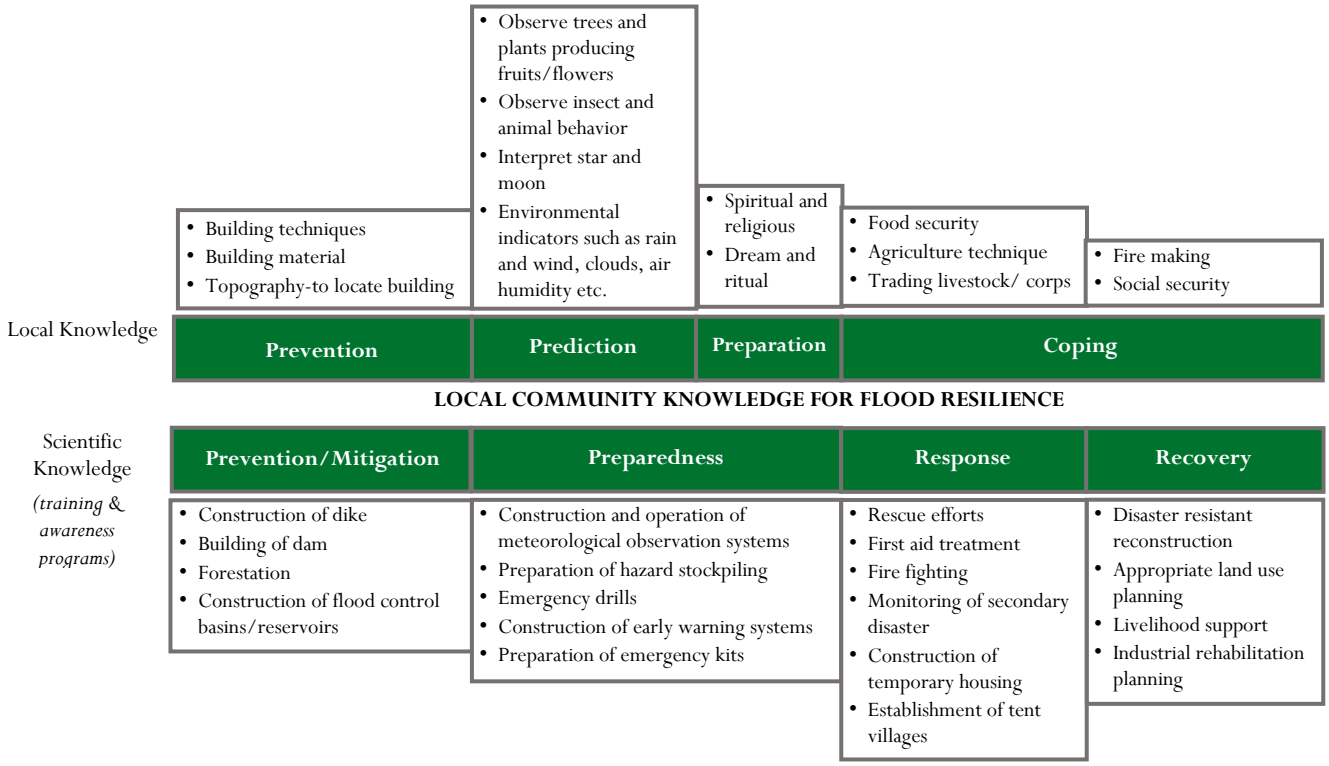


Figure 9 Integration of local knowledge and scientific knowledge in strengthening local community knowledge for flood resilience – combination of study findings and literature review

As shown in all three cases, implementation of local knowledge is more focused on flood prevention and coping with post-flood effects. Flood prevention strategies implemented as observed include; 1) improving building techniques and building materials (using concrete in construction); and coping strategies including 2) ensuring food security and sufficient emergency supplies; 3) improving agriculture/farming techniques; 4) safeguarding livestock for future trading after flood – fund for reconstruction works and; 5) strengthening social security/safety net by increasing household savings. Also, with clear evidence from the field visit and interview with key informants, it can be concluded damages to community livelihood that caused by flood could be reduced by implementing suitable prevention/mitigation and preparedness measures in all three villages. This finding is indeed in line with lifeline model as previously explained by Hayashi (2017) in Figure 2. The implementation of flood preparedness and response measures to alter hazard and reduce vulnerability to some extent, might put the three villages into the triangle shape (marked in blue in Figure 2) which represents the ideal situation for flood resilient progress. With reduction of hazard and vulnerability, and improvement of community's capacity building through disaster education and preparedness programs, would increase the chances for community to be more resilient hence to reduce future flood risk.

Integration of the knowledge is crucial to strengthen DRR practices both at local and agencies' level. In this case, the government agencies and/or local authorities are directly involved in policy making for DRR combined with local knowledge which are inherited, hold and developed by the communities from generations has proven to be a powerful tool for building local capacity and resilience to flooding. On the downside however, many of these measures are not well documented and disseminated for wider applications (although it is widely practices at community level); hence the government agencies and other external parties are unaware and do not take them (local knowledge practices) into consideration for flood management activities.

This study has provided an important first step for integrating local knowledge and scientific knowledge into DRR which later on can be pick up for further applications by relevant agencies and stakeholder. This is where the role of government agencies and non-governmental bodies are vital to assist local communities by providing long term prospects of utilising both local knowledge and scientific knowledge into DRR practices in the case study areas in the future. Integration of both local knowledge and scientific knowledge are essential for the communities to successfully adapt to any future flood occurrences.

4. Conclusion

The popularisation of the discourse on community resilience concept at the international and national levels including in the Sendai Framework for Disaster Risk Reduction (SFDRR) should be understood in the broader context of growing awareness on the long-term sustainability of people's livelihood especially those with direct exposure to disaster risks and limited capacity

to carry out effective climate adaptation measures. At national planning level, the agenda for strengthening a disaster-resilient community has been highlighted in two significant policy documents namely the National Physical Plan (NPP) 3 (2017–2040) and the National Rural Physical Planning Policy (NRPPP) 2030. Formulation of national level planning and policy indicated a strong political commitment from country's top management to translate SFDRR priority areas and Sustainable Development Goals (SDGs) into local context and application. These efforts bring forward the concept of resilient community as a new way for government and the community to address pertinent issue related climate change events particularly floods, which have affected many parts of the country; hampering the socioeconomic growth and undermining sustainable development of the nation. The continuous process of mainstreaming DRR into national and local policies and strategies has become more common practices by various agencies at federal, state and local level, and unarguably in line with UNISDR for empowering local community to achieve better preparedness to disasters. With a strong buy-in from government agencies, existing DRR strategies for building a resilient community tended to comply with top-down approach i.e. leading by government with expectation that local community will embrace the ready-made initiatives. This situation, to some extent, has undermining the value and contribution of local knowledge in building local resilience to disasters.

Review of literature indicated various labels have been introduced in explaining local knowledge including; peasant knowledge and/or folk knowledge, local and indigenous knowledge, traditional knowledge and/or local people knowledge. Regardless of differences of the terms, local knowledge generally implies to a set of knowledge owned and developed based on local people experience and learning from long term interaction with their surrounding environment. Local knowledge plays a vital part in resilient community concept as explained by Hayashi in the lifeline model, claiming that its underlying strengths are to promote local community's ability to bounce back better, reducing hazards and disaster risks, and enhance local capacity building for climate adaptation through DRR applications that suited local context. Assessment of community resilience performance and the role of local knowledge for flood resilience then carried out using case study of three rural communities in East Coast of Malaysia. East Coast region was selected due to regularity and severity of floods occurrences caused by torrential rain during annual monsoon season. Using a mix method, all relevant data were collected using household survey (questionnaire-guided interview) and field observation.

Findings from data analysis indicated that all communities under studied acquired local knowledge linked to DRR practices. Although the rate and speed for recovery after flood might be different for each village and very much determined by various socioeconomic factors, nevertheless, with continuous adoption of local knowledge and via training inputs from agencies, majority of respondents in all three villages become more aware on their changing environment and highly prepared to face the next flood should it occur. In conclusion, the case study analysis has put forward meaningful empirical evidence about the practical use and integration of local knowledge by rural communities in disaster management is indeed in line with previous studies by other scholars as described in the early section of this paper. It is noted that the measures for flood mitigation and preparation by local communities could be improved by utilising modern and advanced knowledge. However, it is important to ensure that these improved measures are locally appropriate for long term sustainability. It is proven that local community knowledge plays crucial roles in reducing disaster risks hence contributing towards building a resilient community.

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