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Development of Community-Based Early Warning System (CBEWS) in Enhancing Community Preparedness for Dam-Related Disasters in Malaysia

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Series of catastrophic floods that we have witnessed over the last decade in Malaysia have necessitated the adoption of reliable early warning system. Ultimate concern during any event of natural or manmade disaster would be information dissemination to lessen the disaster impact on lives and property. The Bertam Valley incident in the wee hours of 23^{rd} October 2013 has been considered as the game changer of how we view the role of vulnerable communities in facing dam-related disasters. Empowerment of local communities has been considered as vital in disaster management, as they are often the first responders to disaster. Local Community-Based Early Warning System (CBEWS) is a smart mechanism operated by the communities. This study revolves around the actual implementation of such system in Cameron Highlands in the effort of increasing human resilience towards dam-related disasters. While establishing the system, the Bertam Valley community has received support from different individuals and organisations. It is paramount that the community develops and maintains close coordination and strong links with these stakeholders. The performance of early warning systems can be evaluated via key parameters such as timeliness, accuracy, reliability, user friendliness, flexibility, and costs & benefits.

Keywords: Early Warning System; flood; dam disaster

I. INTRODUCTION

An early warning system (EWS) is defined as the set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organisations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss (UNISDR, 2009). A people-centred early warning system comprises four key elements (Basher, 2006 and Cools *et al.*, 2012):

1. Knowledge of the risks.
2. Monitoring, analysis, forecasting and warning of the hazards.
3. Communication or dissemination of early warnings.

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4. Local capabilities to respond to the warnings received.

Warning of an emergency involves far more than just imparting of information on what is about to happen. A warning message, according to Nigg (1995), must be credible, contains explanation in the real time of its pending or actual occurrence, as well as empowering the people at risk with advice on the necessary action to maximise their personal safety and protect their belongings.

Early warning is a key component of disaster risk reduction. According to Hyogo Framework for Action 2005–2015 (UN, 2005), enhancement of risk monitoring and early warning is the second priority in the framework, while the current Sendai Framework for Action 2015–2030 (UN, 2015) has listed early warning as a key component. According to IFRC 2012, an actionable early warning provides a message that reaches a community prior to the emergency, is clearly understood and is acted appropriately upon by the community at risk.

This study focuses on the establishment of community-based eary warning system (CBEWS) in Cameron Highlands, in which warning of impending disaster from Sultan Abu Bakar (SAB) dam can be disseminated to Bertam Valley residents. The establishment of CBEWS is vital to prevent the repeat of 2013 incident, where three people lost their lives. On 22^{nd} October 2013, heavy rainfalls in Cameron Highlands caused water level in SAB catchment area to rise rapidly. When water level reached the danger level in the wee hours of the morning of 23^{rd} October, Tenaga Nasional Berhad (TNB) as the owner of SAB dam, decided to open the dam gate by a few inches. Releasing water from the dam allowed water level in the catchment to be maintained at a safe level, thus prevented a much larger catastrophe. Before water being released, siren at SAB dam was also activated to warn residents living in Bertam Valley. However, due to heavy rain and its mountainous landscape, some residents were not able to hear the activated siren sound.

The release of water from SAB dam, combined with the already high volume of water in the shallow Bertam river due to heavy rainfall, worsened by sedimentation from agricultural activities, eventually caused flooding in Bertam Valley which affected several hundreds residents. In the aftermath, three people died, some 10 kongsi houses on banks of the river were destroyed and around 80 houses as well as 100 vehicles were damaged (The Star, 2013). Among the many lessons learned from the incident is the need to establish CBEWS near resident homes and to conduct annual evacuation drill, as means to improve the residents resiliency and preparedness to future disasters. An early warning system will only be effective if all four elements are effective. It was recognised that communication and dissemination of early warnings as the component which lacks sufficient attention and results in a gap between the information produced by dam owner and information received by community members.

The objectives of this study includes:

1. To establish CBEWS which are anchored in the communities and operated by community members.

2. To provide communities and organisations involved in disaster risk management with

advanced information of risks that can readily be translated into prevention, preparedness and response action.

II. METHODOLOGY

Several successful implementation of CBEWS were reported in Majalaya, Bandung (I Dewa Gede A Junnaedhi *et al.*, 2017), in several European countries (Krzhizhanovskaya *et al.*, 2011), and in Nepal (Paul Smith *et al.*, 2017). These CBEWS were well equipped with Automatic Weather Station (AWS), Automatic Water Level Recorder (AWLR) and Decision Support System (DSS). Inspired by these successful CBEWS implementation, CBEWS in Cameron Highland is also aimed to be a smart system. Cameron Highland CBEWS was developed in two phases. Phase I covers CBEWS development in Bertam Valley town while Phase II covers CBEWS development in Orang Asli settlements. However, as a pilot project, Cameron Highlands CBEWS is still dependent on manual monitoring of water level. In the next phase, Cameron Highland CBEWS will be integrated with rain gauges, flowrate sensors and DSS. The local knowledge and capability of local stakeholders, complemented with inputs by experts, played an important role in CBEWS (Cools *et al.*, 2012 and Baudoin *et al.*, 2014).

Figure 1 shows the five steps in developing and sustaining CBEWS in Cameron Highlands, which cover data (hazard, capacity, vulnerability) assessment, dissemination of early warning, community response and sustainability strategies. Due to time constraint before the next monsoon season, priority is to instal sren stations (Step 3). Hence, Step 2 which covers rain gauge and flow rate sensors was not implemented and will be reserved for future enhancement of CBEWS.

III. RESULTS

Apart than the original master siren at SAB dam, six slave siren stations were installed in Cameron Highlands from 2014 until 2016; three units in Bertam valley town and another three units in Orang Asli settlement areas (Kg Sg Gadok, Kg Pos Menson, Kg Leryar). Figure 2 shows the layout of all siren stations in Cameron Highlands. The location of each siren tower is selected based on the following considerations:

1. Near community area (within 1km radius of siren tower).
2. Open space area (not blocked by trees or buildings).
3. Near ac power source.
4. The area have telco signal coverage.

All slave siren stations are 12m tall and is equipped with Remote Terminal Unit (RTU), Global System for Mobile Communication (GSM), 12V backup battery, motor siren/electronic siren and strobe lights. On a good day, siren strength is estimated to be between 90dB to 95dB at the base of the siren pole. The strength is expected to drop between 2dB to 3dB every 100m from the tower. At 1km distance from the siren station, residents outside their homes will still be able to hear the siren. Figure 3 shows the 1km radius coverage of the three slave sirens in Bertam Valley town while

Figure 1. Five steps in CBEWS Implementation

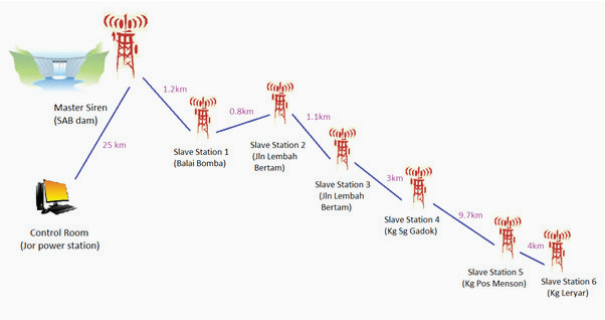

Figure 2. CBEWS Implementation in Cameron Highlands

Figure 4 shows the developed siren station in Kg Leryar.

All slave siren stations can be activated or deactivated using four methods:

1. Trigger remotely from the control room in Jor power station (using siren software)
2. Trigger remotely from the master siren at SAB dam (using manual push buttons)
3. Trigger remotely via SMS (by entering the activation or deactivation code)
4. Manual trigger at each slave station (using push button at each station)

Taking into account the diversity in education background of Bertam Valley residents, it is important to keep early warning simple and easy to be understood by all residents. Table 1 shows two activation modes which were discussed and agreed by the stakeholders.

After the installation of CBEWS and several community awareness road show campaigns, a large scale community evacuation drill was carried out. The following observations were

Table 1. CBEWS Siren Activation Modes

Activation Mode	Siren Sound	Strobe lights	Response to Warning
Alert **(Flood Watch)**	Intermittent (wavering) siren sound	Amber strobe light turns on	Community must make necessary preparations for the possibility of evacuation
Danger	Continuous high pitch siren sound	Red strobe light turns on	Community need to evacuate immediately

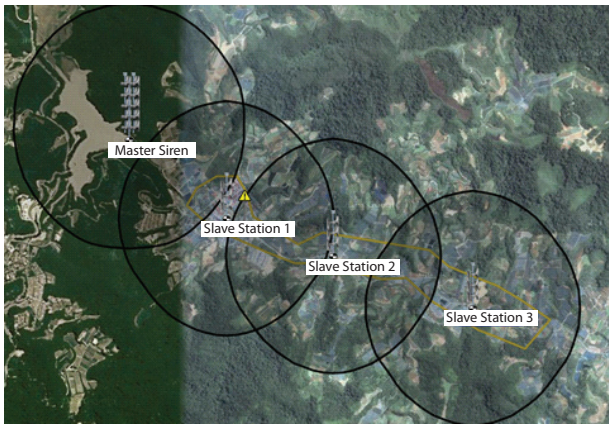

Figure 3. Siren strength in Bertam Valley town

recorded as part of CBEWS performance assessment:

1. All slave siren stations able to generate both alert and danger activation modes.

2. Siren strength from each station is recorded to be between 70 to 95dB within 500m radius from the siren.

3. Orang Asli residents at their settlements were able to hear the siren sound very clearly and loudly due to its close proximity to their houses and their small size villages.

4. Town residents and Orang Asli residents were able to distinguish between the two siren sounds (continuous and intermittent) and take prompt action.

Figure 4. Siren tower in Kampung Leryar, Cameron Highlands

5. There was a delay of more than five minutes before sirens at Kg Pos Menson and Kg Leryar were triggered. This may be caused by the weak signal strength in the two villages. To overcome this, TNB is investigating whether to change service provider, or to trigger siren using other means such as power lines or radio transmissions, or to work with a service

provider in setting up a cell tower.

IV. CONCLUSIONS

CBEWS in Cameron Highlands was successfully developed and tested. Ultimately, CBEWS is aimed to minimise loss of life by disseminating early warning so that Bertam Valley residents can have ample time and take actions to save themselves and their important assets. Continuous awareness campaigns and annual evacuation drills are necessary to create a self-resilience community. Moreover, it is not one person role to save live, hence it is vital for the community leaders to maintain close coordination with all stakeholders (Angkatan Pertahanan Malaysia, Pejabat Pegawai Daerah, Polis Diraja Malaysia (PDRM), Bomba, TNB, Jabatan Kebajikan) in ensuring the safety of all community members.

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