

Building-Capacity through School-Based Engagement on Dam Safety Program in Cameron Highlands

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Abstract. Melaka Declaration on Disaster Risk Reduction in Malaysia (2011) captured the future direction of the country on disaster risk reduction as well as its efforts towards implementing the priority areas for the Sendai Framework, 2015-2030 and together with SDG11 (Sustainable Goals 11: Sustainable Cities and Communities) and SDG13 (Sustainable Goals 13: Climate Change). Therefore, in supporting the government initiatives, Tenaga Nasional Berhad (TNB) as the owner of most of the largest dams in Malaysia, has put into action an initiative in community engagement program for disaster risk awareness campaign in the context to increase the community awareness and preparedness. This paper presents a school-based engagement as part of the community engagement program conducted for Pos Telanok community in Cameron Highlands. This was the pioneer program which was conducted at SK Telanok involving 290 students and staffs. Programs was organised in a few phases starting from November 2018 including awareness campaign, Dam Safety Day, evacuation exercises and CSR. These activities are aimed to educate the school community in Pos Telanok who are vulnerable to flood risk in the event of dam failure, to be more prepared and resilient to face the disasters. The program provides exposure to school children and staffs on the right actions to be taken during emergency situations. On the other hand, the program to strengthen the preparedness of dam owner, local authorities and emergency responders involved with local communities during emergency situations.

Keywords: Disaster Risk Reduction (DRR), resilient community, dam safety, school participation, experiential learning.

1. Introduction

Malaysian National Security Council (MNSC) Directive 20 states that the definition of disaster is an emergency that will cause the loss of lives, damage property, and the environment. . Disasters are also termed as an outcome of combination of the exposure to a hazard, the conditions of present vulnerability and insufficient capacity to reduce the potential negative concerns [1]. The possibility of incidence of a potentially damaging phenomenon within a specific time frame is referred to as a hazard. Hazard is a situation where it has the potential of causing an event which can have negative concerns. In the part of the community's structure, environment or infrastructures are possible to be damaged by the impact of the hazard. Furthermore, risk refers to the probability that loss will occur if the result of an opposing phenomenon happening or the expected losses of lives, injured, property damaged and economic activities interrupted because of it. Moreover, the frequency and severity of disasters is on the rise due to climate change.

In today's living, dams are an important part of this nation's infrastructure, providing flood control, water supply, irrigation and recreation benefits. Despite their many beneficial uses and value, dams also present risks to property and life due to their potential to fail due to extreme flood and heavy raining. According to Malaysian National Security Council (MNSC) Directive 20, dam disaster can be defined

as an incident that occurs suddenly, complex in nature and resulting in the loss of lives, damages to property or the environment as well as affecting the daily activities of the local community.

According to [2] disaster management is defined as an ongoing process composed of a set of activities before, during, and after an event and consists into four main phases which are preparation, response, recovery, and mitigation. Each stage involves the management and coordination of a wide range of stakeholders which are government agencies, non-government organizations (NGO), emergency response teams, and residents. Emphasized the disaster preparedness phases is an important phase which it should include training on disaster preparation and response for agencies and community at risk.

In line with the dam owner effort in supporting and contributing government initiative on towards Sendai Framework, 2015-2030, the preparation phase is the earliest to disaster, preparedness activities such as siren for early warning are designed to plan the unthinkable and increase the readiness of organizations and communities to respond to a catastrophe timely and expertly. Therefore, it is important for dam owner to strategies a good mechanism to overcome disaster risk through its disaster management strategy. Hence, the scientific and approachable early warning system (EWS) is needed to operate effectively towards affected community. EWS is known as the set of capabilities required to create and spread timely and meaningful caution information to enable individuals, communities, and organizations in danger by a hazard to prepare and to act correctly in sufficient time to reduce the possibility of harm and loss [3]. The significance of EWS is to increase the capacity of the community to respond to natural disasters and to enhance readiness on how to remain safe in those situations.

In the late 1990s, the numbers of children affected by disasters were estimated at 6.5 million a year, climate change impacts are projected to increase this to as many as 175 million per year in the coming decade [3]. Evidence proves that investing in Disaster Risk Reduction (DRR) strategies improves the resilience of populations to cope with recurring disasters and keep children in school. DRR and climate change adaptation measures at the school level ensure that the poor are particularly included in Back-to-School initiatives and that their vulnerability is reduced before, during and after emergencies. UNICEF advocates for the protection of the rights of all children, particularly the most deprived and vulnerable, to help meet basic needs and to expand opportunities to reach their full potential. This was highlighted in two of Sustainable Development Goals (SDG) by [4]. According to [4] SDG11 targeted to create safe and resilient living condition including water-related disasters, focus on protecting the poor and people in vulnerable situations, and SDG13 to combat climate change impact by strengthening resilience and adaptive capacity through improving knowledge toward hazards and natural disasters.

2. Education and its role in Disaster risk reduction (DRR)

The DRR is a systematic process for reducing defenselessness and human-made to exposure to hazards, lessening of the vulnerability of people and assets, effective management of land and the environment and improved preparedness for adverse events [5]. Disasters – including situations of chronic disaster caused by environmental degradation – exacerbate the conditions of the most vulnerable, negatively impacting on children's rights and aggravating exclusion of some 68 million children out of school worldwide. As a consequence, disasters are rolling back years of progress towards attaining the Millennium Development Goals for education, and will affect the achievement of UNICEF's equity agenda.

There is increasing evidence that students of all ages can actively study and participate in school safety measures, and also work with teachers and other adults in the community towards minimizing risk before, during and after disaster events. [3] Added value is its capacity to link work at the school and community levels with the education sector and system planning and policies. Working in partnerships, UNICEF is in a unique position to empower the most vulnerable by not only promoting safe schools, but by teaching life skills to children who, as agents for change, in turn teach their

communities. Through the child-friendly schools' initiative, relevant and quality education reach the most threatened and marginalized communities with knowledge, skills and attitudes to the local environment and on how to reduce risks. Children are prepared and empowered to cope with and find solutions to the effects of climate change in their own lives and in their communities.

There are many ways in the learning process that disaster education may take place. According to [6] many researchers have identified that disaster education works best in where the learning process happens out of the traditional classroom setting. In this aspect, the learning process has shown to be more successful through experience-based and action-oriented learning. Therefore, the formulation of an effective DRR program should include collaborations with the dam owner, local community, government agencies and school community so that the learning process not only be based on hard facts but also cross-learning through sharing of stories, facts and cultural approaches [6]. In addition, [6] emphasized the need for integrating community development initiatives to increase resilience with disaster education and facilitate self-help capacities within the vulnerable community to reduce the reliance on external response and recovery resources. Case studies from various countries shows the importance of continuous participation from stakeholders to ensure the community are always prepared and aware of their situation (Table 1).

Table 1. Education in disaster risk reduction for other countries

Author/ Year	Country	Objective	Methodology/Approach	Findings
Bilal Ahmad Bhat, Sidrat-Ul-Muntaha Anees, S. N. Z. Geelani, Nusrat, Irfana Jan, Bisma Ashraf Zargar (Dec, 2017) [7]	India	To access the knowledge, attitudes, and practices of college students studying in district Ganderbal of Kashmir Valley regarding disaster preparedness	Questionnaires were designed to assess students' knowledge and awareness about disaster preparedness.	There is a general lack of information among students regarding disaster awareness and preparedness. This highlights the need for disaster safety education. Formal and informal education can instil students' awareness on the impacts of disasters.
Rina Suryani Oktari, Koichi Shiwaku, Khairul Munadi, Syamsidik, Rajib Shaw (Feb, 2015) [8]	Indonesia	To evaluate current efforts of disaster education and to develop a conceptual model for enhancing coastal community resilience.	Qualitative and quantitative method were used, including Focus Group Discussion and a questionnaire survey	The school-based disaster preparedness (Sekolah Siaga Bencana/ SSB) program was still effective in enhancing the resource mobilization capacity of teachers and students. The proposed model in this study which is School-Community Collaborative Networks (SCCN) is expected to endorse the involvement of community in disaster education efforts and the use of a knowledge management strategy to provide individuals with a correct choice of action to save lives.
Tong Thi and Rajib Shaw (Aug, 2016) [9]	Vietnam	To discuss the variations in the implementation of DRR education	Questionnaire surveys were distributed in order to understand the current level	There is clearly a need to focus more on school capacity in managing financial issues, enrich collaboration with stakeholders as well as strengthen

		amongst the primary student.	of educational resilience to disaster.	the linkage between schools and their community.
T. Fujioka and Y. Sakakibara (Aug, 2018) [10]	Japan	To examine the overall ways that disaster prevention education related to natural disasters in school education has changed and the developments that will be necessary in the future.	‘Learning within specific subject areas’ and ‘educational activities’ was an approach applied in formal education to create awareness amongst school students on how to handle natural disasters.	Disaster prevention education can be perceived as a tangible teaching method that can help to cultivate the skills that future generations will need. Cooperation between entities, such as educational administrations and research institutions, is essential for the construction of a new educational system.
Ana Delicado, Jussara Rowland, Susana Fonseca, Ana Nunes de Almeida, Lui’sa Schmidt, Ana Sofia Ribeiro (Sept, 2017) [11]	Portugal	To assess the roles ascribed to children in policy and education for disaster risk reduction in Portugal	The approach is based on a scoping methodology that encompasses document analysis and interviews with national and local stakeholders and policymakers in the disaster risk reduction field.	Children are often taken as a target group in urban disaster prevention and management, they are seldom considered in terms of active participation in disaster risk reduction programs in the Portuguese context. There are growing awareness and active participation by children in order to create successful DRR.

3. Early warning system for DRR

An early warning system (EWS) is known as the set of capabilities required to create and spread timely and meaningful caution information to enable individuals, communities, and organizations in danger by a hazard to prepare and to act correctly in sufficient time to reduce the possibility of harm and loss (UNISDR, 2009). [12] Defined EWS as an integrated system that comprises disaster risk assessment, hazard forecast, prediction and monitoring, risk communication and emergency preparedness activities. Other than that, EWS is a social process with diverse levels of complexity, vulnerabilities and capacities due to political and socioeconomic contexts in working area [13][14][15]. Moreover, there are also different characteristics, types and frequencies of hazards which are rapid and slow and variations in scale (local regional, national and global), and also the number of stakeholders involved in EWS.

An early warning system is actively applied to mitigate the risks caused by hazards, especially dam disaster problem. According to [16], the consistency and effectiveness must be put a figure on to compare the effect of EWS with alternative risk reduction measures and to optimize their design and operation. The effectiveness of EWS has been measured by the existing of EWS and functioning of EWS itself. Besides, early warning, early action, in particular, is essential in achieving sustainable development. Furthermore, to reduce the loss and damage from disasters, preparedness for response is necessary. The significance of EWS is to increase the capacity of the community to respond to natural disasters and to enhance readiness on how to remain safe in those situations. From community survey

conducted, the feedback of the affected community understands on existing and operational of EWS itself. The characteristics of warning of EWS can be understood among criteria such as the understanding and alert towards emergency warning, the location of EWS, the level of warning reachable to community, i.e., can be heard and see and also can differentiate between the level of warning.

4. Implementation EWS for community in Cameron Highlands

Implementation of EWS in DRR in Cameron Highlands is a part of DRR program to manage dam risk disaster for downstream community. This program's purpose aimed to contribute to disaster awareness and to facilitate disaster management planning for a community in endangered area. EWS protect the community by combining scientific monitoring and detection system with social design factors and components to notify at-risk public. EWS can be seen as having scientific, managerial technological and social elements that integrated with communication processes [17]. However, it just focuses on the system of EWS, not how to operate an effective EWS without the important preparedness activities in the community. Strengthen the EWS and a holistic method for respond is needed to consider in combining with disaster preparedness and response capacities. This program can be as public EWS to easily access for community response. Also, the function of public EWS also is to minimize the human losses and damages to the property, livelihood assets, and infrastructure of the communities itself [5].

According to [18], the traditional conception of EWS conceives it as a linear chain with emphasis on risk prediction, monitoring and warning issued. Warning messages giving out in the Early Warning System (EWS) is one of the essential services that can save many people from becoming a victim of the disaster. Warning message distribution is a linking process between information about the situation and conditions and the community live in the disaster area. Besides, EWS is a crucial component of disaster risk reduction and is an essential module of the Community-Based Disaster Risk Management (CBDRM). [19] Found that EWS is in charge of communities for relevant, topical information on environmental conditions so that they can measure levels of risk and be informed decisions to protect themselves.

EWS is well-thought-out to be effective if these are designed to be 'people-centered approach which is easy to understand, accessible, timely and tried to response actions. The previous study had been adopted two main approaches of EWS which is the "last mile" (hazard centered) and "first mile" (people centered) [18][13][20]. This study will lie on the "first mile" approach, in focusing on people centered EWS, community early warning system, and community-based EWS. According to [21], one of the seven targets of the Sendai Framework is well-thought-out to increase the accessibility to multi-hazard early warning system and disaster risk information to the people by 2030. The key modules of people's centered EWS, as shown in Table 2, include risk knowledge, monitoring and warning service, dissemination and communication and response capacity. Besides, these components should be accompanied by the competent authority and recognized preparations, such as local decision making, legal and regulatory engagements and communication channels between various stakeholders for a practical EWS [6] [3].

Table 2. Four Elements of People Centered Early Warning System. Adapted from (Nifa et al. 2017, UNISDR 2011,World Meteorological Organization, 2010)

General Elements of Early Warning System	1. Risk knowledge	2. Monitoring and Warning Service	3. Dissemination and communication	4. Response Capacity
Technical Specialties required	Scientific Research; Historical databases; Hazard, Vulnerability and Risk Assessments; Local knowledge; Information storage and accessibility	Forecasts and newscasts system based on observational data and monitoring system, numerical weather prediction, conceptual models and situational awareness; Establishment of warning system; Institutional, legal and operational arrangements	Institutionalization of organizational and decision making processes; Effective communication management regarding warning presentation, communication means and effectiveness of communication	Community response capacity assessment and strengthening; Social science and Emergency management covering public perception, public education, establishment of disaster preparedness and response planning
General Elements of Early Warning System	1. Risk knowledge	2. Monitoring and Warning Service	3. Dissemination and communication	4. Response Capacity
Key Outcomes to Strengthen Disaster Risk Governance	Taking into account the risk of small and large-scale, frequent and infrequent, sudden and slow onset disasters, caused by natural or environmental, technological and biological hazards.	The development of quality standards and operational guides on standard operating procedures that link early warning systems and hazard monitoring processes to the response agencies and vulnerable groups	The development of innovative technology and communication systems that provide low-cost early warning systems and emergency communication mechanisms.	To cultivate people's centered approach i.e. enhancing community response capability by ensuring that preparedness and contingency plans are consistently reviewed, updated and linked to warning systems so that timely and appropriate action can be taken by people in advance of, during and after the event

5. Implementation Approach and Strategy

An integrated community-based disaster management (ICBDM) program has been formulated in SK Telanok in Cameron Highland as a part of DRR initiative with an aspiration of empowering the students on how to take life-saving efforts during disasters occur. This non-technical based activity such as drill exercise and engagement program involves the initiatives to educate the school children on the importance of the dam safety program. Fig. 1 shows the overall flows of ICBDM initiated for schools in Cameron Highlands.

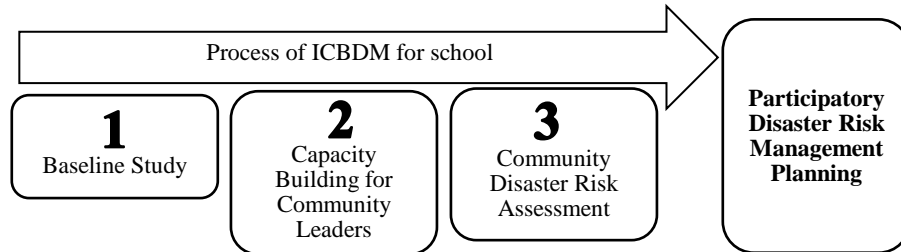


Fig. 1. Steps involved in ICBDM

A baseline study conducted in SK Telanok is to analyze the initial conditions before the start of the ICBDM program. It provides basic demographic of the school's community and disaster risk related information covering school physical conditions and potential risk. Capacity building for school's community is important especially the role played by the teachers. They play a critical role in improving the school condition and safety before and during the disaster. Teachers are responsible to become the representative or spoke person on behalf of school community. Therefore, DRR activities in school were planned together by dam owner, school administrative and local agencies as a part of participatory disaster risk management planning (see Fig. 2).

In a preliminary field work conducted in November 2018, informal meeting has been arranged with school management. Site survey was conducted within the school, and neighboring area in Pos Telanok, Cameron Highlands. The main purpose of this preliminary survey is to assess community awareness and readiness in the study area about flood risk and emergency warning from dam nearby. The study was able to get a perspective of the local and school community in the study area.



Fig. 2. Activities conducted for students and staffs of SK Telanok

Prior to drill exercise that was conducted in March 2019, teachers and school's administrative staff was given a talk on disasters evacuation information and procedures with the primary school students aged 10-12 years old. This program creates a platform for children on action to be taken during dam related disaster. The drill was later planned a few days after the talk to observe their awareness and readiness (see Fig. 3.)



Fig. 3. Drill exercises conducted in the SK Telanok school community

6. Discussion

EWS is a crucial component of disaster risk reduction and is an essential module of the Community-Based Disaster Risk Management (CBDRM) in Cameron Highlands. Based on the programs conducted for the school community, it depicts that the objectives of the programs have achieved. The awareness, understanding and cooperation were reflected during the programs, and these proofed that the affected children are supporting the implementation of EWS. Observation in related activities discovers that the affected community, especially school children are well prepared towards disaster preparedness. It reflected during the program;

1. The understanding and alert towards emergency warning, and they also can differentiate the level of emergency warning.
2. The location of EWS. – It is identifiable by the students
3. The level of warning reachable to community, i.e., can be heard and see and also can differentiate between the level of warning.

Children who have been exposed about the awareness and preparedness of probability disasters from dam and how to react during emergency situations have proved to be able to respond promptly and correctly during the drill, and saving themselves during times of emergencies. The disaster education at school is very important to increase awareness and preparedness amongst community due to the following reasons:

1. Children are one of the most vulnerable group of the society during a disaster;
2. They represent the future generation;
3. SK Telanok serves as a community's central location for meetings and group activities
4. Effects of education can be conveyed to parents and surrounding community

With regard to these reasons, the school is viewed to play a crucial role in raising awareness amongst students, teachers, and parents as well as within the local community. Therefore, readiness of the school community for dam disaster is very important to ensure that the community preparedness is

at a satisfactory level. Other than that, the school community also is very approachable and cooperative to the related agencies involved during the exercises. Hence, as an assumption, with the full coordination, planning and cooperation between stakeholders i.e., communities, agencies, and dam owner will achieve the objectives in implementing EWS for DRM effectively. Therefore, it is important to ensure that the program can be sustained to ensure that the community are equipped with sufficient and updated information. The current approach and strategies by the dam owner supported the government policy in building resilient communities. Fig. 4 shows the relationship of 4 important factors supporting the knowledge building of agencies and communities on disaster risk reduction are:

1. Cooperation – the important of good cooperation between stakeholders and community to ensure they can deliver and receive proper instruction that need to be taken into action during disaster.
2. Communication – it is good to ensure that everybody can understand well any of communication methods used to deliver information.
3. Training – need to be conducted in order to prepare both agencies and communities on disaster event.
4. Sustainability – the most important factor is to sustain and consistence in all activities conducted to encourage community-based disaster risk reduction.



Fig. 4. Relationship of 4 important factors supporting the knowledge building of agencies and communities on DRR

7. Conclusion

Disasters disrupt education and can also cause psychological trauma. Under the UN Convention on the Rights of the Child, children have inalienable rights in all circumstances, including disasters, when they are at their most vulnerable – and the right to participate in decisions that ultimately affect them. Educating children about disaster risk and empowering them to use that knowledge, while ensuring the participation and voice of children in DRR efforts. In this paper, the concept of early warning involves the concern of the warning, the response, and feedback during the disaster. Community-based early

warning systems (EWS) have been developed to assure that Integrated People-Centered EWS are adapted to the local risk culture and that is fully integrated into the risk governance process, to reduce the number of people affected by a disaster. Institutional, legislative, and policy frameworks at the local and national level also have to develop to provide an institutional and legal basis for the implementation and maintenance of effective EWS.

However, future research directions include theory improvement to explain the better effect of social media use on enlightening disaster preparedness, disaster response, and overall process disaster coordination and management performance. Besides, the communication technology signal is the most crucial aspect of these days, and the warning sign in the rural area also needs to expand to improve disaster management. When advanced warnings are available and upgrading, and also the general public is well aware of the multiple hazards that may be faced, disaster preparedness and response strategies become the following topics of significant concern.

References

- [1] H. A. Alhasanah, "Early Warning System Guidance To Mitigate Flash Flood Impacts in Petra Region, Jordan Hussein Abbas Alhasanah," 2017.
- [2] M. P. Mohammed, "ScienceDirect ScienceDirect ScienceDirect," *Procedia Eng.*, vol. 212, pp. 77–84, 2018.
- [3] UNISDR, "Disaster Risk Reduction and Education," 2011.
- [4] U. Nations, "Transforming Our World: The 2030 Agenda for Sustainable Development," *A New Era Glob. Heal.*, 2015.
- [5] M. Inayath, "Early Warning System And Community Based Emergency Response Mechanism," Kobe, Japan, 2016.
- [6] F. A. A. Nifa, S. R. Abbas, C. K. Lin, and S. N. Othman, "Developing a disaster education program for community safety and resilience: The preliminary phase," *AIP Conf. Proc.*, vol. 1891, no. October 2017, 2017.
- [7] B. Ahmad *et al.*, "Biomass estimation at Romshi range of Shopian forest division View project On Generalized Exponential Distribution ... View project A Study on Disaster Awareness And Preparedness Among College Students In District Ganderbal of Kashmir Valley," no. January, 2017.
- [8] R. S. Oktari, K. Shiwaku, K. Munadi, Syamsidik, and R. Shaw, "A conceptual model of a school-community collaborative network in enhancing coastal community resilience in Banda Aceh, Indonesia," *Int. J. Disaster Risk Reduct.*, vol. 12, pp. 300–310, 2015.
- [9] T. Thi and R. Shaw, "School-based disaster risk reduction education in primary schools in Da Nang City, Central Vietnam," *Environ. Hazards*, vol. 15, no. 4, pp. 356–373, 2016.
- [10] T. Fujioka and Y. Sakakibara, "School education for disaster risk reduction in Japan after the 2011 Great East Japan Earthquake and Tsunami (GEJET)," *Terrae Didat.*, vol. 14, no. 3, pp. 313–319, 2018.
- [11] A. Delicado, J. Rowland, S. Fonseca, A. N. de Almeida, L. Schmidt, and A. S. Ribeiro, "Children in Disaster Risk Reduction in Portugal: Policies, Education, and (Non) Participation," *Int. J. Disaster Risk Sci.*, vol. 8, no. 3, pp. 246–257, 2017.
- [12] V. Marchezini, F. E. A. Horita, P. M. Matsuo, R. Trajber, M. A. Trejo-Rangel, and D. Olivato, "A Review of Studies on Participatory Early Warning Systems (P-EWS): Pathways to Support Citizen Science Initiatives," *Front. Earth Sci.*, vol. 6, no. November, pp. 1–18, 2018.
- [13] C. Garcia and C. J. Fearnley, "Evaluating critical links in early warning systems for natural hazards," *Environ. Hazards*, vol. 11, no. 2, pp. 123–137, 2012.
- [14] D. Lumbruso, E. Brown, and N. Ranger, "Stakeholders' perceptions of the overall effectiveness of early warning systems and risk assessments for weather-related hazards in Africa, the Caribbean and South Asia," *Nat. Hazards*, vol. 84, no. 3, pp. 2121–2144, 2016.
- [15] C. Michoud, S. Bazin, L. H. Blikra, M. H. Derron, and M. Jaboyedoff, "Experiences from site-specific landslide early warning systems," *Nat. Hazards Earth Syst. Sci.*, vol. 13, no. 10, pp. 2659–2673, 2013.

- [16] M. Sättele, M. Bründl, and D. Straub, "Reliability and effectiveness of early warning systems for natural hazards: Concept and application to debris flow warning," *Reliab. Eng. Syst. Saf.*, vol. 142, pp. 192–202, 2015.
- [17] M. L. Collins and N. Kapucu, "Early warning systems and disaster preparedness and response in local government," *Disaster Prev. Manag. An Int. J.*, vol. 17, no. 5, pp. 587–600, 2008.
- [18] R. Basher *et al.*, "Global early warning systems for natural hazards: Systematic and people-centred," *Philos. Trans. R. Soc. A Math. Phys. Eng. Sci.*, vol. 364, no. 1845, pp. 2167–2182, 2006.
- [19] M. Macherera and M. J. Chimbari, "A review of studies on community based early warning systems," *Jàmbá J. Disaster Risk Stud. Vol 8, Iss 1, Pp e1-e11 VO - 8*, vol. 8, no. 1, p. e1, 2016.
- [20] F. Thomalla and R. K. Larsen, "Resilience in the context of tsunami early warning systems and community disaster preparedness in the indian ocean region," *Environ. Hazards*, vol. 9, no. 3, pp. 249–265, 2010.
- [21] A. Aitsi-Selmi, S. Egawa, H. Sasaki, C. Wannous, and V. Murray, "The Sendai Framework for Disaster Risk Reduction: Renewing the Global Commitment to People's Resilience, Health, and Well-being," *Int. J. Disaster Risk Sci.*, vol. 6, no. 2, pp. 164–176, 2015.
- [22] World Meteorological Organization, *Guidelines on Early Warning Systems and Application of Nowcasting and Warning Operations*, no. 1559. 2010.
- [23] UNISDR, "Developing Early Warning Systems : A Checklist," *Third Int. Conf. Early Warn.*, no. March, pp. 1–13, 2006.