

Vulnerability Assessment for Climate-Induced Disasters in Malaysia

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Abstract: Climate induced disasters can be considered as an outcome of a triggering agents (often known as the hazard) and vulnerability factors. Within the context of climate-induced disasters, humans do not have the control over the triggering agents. Even though it is difficult to control the triggering agent, the level of its exposure to a vulnerable community or system would determine the severity of its impact. Within this context, by reducing the vulnerability the impact of climate-induced disasters can be minimized. Accordingly, this study evaluates the disaster vulnerability factors in Malaysia with particular reference to the climate-induced disaster- floods. A workshop has been carried out with the involvement of practitioners and professionals who are linked with the disaster management activities to identify the key vulnerable factors from the context of Malaysia. The findings identified Social Vulnerability as the main vulnerability factor that affect the Malaysian community followed by Operational/Managerial, Technological, Economic and Political. The findings of the study revealed the need of addressing vulnerability factors at different levels such as at the community, institutional and policy levels and how the vulnerability factors are interconnected with one another.

Keywords: disasters, clickers voting system, hazard, vulnerability.

1. Introduction

Concerns on the potential impact due to climate change on human beings, natural and built environment are ever increasing. IPCC [1] states that climate change can increase the intensity, frequency and change the distribution patterns of weather events. Studies carried out in Malaysia have revealed that increased temperature due to climate change is often resulted in increased storms and rainfall intensity [2]. The large variations of the rainfall in frequency and intensity have prone to fluctuations in the river flows that have resulted in climate-induced disasters such as floods, landslides, and soil erosion in Malaysia creating unfavourable results for socio-economic systems in the country. Accordingly, it is argued that that climate change has introduced an additional layer of complexity and uncertainty into planning and preparedness for disasters in Malaysia.

Disasters have the common characteristics of a triggering agent (the hazard), and the vulnerability factors [3, 4]. Within the context of climate-induced disasters, humans do not have the control over the triggering agents. Most of the time the triggering agent is an outcome of a powerful natural environment [5], which is beyond the control of the humans. Even though it is difficult to control the triggering agent, the level of its exposure to a vulnerable community or system

would determine the severity of its impact. Therefore, reducing the vulnerability could lead to reduce the impacts of climate-induced disasters as vulnerability factors could intensify the severity of the disaster [5].

Accordingly, this study evaluates the disaster vulnerability factors in Malaysia with particular reference to the climate-induced disaster- floods. The study is based on the outcome of a workshop carried out to evaluate the vulnerability for climate-induced disasters in Malaysia. The paper is structured as follows: first the literature review outlining the disaster vulnerability factors is presented. This is followed by the research methods used to gather the data is presented. Next, data analysis highlighting the most significant vulnerability factors in the Malaysian context is discussed. Finally, conclusions are drawn based on the relevance of the findings within the global context by comparing and contrasting them with similar research carried elsewhere.

2. Literature Review

Disaster vulnerability factors can directly or indirectly affect the process and outcomes of disaster management. Hence, the identification of key disaster vulnerability factors will be an enabler to manage disasters successfully. Eight broad categories of disaster vulnerability factors, which

are common for all types of disasters across the phases of disaster management cycle, were identified through a comprehensive literature review. Based on Pathirage et al. [6]; McEntire, [5]; Kulatunga et al. [7]'s studies, disaster vulnerability factors can be broadly classified into; Technological, Social, Environmental, Legal, Economical, Operational/ Managerial, Political and Cultural based on their characteristics. Though they are classified into eight categories, certain factors have close links and overlaps with others; hence the boundaries between such factors are blurred. These factors are discussed in the succeeding section.

Technological factors include any tool, technique, product, process and method to benefit disaster management. Under this main category, three sub-categories are identified: warning systems, communication systems and structural measures. Disaster early warning systems, such as Tsunami warning system, come under the first sub-category. Communication systems include emergency public sirens, satellite images, geographic information systems, remote sensing tools and broadcasts using radios, televisions and print media. These are used to distribute the information and make people aware on how to evacuate, locate and relocate [8]. Structural measures include the effective application of science and engineering principles for the development of built environment. Physical preventive measures and construction of resilient buildings and structures come under structural measures [9].

Social factors include aspects relating to human society and its members in managing disasters: initiatives to increase the population's level of education, increase employment opportunity, reduce poverty, enhance the role and participation in decision making, including women that would support preparations for future disasters [10].

Natural environmental factors related to the disaster management are included under *Environmental factors*. Maintaining the protective features of the natural environment such as sand dunes, forests and vegetated areas are considered in this category. Management of waste, like hazardous waste, vegetation, soil, sediment, demolition debris etc, created by natural hazards is also considered here.

Legal factors include issues relating to law, accepted rules, and regulations for managing disasters. Various regulations that apply to routine

construction provide for the safe development of infrastructure, capital improvements and land use, ensuring preservation and environmental protection [11].

Long term economic planning measures and financial factors are included under *Economic factors*. Economic planning measures include aspects relating to production, distribution and consumption of goods and services in a society. Issues relating to money and management of monetary assets are covered under financial factors. Taking necessary measures to protect agricultural sector, industrial sector and infrastructure system [12] against natural disasters are few examples on economic planning measures. Finance is an essential resource in disaster management and financial policies and procedures have an effect on disaster management process.

Operational/managerial factors include planning, coordination and management of disaster related activities. Skills and competencies needed to accomplish desired works are also included under this classification. Logistics management, information and communication management and leadership are some other aspects covered under this category.

Political factors include aspects relating to the governance of a country within the context of disaster management such as support given for disaster management programmes by the politicians, inability to develop and enforce disaster risk reduction measures etc [13].

Vulnerability of people to disasters due to their beliefs, values, strong attachments to their land and property, and dependency and an absence of personal responsibility can be considered as *cultural factors* (5, 14). As a result of the cultural vulnerability, community can act as passive recipients from the impact of disasters. The study of and Kulatunga [14] also revealed that sense of powerlessness imposed on communities by beliefs have reduced the proactive involvement of community towards disaster mitigation activities.

Having discussed the vulnerability factors for disasters, the following section outlines the research methodology adopted for the study.

3. Methodology

3.1 The workshop setting

The purpose of this study was to identify and evaluate the most critical vulnerability factors for climate induced disasters with particular reference to floods in Malaysia. A workshop was conducted in Malaysia with the involvement of 50 participants who have been extensively involved in the flood risk management activities in the East Coast floods, occurred in the state of Kelantan in 2014. The participants were from various related organisations in Malaysia representing the policy, social works, building, healthcare and academia. Table 1 below shows the organisations participated in the workshop.

Table 1: List of organisations involved in the workshop

	Organisations	Representatives
1.	SP Setia Berhad Group	3
2.	National Disaster Management Agency	3
3.	TIF3M Consortium	3
4.	Department of Irrigation and Drainage	3
5.	Construction Industry Dev. Board (CIDB) Malaysia	3
6.	Civil Engineering & Urban Transport Department, Kuala Lumpur City Hall (KLCH)	3
7.	Ministry of Women, Family and Community Development	4
8.	Department of Public Works	3
9.	PeerConsult Sdn Bhd	3
10.	Raja Perempuan Zainab (II) Hospital, Kelantan	2
11.	University of Herriot Watt Malaysia (HWUM)	3
12.	Green Campus Unit, Universiti Tun Hussein Onn Malaysia (UTHM)	6
13.	KANZU Research,	7

	UTHM	
14.	University Technology MARA (UiTM)	3
15.	University of Reading Malaysia	1
	Total	50

3.2 Use of Clickers voting system as a data collection tool

To rank the vulnerability factors from climate-induced disasters based on the perspective of the Malaysian respondents, Clickers remote voting system was used. Clicker is a remote personal response system to elicit quick answers to quizzes. These are hand-held devices that allow the responders to provide answers to questions and receive immediate feedback on their answers. Clickers have been identified as a learning technology that for classroom teaching and has been identified as a promising new trend in higher education [15] especially to improve the student engagement during lectures. Clickers generally involve four main elements: computer; hand-held device; software to prepare clicker presentations and processing data from clicker device; and hardware to receive signals from clicker devices.

Compared to the traditional show of hands or flash cards methods when answering to questions, clickers have the advantage of providing answers anonymously. This can be viewed as a positive way of getting responses from those who do not wish to convey their opinion in public. Hinde and Hunt [16] assert that Clickers provide the possibility of quick and accurate aggregation of responses, thus providing a valuable method of evaluating overall opinion of the respondents.

Even though Clickers are being used for teaching and learning in education institutes, the use of them is not limited to colleges and universities [17; 18] but has now been recognized in secondary education [19, 20], for administrative purposes, such as recording attendance, facilitate collaborative learning [21], and even in workshops to elicit responses.

3.3 Ranking the vulnerability factors

The workshop facilitators first introduced the concept vulnerability followed up by presentations from different country context where they have carried out vulnerability assessments in the past. These countries include Sri Lanka, Bangladesh and the UK. Further, three speakers from Malaysia

shared their experience on the East Coast flooding in Kelantan (which has been considered as one of the most severe floods in Malaysia) from the healthcare sector represented by Raja Perempuan Zainab (II) Hospital, Kelantan; Ministry of Women, Family and Community Development Kelantan was represented by Department of Social Welfare; and Department of Irrigation and Drainage, Malaysia.

Following the introductory presentations, participants were asked to rank the eight vulnerability factors (Technological, Social, Economical, Environmental, Political, Cultural, and Operational/Managerial) based on their criticality to the Malaysian context. Thereafter, the five most critical vulnerability factors derived from the respondents' views were chosen for further discussion. The respondents were then divided into groups based on their expertise to further discuss the 5 most critical vulnerability factors in detail.

4. Data Analysis

The participants ranked the vulnerability factors according to their criticality to Malaysian context in the order given below.

1. Social
2. Operational/Managerial
3. Technological
4. Economic
5. Political
6. Environmental
7. Legal
8. Cultural

The five most critical vulnerability factors are discussed in detailed below.

4.1 Social vulnerability factors

Participants view lack of community awareness and preparedness towards disasters as one of the social vulnerability factors in Malaysia. They argue that due to lack of awareness of the impact and the severity of floods, community do not take appropriate measures to protect themselves against it. Further, most of the people give a less priority for flooding, as they are more concerned about the day-to-day activities and hardship. One of the participants commented that '...there should be a mind change in how the society view disasters...(if not), they would not take proactive measures to mitigate the impacts of disasters'. Participants mentioned that some of the buildings in the area have their own protective measures such as half-

walls, but majority of the houses do not have them indicating their lack of preparedness to floods.

4.2 Operational vulnerability factors

Inadequate knowledge and understanding of the authorities regarding the flood-affected areas was highlighted during the discussions. For example, one of the participants commented that 'One of the participants commented that it is a concern that the government agents find it difficult to access the affected areas and reach the affected communities when compared to other counterparts such as NGOs'...'. Some of them were critical about the management structure of the disaster relief work. For example, 'operation manager is retiring in the monsoon season' commented one of the responders. He argued that such incidents make the flood management activities weak due to lack of a commanding personal to give instructions on what needs to be done, who should authorize funding for relief work etc. Similarly, the respondents further noted the none-availability of district officers and, lack of leading personnel at the police department at the time of the flood event. This makes the situation difficult in providing sufficient manpower to manage the relief work and to provide necessary instructions/commands at the most critical time.

Participants further mentioned that the Malaysian authorities have 'plans' in place regarding the operational aspects during disasters, however, whether they have evaluated the 'risk' aspect of those plans were questioned. For example, some of the plans were unable to implement because of certain unforeseen events due to late emergency response, lack of manpower, poor coordination of staffs, late delivery of transportation etc.

Majority of the respondents felt that they do not have sufficient post-disaster waste management to clean the roads following the floods. This creates difficulties for transportation in the areas affected by floods. Another important operational aspect during a disaster is the management and coordination of assistance coming from different organisations and areas. Due to such improper management and lack of coordination and communication, some of the assistance has been distributed to unwanted areas whilst some affected people not receiving any.

4.3 Technological vulnerability factors

Participants were in the view that 'floods in Kelantan was expected but its extreme level of flooding was not anticipated'. Therefore, the flood barriers have failed and unable to control the

amount of water. This was noted even within the main hospital of the Kelantan area where the flood barriers being unable to withstand the in-grace of water to the building.

Lack of early warnings about the floods with insufficient lead-time given to prepare for floods has been identified as one of the main technological vulnerability factors during the flooding. Further, the relief works were largely affected due to the service breakdown such as telecommunication, electricity, water and sanitation. Cut-off of communication network made it difficult to coordinate the relief efforts as well.

4.4 Economic vulnerability factors

Lack of resources to rescue the affected community was noted as an economical vulnerable factor. For example, boats, lorries and amphibious vehicles were not sufficient during the floods. One of the major challenges was finding adequate financiers for flood relief work. Participants noted that the operational budget is prepared based on the activities of a year, however, when something unexpected happen; it is difficult to find money for the relief work. Further, as the Kelantan flood occurred at the end of the financial year (December), it caused a huge problem to secure funding for the relief work. Rebuilding and repair work of houses and infrastructure, maintenance of the business continuity especially the small-scale shops were the main challenges due to insufficient financial resources.

4.5 Political vulnerability factors

Participants opined that political will and support are needed for disaster mitigation and prevention work in Malaysia. They further noted that areas such as building approvals, and flood risk zone planning are sometimes ignored due to political influence. The participants unanimously agreed that people in the government departments work professionally, but political influence sometime affect their working ethos.

Further, it has been noted that some of the flood-affected areas were not getting sufficient support due to political influences. One of the participants commented that ‘...on the ground, politics take place... uneven distribution of resources and financial assistance are influenced by the political decisions where the priority for distribution is based on constituency area irrespective of the actual level of damages’. Therefore, the communities in the affected areas might receive

less finance and resources for flood relief work. Lack of long-term strategic planning has been identified as one of the main political vulnerability factors that affect disaster management work. Respondents commented that ‘as the life-span of politicians’ activities is limited up to the next election’ there is a tendency for insufficient attention to make long-term disaster management strategic planning and activities.

Having discussed the key vulnerable factors for floods in Malaysia, the below section discuss the key conclusions derived from the study.

5. Discussions and Conclusion

The study identified and evaluated the five most critical vulnerability factors for the climate-induced disaster, floods in Malaysia. They include, Social, Operational/Managerial, Technological, Economic and Political vulnerability factors.

The vulnerability factors for the Malaysian context identified from the study indicated that how their susceptibility to disasters has been increased due to ‘socio-economic’ and ‘socio-political’ factors. This corroborate with the seminal work of Westgate and O’Keefe [22], who view the main reason for disasters as the exposure of humans to the physical or natural phenomena due to the impact of socio-economic and socio-political factors. Further, the findings of the study confirm the views of the previous researchers who interpret disasters as collusion between the ‘natural environment’ and the ‘socio-economic’ systems ([23, 5, 7, and 24]. According to Eshghi and Larson [25], this is why different communities pose different levels of vulnerability towards disasters, despite subjecting to triggering agents/hazards with similar intensity and magnitude. Therefore, it can be concluded that the aforementioned “socio-economic” and ‘socio-political’ vulnerable factors need to be given due consideration when developing disaster risk reduction strategies as they make humans more susceptible to disasters.

The findings of the study further revealed the need of addressing vulnerability factors at different levels such as at the community, institutional and policy levels. For example, vulnerability factors such as improving the awareness regarding disasters, following appropriate disaster risk reduction measures in a pro-active manner need to be addressed at the community level. Development of long-term strategic plans for disaster risk management, effective and fair distribution of

funds for the affected communities, minimizing the undue influence of politicians for disaster risk reduction work need to be managed at the policy/strategic level. In between the community and policy level, much work needs to be done at the institutional level to ensure the preparedness, relief and recovery work are well organized and managed and operated.

The findings of the study also revealed that how the vulnerability factors are interconnected with one another. For example, operational vulnerability factors (such as lack of flood risk management personnel and resources) are linked with political vulnerability factors (such as politicians looking after their constituency only). Further technological vulnerability factors (such as lack of early warning systems and lack of effective flood barriers) are linked with the economical vulnerability factors (such as lack of financial resources). Similar findings have been identified in the work of Kulatunga et al [7], where they have identified the interconnectivity of vulnerability factors that has increased the susceptibility of the disaster affected community. The interconnectivity of the vulnerability factors requests for multi-faceted disaster risk reduction strategies as the same vulnerability factor could have different origins and root causes. Therefore, considering a holistic perspective when addressing vulnerability factors can be highlighted.

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7. References

[1]. IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland

[2]. Siwar C, Alam M, Murad W, Al-Amin A Q, 2009, A Review of the Linkages between Climate Change, Agricultural Sustainability and Poverty in Malaysia, *International Review of Business*

Research Papers Vol. 5 No. 6 November 2009, Pp.309- 321

[3]. Pasteur, K. 2011, From Vulnerability to Resilience A framework for analysis and action to build community resilience, Practical Action Publishing Limited, UK [Online] Available from <http://practicalaction.org/from-vulnerability-to-resilience> [Accessed 10 January 2015]

[4]. RICS, 2009, *The Built Environment Professions in Disaster Risk Reduction and Response*, London.

[5]. McEntire, D.A., 2001, Triggering agents, vulnerabilities and disaster reduction: Towards a holistic paradigm, *Disaster Prevention and Management*, Vol. 10(3), pp. 189-196.

[6]. Pathirage, C.P, Seneviratne, K. Amaratunga, D. and Haigh, R., 2012, Managing Disaster Knowledge: Identification of Knowledge Factors and Challenges, *International Journal of Disaster Resilience in the Built Environment*, Vol. 3 (3), pp. 237-252.

[7]. Kulatunga, U, Wedawatta, G, Amaratunga, D and Haigh, R 2014, '[Evaluation of vulnerability factors for cyclones: the case of Patuakhali, Bangladesh](#)', *International Journal of Disaster Risk Reduction.*, 9 (Sep) , pp. 204-211.

[8]. Oloruntoba, R. 2005, "A Wave of Destruction and the Waves of Relief: Issues, Challenges and Strategies", *Disaster Prevention and Management*, 14(4), pp. 506-521.

[9]. DFID, 2005 Natural disaster and disaster risk reduction measures. London.

[10]. Rodriguez, H., Wachtendorf, T., Kendra, J. & Trainer, J. 2006, "A Snapshot of the 2004 Indian Ocean Tsunami: Societal Impacts and Consequences", *Disaster Prevention and Management*, 15(1), pp. 163-177.

[11]. Wilkinson, S., Masurier, J. L. & Seville, E. (2006), *Barriers to Post Disaster Reconstruction*, 2006/03, Wellington.

[12]. Boshier, L., Dainty, A., Carrillo, P. & Glass, J. 2007, "Built-in Resilience to Disasters: A Pre-Emptive Approach", *Engineering, Construction and Architectural Management*, 14 (5), pp. 434-446.

- [13]. McEntire, D., Crocker, C.G. & Peters, E. (2010). Addressing vulnerability through an integrated approach, *International Journal of Disaster Resilience in the Built Environment*, 1, 50 - 64
- [14]. Kulatunga, U 2010, 'Impact of culture towards disaster risk reduction', *International Journal of Strategic Property Management*, 14 (4), pp. 304-313
- [15]. National Research Council, 2000, *How people learn*, Washington D.C.: National Academy Press pp. 182, 218
- [16]. Hinde, K., and Hunt, A. 2006, Using the personal response system to enhance student learning: Some evidence from teaching economics. In Banks, D. A. (2006) (ed). *Audience response systems in higher education: Applications and cases*. Hershey, PA: Information Science Publishing
- [17]. Hafner, K. 2004, In class, the audience weighs in. *New York Times*. Online resource, accessed December 2012, available from: <http://www.nytimes.com>
- [18]. Lightstone K., 2006, Personal response systems: an institutional phenomenon, *International Journal of Learning*, 13, 17-24
- [19]. Hanley J. T. and Jackson P., 2006, *Making it click, Tech and learning*. Accessed March 2012, available online from <http://www.techlearning.com/showArticle.php?articleID=188702514&pgno=2>.
- [20]. Ramaswami R., 2007, Thinking small, *Technological Horizon in Education Journal*, 34(3), 20-22
- [21]. MacArthur J R and Jones L L, 2008, A review of literature reports of Clickers applicable to college chemistry classrooms, *Chemistry Education Research and Practice*, accessed online: February 2012, available from: <http://pubs.rsc.org/en/content/articlepdf/2008/rp/b812407h>
- [22]. O'Keefe, P., K. Westgate, and B. Wisner. 1976. "Taking the naturalness out of natural disasters". *Nature*, vol. 260, pp. 566-567.
- [23]. Alexander, D., 1993. *Natural Disasters*. UCL Press and Chapman & Hall, New York
- [24]. Wisner, B., Blaikie, P., Cannon, T. and Davis, I., 2003, *At Risk: Natural Hazards, People's Vulnerability and Disasters*, 2nd ed., London: Routledge.
- [25]. Eshghi K, Larson R C, 2008, Disasters: lessons from the past 105 years, *Disaster Prevention and Management*, Vol. 17 No. 1, pp. 62-82