Leveraging Vulnerability and Adaptability Assessments to Enhance Fire Safety in Sungai Asap Longhouses, Sarawak

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ABSTRACT

Longhouses in Sarawak are susceptible to fire incidents, and limited research has been conducted on their vulnerability and adaptability to fire hazards. Therefore, this paper aims to examine the vulnerability and adaptability level of longhouses in Sungai Asap to fire hazards. A quantitative approach was conducted. A sampling of 59 respondents was interviewed through a survey and data are analysed using frequency test. The findings revealed that three longhouses were in the category of at-risk while the other three were vulnerable. Fire risks were related with the usage of electricity, inadequate fire safety features, and the proneness of building materials to fire. Recommendations to reduce vulnerability include regular awareness programmes on fire safety, engagement of a certified chargemen and changing to less prone building materials. The findings can assist in improving longhouse fire safety in Sarawak and as a framework to develop guidelines for designing new communal dwellings.

Keywords: Fire hazard, longhouse, Sarawak, vulnerability and adaptation; vulnerability index

INTRODUCTION

Fire incidents can lead to property damage, injuries, and fatalities (Leong et al., 2004). Economically, fires have resulted in losses exceeding RM5 billion nationwide as of 2017 (FRDM, 2018). Specifically in Sarawak, the Fire and Rescue Department reported 59 longhouse fire cases in 2020. This paper focuses on measuring the vulnerability index (VI) of the households in the Bakun Resettlement Scheme (BRC) in Sungai Asap that housed the indigenous ethnic groups to make way for the Bakun dam development (refer to Figure 1). The relocation to a new settlement was completed in 1997 involving 20,000 people from 15 longhouses.

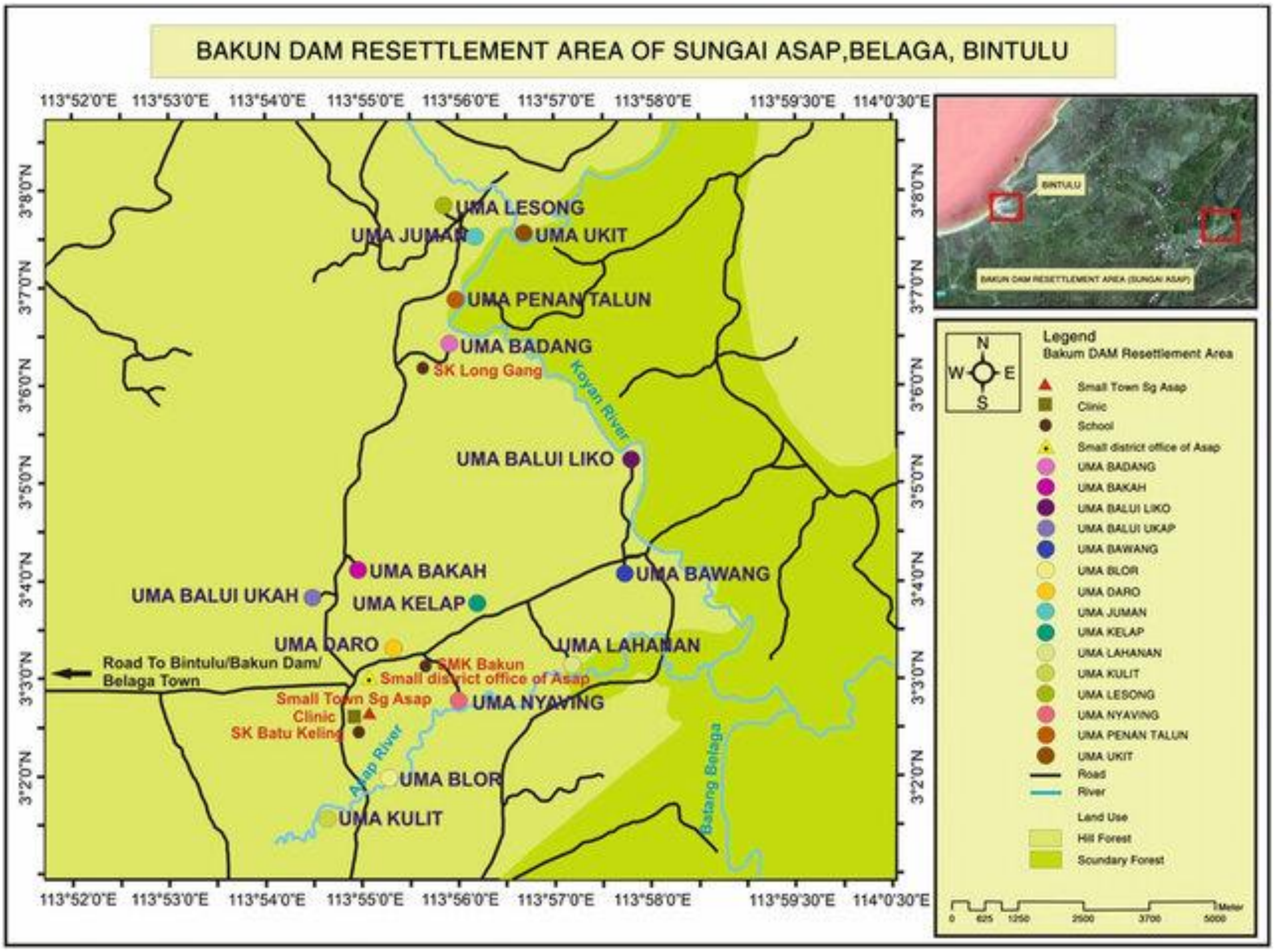

Figure 1: Location of Sungai Asap Resettlement Scheme in relation to Sarawak and the Bakun Dam (Cooke et al., 2017)

In 2019, four longhouses were involved in a fire incident, totalling six out of the 15 available in BRC. Hence, fire hazard is common and unresolved, particularly involving communal dwellings like longhouses. As families grow, existing houses must be expanded to accommodate all family members living together. This has resulted in non-compliance and deviation from the original design, making the occupants vulnerable to unwanted incidents like fire. Overall, research on fire safety in Sarawak is limited, with no studies conducted in Sungai Asap. Therefore, this study addresses the research gap by evaluating the fire hazard vulnerability of longhouse residents in Sungai Asap. Findings from this study can assist in improving fire safety for any longhouse in Sarawak as a framework to develop guidelines for designing new communal dwellings. Therefore, this paper seeks to examine the vulnerability and adaptability of longhouse residents to fire hazards in BRC, Sungai Asap.

Vulnerability and Adaptation Concept

Vulnerability refers to the susceptibility of individuals, communities, or systems to experience adverse effects from a hazard or stressor (Hagenlocher & Castro, 2015; Bustos & Vicuña, 2016; Ismail et al., 2019; Fatemi et al., 2020; Falson, 2021; Said et al., 2024). Vulnerability is a dynamic concept that takes into account both the exposure to hazard and the capacity of individuals or systems to cope, adapt and recover from impacts of the hazard (UNISDR, 2015; Fatemi et al., 2020). Vulnerability is a dynamic and evolving process that depends on the existing weaknesses in a system (UNISDR, 2015; Folke et al., 2002). The ability to survive a disaster through disaster risk management is called defensive capacity (UNISDR, 2015; Sairinen & Kumpulainen, 2006; Schmidt-Thomé, 2005). Vulnerability and disaster risk are related, with the level of vulnerability determined by the risk and potential hazard.

Adaptation is the capacity of individuals, communities, or systems to adjust and respond efficiently to evolving environmental conditions or potential hazards (Rondhi et al., 2019; Ekawati et al., 2022). This includes implementing measures and strategies to reduce vulnerability (UNISDR, 2015; Bhuiyan et al., 2017; Ghinoi & Steiner, 2020; Home, 2022; Said et al., 2024). Adaptation can range from spontaneous actions, such as moving goods to a safer location, to planned measures, such as early warning systems, to respond to ongoing or expected climate change (Willows & Cornell, 2003; IPCC TAR, 2001). The vulnerability and adaptation strategy provide understanding of how individuals, communities, and ecosystems are susceptible to the impacts of climate change and other hazards and to develop strategies and measures to adapt and mitigate these impacts (Thuy et al., 2014; Al-Hatrushi et al., 2015; Sherbinin et al., 2015; Rana & Routray, 2018; Sahrir, 2022; Said et al., 2024).

Vulnerability index is a quantitative measure used to assess the vulnerability of a system or population to hazards (Stanturf et al., 2015; Zhang et al., 2018; Joo et al., 2019; Said et al., 2024). It takes into account socioeconomic factors, exposure to hazards, and adaptive capacity. The vulnerability index helps to inform targeted interventions and policies to reduce vulnerability and enhance adaptive capacity (Paz-Alberto et al., 2019; Zhang & Xie, 2019; Fobert et al., 2021; Kyryzyuk et al., 2021). The primary goal of disaster risk management is to minimize victims' vulnerability, as well as the risks and impacts of disasters. Achieving this requires a shared reference framework to facilitate technical collaboration, knowledge transfer, and the development of methodologies, models, and tools for strengthening risk management (Guarin, 2018). To achieve stability in risk management, related agencies must play their roles in a well-coordinated manner. Sharing knowledge and expertise can help achieve the disaster risk management goal. This paper believes that fire disaster risk management can be improved by identifying the level of vulnerability of the victims to find an effective fire disaster risk management system, particularly for Sungai Asap, Sarawak.

METHODOLOGY

A quantitative approach method is used for this study. The sampling includes six longhouses, which comprise 59 respondents. Data collection is through a household survey. An observation is carried out to assess how well households comply with the fire safety requirements outlined in the Sarawak Building Ordinance (SBO) 1994. However, it must be pointed out that the construction of any longhouse does not need to comply with fire requirements under the Tenth Schedule of SBO 1994 because the longhouse has two different spaces, a communal space as depicted by the ruai and a residential space as depicted by the respective bilik (households), which have different fire requirements. Traditionally, the design has never been meant to comply with SBO 1994. Sampling is chosen through a non-proportionate stratified sampling, whereby the stratified factor is the longhouse experience of fire incident. The selected longhouses are shown in Table 1. From the sampling, two longhouses (Balui Liko and Uma Bawang) are previous victims of fire incidents, while the remaining four have not been involved in any fire incident - Uma Juman, Uma Lesong, Uma Belor and Uma Baha'.

Table 1: Selection of Longhouses using Non-stratified Sampling Method Fire Incident Victims Have not been involved in fire incident (Author's)

Fire Incident Victims		**Have not been involved in fire incident**	
Longhouse	Number of respondents	Longhouse	Number of respondents
Balui Liko	11	Uma Juman	10
		Uma Lesong	10
Uma Bawang	10	Uma Belor	10
		Uma Baha'	8
Total = 59			

Conditions of the longhouses, especially on building materials and layouts are observed and mapped against the SBO 1994 fire compliance checklist. Data analyses are conducted by running frequency tests to identify the trend of demographic profiling and to compare means between the categories to measure the VI. A Likert scale of 5 points is used to measure the VI. The index includes categories under electricity usage, fire safety awareness, human behaviour, building materials and SBO 1994 compliance.

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Table 2: Scale for Vulnerability Index (Author's)

Scoring	Indication
1	Safe
2	Less safe
3	At risk
4	Vulnerable
5	Very vulnerable

The level of vulnerability is determined using the scale shown in Table 2. The VI scale is based on the five scales, with 1 as safe, 2 as less safe, 3 at risk, 4 as vulnerable, and 5 as very vulnerable. A higher index indicates greater vulnerability of the longhouse residents to fire, and vice versa.

RESULTS AND DISCUSSIONS

In Sungai Asap, the average number of residents per longhouse is 1,002, indicating a high electricity usage due to the dense population. Additionally, the average number of occupants per individual room is approximately seven per household. The usage of electricity can trigger fire hazards, especially if a non-certified wireman extends the wiring. For demographic profiling, in terms of gender distribution, there are more or less equal between male and female respondents. With regards to education level, most respondents attended secondary school at 39%, followed by tertiary education (30.5%), while the lowest are those attending primary school at 13.6. This indicates the respondents have a good educational attainment level. Table 3 shows the VI according to different category, whereby compliance to SBO is making them most vulnerable, followed by electric usage, fire safety, human behaviour and building materials. The VI for all categories are vulnerable.

Table 3: Vulnerability index (VI) in general for the longhouses at Sungai Asap, Bakun Resettlement Scheme (Author's Calculation)

Variable	Element	Aspect	VI
Electric usage (4.55)	Deviation to the original design	Additional rooms	4.53
		Extended house	4.58
		Appointment of chargeman	4.50
		Usage of extension cord	4.58
Fire safety awareness (4.22)	Training and equipment	Availability of personal fire extinguisher	4.80
		Availability of fire extinguisher (shared)	4.03
		Attendance to fire safety briefing and training	3.83
Human behaviour (4.22)	Personal behaviour	Barbeque activity within the house compound	4.75
		Vulnerability of cooking method	4.00
		The smoking habit of the households	3.90
Building materials (4.12)	Building materials	Column and frame	4.53
		Walling	4.53
		Ceiling	4.53
		Flooring	4.53
		Roofing	2.50
Compliance to SBO 1994 (4.87)	Guidelines	Opening to the external staircase	5.00
		Equipment testing by the Fire and Rescue Department of Malaysia	5.00
		Two separate staircases	4.93
		Party wall	4.53

Table 4 shows the comparison of VI based on the longhouses. The study found that Uma Juman has the highest level of vulnerability with a VI of 4.15, while Uma Belor has the lowest but still categorise as "at risk". The study also reveals that Uma Juman has the highest vulnerability related to electricity usage and human behavior, while Uma Bawang is most vulnerable in terms of fire safety and compliance with the SBO 1994.

Table 4: A comparison of the vulnerability index across various variables for the longhouses in Sungai Asap, Bakun Resettlement Scheme. (Author's Calculation)

Address	Electricity usage	Fire safety awareness	Human behaviour	Building materials	SBO 1994	VI
Uma Juman	4.18	3.90	3.80	4.50	4.35	4.15
Uma Bawang	3.60	4.25	3.05	4.50	4.83	4.05
Uma Baha'	3.78	3.85	3.38	4.50	4.45	4.00
Uma Lesong	3.83	3.50	3.70	4.50	4.35	3.98
Uma Belor	3.78	3.73	3.53	4.50	4.18	3.95

Table 5: Fire vulnerability levels of the longhouse residents in Sungai Asap, Bakun Resettlement Scheme (Author's Calculation)

Type	Vulnerability Index	Category	Remarks
Overall	3.95	At-risk	6 longhouses
Experienced to fire	3.85	At-risk	2 longhouses
No experience to fire	4.0	At-risk	4 longhouses

Overall, the longhouses have a Vulnerability Index (VI) of 3.95, placing them in the 'at risk' category (Table 5). Based on this research, it is crucial for all longhouses to implement stringent measures to maintain fire safety and prevent potential incidents in the future. Both categories of longhouses are at-risk, with a score of 3.85 for those experiencing fire hazards and 4.0 for those who have not experience fire hazard. Therefore, there is no significant difference between longhouses that have experienced fire incidents and those that have not. Regarding recommendations for enhancing fire safety management in Sungai Asap, Table 6 highlights the most critical aspects that need attention.

Table 6: Fire safety management recommendations for longhouses in Sungai Asap (Author's)

Variable	Element	Recommendation
Electric usage	Deviation to the original design	local authority or Ketua Kampung should regulate the situation by implementing appropriate guidelines
Fire safety awareness	Training and equipment	Scheduled and regular training, along with inspections of firefighting equipment
Human behaviour	Personal behaviour	Establish a designated barbecue area equipped with fire safety features
Building materials	Building materials	Future designs are to come out with non-combustible materials
Compliance to Sarawak Building Ordinance 1994	Guidelines	Amend the Sarawak Building Ordinance 1994 to include requirements for communal dwellings

The study concludes that enhancing fire safety and reducing the vulnerability index requires collaboration between the community, local authorities, and lawmakers to prevent future fire incidents and ensure effective control. It is recommended that the community raise awareness about fire safety management and assess their capacity levels. A lack of awareness regarding the risks of illegal home extensions is the primary factor contributing to their increased vulnerability. The consequence of house extensions is the need for additional wiring systems, which, according to this study, were installed by the occupants themselves without the involvement of certified professionals. This situation poses a danger, as no inspection was conducted to verify the safety and compliance of the installed wiring. Therefore, the community should follow the guidelines set by the local authority to ensure their safety is not compromised. Guidelines should be implemented to regulate the design of communal dwellings. While the existing longhouses were not initially designed with optimal fire safety features, they could have been safer had the community maintained their original structure. Therefore, the local authority must fulfill its role by enforcing the law. Regular inspections of the longhouses are a key strategy to ensure the community remains vigilant about fire safety hazards.

Furthermore, the practice of barbecuing within the house compound should be regulated. One solution is to establish a designated barbecue area with fire safety features for the barbecue pit, located at a safe distance from the main building to prevent fire risks. Additionally, the local authority should implement scheduled training and briefings for the community to ensure they are equipped to handle any fire incident. In this study, 52% of respondents had not attended any fire safety briefing or training, which directly impacts their ability to operate firefighting equipment, such as fire extinguishers. The lack of enforcement of existing requirements in communal dwellings contributes to their vulnerability.

CONCLUSION

In Malaysia, all buildings are required to meet fire safety requirements set by BOMBA under the UBBL 1984. However, longhouses in Sarawak are exempted from these requirements, allowing for unrestricted building and extension of homes. This lack of fire safety regulation is a concern as it makes the communal dwellers vulnerable to fire incidents due to limited emergency escape access. The alteration of longhouses, the lack of party walls, and the morphological design have all been identified as contributing factors to the low fire safety conditions in these homes. The implementation of fire safety requirements must take into account the function of the house and be cost-sensitive, especially for low-income families who may need government assistance or subsidies to install necessary fire safety systems. In addition, cost is a key factor in determining the availability of fire safety systems in longhouses. The use of non-combustible material is crucial for maintaining fire safety, and the extension of these dwellings should also be carefully considered to reduce the fire risk. Adopting new regulations is necessary to increase the level of fire safety in Sarawak's communal dwellings. Fire safety awareness is important among the public to reduce the loss of life and property. The government must work out practical guidelines for the architecture of rural houses, including providing future longhouses with their fire safety design.

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