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Disaster-vulnerable community perception related to pre-earthquake natural phenomena in west sumatera as part of disaster preparedness

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Abstract. This article aims to describe the perception of disaster-vulnerable community-related natural phenomena before the occurrence of earthquakes. This research applies the survey methods and purposive sampling. A total of 229 respondents from earthquake-prone districts respond to questionnaires and interviews. The data are analysis quantitatively (percentages). The finding informs that many people are well acquainted with earthquake characteristics, threats and risks of earthquake impacts in West Sumatra based on scientific knowledge. Amongst the four regions of the community, the Padang Pariaman people experience nature and animal anomaly before the earthquake. The two unusual phenomena which are recognized are the rising temperature and the appearance of a vertical tornado-like cloud, beside nervousness of a dog, cat, cow, and bird. However, the community has not employed this perception based knowledge as a recommendation to act in quake preparedness. Beliefs in religious have much-driven people in responding to the threat of hazard. It can be concluded that even though the community perceives natural changes before the shock, but these phenomena have not become part of disaster preparedness yet. It is being a challenge for further research to build an earthquake preparedness approach which considers scientific knowledge, local knowledge and values, and trust to the Gods' provisions

1. Introduction

In the context of disaster, perception becomes one of the non-technical parameters for increasing community capacity to build responses in times of crisis [1] and becomes a key component of the social resilience framework, for example in Saudi Arabia [2]. Mañez, Carmona, Haro, & Hanger explain that risk perception mainly influences risk management and therefore determines whether risk management is successful in reducing vulnerability [3]. In cases in which people have poor or no perception of a particular risk, their reaction might be inappropriate or even harmful, while people with a perception of risk are framed by historical and social events, risk awareness is high.

Risk is perceived differently by each people in one community [3] due to different hazards environmental that they expose to, or the vulnerability of the area. Vulnerability definition covers the potential for loss [4], easiness exposed to quake and suffer from physical injury [5], and implies some risk combined with the level of social and economic liability, and the ability to cope with the resulting event [6]. When a hazard joined to vulnerability, this crossbreeding increases the risk level [7]. In recent times, experts in various disciplines extensively viewed strategies to improve earthquake preparedness, including new supporting resources, knowledge, program, and tools to improve preparedness skills [8], formal education [9], as well as a civic education program, does [10]. The current evidence indicates that factors influencing preparedness attitudes and behaviors are complex and multifaceted, including



demographic characteristics, trust in government efforts, previous exposure to a disaster, and the number of dependents in a household [11]. Other experts studied on factors that influence disaster preparedness, such as residential unit and respondent educational levels [12], income and age [3], beliefs [13] and trust to the government [14], and culture [15].

Perception related to risk is important for building preparedness in disaster. Kim & Kang discovered two different types of risk perceptions: social and personal risk perceptions for Hurricane [16]. Quite different, Bourque et al., found that risk perception did not directly influence preparedness behavior [17], yet it is largely mediated by knowledge, perceived efficacy, and milling behavior. Helsloot & Ruitenber reported a literature review that there is one important limitation, is the cultural bias in most studies [18].

Mostly preparedness research toward the vulnerable community in West Sumatera concerned about physics developments, infrastructure quality, evacuation area mapping using technology as well as sensor system, health quality improvement [19; 20; 21; 22]. Some reviews on perception related to preparedness were available, such as the contribution of perception to the preparedness of health disaster [23]. Perception measurement related to natural phenomena before the earthquake disaster which links to disaster preparedness has not been conducted. This study aims to describe the perception of the West Sumatera vulnerable society toward contextual natural phenomena as part of pre-disaster awareness for building earthquake preparedness.

2. Methods

This research applied the survey methods. The population is a society that inhabit the earthquake-prone area in the four districts, are Padang Pariaman, Pariaman, Pesisir Selatan and Pasaman Barat in West Sumatera which has a high risk of earthquake and tsunami. Sampling is determined purposively. Respondents are adults group who directly experienced earthquake at least earthquake occurrence in 2009, consist of 229 respondents. To gather the data, we apply a structured questionnaire and interview. Questionnaire consist of three viewpoints: earthquake and its impact, pre-earthquakes unusual natural phenomena, and pre-earthquake unusual animal behavior. The interview is conducted to further exploration and profound explanation of important information based on the answer in the questionnaire. Then, the data analyzed descriptively, in the form of a percentage.

3. Result and Discussion

Perception is constructed by knowledge and experience of responding to the surrounding. Here, there is four focus of finding related to vulnerable people in four earthquake-prone regions of West Sumatera.

3.1. Perceptions about earthquakes and their effects

The people of four districts aware that they live in the prone area due to the geological structure is exactly henced by the crust movement. West Sumatera province is located above the Sunda subduction zone where the Australian plate plunges beneath the Eurasian plate [24] and lies broadside on Andaman Islands to Sunda strait plate boundary which has ruptured triggered the 2004 Indian Ocean tsunami. People have known that the next Mentawai earthquake will produce stronger shaking along the Sumatran coast and would cause a potential for loss of life on the scale of the 2004 Indian Ocean tsunami.

Generally, this society has experienced many earthquakes since 2004, however, the 2009 earthquake was the most remembered. This indicates that the impact of the 2009 Padang earthquake caused deep trauma. One of the vital features of the 2009 earthquake is plenty of very large and devastating landslides that occurred in the district of Pariaman [25]. The Emergency and Humanitarian Action (EHA) reported that even the 19 cities/districts were affected by the earthquake and Padang city was among the worst hits [26].

In local people's perception, the impact of the 2009 earthquake also can cause mental disorders or mental stress, known as PTSD (Post Traumatic Stress Disorder), a kind of psychological problem that are considered severe, long-term due to natural disasters or traumatic social events. Nashori estimates that one percent of catastrophic event victims experience PTSD [27], therefore Salcioglu, Basoglu, &

Livanou highlights the need for a cost-effective mental health care model for earthquake survivors [28]. Musa et al., measured among survivors of earthquakes in North Sumatra and West Sumatra and 19% were found to suffer from a high level of depression, 1 in 2 (51%) had anxiety and 1 in 5 (22%) experienced stress [29]. Given the fact of mental health risks associated with disasters, further studies are needed on psychological approaches to disaster management in the West Sumatra disaster-prone area.

3.2. *Perceptions about pre-earthquake natural phenomena*

The percentage of people who were familiar with pre-earthquake natural phenomena in the four regions was 82.69%, 29.12%, 28.03%, and 23.82% for the Padang Pariaman, Padang, West Pasaman, and South Pesisir regions, subsequently. The people of Padang Pariaman are the communities that capture the most natural anomalies and are much larger than the city of Padang, although residents in these two regions are the most victims of the 2009 earthquake. This is thought to be related to social character factors culture, in which the people of Padang Pariaman generally have work in farming, trading, gardening so they have access to and are exposed to the natural environment more and longer than the people of Padang.

The people of the fourth district convince that nature implicitly deliver any message for human wealth, include express signs to safe from disaster. Also, their existence today is influenced by their chance to perform earlier evacuation after detecting pre-earthquake signs, which are the spreading of small vibrations and rumbling sounds. The vibration that precedes an earthquake is called foreshock, which mostly occurs before a large fraction of the world's major ($M > 7.0$) earthquakes and appears in 10% of the world's major events within 100 km and 3 months [30]. After detecting foreshock, people have the time to save themselves by running out of the house and stopping vehicles when traveling. In this case, it can be seen that the community has recognized the need for open space as one of the supporting facilities for basic rescue measures in earthquake disasters. Shrestha, Sliuzas, & Ku explained that open spaces are a key component of disaster response as they are safe locations and offer spaces for communities that enable mutual coping among its members [31]. Earthquake sounds are also well known as acoustic signals [32] created by P wave radiation patterns. Seismic sound is sometimes heard before shaking, possibly because it is mainly produced by P waves [33], while visible vibrations are often associated with S waves. In general, earthquake sounds are heard in the area around the epicenter, even for minor events. Among the many observations that accompany earthquakes, rumblings have often been reported.

Earthquake precursors can be studied to predict the occurrence, characteristics, and level of danger that will be caused. Half of the precursors are observable due to these processes associated with the biosphere [34] in where human run the daily activities. Hayakawa et al., explains that there are three groups of precursors, namely mechanical precursors, electromagnetic precursors and precursors of macroscopic phenomena [35]. Furthermore, Yamauchi et al. added several other macro anomalous phenomena such as abnormal noise, earthquake lightning, earthquake clouds, soil deformation, and groundwater abnormalities. Other pre-earthquake processes proposed are subsurface ions, air ionisations, corona discharges, oxidation of water to hydroxide in water, and oxidation reactions in soil [36]. Fidani has surveyed many respondents in many areas around the L'Aquila Italy earthquake to find out what macroscopic anomalies were recorded by the public for 5 days before the earthquake occurred [37].

The vulnerable community in Padang Pariaman, Pariaman, Pasaman Barat, and Pesisir Selatan has sensitively perceived and aware for mechanical precursor, in the form of foreshock activity. Furthermore, the people in this area have frequently caught four unusual phenomena in nature, called as natural signs before the slip. Firstly, the air is sensed as hot unnaturally. The people admit that any unusual environmental temperature, even the sunshine as usual. Liperovsky et al., call such phenomena as infrared radiating (IR) [38]. Infrared emissions (IR) is electromagnetic radiation of wavelengths longer than visible light which is caused by Radon gas emanation and electric fields. IR cannot be seen but can be felt in the form of heat (thermal).

The second characteristic is the emergence of vertical clouds resembling porous whirlwinds caused by electromagnetic waves. Similar phenomena had ever been observed and reported by Ondoh which an upward tornado-type seismic cloud over the epicenter region before the M7.2 Nanbu earthquake of 17 January 1995 [39]. In 1980, Guo & Wang found both thermal anomalies and abnormal cloud above an active fault and considered that cloud anomaly and thermal anomaly were both related to the earthquakes. Although the mechanism in the field is still unknown, some rock cracking experiments have been carried out to try to explain this anomaly [40]. If the two methods, thermal anomaly and cloud anomaly, are connected with other geophysical methods, it will help the study of the earthquake. Another phenomenon that has been observed by the public is that nature looks calm, there is no wind, and the appearance of black clouds.

The emergence of natural anomalies observed by the community occurs at different times. Cloud anomalies occur in a matter of weeks before an earthquake, whereas environmental temperature anomalies occur closer to the earthquake event. Guo & Wang report the occurrence of hot anomalies and clouds to occur within 69 and 64 days before an earthquake, respectively [40]. Quite different, the four communities in this research area did not mention the exact number for the time and duration of natural anomaly emergence, due to they did not put a serious observation on these phenomena.

3.3. Perception of unusual animal behavior

Generally, the majority of respondents confirm the existence of unusual animal behavior which precedes the disaster. Among all four regions, more than 50% of people recognize the anomalous behavior of cats, dogs, birds, cows, about 30-50% recognize the behavior anomalies of fish, ants, mice, snakes, frogs/ lizards, insects, elephants, horses and less than 30% who recognize anomalous behavior of Worms, Lizards, Pigs. The behavior anomaly here is defined as restless behavior, yet no more explanations for detail animal restless expression. The people of Padang Pariaman are the people with the highest percentage in terms of recognizing natural symptoms before the earthquake (an average of 82.69%) of all respondents, highly differ from the percentage of disaster-prone communities living in Padang (29.12%), West Pasaman (28.03%), and Pesisir Selatan (23.82%).

Geophysical phenomena that occur before an earthquake can stimulate certain responses from certain types of animals. The animal's response can be observed in the form of behavioral anomalies [41]. Reports of unusual animal responses or behavior before the earthquake were abundant [34], although investigations about physical and chemical factors that cause behavioral change responses to continue. Animal precursors have appeared during the earthquake and tsunami in Aceh, 2004 [42]. In that event, no elephants were lost or injured because the elephants showed behavior away from the source of danger. This is because the elephant can detect and respond to sound waves 38.1 minutes before the Tsunami comes, even though it is about 1000 km from Sumatra, which is around Phuket, Thailand and Yala National Park, Sri Lanka. Another anomaly that has been reported is the number of fish in Meulaboh Beach. Yet, the use of animal precursors to recognize signs of an earthquake in West Sumatra has never been reported.

Yamauchi et al. suggested an unusual animal behavior (anomaly behavior) is an approach to predicting large earthquakes based on the Tohoku earthquake case [36]. Lakshmi, Nagesh, & Krishna stated that earthquake prediction can be made by utilizing the abnormal behavior of animals that precede seismic events in active seismic regions because animals are relatively more capable than humans in capturing certain types of geophysical stimulus that precede earthquakes [43]. Selby & Kagawa argues that by building community participation to monitor earthquake precursor signals, people can realize the chances of an earthquake and have a mental readiness to take action to prevent the effects of disasters [44]. The success of the introduction of precursors by the community in reducing the impact of earthquakes has been published by Tong (1988) in [45]. The Chinese people made a successful prediction and moved the evacuation in Haicheng City before the 7.3 magnitude earthquake based on observing the abnormal behavior of animals. Although the damage to the city reached 90%,

Although most people of Padang Pariaman, Pariaman, Pasaman Barat and Pesisir Selatan have ever observed changes in animal behavior before the earthquake, they did not take action based on this

knowledge. There are three reasons delivered. At first, the residents convince that the behavior change they observed would be a coincidence. The communities do not understand how earthquake relate to animal response, what surrounding animals perform do not have any association to the disaster. At one opportunity, anomaly behavior is followed by tremor, yet at another time, the anomaly is not followed by the shocks. Secondly, all disasters happen in certain places base on the god provision, as well as the death of any living thing on the earth's surface, therefore people should welcome it wisely. The last, the community well realized that they inhabit the disaster-prone area due to the all the year crust movement. Yet, the people do not wish to move and avoid settling in other areas that are not prone to disasters due to nobody could deny disaster if God wants it to happen. Briefly stated, people just need to act appropriately in the event of an earthquake, for example out of a building to avoid the possibility of building rubble. Besides, earthquakes are not new and have been happening for a long time. Ancestors also faced earthquakes but acted only as necessary due to their survival based on the god willing.

3.4. Pre-earthquake-based perception for disaster preparedness

Communities living in disaster-prone areas show the diversity of knowledge and attitudes as a basis for disaster preparedness. People who are already aware of the plan tend to show interest and concern for all aspects of life that are in line with disaster preparedness. For example, people make simple earthquake vibration detectors from pairs of glass and spoon sets. Regardless of whether the detector device is functioning or not functioning, people have shown disaster preparedness behavior. Another form of awareness is to have an emergency bag, it's just that the emergency bag does not contain emergency needs, but instead focuses on personal documents that are considered to be of high monetary value. Community awareness in recognizing unusual environmental conditions can also be extended as an indicator of earthquake preparedness.

According to Russel there are three predictive factors of earthquake preparedness, are socioeconomic and demographics, personality traits and earthquake-related variables [46]. Local knowledge and perceptions are categorized as variables related to earthquakes and it is important to pay attention to developing earthquake disaster preparedness. This potential is included in the Community-based disaster preparedness (CBDP) approach, which according to Allen & Researcher CBDP are increasingly important elements of vulnerability reduction and disaster management strategies [47].

Based on the research findings, it appears that in a community with a certain character of disaster, there is an authentic local knowledge that has the potential to be developed into local wisdom. Knowledge originating from indigenous knowledge has the potential to be conserved as local wisdom. The role of local wisdom in a state of disaster as well as understanding the character of the community that is associated with the role of a leader is an important potential [1] to strengthen community preparedness. To help the victims of disasters, one must understand who they are and what they need from their perspective. To do so, it is essential one must understand and respect their culture [48]. Understanding of hazards, risks and early-warning systems are the main factors in building an effective community response [1].

Public perception of West Sumatera related pre-earthquake phenomena is an association of three aspects, scientific explanations, local knowledge including religious guidance. Scientifically, the residents already know well that their area of residence is in the area where the plates meet so that earthquakes can occur at any time. The way individuals perceive their vulnerability to natural hazards shapes their reactions and ways of coping with these risks; hence their cost [49]. Slovic noted that if people perceive a risk to be real, then they would behave accordingly [50]. The public should understand better the cyclic geological process that generates great megathrust earthquakes, as well as the hazards that these earthquakes pose to specific human populations [7]. Therefore, the community in the four earthquake-prone areas in West Sumatera showed an attitude of acceptance that they termed destiny.

However, people have not used this sign as a marker of the earthquake and tsunami and decided not to do anything even though they saw the natural phenomenon include anomaly of animal behavior. Community assures that only religious leaders can capture pre-earthquake phenomena and interpret them as disaster warnings. Religious figures are believed to have the ability to interpret the signs of

nature, while the religious leader (interviewee 1) confirms that he never announced signs that he considered being alarms to be broadcasted to the general public to avoid public misleading to shirk. Further, Leader 2 (interviewee 1) view that earthquake disaster will come in an area if the community commits many observable violations of religious teachings. Usually preceded by the phenomenon of social disasters such as a group of people who bluntly legalized prostitution and deviant sexual behavior. In this term, Gianisa & Le De that religious beliefs and practices bond local people together and contributed to successful coping with disasters [51]. It also emphasizes that religious communities can fill response and recovery gaps, such as when external intervention is limited. Religious beliefs and practices, combined with other mechanisms, should be integrated within disaster risk reduction disaster management and activities as this would help build more resilient communities [51].

The existence of beliefs in disaster preparedness hence the need of policymakers and practitioners to value and capitalize on the constructive impacts of religious belief and to make an effort to moderate those impacts where they may be obstacles [52]. The policymakers need to give due consideration to how different ethnic groups understand and prepare for disasters, and to design disaster management and communication plans that cater to different language ability [53].

4. Conclusion

Based on the results of the study it can be concluded that the perception of the community in four West Sumatra disaster-prone areas of natural phenomena before the earthquake disaster has been formed based on the experience of the 2009 earthquake. The majority of people are well acquainted with earthquake characteristics, threats and risks of earthquake impacts in West Sumatra based on approximately accurate and scientific knowledge. The community also knows that the impact of the earthquake is not restricted to physical damage, but also causes psychological disorders.

Inhabitants' perception of the anomaly of natural phenomena before the earthquake in the four regions is diverse. Public perceptions of animal behavior anomaly in the four disaster-prone community groups also differed in the emergence of four animals, namely dogs, cats, birds, and cows. In this case, the people of Padang Pariaman are the communities that most recognize and encounter unusual natural and animal behavior. While this community has adequate literacy about earthquakes, their perceptions have not been a motive for acting in conditions an earthquake occurred. The response of community actions in earthquake conditions is more influenced by factors of belief in the power of the creator and the attitude of accepting the provisions. It is recommended to develop preparedness disaster based on their potential perception.

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