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Paper:

Statistical Analysis of the Relationship Between Social Capital and Evacuation: The Case of the 2017 Mt. Agung Eruption

Michimasa Matsumoto*,†, Miwa Kuri*, Kazuya Sugiyasu*, Yasuhito Jibiki*, Ni Nengah Suartini, and I Made Budiana*****

*International Research Institute of Disaster Science (IRIDeS), Tohoku University
6-6-11-901-2 Aoba, Aramaki, Aoba-ku, Sendai 980-8579, Japan
†Corresponding author, E-mail: matsumoto@irides.tohoku.ac.jp
**Japanese Education Department, Faculty of Arts and Letters, Universitas Pendidikan, Bali, Indonesia
***Japanese Department Faculty of Letter, Udayana University, Bali, Indonesia
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This study aimed to examine actual situations and problems involving evacuation activity during the Mt. Agung eruption in the autumn and winter of 2017. It also clarified (from the viewpoints of administrative information, individuals, families, local residence organizations, and simple notification services) the factors that promoted evacuation based on an examination of data from evacuees and supporters as provided by administrative agencies, questionnaires, and surveys. There were two main results. The first involved the relationship between alert recognition and recognition of the call for evacuation. When people received the volcanic eruption alert from real media sources, they also recognized the call for evacuation from other people or parties within those sources. When people received the alert through virtual media, they also recognized the call for evacuation from the same media. The information recognition path available through real media was narrower than that involving virtual media. Second, only the factor of "alert recognition" realized "group evacuation." Factors such as "prior action" and "recognition of eruption in 1963" were not directly related to "group evacuation."

Keywords: volcano, evacuation, social capital, Banjar, Indonesia

1. Introduction

1.1. Identifying Problems

Bali, Indonesia is a world-famous sightseeing resort. Local Mt. Agung has long been considered a sacred object of faith and is now a tourist destination. Mt. Agung is also known to periodically erupt. Large eruptions occurred in 1808, 1821, 1843, and 1963. Nearly 2,000 people died as a result of the 1963 eruption. Last year, a series of eruptions occurred throughout the autumn and winter of 2017. More than 140,000 people evacuated during this time; this was almost twice the number directed by the government.[1]

On the other hand, Japan experienced large tsunamis in March 2011 that caused tremendous damage on its eastern side along the Pacific Ocean. However, not much was learned from this disaster; the tsunami warning for the Fukushima offshore earthquake in November 2016 brought disorder along the Japanese coastline. The area population was supposed to evacuate on foot, but most did so using automotive assistance, thus resulting in major traffic congestion (many did not evacuate at all).

1. With reference to Matsumoto et al. [1], this research involved various systems related to Indonesian volcanos, including the "agency in charge of disaster countermeasures," "system for volcano observation," "volcano disaster danger area," and "volcanic activity level in Indonesia." According to JICA [2, 3], the volcanic disaster risk reduction and management systems managed by the Indonesian government agencies are mainly confined to those in charge of disaster countermeasures (e.g., the National Disaster Management Agency abbreviated as "BNPB" in the Indonesian language) and observation (e.g., the Centre for Volcanology and Disaster Hazard Mitigation (CVGHM) as abbreviated as "PVMBG" in the Indonesian language). The central, province and local (i.e., "Kabupaten (regency in English)" and "Kota (city in English") governments alter their command systems and responses depending on disaster scale. After the law was amended in 2007, the Indonesian government established the National Disaster Management Agency (BNPB) in 2008 as a permanent central organization designed to deal with disasters under the direct control of the President. The national, province and local governments are currently establishing a Regional Disaster Management Agency (abbreviated as "BPBD" in the Indonesian language) and are developing relevant systems. BNPB takes both prior and recovery actions and countermeasures against all types of disasters. BNPB is authorized to order other ministries to take immediate action when a disaster occurs. The emergency measures budget is also controlled by BNPB. BNPB provides advisories to other ministries in ordinary and recovery times. BNPB also supports evacuation, but initial actions are taken by the local governments. BNPB monitors needs of provincial and local governments, and provides assistance if necessary. PVMBG, which belongs to the Geological Agency in Ministry of Energy and Mineral Resources, plays the central role for observation. One of the PVMBG's missions is to constantly observe volcanic activities while recording data on volcanos, landslides, earthquakes, and tsunamis in addition to conducting surveys, research, and hazard mapping. It also provides early warnings regarding volcanic activity and landslides. According to the PVMBG Website, the organization classifies 127 volcanos in Indonesia according to the following three types based on activity status (it monitors and observes 65 active Type A volcanos at its observatories):
-Type A (80 volcanos): There are records of all eruptions occurring since 1600.
-Type B (29 volcanos): There is no reliable eruption record, but craters emit visible steam and sulfur.
-Type C (21 volcanos): There is no crater, but steam and sulfur rise.

The community organization called Banjar[2] is important when studying the behaviors of people in Bali. The strong Banjar solidarity was described by Geertz [5]. Banjar may have influenced the increased evacuation numbers during the eruption in 2017. However, community organizations do not always affect evacuation. For example, a survey in Okuma-cho, Futaba-gun (where all citizens evacuated the earthquake disaster area near the nuclear power plant) indicated that "the community was absent" (Yoshihara) [6]. In other words, the community that existed before the earthquake did not facilitate the evacuation or the living conditions in the evacuation sites, where forming new communities was difficult. An accumulation of case studies would be useful in studying the different roles of community organizations in different countries or regions during different disaster types.

This study aimed to examine actual situations and evacuation actions involving the Mt. Agung eruptions during the autumn and winter of 2017 by clarifying (from the viewpoints of administrative information, individuals, families, local residence organizations, and simple notification services (SNSs)) the factors that promoted evacuation based on data from evacuees and supporters as provided by administrative agencies, questionnaires, and surveys. This paper is organized as follows. The next section summarizes previous studies on volcanic eruption evacuations and examines their relationship to the present study.[3] Section 2 provides an overview of the Mt. Agung eruptions that occurred in 1963 and 2017 in addition to the reactions of local governments and community organizations. Section 3 analyzes the evacuation situation using a questionnaire survey that was conducted from December 2017 to March 2018 among people at the evacuation sites. Section 4 discusses a covariance structure analysis (SEM: Structural Equation Modeling) that was conducted to determine the relationship between evacuations and the attitudes of evacuees prior to the eruption based on popular stories about past eruptions as relayed through oral tradition. Section 5 provides a conclusion and discusses future problems.

KRB I (yellow)	This area may have received damage from lahars (volcanic mud flows) or floods. There is an undeniable risk of ardentes and lava flows.
KRB II (pink)	This area poses risks of ardentes, toxic gases, lava collapses, and lahars. If volcanic activity increases, people must follow PVMBG evacuation advisories until the area is determined to be safe. The local government decides whether people must evacuate or if they can remain home. It also decides whether evacuees can return home based on the current laws.
KRB III (red)	This area poses risk of lahars, frequent ardentes, lava flows, lava collapses, toxic gases, cinders, and heavy ash falls. People are not allowed to settle in this area.

PVMBG published hazard maps for volcanos showing the volcanic disaster danger according to three levels. The maps also show the type and feature of the volcanic danger, disaster danger areas, evacuation routes, and disaster control centers.
PVMBG defines four volcanic alert levels. The highest is Level 4, while the lowest is Level 1. PVMBG declares alert levels according to volcanic activities.

2. The Council of Local Authorities for International Relations [4] overviews the local government system in Indonesia. Roughly speaking, Indonesia has a three-layer structure consisting of the nation (central government), province, and regencies (locally called as "kabupaten") and cities (locally called as "kota"). The Banjar (citizens organizations in Bali) mentioned in this paper are subordinate to villages (Desa).
3. Numerical targets of the Sendai Framework for Disaster Risk include "(a) Reduce mortality" and "(g) Strengthen the early alert system." The logical relationship between these two targets is that the early alert system is strengthened to reduce the mortality rate during disaster. In this paper, we focused on whether regionally developed resources (e.g., social capital) could enhance the effects of the early alert (including the call to evacuate). Clarification of the usefulness of these resources would increase the number of evacuees while decreasing mortality.

1.2. Previous Studies

Many studies have been conducted on the volcanos (i.e., Merapi and Kelud) in Java, Indonesia.[4] Jibiki et al. [8] conducted a study on the acquisition of early warnings on the eruption and the subsequent actions taken during the 2007 Mt. Kelud eruption. They asked a question, "From whom did you hear about AWAS (the highest level of eruption warning in Indonesia)?" Most people chose the following answer: "Leader of the village (Desa) or community (Dusun)." The second most chose "Neighbors," while the third most chose "Television." Very few respondents chose "Family." Donovan [9] examined the Mt. Merapi case (which erupted in 2006) and discussed the sociocultural features of the area. According to Donovan, the local people did not accept the governmental volcanic warnings, which was based on science, because they were more concerned about livelihood security (they would not be able to farm or care for livestock if they evacuated) and their traditional ways of thinking. Andreastuti et al. [10] studied Mt. Sinabung in Sumatera and found that informal conversation and the establishment of trust between local residents and observatories were effective in acquiring information from the volcano-monitoring agency. Haynes et al. [11] surveyed Montserrat in the Caribbean and showed that friends and relatives were the most reliable sources of volcano information.

Jibiki et al. [8] discussed the eruption of Mt. Kelud in 2007 to examine evacuation calls. They posed a question, "From whom did you hear the evacuation alert?"

4. Tanaka [7] summarized the features and issues related to volcanic disasters, including the following four evacuation characteristics: (1) Wide-area cooperation is necessary, (2) there is a strong dependence on experts, (3) long-term evacuation is required, and (4) maintenance of the regional economy is necessary. As far as the authors know, no preceding study has comprehensively reviewed the fundamental issues of evacuation involving Indonesian volcanos, and no preceding study has developed an established theory that is accepted among experts. To grasp the evacuation issues involving Indonesian volcanos, we introduce problems with using recent large eruption cases. In 2010, the evacuation advisory from the volcano-monitoring agency and the government order to evacuate after the Mt. Merapi eruption in Java were not accepted by social and cultural leaders. This famous case is known as "Mbah Marijan." As an extremely exceptional assistance, compensation was provided based on damage to livestock cows in that case. In 2010, Mt. Sinabung in Sumatra suddenly erupted for the first time in approximately 400 years. Volcanic activities are expected to continue in the mountain for some time. As of July 2018 (when this paper was written), support for citizens still continued; some individuals permanently relocated. Mt. Bromo in Java also erupted in 2010. The volcanic activity continued for nine months, which was extraordinary exceptional in its eruption history. In this case, the long-term evacuation was observed. However, evacuees later returned to their homes. Known for its frequent activity, Mt. Lokon in Sulawesi Island erupted in 2011. Approximately 27,000 people living within about 3.5 km of the crater were forced to evacuate by the government order and eventually 6,000 people made evacuation. These cases suggest that social and cultural backgrounds, long-term volcanic activities and evacuations, relocation difficulties, and livelihood security are considered to be key aspects in the context of evacuation in volcanic eruptions in Indonesia.

The overwhelming majority of respondents chose the answer "Leader of village (Desa) or community (Dusun)," while the second most chose "Police or army." Very few chose "Family." De Bélizal et al. [12] also studied the 2007 Kelud eruption and analyzed the factors that inhibited evacuation (i.e., anxiety about caring for livestock or livelihood). They found that the evacuation alert was not thoroughly enforced or emphasized. They identified the importance of improving communication between local residents and the government. Lavigne et al. [13] discussed the relationship between evacuations and local communities. They studied four volcanos in Java and pointed out that "Cultural beliefs specific to Java" were evacuation-inhibiting factors (p. 282); this specifically included the local community structure and leadership roles. Mei et al. [14][5] studied Mt. Merapi, which erupted in 2010. They clarified that the ratio of the people who heard an evacuation alerts from the village mayors was highest among other methods. The Social Network Services (e.g., Twitter and Facebook) also influenced evacuation behavior. Sorensen and Sorensen [15] performed a U.S. case studies and identified factors that encouraged evacuation, including "Community involvement," "Kin relations (number)," and "Channel: Media"(p.191).

The above studies argue organizations (e.g., villages or communities) that played important roles in disseminating evacuation alerts or calls for evacuation. However, they lacked a viewpoint of locally-formed resources (e.g., social capitals). A review-paper by Meyer [16] stated that 195 papers were written on "Social Capital in Disaster Research" from the year of 1998 to 2015, but that only a few of them studied the relationship between evacuation and social capital. A model taking these variables into account is still under development. The present study is expected to provide empirical findings.

2. Overview of the 1963 and 2017 Mt. Agung Eruptions and Subsequent Actions Taken

2.1. Overview of the 1963 Eruption

A standard hazard map was created for Indonesia after the eruption of Mt. Agung in 1963. Problems with area evacuation reactions were then analyzed. The significance of the 1963 eruption remains; it is overviewed here for comparison with the 2017 eruption.

According to Crandell et al. [17], the Netherlands began making a volcano hazard map for Indonesia in 1919. After the 1963 Mt. Agung eruption, a new program was established to create hazard maps for the systematic mapping of the local volcano hazard zones (**Fig. 1**). This program was the first of its kind.

Zen [18] reported on the eruption and resulting damages immediately after the disaster, as follows:

> The Volcanological Survey of Indonesia has submitted its first report on the situation of Mt. Agung on March 13 demanding an immediate evacuation of the people. The "closed zone" is the semicircular area within 10 km radius from the top and the additional areas likely to be hit by lahars (volcanic mud flow) are marked as "danger area."
>
> The official number of death casualties during the first cycle of activity as released by the local government of Bali is 1700 of which 1500 died because of glowing avalanches mainly from the paroxysmal eruption on March 17, and 200 more because of the lahar which hit Subagan on March 21. Most of the death casualties fell in villages in the district of Selat on the southern slope. In the region of Selat only 1200 people died from the pyroclastic flow (original: nuées ardentes) which hit this area several times. But most of the casualties fell within the closed and the danger zone. It is remarkable that there are only 154 people wounded during the first cycle of activity. They suffer from burns caused by pyroclastic flows. 772 cows and pigs were hit by pyroclastic flows and died. Up to March 22, it is reported that 162 houses were completely destroyed by pyroclastic flows and lahars, 2 high school buildings, water reservoir in Klungkung, 1 electric power plant and 1 water reservoir in Karangasem and 10 bridges.

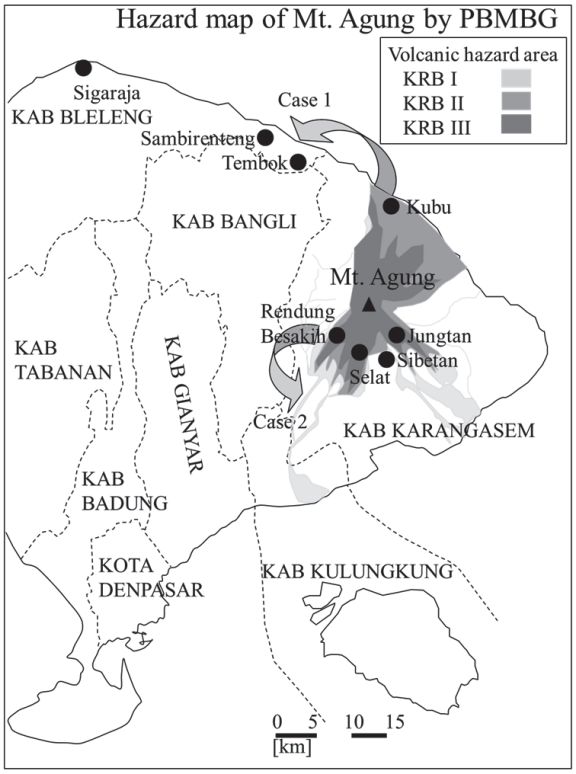

Fig. 1. Areas surveyed in this study (Cases1 and 2) according to a hazard map of Mt. Agung, Bali.

5. It was not described as an "evacuation order" (an "order" is something issued by a local government official). It should therefore be considered as an "alert" given by the volcano monitoring agency.

During the second cycle of activity 120 people were overrun by pyroclastic flows and died. They were all caught either in the "closed zone" or in the "danger area." In addition to this, numerous houses in the villages in the northern and southeastern slopes were destroyed by pyroclastic flows. The village of Tjulik and the temples in Besakih were destroyed by the earthquake of May 18.

Questions have been asked as to the cause of the high death casualties. It can simply be explained by the reluctance of the people to move from the "closed zone" and from the "danger area." And it is regretted that the local government has not taken strong measures for an immediate evacuation. Around March 17, the people of Bali would have their religious ceremonies centered in the main temple of Besakih. Thousands of people from all over the place flocked together to attend the ceremonies. When the area of Besakih was closed, minor ceremonies in smaller temples lying higher up the slope especially in the region of Selat, still continued. This is one of the causes why these people were so reluctant to move out of the closed zone. The second factor is namely the fact that Balinese people have never witnessed a real dangerous volcanic eruption. The last eruption of Mt. Agung happened 120 years ago. No one remembers anymore what terrible things happened at that time and besides, as stated previously, there is no written record about the eruption in 1843. People living in the "danger zone" around Karangasam and along the coast did not realize that lahars could still hit them at such a distance. In short people in Bali did not fully realize the real danger of a volcanic eruption before this catastrophe.

2.2. Overview of the 2017 Eruption

The Center for Volcanology and Geological Hazard Mitigation (PVMBG: Pusat Vulkanologi dan Mitigasi Bencana Geologi) releases current hazard maps (**Fig. 1**), while the National Disaster Management Agency (BNPB: Badan Nasional Penanggulangan Bencana) makes evacuation decisions based on volcanic activity and associated danger areas (**Table 1**).

The number of volcanic tremors around Mt. Agung has increased since the mid-September 2017. PVMBG thus raised the volcanic danger to Level 2 on September 14, Level 3 on September 18, and Level 4 on September 22. According to BNPB data on the number of evacuees released (see the Table), many evacuated to Karangasem, Klungkung, and Buleleng. At Level 4, approximately 80,000 people in a 12 km area around the volcano are required to either prepare for evacuation or evacuate (details are currently being checked because the Level 4 evacuation zone may gradually change). The number of the evacuees increased after September 22, exceeding 140,000 as of September 29 (BNPB) (**Fig. 2**). The Indonesian Government has therefore requested that people outside the areas designated for evacuation return to their homes. The danger was lowered to Level 3 on October 29 because of a decline in seismic activity, but was raised to Level 4 on November 26 after one small eruption on November 21 and a number of successive eruptions beginning on November 25. On January 4, 2018, the restricted zone was reduced to a 6 km area with Level 4 restrictions. On February 10, the area was lowered to Level 3 and the restricted zone was reduced to 4 km.

2.3. Peoples' Actions During the 2017 Eruption and Memories of the 1963 Eruption

The authors conducted oral surveys on October 5 and 6 and from December 2 through 5 in 2017 (**Table 2**). This research focused on the fact that (1) double the expected number of persons evacuated as a precaution and (2) elderly persons living near the mountainside were influenced to evacuate by their experiences during the 1963 eruption; those who moved into their homes after the 1963 eruption were also somewhat influenced to evacuate during the middle of September based on this event. However, disruption occurred because the evacuation sites were not under direct government control. This resulted in a lack of relief supplies and unfair treatment. In addition, (3) information transfers among residents and family members using SNS (i.e., Short Message Service) had the following characteristics: In early October, there was difficulty in determining whether information was correct, thus resulting in confusion. However, by early December, both the evacuation site management staff and residents had begun to check whether information had originated from a public agency [19].

A BNPB report indicated that Karangasem, Klungkung, and Buleleng received many evacuees. Since the evacuation sites in Klungkung were closed in March, we did not survey evacuees in this area. We instead focused on evacuees that had collected information before making their evacuation decisions. We thus chose the following case examples: Case 1 in the north side[6] (evacuations to areas outside the prefecture (mainly individual evacuations to Sambirenteng Village in Buleleng and community evacuations to Tembok Village)) and Case 2 in the south side[7] (individual evacuations to Rendang Village in Karangasem). Survey sheets were then distributed to these locations and an oral survey was conducted on March 5, 2018 among evacuees and supporters at Karangasem Regional Disaster Management Agency and in Rendang Village, Karangasem. For comparison, an oral survey was conducted on October 5, 2017, through the Japanese Association of Bali in Denpasar. This survey asked respondents how they acquired information from outside the evacuation areas.

6. The evacuation from Kubu Village, Karangasem to Tejakula, Buleleng.
7. The evacuations from Jungutan Village on the mountainside to the mountain foot and from Rendang Village on the mountainside to the mountain foot.

Table 1. Evacuation settings according to volcanic activity level and volcanic disaster danger areas in Indonesia (created by PVMBG).

		Volcanic activity level			
		Normal: 1	Waspada: 2	Siaga: 3	Awas: 4
Volcanic disaster danger areas	KRB I	People can live normally	People can live normally	People pay attention and prepare for evacuation	People must start preparing for evacuation
	KRB II	People can live normally	People can live normally	People must start preparing for evacuation	The elderly, children, and the disabled evacuate
	KRB III	People can live normally	People pay attention and prepare for evacuation	The elderly, children, and the disabled evacuate	All people must evacuate

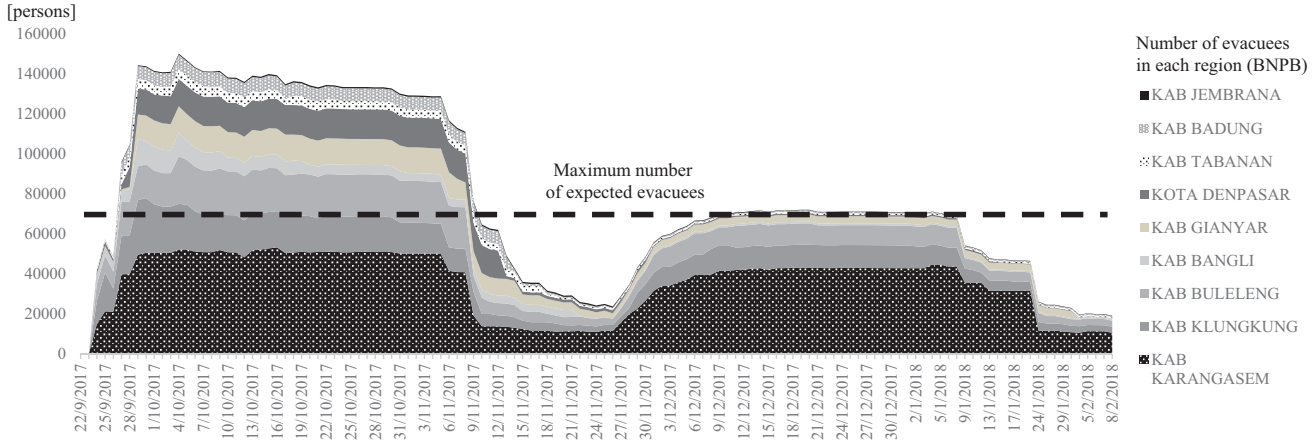

Fig. 2. Changes in the number of evacuees per day (released by BNPB).

Table 2. List of oral surveys.

Date	10/5/2017	12/2	12/2	12/3	12/4	3/5/2018	3/6
Region	Denpasar	Tejakula, Buleleng			Karangasem		
Target	Japanese Association of Bali	Base site in Les Village	Sambirenteng Village (Case 1a)	Tembok Village (Case 1b)	Sibetan Village, Jungutan (Case 2b)	Rendang Village (Case 2a)	Karangasem Regional Disaster Management Agency
Overview	Information acquisition outside the evacuation areas***	Evacuation to Buleleng	Evacuation of individuals and management of evacuation sites using PMI	Evacuation of communities and management of evacuation sites by village leaders	Evacuation of communities according to the alert in 2017 based on experience with the 1963 eruption	Evacuation of individuals and management of evacuation sites using PMI; religious behavior and evacuative behavior	Evacuation behavior

2.3.1. The Evacuation Situation in Buleleng

We conducted an oral survey in Tejakula, Buleleng on December 2 and 3 of 2017. The evacuation camp in Les Village was transformed into a base site to support evacuees in Buleleng. Staff members from BNPB evacuation rescue, Red Cross Indonesia (PMI), and medical organizations were ready to serve the site around noon on December 2. Evacuees to both government-designated and private evacuation sites in Buleleng were counted and managed by BNPB. Tejakula accepted as many as 12,000 evacuees, most of which originating from Kubu Village on the north side of Mt. Agung. The public evacuation site in Sambirenteng Village was a community center that was run by PMI. Under the control of the central, state, and prefectural governments, five PMI staff members (three of which having been trained for disaster response) visited all evacuation sites in Buleleng for the purpose of integrating voluntary workers and direct evacuees to promote site management. The last evacuees arrived in late September, at which point the sites in Buleleng were temporarily closed. New evacuees en-

tered Buleleng in late November; many were received by an evacuation site in Tejakula, which was closer to their home. These evacuees wished to return home to care for livestock during the day and only stayed at the evacuation site at night. In Tembok Village, people individually evacuated to their own places, the places of relatives, or private and public evacuation sites. The public evacuation sites accepted livestock and were managed through strong leadership by the village mayor. In September, approximately 7,000 evacuees were accepted at 75 village sites. According to the mayor, the village did not have sufficient warning and was thus in panic. The accurate amount of evacuees and relief goods was not obtainable and the goods could thus not be distributed equally among evacuees who complained about their circumstances. The complaints caused trouble for evacuation site management. The evacuees returned home on the day of Galungan (an event to host ancestor spirits). The public evacuation sites were then temporarily closed, but reopened after the eruption in late November. Evacuees were accepted at this time as a Banjar (local community unit) group and obliged to take turns managing the evacuation sites. Tembok Village and each Banjar agreed on the evacuation rules. About 3,000 evacuees were accepted in the beginning of December. Information on the agreement, fair distribution of the relief goods, and managerial distribution policy were actively delivered and released through SNS.

2.3.2. The Evacuation Situation in Karangasem

An oral survey was conducted among respondents who had experienced the eruption in Jungutan Village in Karangasem on December 4, 1963 (Jungutan is a mountainous area about 12 km south from the top of Mt. Agung). The survey was designed to obtain information about evacuations from the foot and side of the mountain. A survey was also conducted among three elders who evacuated from a Banjar closer to the mountain top than the communities on the side of Mt. Agung. These elders also remembered the eruption in 1963. They recalled information about a mud flow, explosive eruption, and escape from a lava flow. They were notified by the government of the necessity of the evacuation on September 19; a total of 435 people of the Banjar evacuated on September 22 using trucks arranged by the government to carry them to the evacuation site (community center Br. Dukuh) in Jungutan Village. These evacuees had a highly positive opinion of the government regarding their evacuation efforts just prior to the dangerous situation. The government efficiently provided prior notification, arranged trucks for evacuation, and had furnished evacuation sites. Each Banjar on both the foot and side of the mountain usually conducted evacuation drills for volcanic eruptions according to a policy determined by the Banjar head. These Banjar did not therefore consider that any other drill would be necessary. No questionnaire survey was created for residents of Jungutan Village because the Balinese language was spoken there and the Banjar had evacuated from the side to the foot of the mountain under the direction of the Banjar head. Evacuees were not able to make individual decisions about their evacuation.

An oral survey was also created for a PMI staff member and volunteer chief on March 5, 2018. The survey was designed to gather information about the evacuation situation in the Rendang Village. The area housed an evacuation site containing agricultural facilities (Kantor Pertanian) in southern Rendang Village. There, PMI supported evacuees on a 24-hour basis. Evacuees were from multiple Banjars near Besakih Temple in northern Rendang Village. The site contained a maximum of approximately 3,500 evacuees by September 22. At the time of our visit, there were 519 evacuees from 135 households. In the residential area near Besakih, buildings and roads were severely damaged by the 2017 earthquake. This had also occurred during the 1963 eruption. The evacuation site was smoothly managed under 24-hour PMI control. Evacuees performed commercial activities through which they interacted with local citizens. The PMI staff pointed out the following background. The evacuees and evacuation supporters shared the same understanding regarding local needs and evacuation site management practices. That is, both groups believed that the evacuation sites were only supposed to provide evacuees with goods and recommendation letters to medical institutions. This was believed because medical institutions contributed to the physical care of evacuees while religious organizations provided mental care. This mutual understanding enabled smooth management of the evacuation site. Evacuees stayed at the site following the evacuation order subsequent to the first evacuation during mid-September. However, in the beginning of November, almost all (except the elderly and sick) temporarily returned home for Galungan. The evacuation site manager could not stop this since there was no formal arrangement for the evacuees to return home and there was no eruption at that time. After January, the area designated for evacuation became smaller gradually. Early March, the regulated area was within 4 km from the mountain but many of the people who were from the area 8 km from the mountain still stayed at the evacuation sites at night and returned home only during the daytime because the roads to the home area were destroyed and people could not go home by car but had to bike or walk.

2.4. The Karangasem Regional Disaster Management Agency (BPBD) and Preventative Actions During the 2017 Eruption

An oral survey was conducted on March 6, 2018 at the Karangasem Regional Disaster Management Agency. Karangasem consists of three cities, 52 counties, 75 villages, and 554 Banjars. Karangasem furnished 383 evacuation sites for approximately 2,000 evacuees. Since this occurred in the rainy season, outdoor evacuation was not appropriate and a community center in Banjar was used as an evacuation site. Some people evacuated to the homes of relatives. Evacuation organizations (e.g., PMI and the rescue organization) shared a logistics warehouse

and 20 trucks.

Most people moved to the evacuation sites by themselves. Many used their cars and trucks to bring as many belongings as possible. The government used eight trucks to evacuate people. They first evacuated the elderly, children, and babies. The physically disabled and sick people (including sick youths) were then evacuated. Finally, the young were evacuated.

Since this was the first experience in which disaster-management action was taken following the eruption of Mt. Agung, the BPBD announced village mayors the evacuation site locations,[8] but did not decide which village was to evacuate to which site or the route they were meant to take. When the danger level was lowered to Level 3 at the end of October, a significant number of people returned home to care for livestock or retrieve items. However, the Disaster Prevention Bureau did not know the exact number. Children and the elderly remained at the evacuation sites.

A volunteer organization called "Pasbaya" was also present. Pasbaya consisted of evacuees organized by Karangasem and the Regional Disaster Management Agency. The volunteers did not receive a salary, but were compensated with foods and goods, including walkie-talkies (including a wireless receiver and transmitter). Pasbaya established a system to spread information immediately. The government was thus able to acquire information on evacuees and supplies every six hours. The management committee consisted of 100 members, including village mayors and Banjar heads. The organization consisted of 275 formal members. The total number reached 700. Those who did not have walkie-talkies could communicate using cellular phones. Internet services and electric companies collaborated to manage large-scale evacuations and adjusted relay stations to maintain excellent communication. In addition to the information exchange among local communities, the volunteer organization set two volunteers at the volcano monitoring station to receive information immediately and directly from experts. This information was shared among the concerned people when unusual volcanic activities were detected.[9]

3. Evacuation from Eruption in 2017

3.1. Overview of Survey and Idea of Analysis

This study aimed to find the factors that influenced evacuation after the eruption and, more specifically, to understand the relationships among the people, media, community, past disasters, and current disaster countermeasures. Section 2 discussed volcanic eruptions and the actions taken after they occurred from viewpoints of those who "give directions on evacuation," including local governments, supporting organizations, and community leaders. In this section, we overview the questionnaire survey results among people living in the three evacuation sites (i.e., Sambirenteng, Tembok, and Rendang) (**Table 2**). As described in Section 2, these were the locations in which the oral surveys were conducted. The surveys focused on residential areas (i.e., Desa and Banjar), alert recognition, evacuation actions, problems living in evacuation sites, recognition of the 1963 eruption, and actions taken before the eruption. In this section, we first discuss the process involving alert recognition, the call for evacuation, and the evacuation itself. Items related to "past disaster" and "prior actions taken before disaster" are also discussed in this section. This is done to examine how "past disaster" and "prior actions taken before disaster" affect evacuation using the SEM described in Section 4.

A questionnaire detention survey method was employed among respondents. The authors explained the aim of the survey to evacuation site leaders and asked them to distribute the questionnaire sheets to all households. The same leaders collected the sheets afterwards. The survey was conducted among householders (or people in similar positions) living at Sambirenteng and Tembok evacuation sites December 2017 and at Rendang in March 2018. A total of 40 answer sheets (and attributes of respondents) were collected in Sambirenteng. Ages were as follows: 20s (15.0%), 30s (30.0%), 40s (32.5%), 50s (15.0%), 60s (5.0%), and 70s or higher (2.5%). A total of 75 sheets were collected in Tembok. Ages were as follows: 20s (9.3%), 30s (32.0%), 40s (37.3%), 50s (9.3%), 60s (6.7%), 70s or higher (2.7%), and unknown (2.7%). A total of 92 sheets were collected in Rendang (ages were not asked unknown).[10]

3.2. Survey Results

ASSUM for Windows was used to analyze the survey results. The difference from the total average was evaluated using ▲ ▼ at a significance level of 1%, △ ▽ at a significance level of 5%, ↑ ↓ for a significance level of 10%, and ∴ ∵ for a significance level of 20%. Survey data were totaled for each evacuation site and compared between sites. The basis for fact finding was at a significance level of 1 or 5%, but was sometimes placed at 10% or 20% to determine the tendencies of each evacuation site.

3.2.1. Evacuation from Eruption in 2017

(1) Means Through which Alerts Were Recognized

How were the alerts recognized (**Table 3**)? In Sambirenteng, most people answered television or radio, followed by SNS and family or relatives. Compared to the

8. As discussed in footnote 2, the Banjar is subordinate to the village (Desa). The Banjar chief is therefore notified by the village (Desa) mayor.
9. If we combine the information we obtained from other Regional Disaster Management Agencies, we find the following: The Level increased from 1 to 2 on September 14 and the Regional Disaster Management Agency in Bali sent the first report to the Regional Disaster Management Agencies in neighboring prefectures. When the Level increased to 3 on September 19, the decision was made to accept evacuees in Karangasem, Klungkung, and Buleleng. When the Level increased to 4 on September 22, the evacuation operation began.
10. Ages were unknown due to the nature of the survey. Since they were householders (or persons in similar positions), ages should be around 30 to 40.

Table 3. Means of alert recognition.[11]

	Num	Fam	Peo	Tel	Nei	SNS	Int	Loc	Oth
Total	207	53.1	47.8	41.1	39.1	27.1	17.9	3.9	3.9
Sambirenteng	40	▼30.0	▽27.5	▲72.5	▼15.0	△42.5	20.0	2.5	2.5
Tembok	75	▲84.0	46.7	▼20.0	▲64.0	▼12.0	▼1.3	9.3	1.3
Rendang	92	▼38.0	↑57.6	44.6	↓29.3	32.6	▲30.4	–	∴6.5

Num: Number of surveyed persons, Fam: Family or relatives, Peo: People of Banjar or Desa,
Tel: Television or radio, Nei: Neighbors, Int: Internet, Loc: Local government, Oth: Others

Table 4. Recognition of the call for evacuation.

	Num	Fam	Peo	Nei	Tel	Loc	Int	SNS	Oth
Total	207	66.7	65.7	55.6	15.0	6.3	5.8	4.8	8.2
Sambirenteng	40	65.0	∵55.0	∵45.0	△27.5	5.0	7.5	∴10.0	–
Tembok	75	▲85.3	72.0	61.3	▼2.7	△13.3	–	–	–
Rendang	92	▼52.2	65.2	55.4	19.6	▽1.1	∴9.8	6.5	▲18.5

Num: Number of surveyed persons, Fam: Family or relatives, Peo: People of Banjar or Desa,
Nei: Neighbors, Tel: Television or radio, Loc: Local government, Int: Internet, Oth: Others

other evacuation sites, the number of people who chose television or radio was significantly higher. However, the number of people who chose Banjar or Desa and neighbors was significantly lower. In Tembok, most people chose family or relatives, followed by neighbors and family or relatives. Compared to the other evacuation sites, the number of people who chose family or relatives was significantly higher, while the number of people who chose television or radio, internet, and SNS was significantly lower. In Rendang, most chose Banjar or Desa, followed by television or radio and family or relatives. Compared to the other evacuation sites, the number of people who chose Banjar or Desa and internet was significantly higher. As seen above, each evacuation site contained unique characteristics regarding the means of alert recognition.

(2) Recognition of the Evacuation Call

By which of the above recognition methods did people receive the call for evacuation (**Table 4**)? In Sambirenteng, most people chose family or relatives, followed by Banjar or Desa and neighbors. Compared to the other evacuation sites, the number of people who chose television or radio was significantly higher, while the number of people who chose neighbors and Banjar or Desa was significantly lower. In Tembok, most people chose family or relatives, followed by Banjar or Desa and neighbors. Compared to the other evacuation sites, the number of people who chose family or relatives was significantly higher, while the number of people who chose television or radio was significantly lower. In Rendang, most people chose "People of Banjar or Desa," followed by "Neighbors" and "Family or relatives." Compared to the other evacuation sites, no items were chosen at significantly higher rates, while the number of people who chose family or relatives was significantly lower. In this relative evaluation, people in Sambirenteng evacuated based on media information while people in Tembok and Rendang evacuated based on information from families and communities.

Table 5. Reasons for evacuation.

	Num	Dam	Fre	Dir	Eva	Bec	Oth
Total	207	96.1	81.6	10.6	6.3	5.8	1.0
Sambirenteng	40	▽90.0	↓70.0	↑20.0	–	10.0	–
Tembok	75	97.3	80.0	14.7	▲17.3	8.0	–
Rendang	92	97.8	∴88.0	▽3.3	–	∵2.2	2.2

Num: Number of surveyed persons,
Dam: Damage from volcanic eruption,
Fre: Frequent earth-quakes,
Dir: Direction on evacuation site by local government or Banjar,
Eva: Evacuation to far family or relatives,
Bec: Because others evacuate,
Oth: Others.

(3) Reason for Evacuation

Here, we discuss the reasons for evacuation (**Table 5**). Most people at the evacuation site in Sambirenteng chose to evacuate because of damage from the volcanic eruption, followed by frequent earthquakes. Compared to the other evacuation sites, the number of people who chose to evacuation based on the direction of the local government or Banjar was significantly higher. In Tembok, most people chose to evacuate because of damage from the volcanic eruption, followed by frequent earthquakes. Compared to the other evacuation sites, the number of people who chose to evacuate to family or relatives was significantly higher. In Rendang, most people chose frequent earthquakes, while relatively few chose local government or Banjar.

(4) People Accompanied During Evacuation

Who did the evacuees accompany during the evacuation (**Table 6**)? In Sambirenteng, most people chose "Family or relatives," followed by "Neighbors." Compared to the other evacuation sites, the number of people

11. The units shown in **Tables 3–14** in this section are percentages (%).

Table 6. People accompanied during evacuation.

	Number of surveyed persons	Family or relatives	Neighbors	People of Banjar or Desa	Alone
Total	207	82.6	59.4	47.8	1.0
Sambirenteng	40	77.5	·.· 47.5	↓32.5	–
Tembok	75	84.0	60.0	▼32.0	–
Rendang	92	83.7	64.1	▲67.4	2.2

who chose neighbors and Banjar or Desa was significantly lower. In Tembok, relatively few people chose Banjar or Desa. The evacuation site in Rendang was characterized by different tendencies compared to other sites, while the number of people who chose Banjar or Desa was significantly higher. The survey results on accompanied persons indicated that many people in both Sambirenteng and Tembok evacuated with family and relatives. Many people in Rendang evacuated as a community.

(5) Difficulty at the Evacuation Sites

At the evacuation site in Sambirenteng, people had difficulty with lack of food and drink, lack of showers and toilets, and lack of information from television or radio (**Table 7**). Compared to the other evacuation sites, the number of people who chose lack of food and drink, lack of showers and toilets, and lack of information from television or radio was significantly higher, while the number of people who chose lack of privacy and difficulty in communication with neighbors was significantly lower. In Tembok, people had difficulty with lack of food and drink, lack of support between evacuees, and information about volcanic status. Compared to the other evacuation sites, the number of people who chose lack of support between evacuees and difficulty in communication with neighbors was significantly higher, while the number of people who chose lack of showers and toilets and lack of privacy was significantly lower. In Rendang, people had difficulty with lack of showers and toilets and lack of welfare services. Compared to the other evacuation sites, the number of people who chose lack of welfare services and lack of privacy was significantly higher, while the number of people who chose lack of food and drink was significantly lower. As seen in this survey, the people at the evacuation site in Sambirenteng were not satisfied with the hardware or information, but established human relationships. On the other hand, the evacuation site in Tembok had the opposite tendency. People at the evacuation site in Rendang were not satisfied with the hardware or privacy, but established human relationships to a certain extent.

3.2.2. The 1963 Eruption

(1) Recognition of Past Eruptions

How many people knew about the 1963 eruption (**Table 8**)? Between 70–90% of people at every evacuation site answered, "I know." This was much larger than the percentage of people who answered, "I do not know." A significant number in Tembok knew about the eruption.

(2) Means of Recognition (Based on the Number of Persons who Recognized the Eruption)

Next, we studied the means by which people knew of the 1963 eruption (**Table 9**). In Sambirenteng, the means were (in decreasing order) "Television or radio," "Family or relatives," and "Banjar or Desa." Compared to the other evacuation sites, the number of people who chose "Television or radio," "Banjar or Desa," and "SNS" was significantly higher. On the other hand, the number of people who chose "Family or relatives" was significantly lower. In Tembok, nearly 90% chose "Family or relatives." Less than 20% chose "others." The number of people who chose "Family or relatives" was significantly higher than at the other evacuation sites. In Rendang, the number was more evenly distributed. That is, "Television or radio," "Internet," and "Neighbors" were chosen by approximately 30% of respondents each. Compared to the other evacuation sites, the number of people who chose "Internet" was significantly higher, while the number of people who chose "Family or relatives" and "SNS" was significantly lower. In Sambirenteng and Rendang, people recognized the eruption through a variety of means, while in Tembok, the means of recognition was nearly limited to family or relatives. This could be one reason for the high recognition rate.

(3) Depth of Recognition (Based on the Number of Persons who Recognized the Eruption)

How much do people know about the damage from the 1963 eruption (**Table 10**)? In Sambirenteng, 70% of respondents recognized "Human damage," but the number of people who recognized "Property damage" was significantly lower when compared to respondents at the other sites. In Tembok, more than 80% of respondents recognized both human and property damages. Respondents at the evacuation site in Rendang had almost the same tendency as those in Sambirenteng. In other words, human damage was recognized by many people, but property damage was only well-recognized in Tembok.

(4) Recognition of Eruptions Before 1963

The recognition ratio was less than 10% at all evacuation site (**Table 11**).

3.2.3. Actions Prior to the Eruption

(1) Recognition of Eruptions Before 1963

Finally, we assessed disaster response communication prior to the eruption (**Table 12**). In Sambirenteng, 70% of respondents answered "Yes," which was significantly higher than the response rates in other areas. In Tembok, 60% of respondents answered "Yes," while nearly 40% answered "No." This was significantly higher than the response rates in other areas. In Rendang, about 40%

Table 7. Reasons for evacuation.

	Num	Lc-fd	Lc-st	Lc-i	Wel	Lc-se	Lc-itr	Dif	Lc-pr	Bad	Lc-inm	Oth
Total	207	40.1	37.7	37.2	30.9	28.5	23.7	17.9	14.0	9.7	9.2	1.0
Sambirenteng	40	▲62.5	▲60.0	35.0	∵ 20.0	▽12.5	▲50.0	▽2.5	–	∵ 2.5	∵ 2.5	–
Tembok	75	▲56.0	▼14.7	41.3	▽18.7	▲42.7	18.7	▲32.0	▽4.0	13.3	–	–
Rendang	92	▼17.4	↑ 46.7	34.8	▲45.7	23.9	↓ 16.3	13.0	▲28.3	9.8	▲19.6	2.2

Num: Number of surveyed persons, Lc-fd: Lack of food or drink, Lc-st: Lack of showers and toilets,
Lc-i: Lack of information about volcanic status, Wel: Welfare services, Lc-se: Lack of support between evacuees,
Lc-itr: Lack of information about volcanic status from television or radio, Dif: Difficulty communica-ting with neighbors,
Lc-pr: Lack of privacy, Bad: Bad living conditions (in terms of space and sanitation),
Lc-inm: Lack of information about volcanic status from newspapers or magazines, Oth: Others

Table 8. Recognition of the 1963 eruption.

	Number of surveyed persons	I know.	I do not know.	Not answered.
Total	207	77.8	20.8	1.4
Sambirenteng	40	70.0	27.5	2.5
Tembok	75	↑ 86.7	∵ 13.3	–
Rendang	92	73.9	23.9	2.2

Table 9. Means of recognizing the 1963 eruption.

	Number of surveyed persons	Family or relatives	Television or radio	Internet	Neighbors
Total	161	52.2	26.1	21.7	20.5
Sambirenteng	28	↓ 35.7	▲57.1	17.9	17.9
Tembok	65	▲89.2	▼7.7	15.4	15.4
Rendang	68	▼23.5	30.9	∴ 29.4	26.5

	Number of surveyed persons	People of Banjar or Desa	SNS	Local government	Others
Total	161	9.3	9.3	3.7	1.2
Sambirenteng	28	▲28.6	21.4	3.6	–
Tembok	65	↓3.1	9.2	6.2	–
Rendang	68	7.4	∵ 4.4	1.5	2.9

Table 10. Depth of recognition regarding damage from the 1963 eruption.

	Number of surveyed persons	Human damage	Property damage	Others
Total	161	71.4	47.2	1.2
Sambirenteng	28	67.9	▼7.1	▲7.1
Tembok	65	↑ 81.5	▲83.1	–
Rendang	68	∵ 63.2	▼29.4	–

Table 11. Recognition of eruptions before 1963.

	Number of surveyed persons	I know.	I do not know.	Not answered.
Total	161	5.6	80.7	13.7
Sambirenteng	28	3.6	82.1	14.3
Tembok	65	6.2	86.2	∵ 7.7
Rendang	68	5.9	75.0	∴ 19.1

Table 12. Prior disaster response communication.

	Number of surveyed persons	Yes, I had.	No, I did not have.	Not answered.
Total	207	55.1	30.0	15.0
Sambirenteng	40	↑ 70.0	∵ 20.0	10.0
Tembok	75	61.3	36.0	▼2.7
Rendang	92	▽43.5	29.3	▲27.2

of respondents answered "Yes," which was significantly lower than the response rate in other areas. These results indicate that the ratio of people who had interest in disaster response was highest in Sambirenteng, followed by Tembok and Rendang.

(2) Persons with whom to Communicate About Disaster Response (Based on the Number of Households)

With whom did people communicate about disaster response (**Table 13**)? In Sambirenteng, most people discussed this issue with "Family or relatives," followed by "Neighbors." Compared to the other evacuation sites, the number of people who chose "Workplace" was significantly higher, while the number of people who chose "Banjar or Desa" was significantly lower. The evacuation site in Tembok had similar tendencies to the sire in Sambirenteng. However, when compared to the other evacuation sites, the number of people who chose "Neighbors," "Banjar or Desa," and "Local government staffs" was significantly higher. The evacuation site in Rendang also had this tendency, but the number of people who chose "Neighbor" was significantly lower than at other evacuation sites. The above results indicate that respondents at all evacuation sites communicated with their families or relatives. Moreover, the people in Tembok talked with neighbors and Banjar, while those in Sambirenteng talked with neighbors, and those in Rendang mostly communicated with family.

(3) Discussion Topics (Based on the Number of Households)

What did people discuss regarding disaster response (**Table 14**)? In Sambirenteng, more than 80% of re-

Table 13. Persons with whom to communicate about disaster response.

	Number of surveyed persons	Family or relatives	Neighbors	People of Banjar or Desa	Police or fire station	Local government staffs
Total	114	73.7	45.6	26.3	9.6	7.0
Sambirenteng	28	71.4	46.4	∵ 14.3	10.7	–
Tembok	46	78.3	∴ 56.5	△39.1	4.3	▲17.4
Rendang	40	70.0	↓ 32.5	20.0	15.0	–

	Number of surveyed persons	School	Workplace	NPO	Others
Total	114	2.6	1.8	–	1.8
Sambirenteng	28	–	△7.1	–	–
Tembok	46	↑ 6.5	–	–	–
Rendang	40	–	–	–	5.0

Table 14. What was discussed regarding disaster response?

	Number of surveyed persons	Evacuation site	Things to bring	Readiness	Securing foods and drinks	How to evacuate	Others
Total	114	57.0	51.8	17.5	13.2	10.5	2.6
Sambirenteng	28	▲82.1	▽28.6	17.9	17.9	7.1	–
Tembok	46	56.5	▲82.6	23.9	∴19.6	↓ 2.2	–
Rendang	40	▽40.0	▽32.5	10.0	▽2.5	△22.5	↑ 7.5

spondents talked about the "Evacuation site," followed by "Things to bring." Compared to the other evacuation sites, the number of people who chose "Evacuation site" was significantly higher, while the number of people who chose "Things to bring" was significantly lower. In Tembok, most people chose "Things to bring," followed by "Evacuation site." Compared to the other sites, the number of people who chose "Things to bring" was significantly higher. In Rendang, most people chose "Evacuation site," followed by "Things to bring" and "How to evacuate." The choices were relatively dispersed compared with those at other sites. The above results indicate that the people at the evacuation site in Sambirenteng were interested in the evacuation site, while the people in Tembok were interested in things to bring. Respondents in Rendang talked about various matters.

In this section, we overviewed a questionnaire survey conducted among evacuees living at the evacuation sites in Sambirenteng, Tembok, and Rendang. Respondents were asked about (1) evacuation from the 2017 eruption, (2) the 1963 eruption, and (3) actions taken prior to the eruption. The major results were as follows:

Sambirenteng: People recognized the alert and call for evacuation through television and radio, and evacuated with their families and relatives.

Tembok: People recognized the alert from their families, relatives, and neighbors. They recognized the call to evacuate from community members such as family, relatives, and neighbors, and evacuated with their families and relatives.

Rendang: People recognized the alert from the community and Internet. They recognized the call to evacuate from their families and the community, and evacuated with the community.

By using the item "(1) evacuation from the 2017 eruption" from the questionnaire survey results, we conjectured the flow of events starting from the alert recognition and ending with the evacuation, as follows: Alert recognition → call for evacuation → evacuation. In the next section, we discuss the relationship between the (2) 1963 eruption and (3) the actions taken prior to the eruption and evacuation.

4. Past Eruptions, Alert Recognition, Social Capital, and Group Evacuation

4.1. Past Eruptions, Alert Recognition, and the Call for Evacuation

In the previous section, we studied the flow of events starting with alert recognition and ending with the evacuation as well as recognition of past eruptions (e.g., 1963) and actions taken prior to the eruption at each evacuation site. In this section, we discuss how social capitals (e.g., recognition of past eruptions and actions taken prior to the eruption) affected the number of channels involving the call for evacuation. Putnam [20] referred to this as "Social capital that promoted people's cooperative behavior to improve the efficiency of the society." Many arguments exist on the associated definitions and measurement methods. We do not provide details in this regard. In this paper, we simply define social capital as "communication among individuals about disaster and the accumulation of knowl-

Table 15. The relationship between alert recognition and the call for evacuation.[12]

		Number of surveyed persons	Call for evacuation			
			Family or relatives	Neighbors	People of Banjar or Desa	Television or radio
Total		207	66.7	55.6	65.7	15.0
Alert recognition	Family or relatives	110	▲81.8	59.1	↑ 74.5	↓ 9.1
	Neighbors	81	▲87.7	▲81.5	∴ 72.8	11.1
	People of Banjar or Desa	99	66.7	▲68.7	▲79.8	17.2
	Television or radio	85	67.1	60.0	67.1	▲25.9
	Internet	37	75.7	▲78.4	70.3	16.2
	SNS	56	71.4	△69.6	62.5	16.1
	Local government	8	–	–	△100.0	12.5
	Others	8	▽25.0	62.5	▽25.0	↑ 37.5

		Number of surveyed persons	Call for evacuation			
			Internet	SNS	Local government	Others
Total		207	5.8	4.8	6.3	8.2
Alert recognition	Family or relatives	110	4.5	3.6	▽0.9	10.0
	Neighbors	81	6.2	2.5	∵2.5	△14.8
	People of Banjar or Desa	99	7.1	7.1	4.0	↑ 13.1
	Television or radio	85	7.1	5.9	4.7	△15.3
	Internet	37	▲27.0	▲18.9	2.7	5.4
	SNS	56	▲17.9	▲17.9	7.1	10.7
	Local government	8	–	–	▲100.0	–
	Others	8	12.5	12.5	–	12.5

edge (e.g., know-how) through such communication."

4.1.1. The Relationship Between Alert Recognition and Responses to the Call for Evacuation

People who recognized the evacuation alert from "neighbors" tended to respond to the call for evacuation based on information from "family or relatives" and "neighbors" (**Table 15**). Alert recognition from the "Internet" or "SNS" exhibited similar tendencies. Namely, people who recognized the alert from the "Internet" or "SNS" tended to respond to the call based on information from the "Internet" or "SNS," respectively. The relationship between alert recognition and response to the call for evacuation can be summarized as follows: "Family or relatives" → "Family or relatives," "Neighbors" → "Family or relatives" + "Neighbors," "Banjar or Desa" → "Neighbors" + "Banjar or Desa," "Television or radio" → "Television or radio," and "Internet," "SNS" → "Internet," "SNS." When people recognized the volcanic eruption alert from real media sources, they tended to recognize the call for evacuation based on information from other people or parties within the real media. When people recognized the alert from virtual media, they recognized the call to evacuated mostly based on information from the same media. The information recognition path from real media was narrower than that from virtual media.

4.1.2. The Relationship Between Past Eruptions and the Call for Evacuation

Here, we discuss the relationship between the means of recognizing the 1963 eruption and the call for evacuation in 2017 (**Table 16**). Those who recognized the 1963 eruption based on information from family or relatives responded to the call for evacuation based on information from "Family or relatives," "Neighbors," and "People of Banjar or Desa," but did not respond at high rates to "Television or radio." Those who recognized the 1963 eruption based on information from "Neighbors" or "People of Banjar or Desa" showed almost the same tendency, but responded at slightly higher rates to the call for evacuation based on information from the "Internet." Those who recognized the 1963 eruption based on information from "Television or radio" responded to the call for evacuation based on information from "Television or radio" and the "Internet," but responded at lower rates to information from "Neighbors" and "Banjar or Desa." Those who recognized the 1963 eruption based on information from the "Internet" or "SNS" responded to the call for evacuation based on information from people with whom they had actual connections.

4.1.3. Relationship Between Prior Actions and the Call for Evacuation

Here, we discuss the relationship between persons with whom to communicate regarding actions prior to the eruption and the call for evacuation. Those who talked with "Neighbors" about these matters tended to respond to the call for evacuation based on information from "Neighbors" and "Family or relatives." On the other hand, those who talked with "Banjar or Desa" about these matters tended to respond to the call for evacuation based on information from "Family or relatives," "Neighbors," and "Banjar or Desa." The relationship between prior actions and the call for evacuation was similar to the relationship seen in (1) (**Table 17**). There was also a tendency in which "people responded to the call for evacuation from some of

12. The units shown in **Tables 15–17** in this section are percentages (%).

Table 16. Relationship between the 1963 eruption and the call for evacuation.

		Number of surveyed persons	Call for evacuation			
			Family or relatives	Neighbors	People of Banjar or Desa	Television or radio
Total		161	66.5	58.4	65.8	13.7
Means to recognize past eruption	Family or relatives	84	▲81.0	∴ 66.7	∴ 72.6	▼2.4
	Neighbors	33	63.6	63.6	↑ 81.8	6.1
	People of Banjar or Desa	15	80.0	66.7	△ 93.3	20.0
	Television or radio	42	↓ 52.4	52.4	59.5	▲38.1
	Internet	35	74.3	∴ 71.4	62.9	∵ 5.7
	SNS	15	80.0	66.7	53.3	13.3
	Local government	6	–	–	↑ 100.0	16.7
	Others	2	100.0	50.0	50.0	–

		Number of surveyed persons	Call for evacuation			
			Internet	SNS	Local government	Others
Total		161	5.6	3.7	6.8	5.0
Means to recognize past eruption	Family or relatives	84	6.0	2.4	∴ 10.7	∴ 8.3
	Neighbors	33	∴ 12.1	3.0	–	▲15.2
	People of Banjar or Desa	15	△ 20.0	6.7	–	▲26.7
	Television or radio	42	↑ 11.9	7.1	2.4	4.8
	Internet	35	▲17.1	∴ 8.6	△ 17.1	–
	SNS	15	▲33.3	▲26.7	6.7	6.7
	Local government	6	16.7	↑ 16.7	▲83.3	∴ 16.7
	Others	2	–	–	–	▲50.0

Table 17. Relationship between prior actions and the call for evacuation.

		Number of surveyed persons	Call for evacuation			
			Family or relatives	Neighbors	People of Banjar or Desa	Television or radio
Total		114	56.1	47.4	67.5	16.7
Person to communicate with for prior actions	Family or relatives	84	61.9	51.2	73.8	17.9
	Neighbors	52	▲76.9	▲75.0	71.2	19.2
	People of Banjar or Desa	30	△76.7	▲73.3	↑ 83.3	∵ 6.7
	Local government staffs	8	↓ 25.0	25.0	△100.0	–
	Police or fire station	11	↓ 27.3	↑ 72.7	∵ 45.5	↑ 36.4
	School	3	∴ 100.0	↑ 100.0	66.7	–
	Workplace	2	50.0	50.0	50.0	50.0
	NPO					
	Others	2	–	–	–	▲100.0

		Number of surveyed persons	Call for evacuation			
			Internet	SNS	Local government	Others
Total		114	3.5	3.5	7.9	2.6
Person to communicate with for prior actions	Family or relatives	84	1.2	1.2	∵ 3.6	1.2
	Neighbors	52	1.9	–	∵ 1.9	1.9
	People of Banjar or Desa	30	↑ 10.0	6.7	3.3	3.3
	Local government staffs	8	–	–	▲75.0	–
	Police or fire station	11	9.1	▲18.2	–	–
	School	3	–	–	–	–
	Workplace	2	▲50.0	–	–	–
	NPO					
	Others	2	–	▲50.0	–	▲100.0

the people with whom they communicated regarding prior actions."

4.2. The Relationship Between Past Eruptions, Prior Actions, Alert Recognition, and Evacuation

In this section, we discuss how the 1963 eruption and actions taken prior to the eruption (which are a kind of social capital) affected evacuation behavior. For this purpose, we employed a SEM method to clarify the relationships among past experiences, prior actions, alert recognition, and evacuation. The model is shown in **Fig. 3**. The variables were set as follows: For "prior action" involving communication about disaster, an observable variable is the "number of persons with whom to communicate." For the "eruption in 1963," an observable variable is whether people "recognized or not" (the value of the variable is defined as "recognized = 1" and "not recognized = 0"). For "alert recognition," an observable variable is "recognized

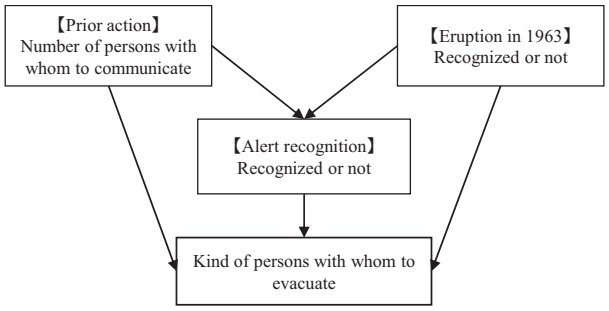

Fig. 3. The relationships among past eruptions, prior actions, alert recognition, and evacuation.

Table 18. Suitability at each evacuation site.

	RMR	GFI	AGFI	CFI	RMSEA
Sambirenteng	0.10	0.98	0.83	0.99	0.09
Tembok	0.02	1.00	0.99	1.00	0.00
Rendang	0.03	0.99	0.93	0.99	0.06

or not." For "kind of persons with whom to evacuate," an observable variable is "kind." For cases in which individuals "evacuated alone," the value of the variable was set to -1.

The item "Kind of persons with whom to evacuate" was chosen as an objective variable to study how "prior action" and "prior recognition" (which are resources "for evacuation" (a social capital)) were connected to the evacuation. This was particularly studied in regard to "evacuation as a group (especially Banjar)." The suitability analysis at each evacuation site (**Table 18**) indicated almost no problems with RMR, GFI, AGFI, CFI, or RMSEA.

The model resulted in the outcome shown in **Table 19**. In Sambirenteng, "recognition of the 1963 eruption" led to "alert recognition," which promoted "evacuation with someone." In Tembok, "prior action" led to "alert recognition," which promoted "evacuation with someone." To the contrary, in Rendang, "prior action" hindered "alert recognition." Here, only "alert recognition" resulted in "evacuation with someone." In these areas, the past eruption and prior actions were positively (or negatively) connected with recognition of the evacuation alert, but were not directly related to "evacuation with someone." Although additional surveys are necessary, neither past experience nor prior action was directly linked to the evacuation, but mediation of the "alert recognition" variable was necessary. This fact was confirmed only at the evacuation sites examined in this study, but is likely to be characteristic of all evacuation behaviors subsequent to the eruption of Mt. Agung.

5. Results and Discussion

This study examined responses to the fall 2017 eruption of Mt. Agung in Bali, Indonesia.

In Section 2, we overviewed the 1963 and 2017 Mt. Agung eruptions. The 1963 eruption resulted in many deaths; there were two major causes. First, people refused to move from the "closed area" or "danger area." The emergency local government evacuation order carried no legal force. Second, people living near the mountain had not seen the dangerous eruption or fully recognized the danger. We also overviewed the oral surveys conducted in 2017 among the administration staff, supporters, and community leaders at the evacuation sites. We then clarified the evacuation processes at each evacuation site, the system developed to accept and support evacuees, and the current situation and problems associated with evacuation site management (e.g., the distribution of supply goods). The authors found that no specific evacuation plan was developed in advance and that each village (Desa) mayor was given of a list of evacuation sites so that the entire village (Desa) could evacuate to one following their direction. This is consistent with the existing studies discussed in Section 1.2. These actions were taken from the viewpoint of "those who direct evacuation" (e.g., local government, supporters, and community leaders).

In Section 3, we summarized the survey results among evacuees at the evacuation sites in Sambirenteng, Tembok, and Rendang. This was done to study the viewpoints of people who "received the evacuation alert." We specifically investigated the alert recognition means, details of evacuation, difficulty at each evacuation site, matters related to the 1963 Mt. Agung eruption, and disaster responses prior to the 2017 eruption. The results revealed the following tendencies depending on the evacuation sites: Evacuees in Sambirenteng recognized the alert and call for evacuation through the television and radio, and evacuated with family and relatives. The evacuees in Tembok recognized the alert from family or relatives and neighbors, heard about the call for evacuation from family and neighbors in the community, and evacuated with family and relatives. The evacuees in Rendang mainly recognized the alert from the community or Internet, heard about the call for evacuation from family and the community, and evacuated as a community. The evacuation sites were smoothly managed since evacuees and evacuation supporters shared the same religion and culture and had the same understanding of the roles involved in goods support, mental support, and health support at each site. We were therefore able to identify the different evacuation characteristics among the three evacuation sites.

In Section 4, the cross tabulation and SEM were discussed to determine the relationship among the 1963 eruption, prior actions, and the evacuation. The major results of the cross-tabulation analysis indicated a relationship between alert recognition and recognition of the call to evacuate. In other words, when people recognized the volcanic eruption alert from real media sources, they recognized the call to evacuate based on information from other people or parties within the real media. When people recognized the alert from virtual media, they mainly recognized the call to evacuated from the same media source. The information recognition path from real me-

Table 19. Estimates and test values at each evacuation site.

Pass			Sambirenteng			Tembok			Rendang		
			Estimate	t-value	Probability	Estimate	t-value	Probability	Estimate	t-value	Probability
[Alert recognition] Recognized or not	←	[Prior action] Number of persons to communicate with	0.09	0.68	0.50	0.30	2.73	0.01	−0.37	−3.83	***
[Alert recognition] Recognized or not	←	[Eruption in 1963] Recognized or not	0.53	3.88	***	0.17	1.53	0.13	0.07	0.75	0.46
Kinds of persons to evacuate with	←	[Prior action] Number of persons to communicate with	−0.11	−0.83	0.41	0.20	2.00	0.05	−0.12	−1.21	0.23
Kinds of persons to evacuate with	←	[Eruption in 1963] Recognized or not	−0.11	−0.76	0.45	−0.13	−1.29	0.20	−0.06	−0.68	0.50
Kinds of persons to evacuate with	←	[Alert recognition] Recognized or not	0.66	4.34	***	0.49	4.82	***	0.47	4.90	***

dia was narrower than that from virtual media. In the SEM, we studied factors constituting the various behaviors of people (e.g., past experiences, prior actions, alert recognition, and evacuation) and the relationship between the factors and behaviors. The model indicated that only "alert recognition" resulted in "group evacuation," while factors such as "prior action" and "recognition of the 1963 eruption" were not directly related to the "group evacuation."

What information is revealed by these results? They may suggest that, if a relationship (social capital) in each community (the Desa and related Banjar) is established, group evacuation is only realized by establishing a channel to "promote evacuation" even without establishment of a systematic evacuation system under the control of central or local government. A viewpoint from the context of the Bali community in regard to regional society and religion (e.g., Bali Hindu) is necessary in future work.[13]

The information communication environment has rapidly grown in Indonesia and Bali since the beginning of the 21st century. It is therefore necessary to study the relationship between alert recognition and the call to evacuation based on information from both real (i.e., people) and virtual (e.g., television and internet) media sources. Regarding real media (as discussed in Section 4.1), people responded to the call for evacuation "as far as they recognized" it. The point of emphasize is not on the relationship between real and virtual media, but on "separation." People who recognized the alert based on information from real media sources tended to respond to the call for evacuation based on information from real media, while people who recognized the alert based on information from virtual media tended to respond to the call for evacuation based on information from virtual media.

However, these results are limited to information obtained through this study's surveys. The oral survey conducted among government staff indicated that these individuals tried to correct the issue of "separation" by creating connections. From the viewpoint of Putnam's discussion regarding social capital, each community in Bali functioned to form community bonds (communities evacuated as groups) at the time of evacuation, but had difficulty bridging to other entities (particularly between the local government and its citizens).[14] These results are consistent with a study by De Bélizal et al. [12]. This may be explained by the existence of a mutual understanding between communication leaders (e.g., village (Desa) mayors) and the local government, but ordinary people did not share this understanding. Survey studies from the viewpoints of people and parties who provide direction (e.g., the local government or community leaders) and ordinary people who receive such direction are in their early stages. Surveys based on the following two viewpoints should be conducted: The first should analyze the development process among community social capitals (as regional resources) during times without disaster. The second should be conducted to develop a more dynamic model involving the features of a volcanic eruption (e.g., changes in eruption alert levels and the length of the evacuation period). Considering that "separation" in terms of alert recognition was apparent from six months prior to September (when the volcanic eruption began) to March of the next year, social capital appears to have not only encouraged the evacuation, but also temporarily suppressed it. However, this is preliminary knowledge that we acquired during this study. Further research is necessary.

13. The survey results indicate that the evacuation sites had the characteristic feature of "evacuation led by Desa." Further oral surveys are necessary to understand the background.

14. According to the classification defined by Aldrich [21], the hierarchical relationship between the local government and its citizens is "Linking." Here, we discuss these events using the term "connection" according to the patterns defined by Putnam.

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Name:
Michimasa Matsumoto

Affiliation:
Associate Professor, International Research Institute of Disaster Science (IRIDeS), Tohoku University

Address:
6-6-11-901-2 Aoba, Aramaki, Aoba-ku, Sendai 980-8579, Japan

Brief Career:
2002- Japan Consumer Marketing Research Institute
2007- Fukushima National College of Technology
2013- Tohoku University

Selected Publications:
• "Survey analysis of coastal areas in Fukushima prefecture: The real situation and changes in the devastated communities," Ochanomizu-shobo, 2015.

Academic Societies & Scientific Organizations:
• Japan Society for Urbanology (JSU)
• Japan Association of Regional and Community Studies (JARCS)
• Japan Society of Civil Engineers (JSCE)

Name:
Miwa Kuri

Affiliation:
Lecturer, International Research Institute of Disaster Science (IRIDeS), Tohoku University

Address:
6-6-11-901-2 Aoba, Aramaki, Aoba-ku, Sendai 980-8579, Japan

Brief Career:
1999- Post-Doctoral Research Fellow, Geological Survey of Japan, National Institute of Advanced Industrial Science and Technology (AIST)
2002- Post-Doctoral Research Fellow, Geology, Science, Tohoku University
2013- Lecture, IRIDeS, Tohoku University

Selected Publications:
• "Response of the Tourism Industry to Volcanic Hazard Information: A Case Study of the Volcanic Warning at Zao Volcano in 2015," J. Disaster Res., Vol.13, No.3, pp. 547-558, 2018.
• "Science Communication of Hazards with Scientific Uncertainty: In the Cases of Volcanic Activity," J. Disaster Res., Vol.11. No.4, pp. 707-719, 2016.

Academic Societies & Scientific Organizations:
• Japan Geoscience Union (JpGU)
• Volcanological Society of Japan (VSJ)
• Japanese Society for Science and Technology Studies (STS)

Name:
Kazuya Sugiyasu

Affiliation:
Assistant Professor, International Research Institute of Disaster Science (IRIDeS), Tohoku University

Address:
6-6-11-901-2 Aoba, Aramaki, Aoba-ku, Sendai 980-8579, Japan

Brief Career:
2012-2013 Researcher, The University of Tsukuba
2013- Assistant Professor, Tohoku University

Selected Publications:
• "Case Study of Tsunami Evacuating Action and Future planning after the 2011 Great East Japan Earthquake, in Iwaki City, Fukushima, Japan," 16th Int. Symp. on New Technologies for Urban Safety of Mega Cities in ASIA (USMCA-2017), 2017.
• "Understanding Regional Building Characteristics in Yangon Based on Digital Building Model," J. Disaster Res., Vol.13, No.1, pp. 125-137, 2018.

Academic Societies & Scientific Organizations:
• Architectural Institute of Japan (AIJ)
• City Planning Institute of Japan (CPIJ)
• Institute of Social Safety Science (ISSS)
• Japan Association for Earthquake Engineering (JAEE)

Name:
Yasuhito Jibiki

Affiliation:
Assistant Professor, International Research Institute of Disaster Science (IRIDeS), Tohoku University

Address:
6-6-11-901-2 Aoba, Aramaki, Aoba-ku, Sendai 980-8579, Japan

Brief Career:
2008 Research Fellowship for Young Scientists (DC2), Japan Society for the Promotion of Science
2010 Project Assistant Professor, Center for Integrated Disaster Information Research, The University of Tokyo
2013- Assistant Professor, Tohoku University

Selected Publications:
• "Analyzing Why Sovereign States Adopt the Cluster Approach in Humanitarian Response," Ph.D. Dissertation for The University of Tokyo, 2013.
• "Typhoon Yolanda in the Philippines: Qualitative analysis of institutional and political factors influencing the continuum," A. Hanatani, O. A. Gómez, and C. Kawaguchi (eds.), Crisis Management Beyond the Humanitarian-Development Nexus, 2018 (forthcoming).

Academic Societies & Scientific Organizations:
• Japan Association of International Relations (JAIR)
• Japan Society for Disaster Information Studies (JASDIS)
• Institute of Social Safety Science (ISS)

Name:
Ni Nengah Suartini

Affiliation:
Lecturer, Ganesha University of Education

Address:
Pegok, Jalan Raya Sesetan No.196, Sesetan, Denpasar Selatan, Pedungan, Denpasar Sel., Kota Denpasar, Bali 80223, Indonesia

Brief Career:
2000-2002 Event Coordinator at Bali Event Organizer
2002-2005 Japanese Teacher and Interpreter at Japanese Studies, Udayana University
2005- Universitas Pendidikan Ganesha

Selected Publications:
• The Emergence of Lifestyle Migration and the Change of Cross-cultural Marriage On Japanese Women in Bali

Academic Societies & Scientific Organizations:
• Asosiasi Studi Pendidikan Bahasa Jepang Indonesia (ASPBJI)

Name:
I Made Budiana

Affiliation:
Lecturer, Japanese Department Faculty of Letter, Udayana University

Address:
Jl. Baja Taki II A No 21, Padangsambian Kaja, Denpasar Barat, Bali, Indonesia

Brief Career:
2005- Lecturer, Japanese Department Faculty of Letter, Udayana University

Selected Publications:
• "Three Argument Verb in Japanese And Balinese," Thesis, Postgraduate Udayana University, 2016.

Academic Societies & Scientific Organizations:
• Indonesian Linguistic Society