Paper:

Designing an Indonesian Disaster Management Information System with Local Characteristics: A Case Study of Mount Merapi

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Effective preparation can help minimize the number of victims and the amount of damage caused by volcanic eruptions, as well as facilitate the recovery of victims' livelihoods after such disasters. Hence, it is crucial to coordinate and integrate all stakeholders in a management information system in which each stakeholder is interrelated but has different roles and functions. This paper presents the design of a disaster management information system (DMIS) with consideration for the volcano's location and characteristics. This includes identifying disaster management stakeholders and their respective roles and the volcano's location and characteristics combined with accessible databases. To validate the design, the results of the DMIS calculations of the needs of refugees from the eruption of Mount Merapi in November 2020 in Kalitengah Lor, Glagaharjo Village, Sleman were compared with the number of real items distributed by the government and donors. The results of this comparison showed that the needs of refugees were fulfilled at a percentage ranging from 66–99%.

Keywords: disaster management, information system, volcanic eruption

1. Introduction

Disasters are sudden events, that can result in significant casualties, damage, and destruction.

When they are not properly managed, disasters can cause far greater damage than if sufficient preparations are made [1]. Disasters have also been defined as disruptive large-scale events that are expensive, unexpected, and adversely affect the general public [2]. Disasters can be natural or man-made; with natural disasters comprise earthquakes, fires, floods, storms, landslides, tornadoes, tsunamis, and volcanic eruptions, while man-made disasters include socio-technical or industrial disasters or the results of military conflicts.

To reduce the threat caused by volcanic eruptions and to improve preparedness, contingency plans are prepared at the national, provincial, and district levels. A contingency plan is a plan made at the pre-disaster stage that is carried out under normal conditions or when a potential disaster occurs. This study aims to design an integrated disaster information system that will can be used to support the implementation of contingency plans.

The characteristics of natural disasters are uncertainty, limited available resources in the affected areas, and dynamic environmental changes [3]. While natural disasters are difficult to predict, their impacts can be reduced through good preparation [4]. One form of preparation involves predict possible risks that arise based on past events. Common risks that may occur include damaged or lost property, injured victims, and death.

These risks can be reduced and anticipated by predicting the probability of an eruption using Event Trees (ET) that observe past volcanic activity under the assumption that future activity will either mimic the past or follow current trends. Each tree branch in an ET is a previous event with certain characteristics that leads to a different risk probability [5]. ET has been widely applied, for example in locations like Mount Vesuvius in Italy [6] and the Galunggung, Guntur, Kelud, Merapi, Sinabung, and Semeru volcanoes in Indonesia [7]. Other studies have examined the hazards of volcanoes that occur in the non-eruptive phase, arranged such hazards into a stochastic model using eruption sequence analysis, and integrated this into the Bayesian Event Tree (BET) structure [8]. Based on these predictions, disaster management authorities can coordinate with other government agencies, communities, donor agencies, and NGOs through an integrated information system.

While prior studies have made various efforts to anticipate volcanic disasters by predicting the possibility of an eruption, follow-ups are needed in the form of preparing coordinated assistance in an effective and efficient manner.

When volcanoes erupt, large geographical areas are affected, which results in complex social problems. Therefore, good disaster management must be conducted before, during, and after a disaster. A major source of this complexity is disaster timing, as sudden and unexpected disasters can cause large-scale damage that is difficult to accurately predict [9]. Disasters can affect any country regardless of its size, wealth, or preparedness; however, complexity increases when many organizations and individuals respond to a disaster. In some countries, the armed forces and police are required to respond to disasters along with the official disaster management agencies at the state, regional, or national levels. Non-governmental organizations (NGOs), national and international Red Cross associations, various international relief organizations, and impromptu volunteer groups also often rush to assist.

The large numbers of organizations and volunteers that seek to work together to assist disaster victims have often led to chaotic and confused relief operations. Therefore, better planning in the preparedness phase is required before possible eruptions occur. The preparedness phase includes activities related to community planning and preparation for disaster occurrences [10, 11]. The preparations carried out included the development of an early warning system or emergency response training [12]. To be able to determine what actions must be taken when a disaster strikes, community members need to be given preparedness training. Disaster preparedness training has the following key objectives: assisting people to avoid potential disasters, making plans, gathering resources, and developing the mechanisms to ensure that adequate support is available in the event of a disaster [13]. The main planning required is the development of a population database the mapping of the characteristics of areas that may be affected by an eruption. Database planning must be integrated into the disaster information system. Disaster information systems may be the key to effectively coordinating relief efforts, ensuring smooth relief operations, and guaranteeing that the right disaster relief is available to every person affected by the disaster on time and on target.

The efficiency and effectiveness of information systems that integrate cross-ministerial information and information sharing among various disaster response organizations have been verified. This was evidenced by the trials of the Share Information Platform for Disaster Management (SIP4D) during the Kumamoto earthquake in 2016 [14]. Another example is the use of an integrated interdisciplinary information system to deal with the potential for a tsunami disaster in the coastal city of Padang, Indonesia [15].

It is difficult to predict when a volcanic eruption will occur, because eruptions are not uniform and the time between the prediction of the event to the eruption is variable even if a prediction is made. ET researchers attempt to predict these difficult events. Differences in the characteristics of areas that are predicted to be affected can include elements like population, age and gender, culture, habits, infrastructure, and local government policies.

If a disaster occurs, the needs of the affected population can be quickly prepared using a disaster management information system that takes into account the characteristics of the mountain and the affected area [16].

The response information system referred to above is an integrated DMIS that considers the local characteristics of the affected area. The availability of this DMIS will facilitate more effective decision-making in disaster management. The design of such an information system requires a database that is useful at the mitigation stage so that users or stakeholders, especially the local government, can improve their disaster expectation and forecasting capabilities. Using such a database, users can determine what post-disaster relief will be needed so that disaster management can be rendered quickly and precisely. Data accumulated within the database system can be retrieved through data collection from related agencies such as the Regional Disaster Management Agency (Badan Penanggulangan Bencana Daerah (BPBD)), the Indonesia National Board for Disaster Management (Badan Nasional Penanggulangan Bencana (BNPB)), and the Geological Agency of Indonesia, Ministry of Energy and Mineral Resources. Additionally, data were also procured through field surveys and interviews with related parties such as the Volcano Observation Post (Post Pemantauan Gunung Api (PPGA)), the relevant local government units, and community organizations. The design of this system is intended to integrate information among these agencies and provide complete volcanic mountain data.

In this research, a case study was conducted on Mount Merapi in Central Java to see if DMISs could be developed. All the design steps mentioned above were performed.

2. Identifying Needs

The disorganized anticipation of natural disasters has become a concern for governments, communities, and researchers. As natural disasters are often difficult to predict, reliable systems must be constructed in disaster-prone areas to deal with the various consequences of such disasters. When these disasters occur, victims need quick and appropriate relief; both healthy and injured victims need food and medical care. However, when a disaster occurs, relief teams often have difficulty accessing the correct type and amount of relief, which can be addressed by systems and human resources that have examined such needs beforehand. Nevertheless, at the time of a disaster, attention tends to be more focused on repairing or developing the necessary infrastructure to reduce the impacts of the disaster [17] and strengthen existing disaster communication and information systems and physical facilities to ensure adequate network availability [18]. When disasters strike, a great deal of information is rapidly sent through social media such as Facebook, SMS, Twitter, WhatsApp, Instagram, or phone calls [19–22]. However, as biased, unclear, and inaccurate social media information has been found to cause chaos both for those who need help and those who are trying to provide help, information must be filtered for credibility, and more accurate information should be given to the public through official information systems. Therefore, a properly functioning information system is the most important factor in the success or failure of disaster relief operations [23, 24].

In the process of helping disaster victims, it is extremely important to quickly coordinate the units involved based on local data and local situations [25]. Coordination is important in these situations because disasters are chaotic, and relevant information is needed quickly [26]. As there is often limited available data during a disaster, data accuracy must be ensured to provide victims with logistical assistance. Therefore, it is necessary for disaster information systems to meet the needs of the disaster management operations decision makers [27]. Chief challenges in disaster management are coordination and information sharing about the situation on the ground [28]. While information systems may efficiently share information, they may not be operationalized by the disaster management actors [29]. Experience indicates that disaster response organizations cannot work effectively without sharing information. However, the shared information must be selected so that only useful and high-quality information is shared [30].

A reliable and integrated system must combine various parties with the authority to make decisions and responsibilities to deal with disasters centrally or at each location. This integrated system must have an accountability tracking system and an explicit monitoring function. It must provide parties with certain access to operate from their current location such as their homes or offices. It is thus vital to establish a decision support system that can be used as a single access point for stakeholders [31]. This system must be developed with sufficient knowledge and good facilities so that information can be utilized by the right stakeholders in the right form.

The disaster management systems, often called DMISs, which some researchers have proposed, have not been entirely applied in the case of volcanic eruptions. Disaster management systems are difficult to establish in such cases, as the conditions of the area in which an eruption occurs is never the same. Each area has different characteristics regarding population, location, natural conditions, the shape and height of volcanic mountains, and many other specific factors.

This paper presents the results of this study through the design of a DMIS that uses relevant information according to a disaster area's characteristics or conditions.

3. Research Method

A three-stage methodology was employed in this study: identifying needs, designing, and testing. The identifying needs stage involved collecting information about what is needed to effectively prepare a volcanic eruption information management system. The designing stage involved the development of an effective disaster management information management system, and the testing stage tested the viability of the proposed system using a volcanic eruption case study.

The aim of this study was to design an information system that integrates all relevant parties in volcano disaster management. First, the parties involved in each volcanic disaster management effort were identified. A general data flow diagram (DFD) was prepared for all volcanic disasters, based on which a DMIS computer program was designed to facilitate design implementation. The results were then tested on an active volcano in Central Java.

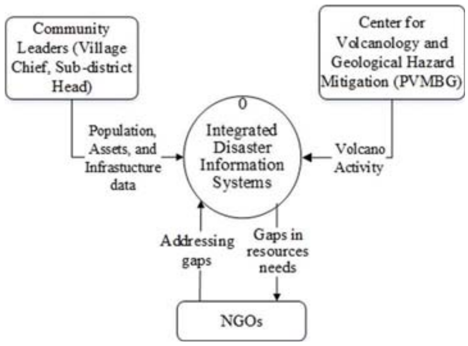

Fig. 1. DFD level 2.

DMIS requires a reliable database management system, which is a software application that stores database structures, relations among data in databases, forms, and reports from stakeholders [32]. The database system is an important component that consists of a management information system (MIS), as a database system's constituent is crucial in supporting MIS performance functions. The database also functions as an MIS infrastructure, an MIS information source, and a means for MIS efficiency and effectiveness. The database was equipped with data collected through various methods. To determine the contents of the design, primary data were obtained through direct field surveys and interviews with parties related to volcano disasters, such as PPGA officers, district/city BPBD officers, and provincial BPBD officers. In addition, secondary data were also collected through documents or information provided on the official websites of the relevant agencies, such as the Geological Agency Data and Information Center, the BPBD, and the BNPB. Secondary data include information related to the eruptions and characteristics of volcanoes, the preparation of contingency planning guidelines, and data projection of needs along with the standard requirements of the contingency plans. On the basis of the data obtained, the selection of relevant data was incorporated in the database design.

4. Designing the Disaster Management Information System

The following steps were followed in the design of the DMIS:

- Designing DFDs to describe the data flow in the system. In this design, the DFD was divided into three parts: context diagrams or DFD level 0, DFD level 1, and DFD level 2 as shown in **Figs. 1**, **2**, and **3**, re-

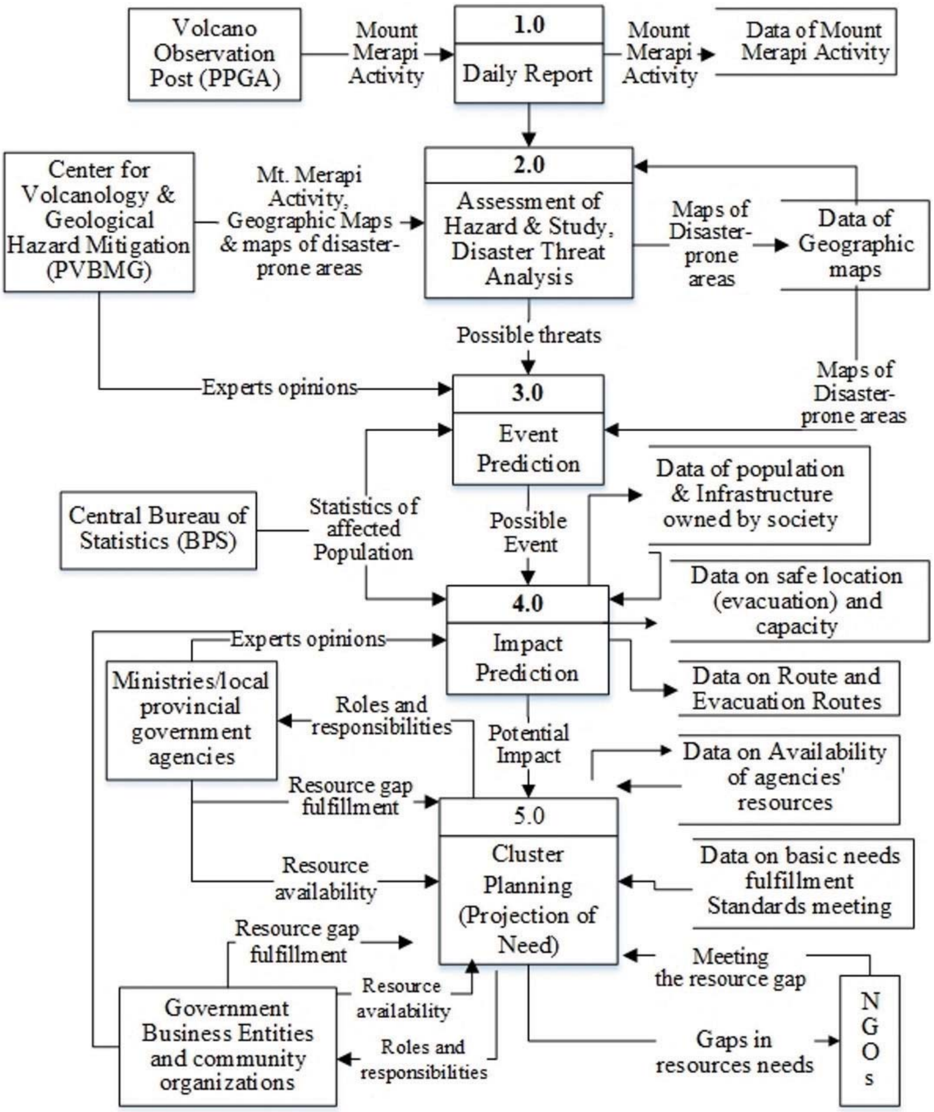

Fig. 2. DFD level 1.

spectively.

- Designing systems and procedures in two separate pages as shown in **Figs. 4** and **5**.
- Designing database files using Web programming with Javascript.
- Testing the design results.

4.1. DFD Design

An integrated disaster information system was developed to support the BPBD in preparing a contingency plan and to provide information about the relief needed in each affected area. This information was shared with the local community and NGOs, which allows them to provide appropriate relief according to refugees' needs. DFD is a graphical representation of the flow of data through the integrated disaster information system. DFD level 0 contains one process node ("Process 0") that generalizes the function of the entire system in relationship to external entities, like Community leader, Badan Pusat Meteorologi Vulkanologi dan Geologi (BPMVG) or the Center for Volcanology, and Geological Hazard Mitigation (PVMBG) and NGOs.

DFD level 0 (**Fig. 1**) then moves into DFD level 1, which consists of five stages (**Fig. 2**).

DFD level 1 is broken down into DFD level 2 (**Fig. 3** specifically for DFD level 1 stage 5), Standard Operating Procedures (SOP) for DFD level 1 stage 2 (**Fig. 4**), and SOP for DFD level 1 stages 3–5 (**Fig. 5**).

The SOP for the process of hazard assessment and the study and analysis of volcanic threats (DFD level 1 for phase 2) involves PPGA, Institute of Investigation and Development of Geological Disaster Technology (BPPTKG), BPBD, and Community.

Figure 5 is a SOP for predicting volcanic eruptions and their impacts, and cluster planning and projections to meet the needs for relief for each cluster (DFD level 1 for phases 3–5).

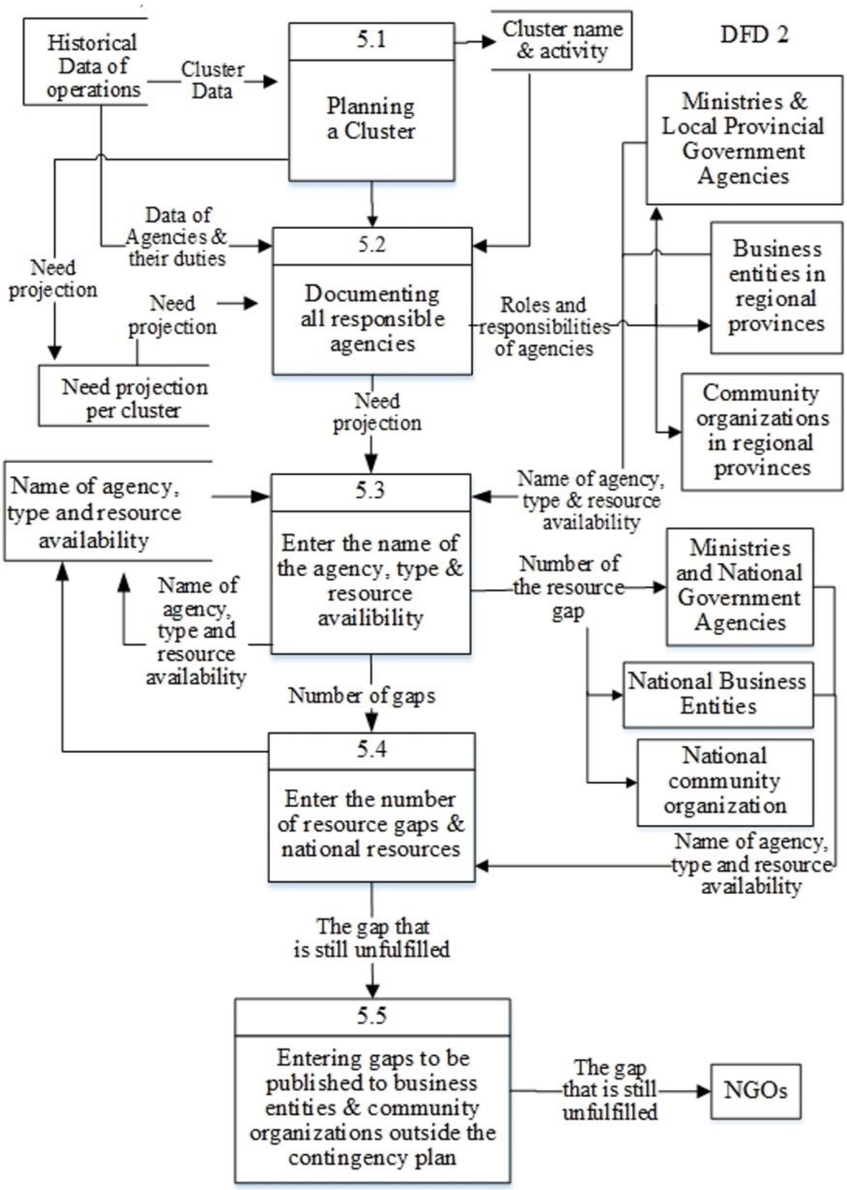

Fig. 3. DFD level 2.

4.1.1. DFD Level 0

DFD level 0 (**Fig. 1**), which is a context diagram, provides a basic overview of the entire integrated disaster information system. DFD level 0 shows the input of volcanic activity data obtained from the PVMBG. On the other side, data are input from community leaders, such as the population, assets, and infrastructure. Meanwhile, the data of gap fulfillment can be obtained from NGOs. After processing the data, the integrated disaster information systems provide information about gaps in resource needs to NGOs and the community.

4.1.2. DFD Level 1

DFD level 1 (**Fig. 2**) is an extrapolation of DFD level 0; it is a general overview to show the flow of data through the integrated disaster information systems in more detail. In DFD level 1, the single process node in DFD level 0 is decomposed into multiple sub-processes. DFD level 1 contains five process nodes to describe the integrated disaster information systems, such as the daily report; assessment of hazard and study, disaster threat analysis; event prediction; impact prediction; and cluster planning. Thus, the process of creating detailed contingency plans can be seen in **Fig. 2**.

4.1.3. DFD Level 2

DFD level 2 presents the details of the processes outlined in DFD level 1. Only one process was developed in DFD level 2: cluster planning (need projection). The details of the DFD level 2 process can be seen in **Fig. 3**. DFD level 2 here describes the data and information flow regarding the cluster planning process to predict the fulfillment of basic needs. In DFD level 2, cluster activity is more clearly visible, whereas in the previous stage, the

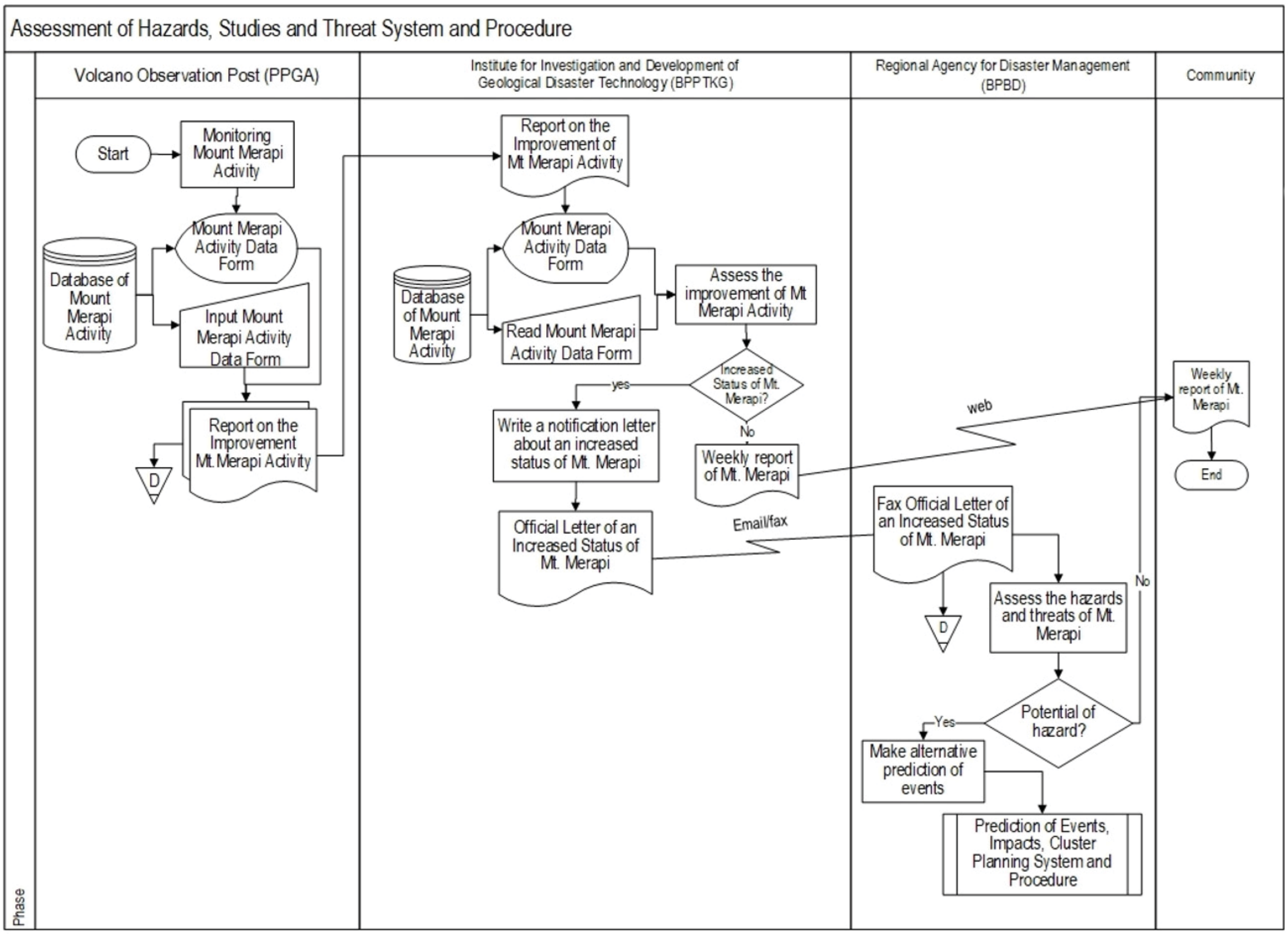

Fig. 4. Assessment of hazards, studies, and threat system and procedure.

evaluation of threat assessment in impact prediction is not explained further because the activities and information have already been described in detail.

Cluster planning consists of projections, each cluster's needs, and the agencies involved (both government and nongovernment). Each cluster addresses needs according to the availability of resources. The required data include prediction data on the number of evacuees, evacuee location, standard data on basic needs fulfillment, data on evacuation routes and directions, data on the availability of agency resources, and standard data on general costs. The intended clusters are social health, education, temporary shelter, water and sanitation, infrastructure facilities, search and rescue, and food and nutrition.

4.2. System and Procedure Design

The design of systems and procedures started with PPGA's monitoring of activity at Mount Merapi. PPGA provides volcanic activity reports to the PPTKG Agency, which has the authority to determine the status of the mountains. The volcano activity report is archived based on time.

BPPTKG then receives the volcanic activity report and assesses whether the status of the volcanoes should be changed. If not, the BPPTKG provides weekly reports to the government (BPBD) and the public through the Ministry of Energy and Mineral Resources website. However, if the status changes, then the BPPTKG sends an official volcano status notification letter to the local government and the BPBD through an e-mail or fax.

BPBD receives a fax regarding the "increase in volcano status" notification letter and archives it. Furthermore, the BPPTKG assesses the danger and threat of volcanoes by forming a team to handle disaster management. If the assessment shows a potentially dangerous outcome, then the team proceeds with a predicting the possibilities of upcoming volcanic eruptions. If not, it is sufficient to publish a weekly volcano report on the Ministry of Energy and Mineral Resources website.

4.3. Prediction of Events, Impacts, and Cluster Planning as Well as Need Fulfillment

BPBD prepares a prediction of possible upcoming events based on recommendations from the BPPTKG accompanied by expert opinions on eruption characteristics, KRB maps, ATL maps, and historical data. The data and information help determine alternative events, which are then used for impact prediction.

Impact prediction reports are prepared based on alternative events. Population data are acquired from the Cen-

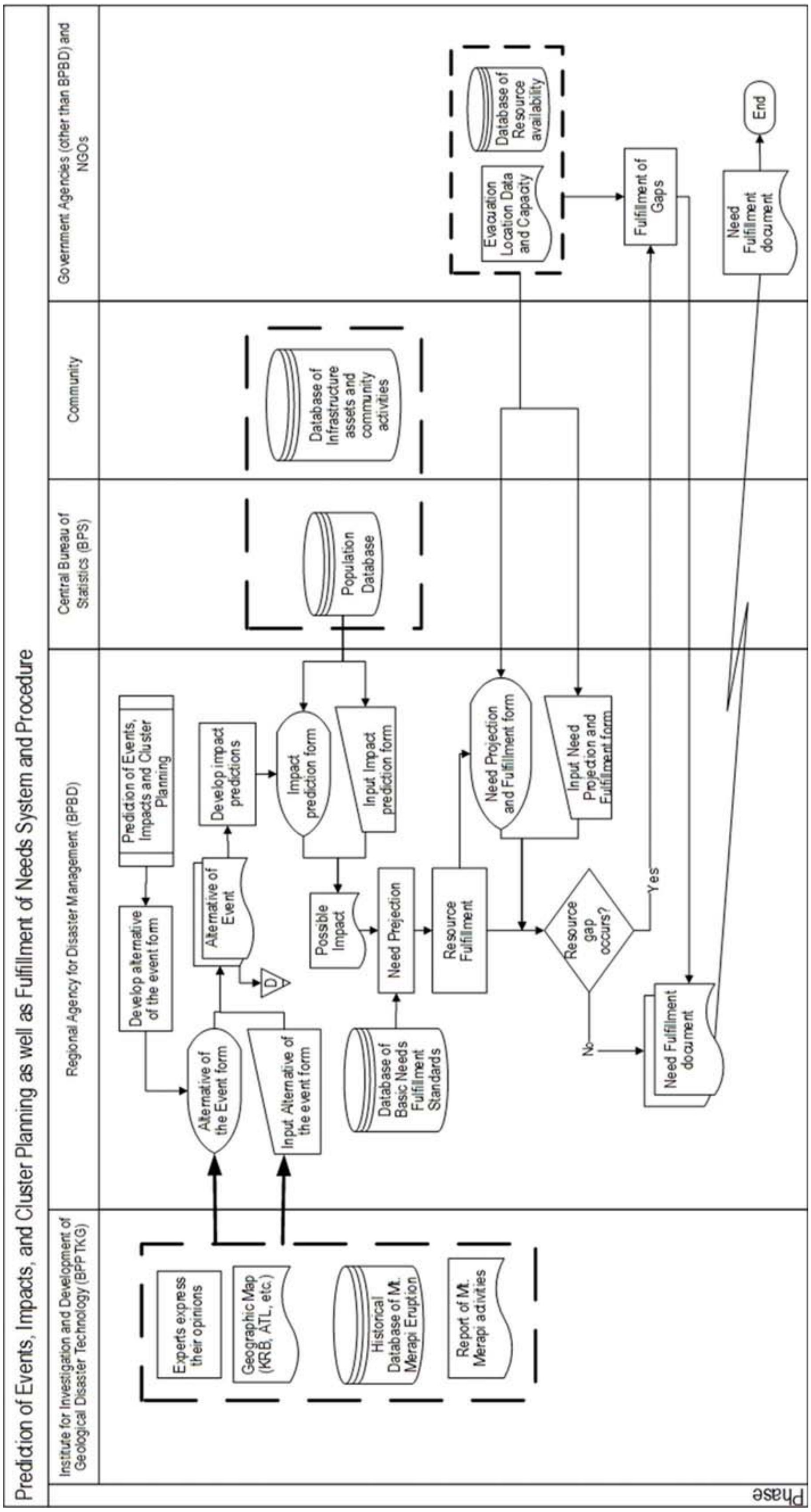

Fig. 5. Systems and procedures for predicting events, impacts, and cluster planning as well as fulfilling needs.

tral Bureau of Statistics (BPS) to adjust the data regarding alternative events to enable predictions regarding population impacts, such as the number of casualties, missing, injured, and non-care victims.

Furthermore, when the number of evacuees is determined, the extent of need can be calculated from the results alongside basic needs standards. Needs are classified according to clusters. In fulfilling resources, relevant agencies need to provide data on their availability. If there is a gap during resource fulfillment, it will be addressed by government agencies such as the BPBD, as well as non-governmental agencies. Subsequently, a need fulfillment document can be drafted to be used in the contingency plan and later during emergency response.

4.4. Designing the Database File

The database file design includes tables, relations among tables, queries, forms, and reports.

5. Testing Design Results in a Case Study

5.1. Case Study

This design used past Mount Merapi data and some government data. Currently, the government conducts pre-disaster preparedness activities called contingency plans. Contingency plans consist of agreements and joint commitments among stakeholders to undertake disaster management efforts during emergency response [33].

This database system design has tables, relationships between tables, and reports to support decision-making.

5.2. Tables

Tables consisting of rows and columns serve to input and store data. There are several tables in the database design:

a. The volcano profile table (tbProfil) defines existing volcanic mountains and mountain profiles.

b. The mountain status table (tbMtStatus) contains the status of the current volcanic mountains according to the time available.

c. The historical volcanic eruption table (tbHist_Eruption) inputs eruptions that have occurred in the volcanoes.

d. The village table (tbVillage) stores information about villages around the mountain that are at risk of being affected by volcanic eruptions.

e. The population data table (tbPopulationData) contains population data based on age and sex for each village.

f. The number of people at risk table (tbThreatened) is a query on the results of data multiplication between the population data table and the victim percentage table.

g. The victim percentage table (tbVictimPercentage) inputs the ratio of victims in each category by year, such as casualties, loss, injury, or survivors.

h. The evacuee data table (tbRefugees) is the result of queries that store data based only on selected ones from the threatened-soul data table.

i. The event scenario table (tbScenario) contains the types of event scenarios based on volcanic eruption characteristics.

j. The standard needs table (tbStandardNeeds) contains the standard number of each type of need based on the cluster.

k. The needs table (tbNeeds) is a query of the results of the data multiplication between the evacuee data table and the standard needs table.

l. The availability table (tbAvailability) contains the types of needs and the extent of each agency's availability.

m. The fulfillment table (tbFulfillment) stores fulfillment data provided by each agency.

n. The list of institutions table (tbAgency) enumerates various institutions/agencies involved in the database system, including the determination of authority or authorization in accessing the system through passwords and user levels.

o. The cluster list table (tbCluster) contains seven existing clusters during the fulfillment of evacuee needs.

p. The user-level table (tbUserLevel) defines the authority for each user.

q. The unit table (tbUnit) contains the names of units involved in a certain type of need.

5.3. Inter-Table Relations

Figure 6 shows the relations among tables that can be used to find the necessary data. These connections also facilitate the database design process.

In tbProfil, several volcanoes will be used in other tables, so it will have a one-to-many relationship with tbMtStatus, tbHist_Eruption, tbScenario, and tbVillage. Meanwhile, the relation of tbScenario and tbVictimPercentage with tbPopulationData is based on time or year. This time relationship is used until tbThreatened and tbRefugees. The number of people at risk and evacuee data can only be raised once based on the desired time, hence the one-to-one connection. In addition, tbNeeds also raises the evacuee data only once; thus, the relationship is also one-to-one. The cluster and institution list can repeatedly be incorporated to tbFulfillment, creating a one-to-many connection. Additionally, a one-to-many association is found from tbUserLevel to tbAgency in that one authority can be given to several agencies.

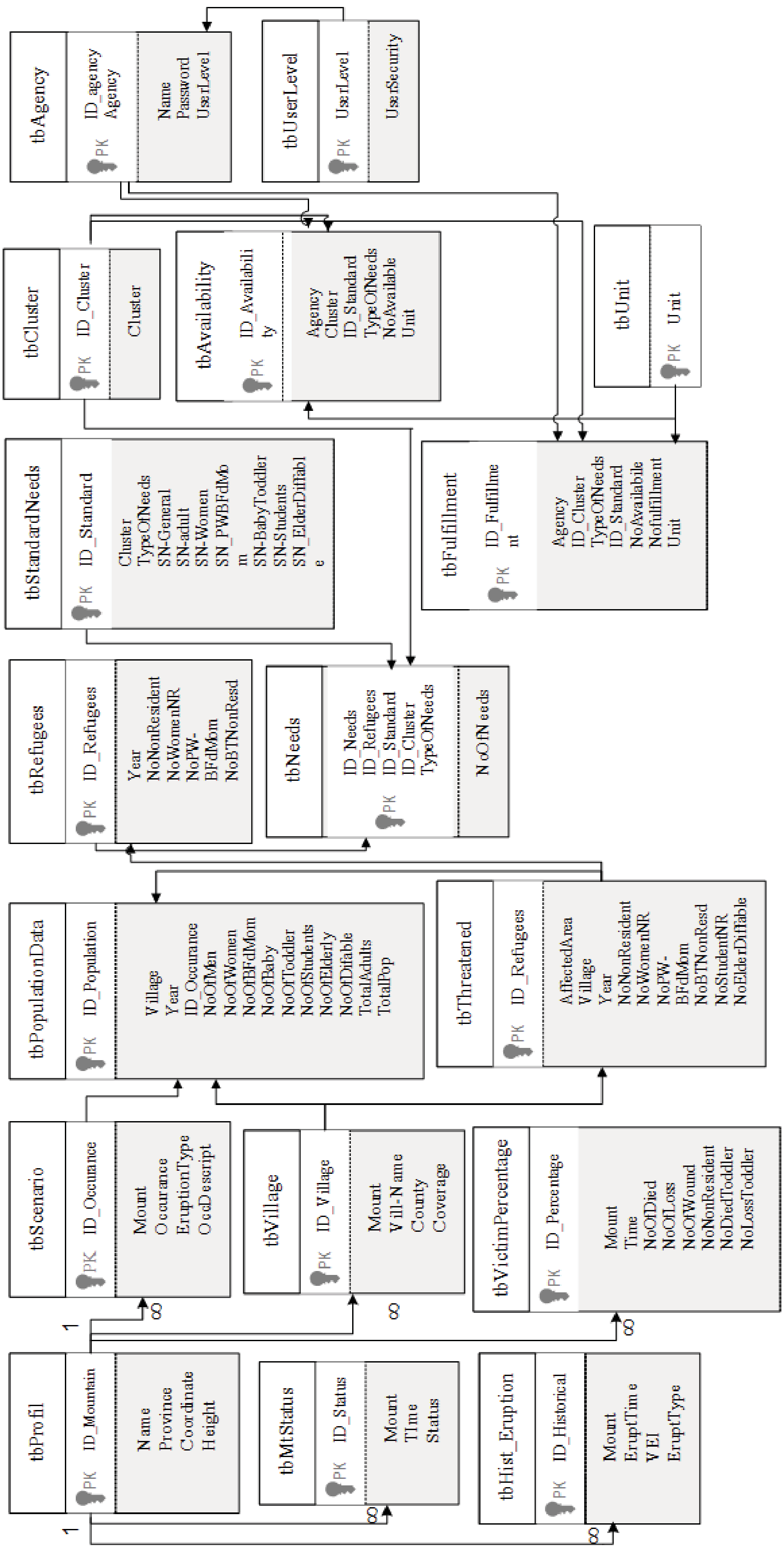

Fig. 6. Inter-table relationships.

Table 1. Population of the case study.

Adult	Woman of child-bearing age	Pregnant and lactating mothers	Infants/ toddlers	Student	Elderly	Total
207	205	4	36	42	43	537

5.4. Reports

A report presents information in accordance with data processing or analysis results. Some of the reports in this study include the following:

a. "The Mountain Status Report" by the BPPTKG and the BPBD can be seen through the "View Mountain Status" menu to obtain the latest mountain updates.

b. "The Volcanic Eruption Historical Report" can be accessed by the BPPTKG and the BPBD to see the time history, VEI, and the nature of the volcanic eruption.

c. "The Population Data Report" shows population data by year. Here, the population is classified according to age and sex and also includes vulnerable groups.

d. "The Recapitulation of Villages and Threatened Souls Report," accessible by the BPBD, indicates which villages are affected and selected as refugee data.

e. "The Evacuee Data Report" shows overall evacuee data by year and is classified into population and victim categories.

f. "The Recapitulation of Need per Type of Need Report" indicates the amount of each type of need that must be met. This report supports the decisions of the agencies involved in need fulfillment.

g. "The Recapitulation of Institutional Availability Report" can be accessed by the BPBD and all agencies involved in fulfilling needs. This report shows the availability of recapitulation based on each agency that has provided data.

h. "The Recapitulation of Agency Compliance Report" shows the results of the amount of needs per type, the amount fulfilled by certain agencies, and the number of existing gaps.

i. "The Recapitulation of Needs per Village Report" shows the recapitulation of the amount of needs for each village displayed according to population. This report will later support the decision to distribute needs to each village.

j. "The Recapitulation of Needs by Type of Needs Report" shows the recapitulation of the amount of needs for each village displayed according to the type of need.

k. "The Gap Report" shows the types of needs with gaps that must be addressed. This report can be consulted by agencies before completing need fulfillment.

6. Validation

All the data and information required for disaster management are located in several different agencies and consolidating them for contingency planning is time consuming and costly. This paper presents the design of an integrated disaster management information system in order to obtain the data needed to meet the needs of relief items for groups (age, gender, physical condition, etc.) at all levels of society. This information can be accessed by all those who assist disaster victims, including NGOs, so that the relief provided is in accordance with what is needed.

Validation is carried out by comparing the predicted results of relief items needed for each affected population group with the real amount of relief received by the BPBD.

All relief received by the BPBD will be inputted into the information system so that the amount of supplies is continuously updated. The gap between the number of relief items received and the predicted needs occurs because many people, including NGOs, who already possess information on needs at a certain time, need time to send their relief. When the relief is received by the BPPD, data on the needs of community groups and relief items change because they are updated in real time.

The following is a case study as an example of validation calculations carried out for Kalitengah Lor, Glagaharjo village, Cangkringan district, Sleman (**Table 1**). Residents left their villages and lived in refugee camps during the eruption of Mount Merapi in November 2020. The total population of Kalitengah Lor and its composition or category according to age and gender characteristics who fled during the eruption is presented in **Table 1**.

The needs of each group during the emergency response period (seven days) can be obtained by multiplying the number of people in a certain group with the standard requirements according to government regulations. The results of calculating the needs for each aid item in all groups and the total needs during the emergency response are as shown in **Table 2**.

To validate the design, the results of DMIS calculations on the needs of refugees from the eruption of Mount Merapi in November 2020 in Kalitengah Lor, Glagaharjo village, Sleman were compared with the number of real items distributed by the government (BPBD) and donors and those received by refugees. The results of this comparison show that the needs of refugees were fulfilled at the level of 66–100%, as shown in **Table 3**. The percentage of accuracy will increase if all stakeholders involved are willing to use DMIS effectively.

Table 2. Needs of each group.

Types of needs	Dimension	Adult	Woman of child-bearing age	Pregnant and lactating mothers	Infants/ toddlers	Student	Elderly	The first week of the emergency response period
Notebooks	dozen	–	–	–	–	42,00	–	42,00
Rice	kg/week	62,10	51,25	1,00	2,70	6,30	6,45	908,60
Instant noodles	box/week	621,00	615,00	12,00	72,00	126,00	129,00	11.025,00
Drinking water	liter/week	414,00	410,00	8,00	36,00	63,00	86,00	7.119,00
Infant formula	box/week	–	–	–	28,80	–	–	201,60
Blanket	unit	207,00	205,00	4,00	36,00	42,00	43,00	537,00
Bandages	unit/week	–	615,00	–	–	–	–	3.075,00
Sleeping mats	unit	207,00	205,00	4,00	36,00	42,00	43,00	537,00

Table 3. Needs and distributed relief.

Types of needs	Dimension	Total needs	Distributed	[%]
Notebooks	dozen	42,00	31,00	73,81
Rice	kg/week	908,60	904,87	99,59
Instant noodles	box/week	11.025,00	7.336,00	66,54
Drinking water	liter/week	7.119,00	4.891,00	68,70
Infant formula	box/week	201,60	159,00	78,87
Blanket	unit	537,00	537,00	100,00
Bandages	unit/week	3.075,00	2.796,00	90,93
Sleeping mats	unit	537,00	537,00	100,00

7. Conclusion

This study has presented the design of a DMIS capable of integrating information for various related parties such as the BNPB/BPBD and other government as well as nongovernment agencies. The information system and database design can be applied using past data sources. This design can save time for the BPBD and related parties in preparing and accessing data related to a contingency plan. While the extent of time saved cannot be calculated with great accuracy, coordination that does not involve waiting can shorten the time needed. This system can be further developed into an online application so that it can be accessed in real time, especially by those who need it, under the responsibility of the BPBD.

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- "Development of Fuzzy RUASP model – Grasp Metaheuristics with time window: Case study of Mount Semeru eruption in East Java," IOP Conf. Series: Earth and Environmental Science, Vol.235, No.1, 011002, 2019.

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No.4 (Jun)
Special Issue on e-ASIA JRP: Development of a Landslide Monitoring and Prediction System in Monsoon Asia
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Special Issue on e-ASIA JRP: Development of a Landslide Monitoring and Prediction System in Monsoon Asia

Editorial: doi: 10.20965/jdr.2021.p0483 pp. 483-484

e-ASIA JRP: Development of a Landslide Monitoring and Prediction System in Monsoon Asia
Akihiko Wakai, Go Sato, The Viet Tran, Jessada Karnjana, and Jiro Komori
pdf

This special issue summarizes some of the findings of the first half of our international joint research between Japan, Thailand, and Vietnam. This collaborative research is based on the framework of the e-ASIA Joint Research Program (e-ASIA JRP) and lasts for three years. Rainfall-induced landslides are a common disaster in many Asian countries. Our goal is to develop a practical method for landslide susceptibility mapping so that there are fewer landslide disasters in the future.

The e-ASIA JRP is an international joint initiative of public funding organizations in the East Asia Summit member countries. Based on the co-funding mechanism, support for the research teams is received from the funding organizations in their respective countries. Since 2019, the Japanese, Thai, and Vietnamese teams have been supported by the Japan Science and Technology Agency (JST), the National Science and Technology Development Agency of Thailand (NSTDA), and the Ministry of Science and Technology of Vietnam (MOST), respectively.

In the first half of our project, we completed the basic steps for developing the system. In this special issue, we are proud to present some of our achievements, including studies on slope failure analysis, landslide prevention works, meteorological observations, landslide monitoring, statistical or wide-area risk evaluations, mathematical models, and flash flood control. In addition to the above, we also present other valuable research achievements that related members have provided to help ensure the achievement of our goals. In total, 20 papers are published here. We believe that our comprehensive research activities will dramatically increase future landslide disaster mitigation, especially in monsoon Asia, and will strongly augment the roadmap for achieving the global Sustainable Development Goals (SDGs) as a common desire of humanity.

Paper: doi: 10.20965/jdr.2021.p0485 pp. 485-494

Stability Analysis of Slopes with Terraced Topography in Sapa, Northern Vietnam: Semi-Infinite Slope Assumption with Specific Lengths for Slope Failure
Akihiko Wakai, Akino Watanabe, Nguyen Van Thang, Takashi Kimura, Go Sato, Kazunori Hayashi, Nanaha Kitamura, Takatsugu Ozaki, Hoang Viet Hung, Nguyen Duc Manh, and Tran The Viet
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Paper: doi: 10.20965/jdr.2021.p0495 pp. 495-500

The Helical Anchor Type with Application as a Horizontal Drainage Equipment for Slope Protection
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Paper: doi: 10.20965/jdr.2021.p0512 pp. 512-520

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Deepak Raj Bhat, Soichiro Osawa, Akihiko Wakai, Katsuo Sasahara, Netra P. Bhandary, Fei Cai, Hirotaka Ochiai, and Norihiro Tanaka
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Special Issue on the Tokyo Metropolitan Resilience Project

Editorial: doi: 10.20965/jdr.2021.p0675 p. 675

the Tokyo Metropolitan Resilience Project
Naoshi Hirata
pdf

Natural hazards continue to be an increasing challenge to societies around the world, with many societies being impacted by multiple types of hazard events. To reduce the impact of these hazards, we must not only quantify the hazard and risk associated with multi-hazard events but also understand the uncertainty associated with these events. Resilience can only be improved by considering all these factors. Multi-hazard and risk-modeling approaches are receiving increasing attention globally; however, the challenges of assessing uncertainty in both single- and multi-hazard risks are considerable. Without a clear understanding of the risks and their uncertainties, measures to mitigate these risks and to increase resilience face difficult decisions. In the present Special Issue, we have five papers and one report on the Tokyo Metropolitan Resilience Project: *Interdisciplinary and Industry-Academia Collaboration Research for Enhancing Social Resilience to Natural Disasters in the Tokyo Metropolitan Area –DEKATSU Activity–, Multi-Data Integration System to Capture Detailed Strong Ground Motion in the Tokyo Metropolitan Area, Development of the Training Tool "KUG" for Temporary Lodging Facilities and Companies for Stranded Commuters, Development of Matching Modeling for Human Resource Allocation of Shelter Management by the Set Theory, Time-Cost Estimation for Early Disaster Damage Assessment Methods, Depending on Affected Area, and A Report of the Questionnaire Survey on Awareness of COVID-19 and Shelters.*

Paper: doi: 10.20965/jdr.2021.p0676 pp. 676-683
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Takashi Furuya and Naoshi Hirata
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Development of the Training Tool "KUG" for Temporary Lodging Facilities and Companies for Stranded Commuters
U Hiroi, Sakurako Miyata, Jun Shindo, and Tsuyoshi Kurome
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Paper: doi: 10.20965/jdr.2021.p0719 pp. 719-732
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Muneyoshi Numada
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Paper: doi: 10.20965/jdr.2021.p0733 pp. 733-746
Time-Cost Estimation for Early Disaster Damage Assessment Methods, Depending on Affected Area
Munenari Inoguchi, Keiko Tamura, Kousuke Uo, Masaki Kobayashi, and Atsuyuki Morishima
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Amelia Santoso, Joniarto Parung, Dina Natalia Prayogo, and Ameilia Lolita
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Note: doi: 10.20965/jdr.2021.p0778 pp. 778-785
3D Total Lightning Observation Network in Tokyo Metropolitan Area (Tokyo LMA)
Namiko Sakurai, Koyuru Iwanami, Shingo Shimizu, Yasushi Uji, Shin-ichi Suzuki, Takeshi Maesaka, Ken-ichi Shimose, Paul R. Krehbiel, William Rison, and Daniel Rodeheffer
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Paper: doi: 10.20965/jdr.2021.p0786 pp. 786-793
A Comparison Between Global Satellite Mapping of Precipitation Data and High-Resolution Radar Data – A Case Study of Localized Torrential Rainfall over Japan
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Paper: doi: 10.20965/jdr.2021.p0794 pp. 794-812
Typology of Learning Contents in "Supplementary Textbook for Disaster Prevention Education" – What Are Teachers in the Areas Affected by the Great Hanshin-Awaji Earthquake in 1995, and the Great East Japan Earthquake in 2011, Striving to Teach Students in Junior High School? –
Koji Sato, Reo Kimura, and Shoji Ohtomo
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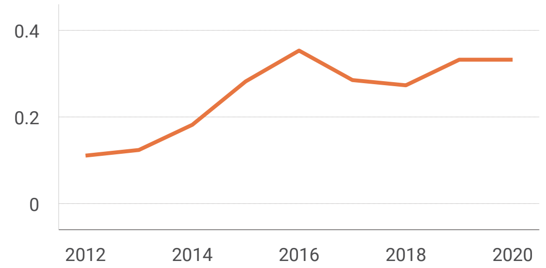

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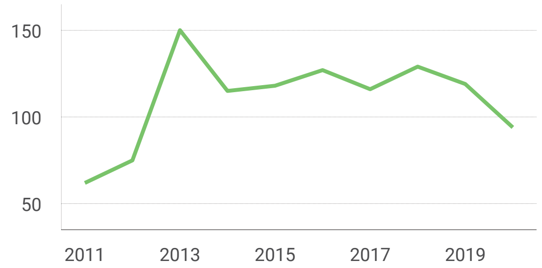

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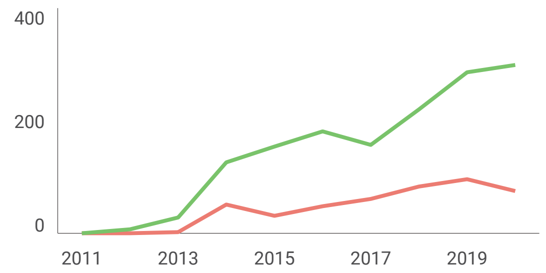

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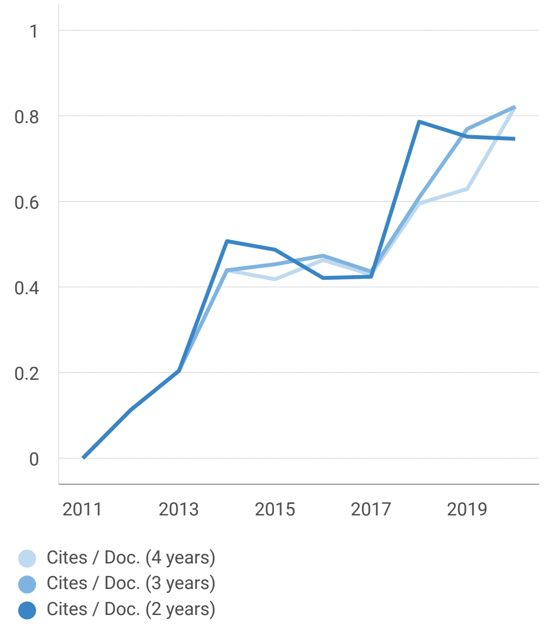

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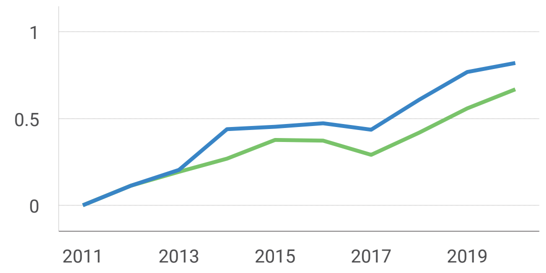

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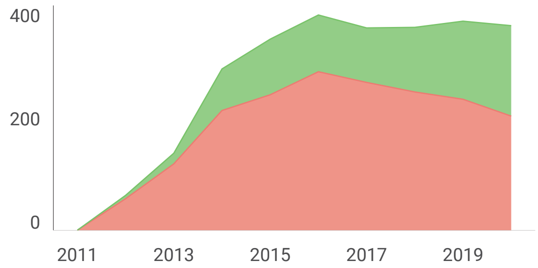

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