Chapter

Participatory Contingency Plan to Covid 19 Adaptation of Merapi Volcano Eruption - Indonesia

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Abstract

The contingency plan was carried out for the seven highest villages in Sleman Regency, Yogyakarta Special Region, as areas prone to eruption of Merapi Volcano. This contingency plan was prepared based on a scenario with a volcanic eruption index of 3, in the form of the collapse of a lava dome of 5 million cubic meters. The collapse of the lava dome formed a hot cloud that moved 6–9 km towards the Gendol River, Opak River, Kuning River, Boyong River and Krasak River. The number of exposed residents is 18,880. The emergency situation period is estimated to be 30 days, from the time the status is increased to Alert. This contingency plan was prepared in a participatory and collaborative manner, under the coordination of the Sleman Regency Regional Disaster Management Agency (RDMA). This process includes: (1) Updating the village level contingency plan as materials for the district level. (2) Formation of a substance team from local government, universities and non-governmental organizations, and (3) Conducting a series of workshops for related organizations to compile documents and equate perceptions on the adaptation of contingency plans with the Covid 19 health protocol. The preparation of this document also involves the participation of children, in order to express their opinions and needs in implementing emergency management.

Keywords: Participatory contingency plan, covid-19 adaptation, children participation

1. Introduction

Sleman Regency is on the southern slopes of Merapi Volcano, at an altitude between 100 and 2,500 meters above sea level. This regency consisting of 17 districts, 86 sub-districts and 1,212 hamlets. The boundaries of Sleman Regency, to the north, are bordered by Boyolali Regency, Central Java Province. In the east, it is bordered by Klaten Regency, Central Java Province. In the south, it is bordered by Bantul Regency and Yogyakarta City, Yogyakarta Special Region. In the west, it is bordered by Kulon Progo Regency, Yogyakarta Special Region and Magelang Regency, Central Java Province.

Merapi Volcano has been the most active volcano during Holocene time. As strato volcano, Merapi exhibit altwrnating volcanic activities of effusive and axplosive character and self destruction. The explosivity index has involved during the last ten tousand years. The effusive activities were characterized by the occurence

of lava flow, the development of lava dome, and the production of the nuee ardente d'avalanche, called Merapi type (69–74, [1]).

Merapi Volcano since 1768 has recorded more than 80 eruptions. Among them are large eruptions with a Volcano Eruption Index (VEI) of more than 3. Major eruptions occurred in 1768, 1822, 1849, 1872 and 1930–1931. The eruption of Merapi Volcano in 1872–1931 led to the west-northwest. From the big eruption in 1930 until the eruption in 2001 the direction of the eruption changed to the southwest. The 1994 eruption occurred a deviation to the southwest - south, namely upstream of the Boyong River, between the Turgo and Plawangan hills (69–138, [2]).

Of 1.1 million people living on the flanks of the active Merapi volcano, 440,000 are at relatively high risk in areas prone to pyroclastic flows, surges, and lahars. For the last two centuries, the activity of Merapi has alternated regularly between long periods of viscous lava dome extrusion, and brief explosive episodes at 8–15 year intervals, which generated dome-collapse pyroclastic flows and destroyed part of the pre-existing domes. Violent explosive episodes on an average recurrence of 26–54 years have generated pyroclastic flows, surges, tephra-falls, and subsequent lahars. The 61 reported eruptions since the mid-1500s killed about 7000 people (479–502, [3]).

The distribution and run-out distances of these flows have frequently exceeded those of the classic Merapi-type nuées ardentes of the recent activity. Widespread pumiceous fallout deposits testify the occurrence of moderate to large (subplinian) eruptions (VEI 3–4) during the mid to late Holocene. VEI 4 eruptions, as identified in the stratigraphic record, are an order of magnitude larger than any recorded historical eruption of Merapi, except for the 1872 AD and, the October–November 2010 events (1213–1233, [4]). The last eruption in 2010 was one of the most explosive eruptions with a hot cloud range of up to 15 km.

The geologic record suggests the latter, which would place several hundred thousand people at risk. We know of no reliable method to forecast when an explosive eruption will interrupt the present interval of low-level activity. This conclusion has important implications for hazard evaluation (9–50, [5]).

Volcanic eruption contingency plans that address Covid 19 adaptation and involve the participation of children, so as to express their opinions and needs in implementing disaster emergency management.

2. Merapi Volcano Eruption Scenario

The eruption of Merapi Volcano is characterized by the release of surface magma to form a lava dome in the middle of an active crater around the peak. The emergence of new lava is usually accompanied by the destruction of old lava, which blocks the flow, causing lava to fall. The new lava that reaches the surface forms a dome that can grow bigger. The growth of the lava dome is proportional to the magma flow rate which varies up to hundreds of thousands of cubic meters per day. The lava dome that grows in the crater and enlarges causes instability. The lava dome which is unstable in position and pushed by gas pressure from inside causes part of it to collapse, thus forming pyroclastic flows that slide into rivers that originate at Merapi Volcano. The movement speed reaches 60–100 km/hour and will stop when the energy of the motion runs out. Pyroclastic flows are a primary hazard, directly affecting the population, and the most destructive of all types of hazards.

The scenario for the future eruption of Merapi Volcano begins with the formation of a lava dome in the center of the crater on the southeast side. The maximum volume is 10 million cubic meters, and half, as much as 5 million cubic meters, collects into pyroclastic flows. This scenario refers to a large chronology of eruptions in 1992, 1994, 1995, 1996, and 2001. Another scenario is the formation of a lava dome

with the same volume in the center of the crater on the west – northwest side. The growth of the dome is large enough to cause instability/collapse of the crater wall in the western sector and the southern sector close to the crater opening. This scenario is consistent with the eruptive behavior of 1998 and 2006.

After the phreatic eruption on May 21, 2018, the Geological Agency increased the activity status of Merapi Volcano from Level 1 to Level 2, with a recommendation that there should be no population activity within a radius of 3 km from the summit. Furthermore, in 2019 there were 4 eruptions. On September 22, 2019, the eruption column formed ±800 meters. October 14, 2019, formed a ± 3,000 meter eruption column. November 9, 2019, a hot cloud glided into the Gendol River as far as 2 km, with an eruption column of ±1,500 meters. November 17, 2019 formed a 1,000 meter eruption column. After the eruption on June 21, 2020, there was a shortening of the baseline distance of the Electronic Distance Measurement (EDM) in the northwestern sector of Babadan, with an average rate of up to 11 mm/day. The seismicity increased so that on November 4 2020 average shallow volcano-tectonic event earthquake (VB) was 29 times/day, multyphase earthquake (MP) 272 times/day, avalanche (RF) 57 times/day, gusts (DG) 64 times/day, total earthquake energy (Vt and MP) in a year amounting to 58 GJ. Based on these data, the Geological Agency has increased the status of Merapi Volcano activity from Level 2 to Level 3.

The Sleman Government responded and followed up on the change in status by establishing the Merapi Volcano Disaster Emergency Response Status. This determination is the basis for preparing a Disaster Emergency Management Operational Plan. Seven villages in Disaster Prone Area (DPA) III, were designated as potential affected areas, namely the areas of Glagaharjo, Kepuharjo, Umbulharjo, Hargobingan, Purwobinangan, Girikerto, and Wonokerto villages.

In this scenario, people evacuate to reduce risks. Communities are shifting from their higher-risk dwellings to lower-risk shelters. The relationship between the level of risk which is influenced by the position in the disaster-prone area with the status of the volcano is shown in **Figure 1**.

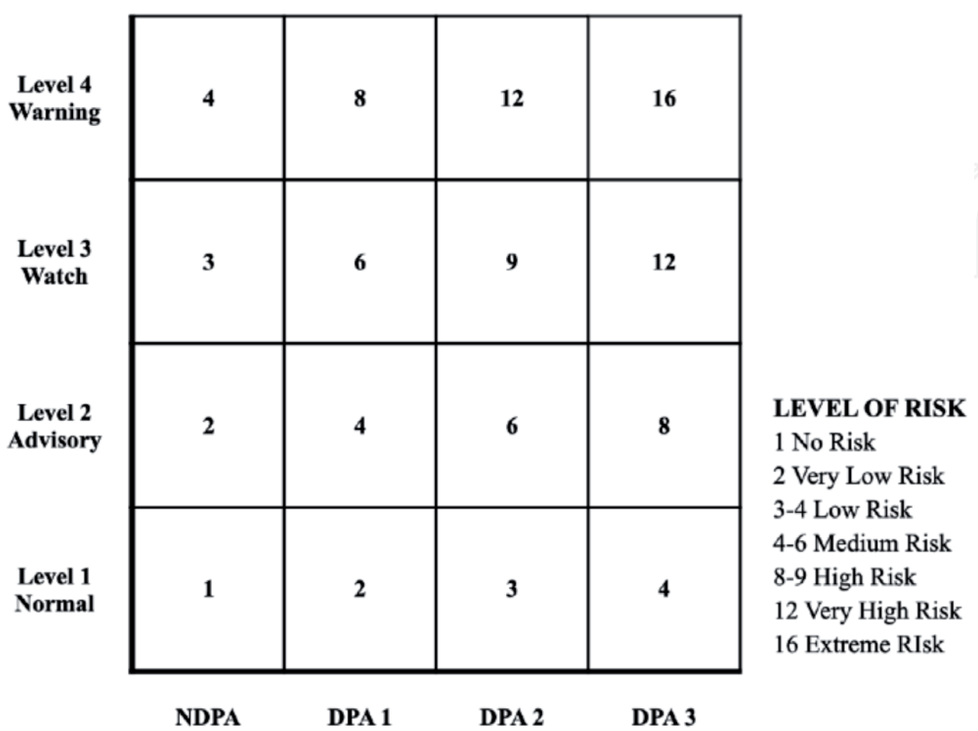

Figure 1.
Level of risk, relation of disaster prone area (X) and volcano status (Y).

3. Prediction of event and impact

Merapi Volcano eruption assumed to be on May 14, 2021, Hours: 23.30 WIB with VEI 2. Merapi Volcano eruptions towards the crater opening to the South - Southeast, namely the Gendol River, Opak River, Kuning River and Woro River. The potential for hot cloud avalanches leads to the South-Southeast, West and Southwest sectors, namely the Gendol River, Opak River, Kuning River, Boyong River, and Krasak River.

The coverage of the Sleman Regency is affected by the danger of pyroclastic flow along the upstream river channels on Merapi Volcano that lead to the South - Southeast, West-Southwest, namely the Gendol River, Opak River, Yellow River, Boyong River, and Krasak River.

No	River	Village	Hamlet	People
1	Gendol (9 km)	Glagaharjo	Kalitengah Lor (5,5 km)	537
			Kalitengah Kidul (6 km)	459
			Srunen (8 km)	459
			Singlar (9 km)	339
			Gading (9 km)	282
	Gendol (9 km) Opak (6 km)	Kepuharjo	Kopeng (7 km)	469
			Jambu (8,4 km)	390
			Batur (8,4 km)	528
			Pagerjurang (10	535
			km) Kepuh (8,7 km)	386
			Manggong (9,9 km)	286
2	Opak (6 km) Kuning (7 km)	Umbulharjo	Pelemsari (8,5 km)	241
			Pangukrejo (6,5 km)	300
3	Kuning (7 km) Boyong (6,5 km)	Hargobinangun	Kaliurang Timur (7 km)	1.198
			Kaliurang Barat (6 km)	1.406
			Ngipiksari (7 km)	1.146
			Boyong (8 km)	980
4	Boyong (6,5 km)	Purwobinangun	Turgo (5,7 km)	507
			Ngepring (8 km)	951
			Kemiri (8 km)	700
			Ngelosari (9 km)	385
			Tawangrejo (10 km)	663
5	Krasak (7 km)	Wonokerto	Tunggularum (8,5 km)	617
			Gondoarum (9 km)	588
			Sempu (9,5 km)	1078
			Manggungsari (9,5 km)	656
6	Krasak (7 km)	Girikerto	Ngandong Tritis (7 km)	758
			Nganggring (8,7 km)	260

Table 1.
Number of people potentially affected by pyroclastic flows.

The primary hazard in the form of pyroclastic flow is the most destructive compared to other types of hazards. Pyroclastic flow is a flow of hot mass (300–800 degrees Celsius) in the form of a mixture of gas and volcanic material consisting of various sizes of clots moving down turbulently with speeds of up to 100–150 km/hour. The number of affected people is 18,880 people in 33 hamlets from 7 villages, from Turi District, Pakem District and Cangkringan District, according to **Table 1**.

4. Merapi volcano status and community activities

In accordance with the Indonesian National Standard (SNI) 8751–2018 concerning Volcanic Eruption Hazard Preparedness Training Management, at Normal status, Level 1, people in DPA I and DPA II, can carry out their daily activities. Communities in DPA III, can carry out daily activities while still complying with local government regulations according to the Geological Agency's technical recommendations (298–310, [6]; 307–320, [7]). In this status, activities in the community are advised to disseminate the DPA map, understand the character of volcanic hazards, understand the location of residence in the DPA, collect data on residents in prone areas, collect data on resources in disaster-prone areas, compile regular procedures, prepare routes and signs for evacuation routes and train preparedness.

At Level 2 status, people in DPA I can still carry out their activities by increasing awareness. People in DPA II can still carry out their daily activities by increasing their awareness of dangers. People in DPA III are advised not to do activities around the crater. Communities in this status are advised to disseminate information on Alert Status, update population data in disaster-prone areas, update vulnerable populations in disaster-prone areas, collect data on resources in disaster-prone areas, prepare equipment and communication systems, prepare evacuation plans,

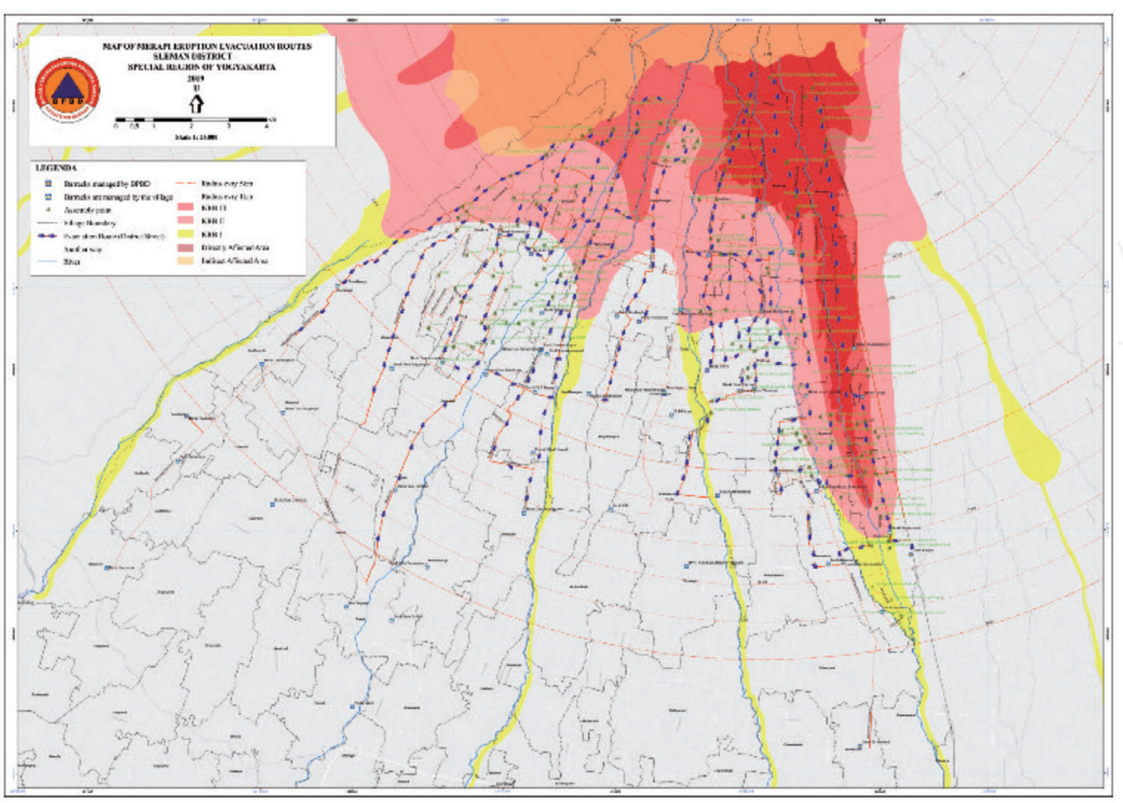

Figure 2.
Disaster Prone Area III (red), II (orange), I (yellow) and evacuation route figure.

prepare evacuation transportation tools, prepare refugee camps, preparation of public kitchens, explanation to the community and division of evacuation groups.

At Level 3 status, the people in DPA I increase their awareness by not doing activities around the river valley that is upstream in the peak area. The people in DPA II began to prepare themselves to evacuate while waiting for orders from the local government according to technical recommendations from the Geological Agency. People in DPA III are not allowed to carry out activities and begin to prepare themselves to evacuate. Communities at this level must disseminate Alert Status information, operate warning signs, operate evacuation transportation equipment, operate evacuation shelters, operate public kitchens ready, activate security, activate fixed procedures, activate communication systems, establish and activate command post for emergency response.

At Level 4 status, people in DPA I, II, and III immediately evacuate based on recommendations from the local government according to technical recommendations from the Geological Agency. In this status the community must disseminate information on Alert Status, sound warning signs, give verbal and written evacuation orders from the emergency response commander, activate regular procedures, carry out evacuations, activate evacuation sites, operate public kitchens, operate security and crisis centers. The DPA I, II and III is shown in **Figure 2**.

5. Emergency management

At level 3 status, the Sleman Government determined a Disaster Emergency Status through a Regent Decree, as well as activated the contingency plan to "Operation Plan for Emergency Management of Merapi Volcano Eruption with Adaptation to the Covid-19 Health Protocol". This activity is carried out to ensure protection and fulfillment of basic needs for survivors including vulnerable groups, including women, children, the elderly and people with disabilities. Henceforth, each component works in accordance with the description of its function, according to **Table 2**.

No	Function	Explanation
1	Command, Control, Coordination, Communication and Information	1. Command of disaster emergency response organization 2. The Command Post is located at the Pakem Sub-District Main Command Post. 3. Command Post as a control center, information center, resource management center as well as a center for coordination, services and complaints.
2	Planning, Handling and Prevention of Covid 19	1. Conducting a situation assessment and making daily progress reports 2. Manage Covid 19 data, information and public relations centers 3. Planning for the needs of refugees / survivors for three days. 4. Planning for the implementation of the Covid 19 health protocol 5. Perform consolidation and coordination 6. Planning and managing volunteers from outside the area 7. Determine treatment priorities 8. Provide assistance to sub-district field posts and village emergency response posts 9. Identify the economic potential that is owned 10. Develop a strategy to strengthen the economy of the community in refugee camps 11. Develop an early economic recovery strategy.

No	Function	Explanation
3	Operation	1. Carry out the process of evacuation and rescuing residents 2. Carry out a process of searching and helping residents 3. Isolating the patrol area and installing portable traffic signs 4. Implement the Covid-19 health protocol in all surgical procedures 5. Support the evacuation and rescue of livestock 6. Supports community livestock management
4	Sub-District Operational Unit Field Post	1. Supporting disaster emergency response 2. Supporting the fulfillment of the basic needs of residents and affected livestock in each village. 3. Ensuring the implementation of the Covid 19 health protocol in villages
6	Village Implementing Unit	1. Implementing Disaster Emergency Management 2. Fulfilling the basic needs of residents and affected livestock is carried out according to procedures 3. Implement Covid 19 health protocol enforcement 4. Providing self-isolation / quarantine for Covid 19
7	Logistic	1. Managing logistics to meet operational needs includes: personnel, facilities, transportation, food, facilities and infrastructure needs 2. Carry out logistics management functions (recording, sorting, storage distribution) 3. Implement the Covid 19 health protocol in all actions / activities
8	Administration and Finance (Secretariat)	1. Carrying out administrative governance functions that meet the principle of accountability 2. Prepare regulations for administrative and financial mechanisms in accordance with applicable laws and regulations 3. Provide support for administrative and financial governance processes

Table 2.
Fungtion and explanation of emergency management.

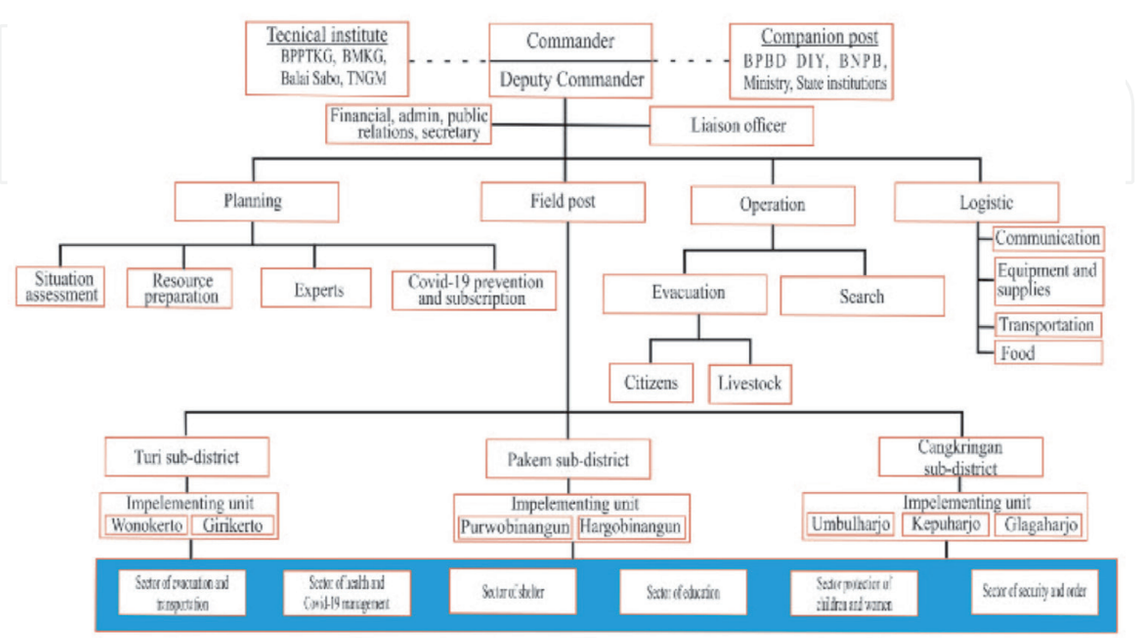

Figure 3.
Emergency Management Structure in Sleman District.

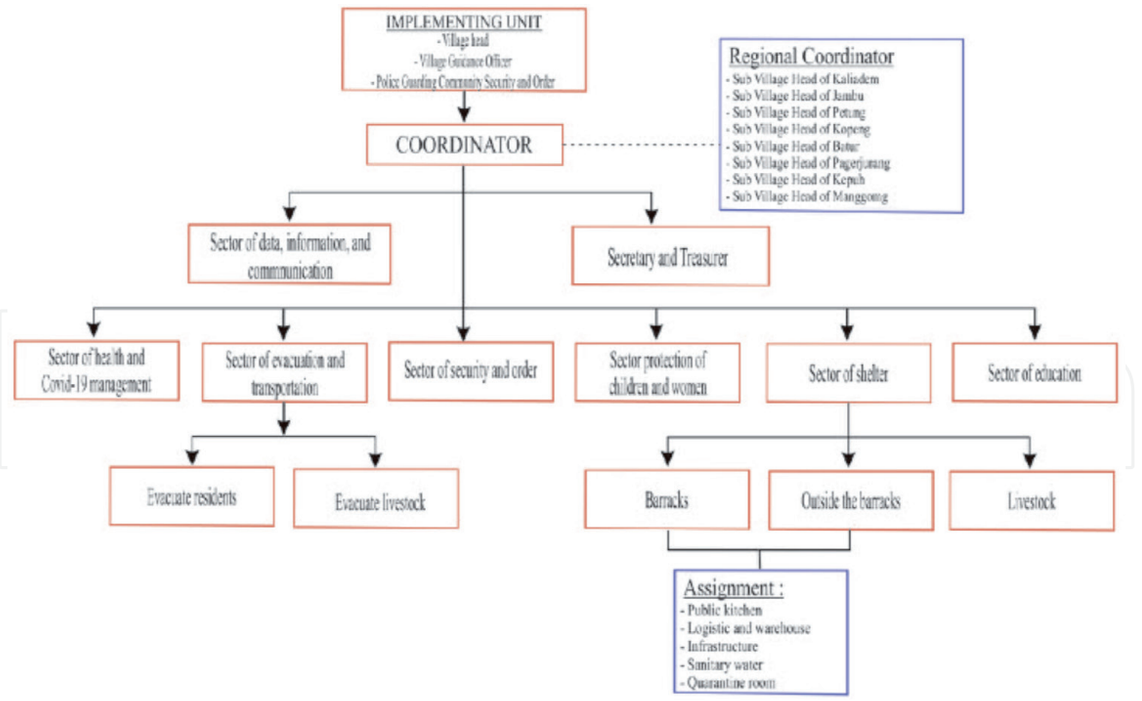

Figure 4.
Emergency management structure in village level.

Coordination is carried out following up the decree determining the emergency status. Therefore, all parties involved in the command structure for disaster emergency handling are urgently required to carry out their respective duties and functions to: (1) activate the information communication and reporting system at the post for disaster emergency management; (2) Mobilizing resources; (3) Determine the emergency response period for 30 days; (4) Prioritizing handling of vulnerable groups; and (5) Implementation of the Covid Health Protocol 19. The organizational structure for implementing emergency management at the district level is shown in **Figure 3**, and the structure at the village level is shown in **Figure 4**.

6. Child participation

Children's participation in the preparation of contingency plans is realized by including a declaration of the results of the children's forum discussion, sebagai berikut: (1). In disaster management, the vulnerable groups are prioritized; (2) The needs for clothing, food and shelter are adjusted; (3) Avoid sexual violence against children; (4) Periodic disaster mitigation activities for children; (5) Basic rights to education, spatial health, sharing and assembly are provided by the government; (6) Increase signposts that are easy for children to understand and lighting for evacuation roads; (7) Making an evacuation map; (8) Ensuring a comfortable place of refuge for vulnerable groups; (9) Involving children as caregivers for others; (10) Children need food that is varied and different from adults; when in evacuation; (11) The government opens the opportunity to cooperate with other parties and does not exploit children when a disaster occurs; (12) Speed up the creation of lost documents; (13) Mode of transportation for vulnerable people; (14) Increase the number of toilets in the evacuation posts and differentiate sanitation facilities for children and adults; (15) Availability of health experts and psychologists for children; (16) There are trauma healing activities as a priority; (17) Additional internal displace person/refugee rooms for children; (18) Use of social media as a means of communication.

7. Conclusion

This participatory and child-friendly contingency plan is a model for emergency response to volcanic eruptions during the COVID-19 pandemic. This document may be adapted for other comparable natural disaster contingency plans. This contingency plan will be easy to implement once it is completed with the Operational Plan document.

Acknowledgements

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