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Sister School for Merapi Volcano Disaster Risk Reduction

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Abstract. Living close to the dangers of volcanoes has become a descending culture in Indonesia, especially for people living around Merapi Volcano. The sister school program is implemented as one of the strategies to reduce the risk of volcanic disasters in the region. The purpose of this study was to examine the perception of the school community towards the sister school program at Merapi (The Case Study of Glagaharjo Elementary School and Bronggang Elementary School, Sleman Regency, Special Region of Yogyakarta, Indonesia). This research is quantitative-qualitative research. Data collection was carried out through in-depth interviews with the school principals in affected schools and supporting schools. In addition, interviews were conducted to all teachers and sufficient representatives of students in both schools. The results showed that principals and teachers in the affected schools and buffer schools agreed with the organization of the sister school, but still needed some improvements in the implementation. Furthermore, 91% of students in schools were affected and 90% of students at the buffer school also agreed with the sister school program.

1. Background

Merapi Volcano is one of the most active volcanoes in the world with more than 70 eruptions since 1548 [21]. Over the past two decades, Merapi Volcano erupted explosively every 8-15 years and even, had massive eruptions every 26-54 years, with an eruption period of approximately 4 years (Thouret, et al., 2000). Volcanic soil rich in minerals and fertility is one big reason for residents tend to live and live in volcanic areas. The more people living in hazard-prone areas, the more likely the disaster will affect the activities of human life. At least 9.6% of the world's population lives in areas that are vulnerable to volcanic activity and the majority of these areas are in developing countries [19]. Until 2010, there were more than 1.3 million people living on the slopes of this volcano (20 km radius from the summit) [14].

The eruption in 1994 and 2006 caused respectively, 6,000 and 20,080 residents to evacuate [13, 20]. Moreover, the last eruption occurred in 2010, left approximately 400,000 people evacuated from the disaster area [14, 17]. The pyroclastic flow that occurred during the Merapi eruption in 2010 also resulted in more than 2,200 houses being severe, moderately and lightly damaged as a result [7]. Since the 2010 eruption, changes in the area of disaster-prone areas (KRB) have been carried out by the



Center for Volcanology and Geological Disaster Mitigation (PVMBG), especially the KRB III (the greatest risk and prohibited from being used as residential areas) along the Gendol River on the southern slope of Merapi. Home damage experienced by residents and the expansion of KRB III made more than 2,200 families have to move from their villages. This was carried out in the rehabilitation and reconstruction phase.

Volcano threats, either during or after eruptions, include lava flows, pyroclastic flows, pyroclastic falls (bombs, lapilli), volcanic ash, lava, and tsunamis. This threat can have a significant impact, but the impact varies spatially because in an occurred eruption various kinds of threats can occur within the same period. Volcanic eruptions vary in terms of amplitude, duration, and frequency, even from the same volcano. This type of volcanic activity can change from time to time, such as the 2007 Kelud volcanic eruption [3] and the 2010 Merapi Volcano eruption [17].

One of the characteristics of Merapi Volcano is the 'growth and collapse of the lava dome' [21]. When the lava dome grows beyond a certain thickness and slope, the dome will collapse due to gravity effect. One of the most dangerous threats from Merapi Volcano is Pyroclastic Density Currents (PCD) or pyroclastic flow because it has destructive power (with temperatures that can reach $> 200^{\circ}\text{C}$). Other threats include ballistic projectiles that can occur within a 20 km radius of the crater during the explosive phase, as well as the threat of volcanic ash (tephra with a diameter of less than 2mm). In addition to the threat, there is still lava which is a common threat along the river with the Merapi upstream. Lava that is formed from pyroclastic deposits mixed with water (usually rainwater) can cause severe damage to the rivers flowing up at Merapi.

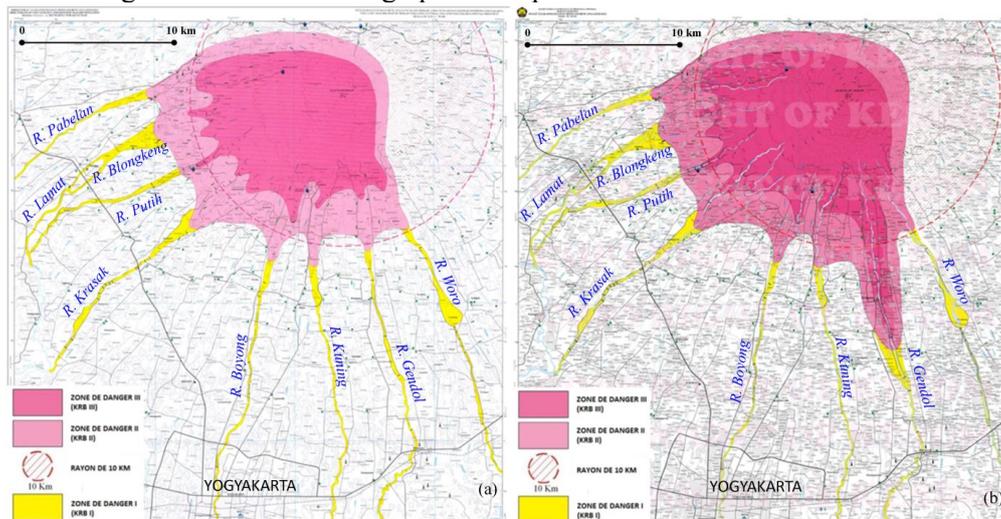


Figure 1. Change in Disaster Prone Areas (a) before and (b) after 2010 Eruption

The disaster-prone area (KRB) of Merapi Volcano is divided into three zones, namely KRB III, KRB II, and KRB I (from high to low vulnerability). KRB III is an area near the source of danger, often affected by pyroclastic flows, lava flows, and runoff. More than one million people live around the slopes of Merapi. Given that, the rate of growth in Central Java Province and Yogyakarta Special Region are respectively, 0.37% and 1.02%, the greater the risk of disasters [14]. Not to mention, according to the geological record that there is a risk of a large explosion that can affect not only the declared hazard area (KRB) but also a few kilometers outside the area [16]. The collapse of the old dome "Geger Buaya" (which is a topographic barrier in the south-southeast region) in 2006 resulted in increasingly open pyroclastic flow paths to the south [15]. The problem becomes more complicated because the trend of urban development in Yogyakarta is in the north (Sleman Regency), which means approaching Merapi. This means that risks increase and more potential problems exist.

Disaster risk reduction is a long-term activity as part of sustainable development using knowledge, innovation, and knowledge to build survival and resilience culture in all education units. Disaster risk

reduction in schools is important to do considering that there are quite a number of schools in the disaster-prone areas of Mount Merapi.

The concept of sister city partnerships in the context of disaster reduction may not be new, for example, the concept of a sister village after the 2010 Merapi Volcano eruption disaster has become one of the development programs in Magelang Regency and Sleman Regency [2, 4, 10, 11]. In addition to the sister village program, the regencies around Merapi Volcano, for example, Magelang Regency and Sleman Regency, have initiated sister school programs around 2012-2013, but only inaugurated at the end of last year. This is also in line with the program that was launched in 2013 by the Sleman District Disaster Management Agency namely the Disaster Preparedness School.

Aspects of disaster risk reduction are listed both explicitly and implicitly in various objectives in the SDGs, namely goals number 2, 9, 11, and 13. The purpose of SDGs number 11 is *Sustainable Cities and Communities: Make cities and human settlements inclusive, safe, resilient and sustainable* as follows ‘*substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, develop and implement, in line with the Sendai Framework for Disaster Risk Reduction, holistic disaster risk management at all levels.*’ emphasizing on disaster risk reduction aspects. Reflecting on number 17 sustainable development goals that emphasize the partnership for the goals, this study will attempt to examine the partnership for the goals issues in the context of disaster risk reduction with more focus on the linkages between safe and vulnerable areas. Several studies related to partnerships tend to lead to sister city partnerships, which have been scientifically proven to provide convenience, efficiency, and synergy between regions in realizing sustainable development goals in several cities [9].

2. Implementation of School Sisterhood in SDN Glagaharjo and SDN Bronggang

The term SDN stands for "Sekolah Dasar Negeri" in Bahasa Indonesia or public elementary school in English. This term will be constantly used in this paper to maintain the original name given by local residents. The sister school collaboration of SDN Glagaharjo and SDN Bronggang has been started since 2015. SDN Glagaharjo is located in Jetissumur, Glagaharjo Village, Cangkringan Sub-district, Sleman Regency with a radius of less than 10 km on the slopes of Merapi Volcano. Meanwhile, SDN Bronggang is located in Gayam Argomulyo, Argomulyo Village, Cangkringan Sub-district, Sleman Regency with a radius of 15 km on the slopes of Merapi Volcano. Both schools are geographically located in KRB III Merapi Volcano which has the highest disaster risk. The concept of sister school approved by both schools is that if there is a Merapi eruption, SDN Glagaharjo as the affected school will evacuate to SDN Bronggang as the first buffer school. The implementation of teaching and learning activities will be divided into two times, namely morning school and afternoon school. Learning equipment in class will be taken from SDN Glagaharjo at the time of the eruption. In accordance with the MoU, the collaboration between the two schools through the sister school program was only conducted during an eruption.

For both schools, the sister school program is an important thing to do primarily for the safety of children during school and the sustainability of children's education in the event of an eruption. Therefore, various stakeholders involved in the organization of sister schools include the BPBD of Sleman Regency, the Local Education Authorities, the District and Village Government, school principals, teachers, guardians of students, and other school residents. BPBD Sleman Regency has a role to facilitate and act as a bridge to connect between the affected schools and buffer schools, conduct training for disaster mitigation, and provide valid information regarding the condition of Merapi. While the Local Education Authorities has a role to facilitate and give permission to evacuate. The local government together with the school plays its main role in the evacuation process.

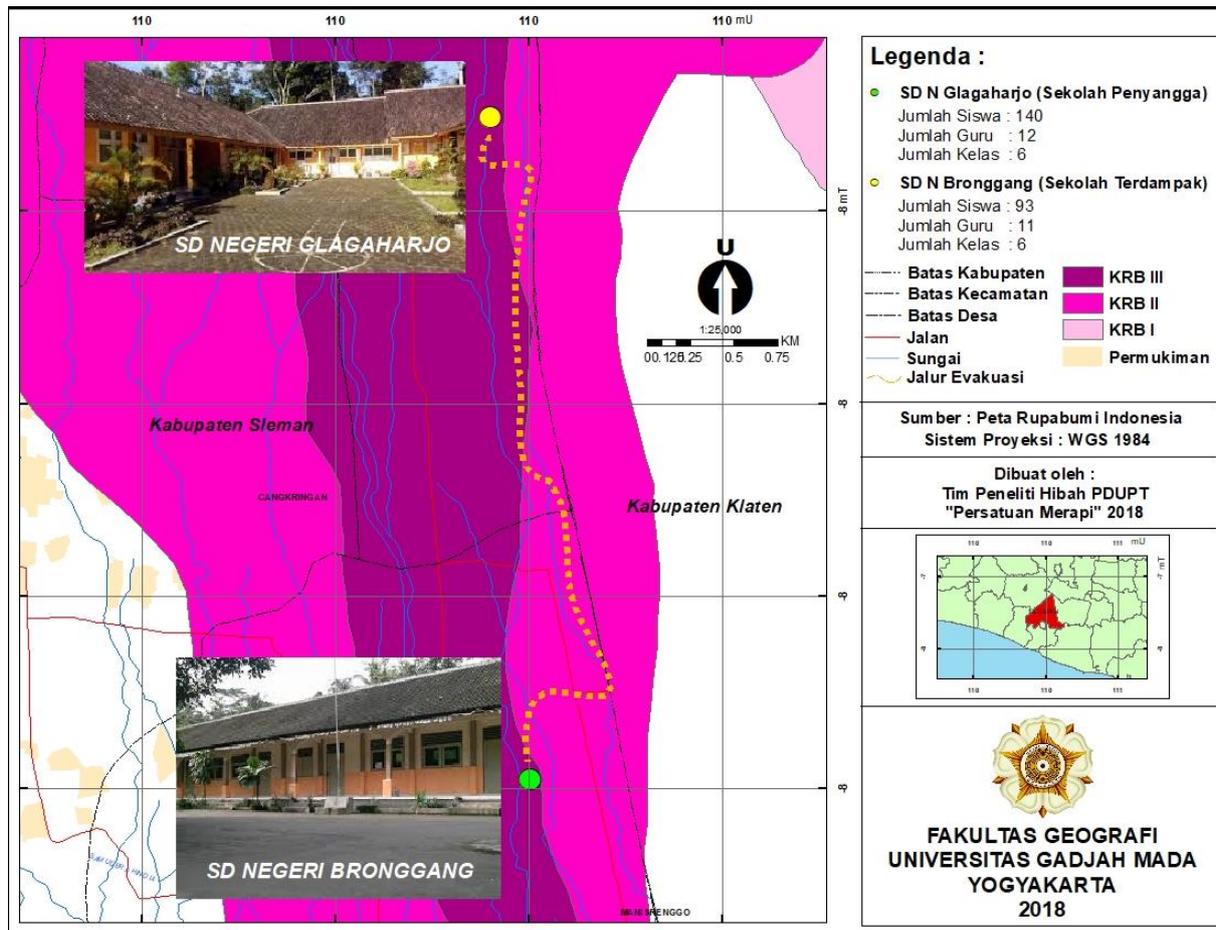


Figure 2.Evacuation Roadmap of SDN Gagaharjo to SDN Bronggang in Sleman Regency
Source: Indonesian Earth Map and Fieldwork Results (2018)

Currently, some of the facilities and infrastructure in both schools are in accordance with the principle of disaster risk reduction. Some facilities and infrastructures that are inappropriate such as the direction of the door, the slope of the roof of the building, and the availability of other supporting facilities. Since the beginning of the sister school collaboration program in both schools, there has been no new physical improvement. However, there are additional support facilities for disaster mitigation such as early warning systems and HT in SDN Glagaharjo and tents at SDN Bronggang.

When the phreatic eruption occurred on May 11, 2018, the implementation of the sister school did not follow the standard operating procedures. SDN Glagaharjo at the time of the eruption did not go to SDN Bronggang due to heavy traffic towards Argomulyo Village. So at that time, SDN Glagaharjo evacuate to SDN Kejambon 2 which was more easily accessed by trucks for the evacuation of students. After the incident, both schools hope for improvement and review of the MoU that had been made since 2015.

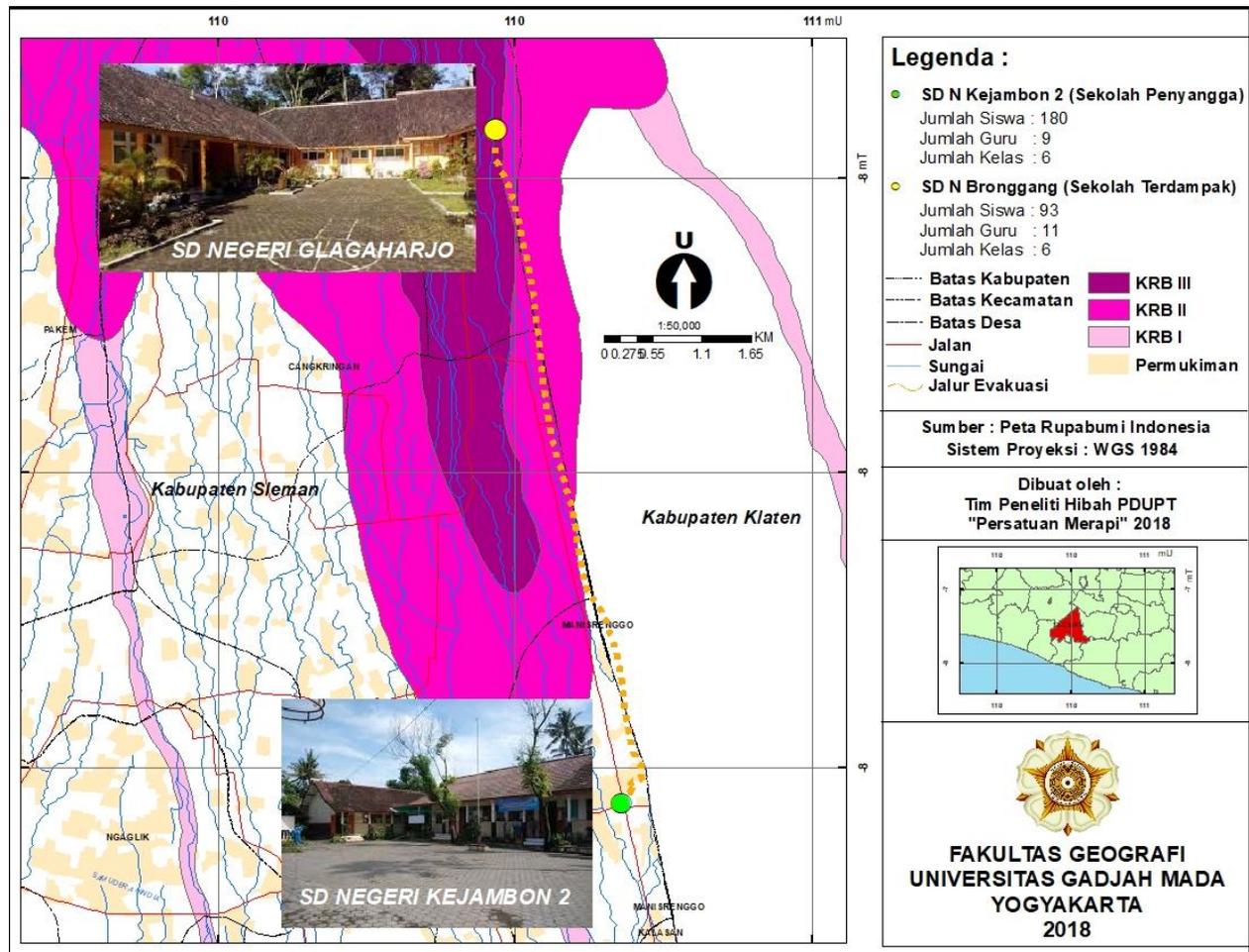


Figure 3. Evacuation Roadmap of SDN Gagaharjo to SDN Bronggang in Sleman Regency
Source: Indonesian Earth Map and Fieldwork Results (2018)

3. Knowledge of Planning Aspects in SDN Glagaharjo and SDN Bronggang

Knowledge of disaster aspects is an important thing to understand in order to support disaster risk reduction efforts. Based on the results of the census of teachers in affected schools and buffer schools, it shows that the level of knowledge of disaster aspects is still lacking, namely the average value of teachers in SDN Glagaharjo by 70 and the average value of teachers at SDN Bronggang by 71. Therefore, increasing knowledge of disaster aspects to teachers needs to be improved. The improvement in disaster knowledge of teachers at SDN Glagaharjo is primarily regarding KRB I and lava as a form of volcanic danger. Besides, knowledge improvement of disaster aspects for teachers at SDN Bronggang is primarily about KRB III and KRB I.

The survey results of 60 students (grade 4, grade 5, and grade 6) at SDN Glagaharjo and SDN Bronggang showed that the level of knowledge of disaster aspects was still lacking. The average test score of students in SDN Glagaharjo and SDN Bronggang are, respectively, 70 and 67 out of 100. This means that knowledge of disaster aspects of students also needs to be improved. The focuses of improvement in students at SDN Glagaharjo are mainly concerning KRB III, KRB I, and magma as the cause of eruption, while for students at SDN Bronggang, knowledge of KRB, causes of the eruption, and the existence of schools in KRB are the most important aspects to focus on the improvement program.

Table 1. Disaster Aspect Knowledge Of Teachers at SD Glagaharjo and SDN Bronggang

Name of School	SDN Glagaharjo	SDN Bronggang
Average score	78	71
Assessment Indicators		
Understanding the danger of volcanoes in the form of hot clouds	90	80
Understanding the danger of volcanoes in the form of lava	70	90
Understanding the danger of volcanoes in the form of ash	80	90
Understanding of magma as the cause of magma eruption	90	90
Understanding of humans as the cause of eruptions	100	80
Understanding of KRB III	100	50
Understanding of KRB I	60	60
Understanding the existence of schools in the KRB	100	80
Understanding possible eruptions again	80	90

Source: Analysis Results (2018)

Table 2. Disaster Aspect Knowledge of Students at SDN Glagaharjo and SDN Bronggang

Name of School	SDN Glagaharjo	SDN Bronggang
Average score	70	67
Assessment Indicators		
Understanding the danger of volcanoes	100	97
Understanding the danger of volcanoes in the form of hot clouds	97	90
Understanding the danger of volcanoes in the form of lava	97	90
Understanding the danger of volcanoes in the form of ash	87	90
Understanding of magma as the cause of magma eruption	43	40
Understanding of humans as the cause of eruptions	83	80
Understanding of KRB III	23	23
Understanding of KRB I	20	23
Understanding the existence of schools in the KRB	77	50
Understanding possible eruptions again	73	83

Source: Analysis Results (2018)

4. Perception of School Sisterhood Programs at SDN Glagaharjo and SDN Bronggang

The implementation of the sister school program at Glagaharjo and SDN Bronggang Elementary Schools has been started since 2015. Based on the census results for teachers in both schools, it was shown that 100% of teachers at Glagaharjo Elementary School had known about the concept of sister school and its existence in the school. However, not all teachers at SDN Bronggang, which is a buffer school, have already known the concept of sister school and its existence in the school. Census results show that 30% of teachers do not know the concept of sister school and 20% are not aware of the program at school. All of the teachers (100%) at SDN Glagaharjo consider the sister school program useful and 91% of teachers at the school are happy with the program. In contrast, only 90% of teachers at Bronggang Elementary School said the sister school program was useful, but no one opposed the program.

Table 3. Perceptions of Teachers at SDN Glagaharjo and SDN Bronggang towards Sister School

Name of School	SDN Glagaharjo	%	SDN Bronggang	%
Number of Teachers (people)	11		10	
Perception of Sister School				
Know about sister school	11	100%	7	70%
Know about the existence of sister school	11	100%	8	80%
Opinions about sister school				
1. Happy	10	91%	8	80%
2. Indifferent	0	0%	2	20%
3. Unhappy	1	9%	0	0%
Opinions about the benefits of sister school				
1. Useful	11	100%	9	90%
2. Not useful	0	0%	1	10%
Know the name of the sister school	10	91%	8	80%

Source: Analysis Results (2018)

According to the results of a survey to 30 students (grade 4, grade 5, and grade 6) at SDN Glagaharjo, a total of 77% of students at SDN Glagaharjo have known the concept of sister school and 53% of its existence in the school. As much as 90% of students are happy with the sister school program, while 3% feel normal and 7% do not like it. A total of 87% of students at Glagaharjo Elementary School said that the sister school program was useful, while the other 13% said it was not useful. Only 30% know the name of the sister school of SDN Glagaharjo. In contrast, the results of a survey of 30 students (grade 4, grade 5, and grade 6) at SDN Bronggang showed that only 13% of students had known the concept of sister school and 40% had known its existence in the school. As many as 93% of students enjoy the sister school program, while 7% feel normal. 100% of the students at SDN Bronggang said that the sister school program was useful and 43% had known the name sister school of SDN Bronggang.

Table 4. Perceptions of Students at SDN Glagaharjo and SDN Bronggang towards Sister School

Name of School	SDN Glagaharjo	%	SDN Bronggang	%
Number of Students (people)	30		30	
Perception of Sister School				
Know about sister school	23	77%	4	13%
Know about the existence of sister school	16	53%	12	40%
Opinions about sister school				
1. Happy	27	90%	28	93%
2. Indifferent	1	3%	2	7%
3. Unhappy	2	7%	0	0%
Opinions about the benefits of sister school				
1. Useful	26	87%	30	100%
2. Not useful	4	13%	0	0%
Know the name of the sister school	9	30%	13	43%

Source: Analysis Results (2018)

5. Conclusions

Knowledge of disaster aspects for teachers and students in affected schools and school support need to be improved. Nevertheless, the school principal and the teachers of SDN Glagaharjo (school affected) and SDN Bronggang (buffer school) have known the existence of the two schools in disaster-prone areas so that they agree with the organization of sister schools in schools but some improvements are still needed in their implementation. In addition, a total of 91% of students in schools were affected and 90% of students at the buffer school also agreed to the sister school program because it could be beneficial for both schools.

6. Acknowledgment

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