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Bridging the existence indigenous knowledge and disaster education: An example of Mount Slamet in Central Java, Indonesia

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Abstract

Indigenous knowledge plays an important role in disaster mitigation, especially in the communities around Mount Slamet, Central Java, Indonesia. This study examines local tradition and sites such as Merti Bumi, Batur Kedawung, Igir Tembalang, and Batu Leebrag, which are the embodiment of adaptive strategies for volcanic disaster preparedness. Using a qualitative descriptive approach, data were collected through field observations, in-depth interviews, and document analysis. The findings of the study show that indigenous knowledge improves community resilience by providing early warning signs, spatial awareness, and culturally embedded mitigation measures. Integrating indigenous knowledge into geography education offers a holistic disaster risk reduction strategy, bridging traditional and scientific perspectives. However, the preservation of local knowledge faces challenges, including urbanization, generational shifts, and limited empirical validation. In addition, rigid national curricula often neglect community-based knowledge, thus limiting its integration into formal education. To address this issue, an inclusive framework is needed to incorporate indigenous knowledge into disaster education, ensuring its sustainability for future generations. The study underscores the importance of collaborative efforts between educators, policymakers, and local communities to maintain indigenous knowledge as a dynamic resource for disaster preparedness.

Keywords: Indigenous Knowledge, Disaster Mitigation, Disaster Education, Mount Slamet, Community Resilience

Introduction

The interplay between ecosystems and community structures fosters the development of Indigenous Knowledge (IK), which is fundamentally embedded within the daily practices of the local community (Bwambale et al., 2020). This body of knowledge, accumulated and transmitted across generations, provides pragmatic strategies for disaster response and mitigation (Aswani et al., 2018). For example, the observations of early warning signs, such as alterations in wildlife behavior, changes in river water color, and distinctive auditory phenomena, prompt preparatory actions for impending disasters (Raburu et al., 2024). Further, cooperative measures, including

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collective evacuation efforts and the protection of essential resources, underscore the profound connection between local expertise and disaster management frameworks (Elvegård et al., 2024). In contemporary times, IK faces numerous significant challenges (Aswani et al., 2018). The rapid pace of technological advancement, urbanization, and the extensive dissemination of information contribute to the dilution or even loss of cultural practices and beliefs that have been passed down through generations (Youvan, 2024). Nonetheless, the potential for integrating traditional knowledge with modern technological solutions presents both a challenge and an opportunity to enhance the efficacy of disaster risk management. To maintain the relevance and utility of local knowledge, an inclusive strategy is imperative (Xiao et al., 2018). This approach should particularly focus on involving the youth through community-based educational initiatives and fostering cross-sectoral partnerships (Nirwansyah et al., 2023; Syarif, 2024). Such efforts are essential for preserving and revitalizing indigenous knowledge systems in the face of global changes (Cajete, 2020).

IK in disaster management extends beyond mere adaptive strategies; it represents a vital component of cultural practices, imbued with historical, social, and spiritual values. Cultural practices such as earth almsgiving, the execution of *larung* sacrificial offerings, and communal prayers on mountains are not only acts of religious observance but also demonstrate a community's commitment to environmental stewardship and a balanced interaction with nature (Hastuti et al., 2021; Setiawati et al., 2021). In other words, these practices serve a dual purpose: they are acts of faith and reminders to the community, particularly to future generations, about the importance of coexisting harmoniously with the natural world. Moreover, local narratives and beliefs about natural phenomena, such as mountain myths, play a crucial role in empowering communities to recognize and communicate disaster-related signals effectively (Ratnaningsih et al., 2022). For instance, the story of a "mountain spirit" often illustrates natural events like lightning, seismic activity, and shifts in wind patterns, serving as metaphors for environmental cues that signal potential disasters (Sharon, 2021). These stories, while simplistic in form, encapsulate profound lessons in vigilance and preparedness that are deeply ingrained in the societal fabric (Andharia, 2020).

However, the resilience of this IK is increasingly challenged by the rapid pace of modernization and generational shifts, with a growing reliance on technology that often deems these traditions archaic (Orlove et al., 2022). This is evident from the declining participation in traditional rituals and the diminishing value placed on ancestral narratives among the youth (Knight, 2020). Despite these challenges, if managed effectively, these cultural practices can be potent tools in enhancing the efficacy of locally based disaster mitigation systems (Marhadi et al., 2024). Addressing the challenges posed by modernization and generational change necessitates innovative approaches to ensure the continuity and relevance of this IK, particularly through educational initiatives aimed at integrating IK with contemporary disaster management strategies (Mbah et al., 2021). This integration is essential for preserving the integrity of cultural heritage while adapting to the evolving landscape of disaster threats (Sesana et al., 2018).

In formal education, material on natural signs, traditions, and local practices can be incorporated into lessons such as geography or social studies (Semken et al., 2017). Project-based learning activities, such as field exploration or documentation of local traditions, provide students with hands-on experience to understand IK (Boakye-Yiadom et al., 2025). Informal education through community training, seminars, or cultural festivals is also important to strengthen the transfer of knowledge across generations (Sprinkle & Urick, 2018). In addition, technology can be used to create digital documentation in the form of educational applications or learning videos, so that information is more easily accessible and stored properly (Puspitarini & Hanif, 2019). With

this approach, education not only preserves IK, but also increases public awareness in dealing with disaster threats, as well as strengthening cultural identity in local communities (Triastari et al., 2021). Teachers can combine what they know with new science to better handle disasters (Kamil et al., 2020). Given the crucial role of education, the development and integration of indigenous knowledge-based curriculum in senior high schools, especially in Geography and disaster mitigation subjects, is very important. Although local knowledge has proven to be invaluable in disaster mitigation, the reality is that the current formal education curriculum does not integrate disaster mitigation materials, especially in geography lessons (Lestari & Suwanto, 2024). This makes the great potential of local wisdom less accessible in the learning process at school. Therefore, this study is here to explore how the integration of local knowledge into the curriculum can strengthen students' disaster preparedness while preserving a rich and meaningful cultural heritage (Hidayat & Yatminiwati, 2023).

In the area around Mount Slamet, where communities live side by side with the potential for natural disasters, a deep understanding of how their IK contributes to environmental mitigation and management becomes very relevant (Pawestriana, 2016). Therefore, strengthening education is an important step in disaster prevention and mitigation (Ramadhan et al., 2019). Through formal education, students can be trained to recognize natural signs, understand risk maps, and take part in disaster simulations. This education trains preparedness from an early age (Atmojo et al., 2018). Given the urgency and challenges outlined, this study focuses on how IK contributes to disaster mitigation and environmental management in communities around Mount Slamet, and specifically explores the challenges and opportunities for integrating this local wisdom into the formal education curriculum, especially at the senior high school level (Budiman & Oue, 2025).

Problems

In the Banyumas region, Central Java, Indonesia, the cultural existence is expressed in traditions, myths, and rituals that honor nature and mountains as living phenomena (Fajria Pawestriana, 2016). In this area, that Mount Slamet, with its wealth of IK and cultural heritage, the slopes of Mount Slamet, especially Banyumas, offer great potential to be integrated in efforts to strengthen disaster education (Budiman & Oue, 2025). Some traditions, myths, and customary practices that have been passed down from generation to generation are not just the reason for IK (Darmadi, 2018). They are also an excellent foundation for building a strong concept of disaster education that is complex and very useful for every type of societal problem (Titz et al., 2018). In this view, this study aims to determine how IK and cultural heritage can be documented, developed, and applied as an integral part of an education-based disaster mitigation strategy.

Therefore, it is important to investigate, record, and advocate for local IK within the framework of a community-oriented emergency response (Bhushan et al., 2018), especially for communities living near Mount Slamet. In connection with the previous explanation of the importance of mitigation knowledge based on IK. Regarding to description, this research aims to examine the existence of IK of the community surrounding Mount Slamet, specifically for disaster education purposes (Jiang et al., 2019). Thus, the research is mainly explored the potential use of IK in the formal education of high school, with the integration in the learning approach, student activities in the context of relevant topics in the geography subject.

Method

The study adopts a qualitative descriptive approach focused on uncovering local spatial knowledge and its development for educational materials. The ethnographic approach, which is part of the qualitative descriptive method, allows researchers to dive into individual experiences and perspectives in their cultural contexts (Yanık, 2017). This method emphasizes a holistic understanding of social phenomena through various techniques such as direct observation, field surveys, in-depth interviews with selected informants (see Table 1), and relevant documentation (Mohajan, 2018; Monroe et al., 2019). In this context, the study pays special attention to social relationships and interaction patterns that shape the dynamics of individuals' lives, aiming to reveal hidden factors that contribute to locally-based knowledge (Holt-Lunstad, 2018; Schick et al., 2018). The qualitative descriptive approach allows researchers to collect authentic and in-depth data, ensuring that the findings accurately reflect the realities observed in the field (Lim, 2024).

Table 1. The pseudonym used to refer to the subjects in this study

Informants	Initial	Age	Gender	Occupation
1	Sources (S1)	57	Male	Village Officials
2	S2	51	Male	Farmers
3	S3	87	Male	Agricultural Laborers
4	S4	39	Male	Farmers
5	S5	47	Male	Village Officials
6	S6	58	Male	Village Officials
7	S7	55	Male	Drivers
8	S8	41	Male	Village Officials
9	S9	57	Male	Village Officials
10	S10	43	Male	Public Works Department Employees
11	S11	53	Male	Village Officials
12	S12	64	Male	Farmers
13	S13	46	Female	Food Trader

By focusing on local spatial knowledge, the research aims to develop educational resources that resonate with the lived experiences of individuals within their social and geographical contexts. This integration of expertise with the researcher's knowledge is crucial for capturing local perspectives and ensuring that results are grounded in the cultural and social contexts of the subjects studied (Klenk et al., 2017). Furthermore, this approach highlights the significance of understanding human behavior and experiences as they interact with their natural and social environments (Shamay-Tsoory & Mendelsohn, 2019). Overall, this qualitative descriptive methodology not only aims to describe phenomena but also seeks to develop educational materials that reflect the complexities of IK systems, thereby enhancing the relevance and applicability of research findings in practical contexts.

Data Collection

For this study, data collection through GPS survey was carried out in a period starting from September 2024, with the initial stage in the form of preparing a research. At this stage, the researcher coordinates with various parties to formulate steps to implement the research and ensure the involvement of local communities in the data collection process (Rumkel et al., 2019). The data collection stage was carried out in November 2024, when researchers went directly to the field to conduct observations, interviews. This field activity includes observation of local practices

related to disaster mitigation, exploration of cultural values that still survive, and direct interaction with communities in villages in the research area as priorly presented in (Dasanayaka & Matsuda, 2022). During the survey, a total of 7 locations were marked and evaluated carefully. These locations were identified after consulting with village officials and community leaders, who provided valuable insights into areas rich in IK and relevant to disaster preparedness (Arviansyah et al., 2021). The chosen sites included a variety of settings, such as the Igir Tembalang hills (as part of geological features in Banyumas), the cultural site of *Batur Kedawung* (a site for observation and rituals), and areas known for traditional practices like the *Merti Bumi* ceremony. During these site visits, researchers conducted relevant geological and geomorphological assessments, such as examining slope angles and rock formations. In this stage, the data collection also examined related historical information through interviews, compiling narratives about past disasters and community response (Indah, 2018).

Furthermore, all information relevant to disaster didactics were collected primarily through document analysis as performed in (Boakye-Yiadom et al., 2025). The primary document used was the "*Kurikulum Merdeka*" or Independent Curriculum for the geography subject (Pratama et al., 2023). Key elements extracted from this curriculum included Learning Outcomes (LO) at each grade level, particularly in Phase E (Grade X), which focuses on basic geographic knowledge, and Phase F (Grades XI and XII), which emphasizes complex themes such as sustainable development and disaster mitigation (Kemendikbudristek, 2022). In the geography section of the curriculum, students are expected to achieve certain competencies at each stage (Lambert & Jones, 2013). In Phase E, students must understand basic geographic concepts, map skills, research methodology, and geosphere phenomena. Phase F expands on this, aiming for students to analyze regional characteristics, understand interactions between physical and social elements, and comprehend disaster phenomena and environmental issues, aligning with real-world applications and local contexts (Kemendikbudristek, 2021).

Data Analysis

The GPS-equipped fieldwork activity encompasses the observation of local practices related to disaster mitigation, the exploration of enduring cultural values, and direct interaction with communities in the villages within the research area (Titz et al., 2018). To enhance the clarity and rigor of the research process, a structured observation guide was developed prior to fieldwork. This guide outlined specific aspects to be observed, such as community responses to early warning signs, participation in traditional rituals, and the use of local knowledge in disaster preparedness activities. Observers were instructed to record not only the actions and interactions of community members but also the context in which these practices occurred (Rivera, 2021).

Further, a semi-structured interview protocol was designed to ensure consistency across interviews while allowing for in-depth exploration of participants' experiences (Bilgili et al., 2015). The interview questions focused on topics such as the transmission of IK, changes in disaster-related practices over time, and the perceived relevance of traditional methods in the current context (Markolinda et al., 2025). Both the observation guide and the interview protocol were previously adapted to the local context, ensuring that the data collected would be comprehensive and meaningful (Hirono, 2022). The collected data were categorized into two groups: tangible heritage, such as buildings or artifacts, and intangible heritage, including local traditions and practices for disaster management (Nocca, 2017). This process aims to develop a map reflecting the community's perspective, which can serve as a reference for enhancing the capacity of communities and schools in addressing a curriculum that educates students on disaster preparedness and response (Shah et al., 2020). The outcomes of this analysis form the foundation

for pre-designing a disaster curriculum that integrates IK into the formal education system. Before implementation, the curriculum design undergoes evaluation and review to ensure its feasibility and effectiveness (Uusiku, 2023).

The results from interviews and documentation were analyzed to describe the physical conditions of the location and the characteristics of the disasters that occurred, such as geological processes and eruption track records documented in the research area. The data analysis in this study was carried out in stages through a coding process, which helped researchers explore hidden meanings from qualitative data (Braun & Clarke, 2021; Sahrul et al., 2024). The initial stage began with open coding, where researchers read transcripts carefully and labeled important parts without category limitations. Furthermore, through axial coding, the codes found were connected to identify patterns and relationships between themes. This process continued with selective coding, which was the selection of the main codes that best represented the core findings (Nowell et al., 2017). Through this stage, researchers built a grand narrative from data details, making the research results more structured and meaningful, while maintaining the integrity of the participants' experiences. Additionally, local community knowledge related to disasters, including stories, myths, and traditions, was identified and documented (Yari et al., 2019). For instance, local communities possess hereditary stories of natural signs preceding disasters, which often align with scientific findings (Hadlos et al., 2022). This data was then categorized into two groups: tangible heritage, such as buildings or artifacts, and intangible heritage, including local traditions and practices for disaster management (Ćosović et al., 2019; UNESCO, 2018). This analysis aims to create an image reflecting the community's perspective, which can be used as a reference for enhancing the capacity of communities and schools in dealing with a curriculum that educates students on understanding and managing disasters (Kamil et al., 2020).

The integration of local information is achieved by selecting relevant learning topics for grades 10-12 (Phase E and Phase F). These topics are aligned with the basic competencies in the curriculum, such as understanding disaster mitigation, physical geography, and environmental dynamics (Nurdin, 2019). Furthermore, the integration focuses on the development of teaching materials, learning strategies, and student learning activities (Thibaut et al., 2018). For example, teaching materials may include case studies of local disasters, while learning strategies might involve disaster simulations or field projects to explore IK (Oktari et al., 2020). Student learning activities are designed to encourage active participation, such as group discussions about local stories or myths related to disasters, as well as hands-on practice in identifying natural signs. The results of this analysis serve as the basis for designing a disaster curriculum that integrates IK into the formal education system (Atmojo et al., 2018). Before implementation, the curriculum design is evaluated and reviewed to ensure its feasibility and effectiveness (Chan et al., 2017).

Results

Acquiring IK for Disaster Education

During field research and interviews with informants, it was seen that IK is the community's collective understanding, knowledge and wisdom in facing challenges, including natural disasters. In disaster mitigation education, IK plays an important role in building a culture of preparedness from an early age (Wang et al., 2019). For example, the hereditary story about the origin of the name Mount Slamet, which was previously called Mount Gajah because of its large size on the island of Java, then the eruption of the mountain but still survived and Mount Gajah was renamed Mount Slamet. An S5 village official (47), explained:

"The story from the parents of Mount Slamet was originally called "Gunung Gajah". This name was

changed to Mount Slamet after a major eruption that made the community feel 'safe'."

Viewed from the south side, Mount Slamet is relatively safe from volcanic activity because it is quite far from the crater (about 8–12 km), is outside the vulnerable zone (KRB), and is protected from the flow of volcanic material (Sehah et al., 2023). This research highlights how IK in Banyumas is a guide for communities in dealing with disaster threats, with traditions such as gandulan[6] contributing to preparedness and resilience. IK in Banyumas, especially around Mount Slamet, serves as a valuable resource for disaster education. Integrating this knowledge into the geography curriculum can improve students' understanding of disaster mitigation while preserving cultural heritage to be developed into teaching materials for high school students. S10 (43), a resident of Ketenger village, Baturraden, Banyumas, revealed:

> "The tradition is in the form of "*Gandulan*" or "*Jangan Gandul*". In Javanese, "*Gandul*" means Papaya and "*Jangan*" means cuisine. Gandulan or Jangan Gandul is a tradition where people cook unripe papaya fruits and use them as dishes. This tradition has been going on for generations. The Gandulan tradition is mainly defined as, gumanduling rasa kepada yang kuasa".

IK in Banyumas, including *nyabuk gunung*[7] farming techniques, has great potential in strengthening disaster education (Suwarno et al., 2022). The hilly topography on the southern slopes of Mount Slamet reduces the risk of lava flows because the slope of the mountain is tilted towards utar. On the southern slopes, deep-rooted vegetation and natural cliffs serve as additional barriers. S11 (53), a village official, stated:

> "The hilly topography of the southern slope of Mount Slamet and the direction of lava running tilted northward reduce the risk of lava flows. Mitigation is also carried out by nature that has been designed by the creator with vegetation firmly rooted in the boundary of the vegetation above and natural cliffs as a barrier below."

Nevertheless, the IK of the Banyumas community also relates to the existence of the physical features. The Batu Leebrag, or Leebrag stone, exemplifies a local belief system that remains underexplored in academic discourse, despite its significance as geological knowledge related to early warning systems and the understanding of volcanic activity. Its presence as a geographical marker, a source of folklore, and an educational medium demonstrates the community's holistic interpretation of natural signs. This knowledge not only supports the argument for the relevance of IK in disaster management but also paves the way for further exploration in subsequent sections. Topics such as the role of oral traditions in fostering preparedness, the integration of local agricultural practices with structural mitigation strategies, and the potential of community trust as an ecosystem-based early warning system are crucial for discussion. By emphasizing these aspects, readers are encouraged to consider how the integration of IK can enhance disaster education curricula in secondary schools, thereby equipping future generations to be more responsive to disaster risks.

Geological feature of Igir Tembalang

The hills of the northern region of Cilongok, including Sambirata, Karang Tengah, Gunung Lurah, Sunyalangu, and Sokawera, are part of the geomorphology of the hilly slopes of Mount Slamet. In the Sambirata area, the village mountain itself, according to S5 (47), the height of the

[6] Tradition in the village of the southern slope of Mount Slamet where the community cooks raw papaya into vegetable dishes.

[7] A traditional terracing technique, involves farmers constructing vertical earthen embankments perpendicular to the contour of the slope, interspersed with horizontal terraces parallel to the contour.

village ranges from 400-500 meter above sea level. The slope of the slope varies between 15-40°, creating a distinctive pattern of water flow while increasing the potential for erosion (Dube et al., 2020). This landform not only reflects geological dynamics but also affects people's perception of the risk of volcanic disasters in the region.

The people on the slopes of Mount Slamet have a close relationship with nature and the potential threat of disasters. Their calmness as volcanic activity increases reflects a belief in the inherited balance of nature. Residents continue to farm and carry out their daily activities, believing that volcanic activity will not have a direct impact, especially on the southern side. This belief is strengthened by the existence of the Igir Tembalang hills which are considered natural protectors from volcanic hazards such as lava flows or volcanic ash, as conveyed by S5 (47) and S6 (58). The adaptation of the southern slope community is also reflected in the results of the interviews (S1-S12), where they remain vigilant and carry out their daily routines. S9 (57) gave an example of the increase in activity of Mount Slamet in April-September 2014, which did not stop community activities due to the belief in the protection of the geomorphology of the hills. Their risk perception is more influenced by external threats such as volcanic ash from Mount Merapi.

> "Here when the eruption in 2014 continued to carry out normal activities, only here was also an observation post for Mount Slamet activity at that time, precisely at my house (S9). Residents continue to carry out activities as usual but still with caution, because volcanic ash only passes through here (Semaya hamlet, Sunyalangu, Karanglewas, Banyumas) because there is a hill that leads to Mount Slamet."

The geomorphological role of Igir Tembalang as a natural barrier to volcanic hazards provides direct application for the teaching of physical geography, geomorphology, and hazard mapping. The hills in these areas influence settlement patterns and disaster risk perceptions, illustrating the practical implications of topography in disaster mitigation. By integrating Igir Tembalang into lessons on volcanic hazards, students can learn to interpret topographic maps, analyze slope stability, and evaluate how natural land forms contribute to risk reduction. This learning experience can be enhanced through hands-on activities such as GIS-based spatial analysis, field surveys, and disaster scenario simulations, which are in line with Phase E geography competencies on geosphere phenomena and hazard mitigation strategies.

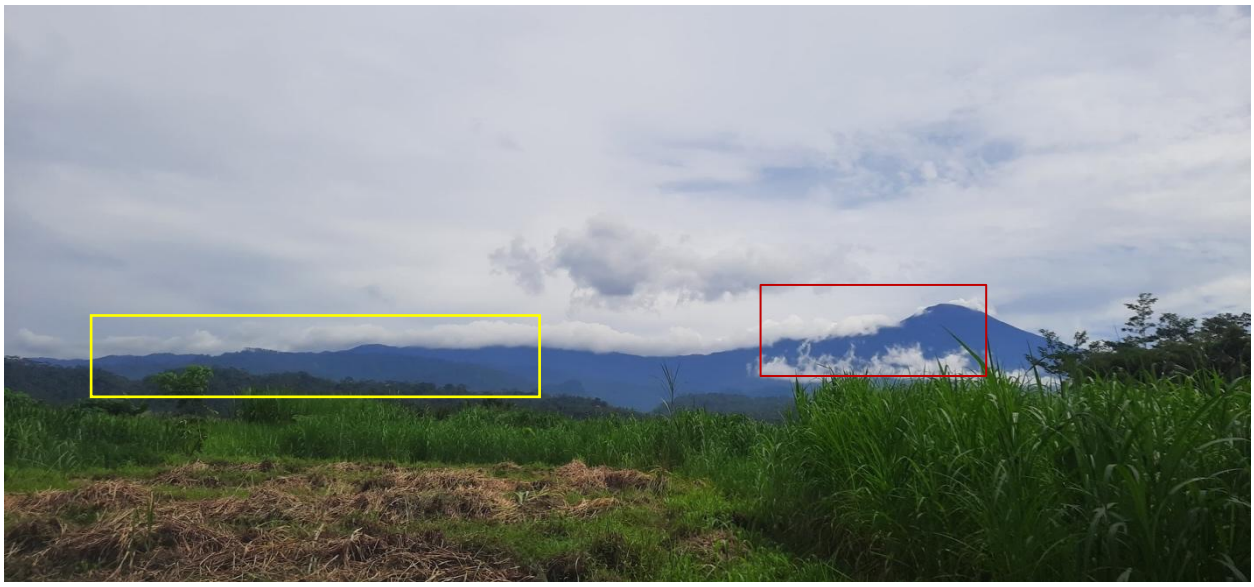


Figure 2. Igir Tembalang (yellow box) ridgeline is considered a natural protector against volcanic hazards (topographic view of Igir Tembalang from Gununglurah, Cilongok district) from Slamet Mountain located in eastern part (red box).

Batur Kedawung

Batur Kedawung, which is located Ketenger village, Baturraden district. The Batur Kedawung site can be interpreted as a location that has historical and social significance in the geographical context of Mount Slamet. The local community's belief in the site's relationship with the Predecessor of Ketenger Village reflects the social and cultural constructs associated with the place. The practice of meditative asceticism carried out by Ketenger Village can be seen as an effort to understand and interact with the natural environment, especially Mount Slamet. Furthermore, the strategic position of this site to monitor Mount Slamet activities shows the existence of an empirical understanding of the community's potential volcanic hazards and traditional disaster mitigation efforts. Thus, the Batur Kedawung Site not only serves as a spiritual space but also as an observation point and early warning against natural threats, which is integrated into the IK of the local community. This is related to the narrative of S10 (43) nurse at the Batur Kedawung Site.

> "The position of the Batur Kedawung site itself faces north (directly facing Mount Slamet) where the place can be said to be quiet, and then a meditation ritual/procession is carried out at night because it is quiet, actually it can be during the day but it is not effective, the story is that this has been carried out before this village existed by the predecessor, namely Kyai Nurasan8."

In the classroom environment, Batur Kedawung can be a case study to understand how people develop observation techniques based on their geographical environment. Students can engage in spatial mapping exercises, analyze the significance of nature observation points in disaster mitigation, and discuss how traditional knowledge complements modern monitoring systems. This supports the learning objectives of Phase F geography, particularly in the study of volcanic hazards and their impacts on human settlements.

[8] Kyai Nurasan, a predecessor figure who, according to local stories, is believed to have meditated before this village was founded, thus making Batur Kedawung a place full of spiritual meaning and very closely related to the historical roots of the local community.



Figure 3. Batur Kedawung as a place of meditation and as an observation of Mount Slamet

Merti Bumi ritual

Traditional life in the villages of the research site (Sungalangu, Gunung Lurah, Sokawera, Karang Tengah, and surrounding areas) is colored by community culture which is reflected in communal rituals. Javanese people, with their thick traditions, have various traditional ceremonies that are carried out repeatedly. These rituals are an important part of community life and are passed down from generation to generation. According to S11 (53), in these villages, there is a "Suran[9]" ritual that is carried out to commemorate the Hijri[10] New Year. This commemoration is held every 1st of Muharram[11], which in the Javanese calendar is known as the 1st of Suro, so the activity is called Suran. In addition, Ketenger has a communal ritual called "Merti Bumi". This ritual is carried out as a form of gratitude to God for the harvest and the safety of the community. The ritual of "slametan," as a popular religious ritual in Javanese Islamic society, is also part of a recurring tradition (Awalin, 2018).

This tradition includes cultural practices that focus on environmental sustainability, such as the prudent management of natural resources and the preservation of local flora and fauna. This approach reflects the community's understanding of the importance of maintaining the balance of ecosystems, which is in line with the principles of physical and ecological geography. In the context of geography learning, it shows how the interaction between humans and the environment can shape local policies and sustainability practices that support ecosystem resilience. Thus, the traditions carried out by the Ketenger community not only function as cultural heritage but also as an adaptation strategy to environmental changes and potential disaster threats. At that time, S11 (53) who conveyed.

> "We believe that if we protect nature, nature will also take care of us. Traditions such as Kupat Slamet, Merti Bumi are prayers as well as reminders to live in harmony with nature."

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[9] The communal ritual held annually on the 1st of Muharram by most Javanese tribes, marks the Islamic New Year. to ensure safety and well-being in the coming year.

[10] Lunar calendar or Islamic calendar used in most Muslim community in Indonesia.

[11] First month in Islamic lunar calendar system



Figure 4. The Merti Bumi Tradition Ceremony of Ketenger Village was carried out by the Kewargian Lemahwangi[12] , Ketenger Village

The Merti Bumi ritual in Ketenger Village serves as a tangible example of the community's deep-rooted commitment to maintaining environmental equilibrium and fostering resilience against disasters. Integrating this rich tradition into Grade XII (Phase F) geography lessons offers a valuable opportunity to explore themes of sustainable development and cultural geography through a practical, localized lens. By utilizing Merti Bumi as a core material, students can delve into the interconnectedness of sustainable resource management, cultural rituals, and ecosystem resilience, gaining a holistic understanding of culture-based conservation. Learning activities can then be structured to facilitate analysis of the Merti Bumi ritual as a case study, examining its alignment with the principles of sustainable development and promoting critical thinking about its ecological impact. Furthermore, group projects could task students with designing innovative community-based disaster preparedness programs inspired by the Merti Bumi, encouraging creative problem-solving and active participation in real-world applications. To augment theoretical insights, field studies can be organized to allow students to observe the ritual firsthand, engage with its participants (e.g., S11), and glean invaluable perspectives on its significance in nurturing ecological balance. To consolidate these diverse experiences and insights, integration into teaching materials could involve the development of a comprehensive lesson plan specifically focused on "Traditional Practices with Disaster Mitigation" which vividly incorporates the Merti Bumi tradition. Additionally, students could be encouraged to create compelling documentary videos on local traditions, highlighting their pivotal role in disaster preparedness and promoting broader awareness and understanding of these valuable cultural assets.

Batu Leebrag

Mount Slamet produces various types of volcanic rocks due to eruptions and magma freezing (Maryanto, 2016). One of them is Batu Leebrag located in Limpakuwus Village, Sumbang District, which is a volcanic igneous rock formed from lava flows. Dark gray in color, but can also be reddish, Composed of fine particles and small crystals, Has an aphanitic to porphyritic texture

[12] *Kewargian* is a social system that regulates interaction and relationships between members in society, Kewargian Lemah Wangi is known through traditions and cultural ceremonies that aim to take care of the environment and respect ancestors located in Ketenger Village, Baturraden District, Banyumas.

(Köken & Tuncay, 2022). The presence of andesite in Limpakuwus Village indicates the volcanic activity of Mount Slamet in the past, where lava melts flowed and froze, forming a dense and compact rock structure. From a geographical point of view, Leebrag Rock is not just a rock, but also a representation of volcanic landscapes and interactions between endogenous forces (magma activity). The name Batu Leebrag was first mentioned by S7 (55), S12 (46), and S13 (59). According to them, this stone has existed since the time of their great-grandfather and has been known by the surrounding community for many years. The uniqueness and story behind Batu Leebrag then inspired the residents to make it the name of a coffee place, namely Leebrag Coffee.

In cultural context, Batu Leebrag, which is believed by the local community to be a volcanic igneous rock resulting from the eruption of Mount Slamet. Although the origin of this stone has not been scientifically confirmed, belief in it has been preserved as part of the local cultural narrative that strengthens the community's connection to the mountain. Located on the edge of an asphalt road, Batu Leebrag is easily accessible and serves as a symbol of cultural identity, reflecting the interaction between geological phenomena and community beliefs. This information was conveyed by S7 (55), the head of the local RT. Then the narrative from S12 (64) corroborates the history of this stone, that this stone is related to Mount Slamet and it is even said that this stone is part of the body of Mount Slamet itself, this information itself has been passed down from generation to generation so that the stone is maintained.

> "This stone is called Batu Leebrag, already from my great-grandmother is already here. Even though the stone is on the side of the road like this, it is not allowed to be "mak-mik" if it is still allowed to sit because there is someone to guard it. Because from the old man this was "Wudeling Gunung Slamet"

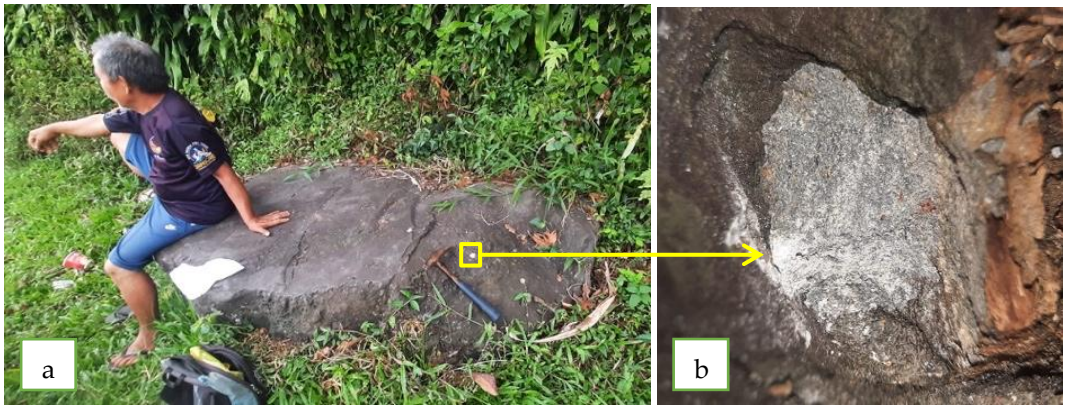


Figure 5. a) Batu Leebrag is believed by local has significant connection to the existence of Mount Slamet with typical b) andesitic rock produced through magma solidification after volcanic eruption

Batu Leebrag, which is easily accessible on the side of an asphalt road in Limpakuwus Village, not only serves as a geological feature; This stone is a manifestation of community relations with Mount Slamet. Although not an elaborate ritual site in the historical record, the local people believe that the stone is the "*wudeling Gunung Slamet*" a real part of the essence of the mountain. "Wudel" itself is interpreted as belly button. In this case, local people believes that this stone must not be moved because it will disturb the tranquility of Mount Slamet. This belief, passed down from generation to generation, reinforces the importance of Batu Leebrag as a cultural landmarker, a symbol of the village's identity that is closely linked to the existence of the volcano. The community's respect for Batu Leebrag, as a tangible element of their heritage and the surrounding environment, serves as a valuable tool in maintaining a harmonious relationship with nature.

The existence of these volcanic rocks, combined with local narratives, offers an interdisciplinary approach to studying the interaction between endogenous processes (volcanism) and cultural geography. In geography education, students can research the mineral composition of volcanic rocks, conduct research on the historical significance of geological formations, and explore how local communities associate meaning with natural landmarks. This fosters a deeper understanding of scientific and cultural perspectives, which reinforces the importance of indigenous narratives in the study of geography while fulfilling the outcomes of Phase E learning on geosphere dynamics and local environmental characteristics.

Integrating IK in intra-curriculum in senior high school

In the context of geography subject and disaster mitigation, understanding the interaction between humans and the natural environment is crucial. People living in disaster-prone areas often have IK accumulated through experience and knowledge passed down from generation to generation (Rahman et al., 2024). This disaster education curriculum based on IK is designed to improve student preparedness through an integrated geography approach (Rogayan & Dollete, 2020). Learning outcomes (LO) are focused on understanding the basic concepts of geography (Phase E) and complex issues such as sustainable development and disaster mitigation (Phase F) (Kemendikbudristek, 2021). Learning materials include cultural traditions, sites, and disaster mitigation, which combines IK with the current curriculum (Kamil et al., 2020). The learning method involves discussions, field studies, and interviews to build a deep understanding. Student activities are designed to actively involve them in identifying local traditions, analyzing the role of cultural sites, mapping potential disasters, and simulating evacuations. Evaluation is carried out through written tests, performance assessments, project assessments, and observations to ensure understanding and application of concepts by students. The curriculum seeks to create locally relevant disaster education, preparing students to face disaster threats with the necessary knowledge and skills. The following table 2 presents the integration local context and the relevant topics in geography subject.

Table 2. Integration of research findings in geography teaching

Class	Learning Outcomes (CP)	Core Material	Learning Activities	Connection to Research Findings
Class 10 (Phase E)	Understanding basic geographic concepts and geospheric phenomena, and analyzing the physical and social characteristics of regions.	- Basic Concepts of Geography	- Group discussion on local geomorphological phenomena. - Conducting quiz debates between individuals	Geomorphology that analyzes on the formation and characteristics of the Igir Tembalang as part of a mountain system that serves as a natural protector, reducing the impact of natural disasters such as volcanic activity.
		- Maps, Remote Sensing, and GIS	- Utilization of maps and GIS for topographic analysis of disaster-prone areas. - Observation and small group discussions in areas around the area's environment	Understand the topographic location map of slope gradients in disaster-prone areas in Karanglewas and Cilongok sub-districts which have highland residential areas and have the Igir Tembalang area..
		- Geospheric Phenomena	- Conducting case studies on geology in class individually - Taking rock samples	Batu Leebrag is an example of a rock formed as a result of volcanic activity on Mount Slamet,

			- Discussion between groups regarding findings - Making posters related to the geosphere	which is believed to be in Limpakuwus village, Sumbang sub-district.
Class 11 (Phase F)	Analyzing the interaction between humans and the environment and its impact on resource sustainability and disaster mitigation.	- Disaster Mitigation	- Interviews with local communities regarding disaster mitigation practices - Conducting video documentation projects on local traditions related to disasters.	Merti Bumi is an example of environmental conservation efforts and culture-based mitigation. Then students can understand the natural mitigation of the igir tembalang landscape as natural mitigation
Class 12 (Phase F)	Evaluating community adaptation strategies to environmental changes and their impact on sustainable development.	- Village-City Interaction	- Analyze the spatial pattern of the village - Preparation of reports on Indigenous Knowledge practices in disaster mitigation.	The study of the relationship between humans and the environment of Ketenger Village through the Merti Bumi tradition and the batur kedawung site which plays a role in village rules which is an environmental sustainability strategy with more than 90% of the territory used for conservation.

The integration of IK into the geography curriculum from Grades X to XII offers a comprehensive approach to education that combines theoretical understanding with practical application. In Grade X, students begin by exploring basic geographic concepts, focusing on maps, remote sensing, and geospheric phenomena. Through hands-on activities such as analyzing maps and engaging in group discussions about natural phenomena, students connect theoretical knowledge with real-world contexts. This approach is exemplified by projects like creating disaster area maps using local landmarks such as Igir Tembalang, which serves as a case study for understanding volcanic activity barriers. Additionally, analyzing the distribution patterns of cultural sites like Batur Kedawung and Batu Leebrag allows students to apply geographic concepts to local conditions, reinforcing the importance of contextual learning in geography education.

As students progress to Grade XI, the curriculum deepens their understanding of regional characteristics and disaster management. Core materials cover the strategic location of regions, biodiversity patterns, and principles of disaster management, with learning activities that include field projects, presentations, and community interviews. These activities integrate IK, as seen in case studies like the Merti Bumi ceremony and the cooking of Sayur Gandul, which highlight the role of cultural factors in disaster preparedness. By directly engaging with local communities, students learn to appreciate the influence of traditional beliefs and communal rituals on effective disaster management strategies. In Grade XII, the focus shifts to sustainable development and spatial analysis, encouraging students to analyze the impact of development on the environment and engage in discussions on global geographic issues. This phase includes studies on culture-based conservation, such as the Merti Bumi ceremony, and comparative analyses of modern and traditional mitigation strategies. Through this structured approach, students not only hone their analytical skills but also develop a deep appreciation for IK, preparing them for future academic and professional endeavors.

Discussion

This study redefines the role of Indigenous Knowledge (IK) in volcanic disaster education by placing it at the intersection of cultural geomorphology and participatory pedagogy—a relationship overlooked in previous studies that focused on non-volcanic contexts. While (Budiman & Oue, 2025) showed the effectiveness of IK in agroforestry zoning, and (Rahmawati & Irawan, 2024) exploring ritual-based preparedness in Merapi, our findings reveal how the Gunung Slamet community operationalizes IK through landscape literacy. And for a study by (Hospitality, 2019) revealing how the involvement of local communities in tourism development can empower indigenous peoples through the management of local natural resources, and a systematic review by (da Silva et al., 2023) highlighting various approaches to IK integration in school curricula with a focus on environments such as forests and coastlines. While (Kaya & Seleti, 2013) offer a valuable response of eurocentric bias in African higher education and advocate the integration of African indigenous knowledge systems (AIKS), this study focuses on the practical application of these principles in the high school geography curriculum in the context of volcanic disaster preparedness.

In the current study, the practice of Merti Bumi goes beyond just a ritual of offering. They conduct regular environmental inspections, where parents or traditional leaders assess natural phenomena such as soil and water flows such as natural mapping systems that work similarly to modern disaster risk maps. Batur Kedawung has two roles at once: as a sacred place and as a place to monitor volcanic activity. This proves that separating 'sacred places' and 'scientific places' in policy rules so far is not appropriate. In fact, Batur Kedawung can be an example of how to integrate UNESCO rules on cultural preservation with disaster risk reduction (DRR) programs. Research on Batu Leebrag also shows a difference in how to find out the truth: western science needs real evidence, while IK believes in intertwined hereditary stories. Unlike previous research (Triastari et al., 2021) which did not test the truth of myths and focused more on learning through games, this study offers a new way: combining folklore with geological knowledge. Folklore can be an additional clue to understanding the state of nature. This is in line with many previous studies that have shown that combining local and scientific knowledge is an effective strategy to reduce disaster risk

However, the study confronts significant challenges in validating the oral traditions and community beliefs through empirical scientific methods. The narrative surrounding Batu Leebrag, for example, underscores its cultural and historical importance but lacks geological verification to definitively link the site to Mount Slamet volcanic structure. The subjective nature of oral histories and the potential for mythological embellishments complicate the direct correlation between local beliefs and geological facts, suggesting a need for further interdisciplinary research that bridges ethnographic and geological methodologies. Incorporating IK into the geography curriculum offers a holistic educational approach that enhances students' appreciation of their cultural and environmental heritage. Field visits to sites like Batur Kedawung and Igir Tembalang provide invaluable hands-on experiences, enabling direct engagement with local communities and fostering a deeper understanding of geographic concepts such as sustainability. The integration of digital technologies for documenting and disseminating IK further enriches the educational landscape, allowing students to create content that connects traditional practices with contemporary disaster education frameworks.

This study underscores the potential benefits of integrating IK into formal education, particularly within geography courses at the secondary education level. The inclusion of cultural traditions and geomorphological insights enriches the curriculum, providing students with contextual and experiential learning opportunities that promote community engagement and environmental awareness. Nonetheless, the formalization of IK within national education policies

remains a significant hurdle, compounded by rapid modernization and the erosion of traditional knowledge transfer between generations. The diminishing involvement of the younger generation in cultural rituals, especially in urban areas, raises concerns about the long-term viability of IK as a tool in disaster preparedness. Addressing these challenges necessitates a collaborative approach among educators, policymakers, and local communities to develop educational materials that integrate scientific and traditional knowledge. Such efforts are essential to ensure that IK remains a dynamic and accessible component of disaster risk management and environmental education.

Conclusion and Recommendation

This study investigates on how indigenous knowledge (IK) contributes to disaster mitigation and environmental management in communities around Mount Slamet. The results of this study confirm that local knowledge plays a significant and applicable role in these important areas, so that its existence is very crucial in the development of disaster mitigation education. Through the examination of practices such as the Merti Bumi cultural ritual and the empirical use of natural landscapes such as Igir Tembalang, this study reveals that the integration of cultural rituals and geomorphological insights not only enriches local learning experiences but also fosters a deeper appreciation and understanding of the interaction between cultural heritage and environmental sustainability. These observations reinforce the urgency of integrating indigenous knowledge with scientific methodologies to formulate more comprehensive disaster risk reduction strategies.

However, the study also identifies significant challenges, notably the difficulty in empirically validating the oral traditions and community beliefs that form the bedrock of such knowledge. The subjective nature of these narratives and the potential embellishments pose challenges in directly correlating local beliefs with scientific evidence. This gap necessitates further interdisciplinary research that combines ethnographic and geological assessments to bridge the divide between cultural significance and scientific validation. Moreover, the integration of IK into formal education faces obstacles within the rigid structures of national education policies, which often prioritize quantitative scientific methods. The decline in cultural participation among younger generations, particularly in urban areas, further exacerbates the risk of losing these valuable traditions. To overcome these challenges, a concerted effort from educators, policymakers, and local communities is essential. Such collaborations should aim to develop inclusive educational materials that honor both scientific and traditional knowledge bases, ensuring their relevance and accessibility to future generations. Finally, this study not only highlights the importance of indigenous knowledge in environmental and disaster management but also sets a framework for its preservation and integration into modern educational systems, ensuring that such knowledge continues to benefit communities in managing their natural landscapes and cultural heritage effectively.

Declarations

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