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There She Blows: Public Perceptions of Mt. Merapi and Mt. Agung

Trey Atticus Spadone
SIT Study Abroad

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There She Blows: Public Perceptions of Mt. Merapi and Mt. Agung

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SIT Study Abroad Indonesia: Arts, Religion, and Social Change

Spring 2019

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Introduction

Since Indonesia sits on the Pacific Ring of Fire, the archipelago is repeatedly affected by tsunamis, landslides, earthquakes, and volcanic eruptions. Indonesia has the most active volcanoes of any country in the world due to subduction zones between the Eurasian and Indo-Australian plates. The last major eruptions were in 2017 (Mt. Agung in Bali) and 2010 (Mt. Merapi in Central Java) which both required thousands of people to be evacuated from their homes. Since volcanoes have such a geological presence in the country, I was interested in investigating how aware the public is of volcanoes and their associated risks. Where and how do they get their information about them? How much of their knowledge is religiously, culturally, a/o scientifically rooted? Furthermore, I wanted to understand the dynamics between communities, government organizations, and academia when it comes to volcano monitoring, disaster mitigation, and rehabilitation efforts.

I believe it is important to understand public perceptions of volcanoes because that information can be used to modify disaster mitigation policies and practices. However, the purpose of this study was not to pass personal judgement, but rather gain insight into the various dynamics at play in areas frequently impacted by natural phenomena. Volcanoes have been pivotal in shaping Indonesia's geological and socio-cultural history from its inception until now.

Field Methods and Ethics

I followed all of the rules and guidelines laid out by SIT Study Abroad concerning interviews and field research. My project was built around primary interviews, secondary research, and participant observation. These methods were employed in the following locations in Java: Yogyakarta, Sleman Regency: Kaliurang, and in Bali: Tabanan Regency: Munduk Pakel, Denpasar, Karangasem Regency: Duda Timur.

During my time in the field, I obtained fully informed oral and written consent before every structured interview. I always explained the purpose of my project orally in English/Bahasa Indonesia. A translator was present at every interview that was not fully conducted in English and always reiterated the goal of my work. Furthermore, I provided every participant with a Certificate of Consent distributed and approved by SIT Study Abroad. I made sure to emphasize that participation was completely voluntary and that the interviewees were free to refuse to answer a question or stop the interview at any point in time. The rights and well-being of my participants was my priority at all times.

All interviews conducted in Indonesian were translated by at least two translators. I had one or more translators at every interview conducted in Bahasa Indonesia and they were pivotal in helping me to understand responses and continue conversations. Additionally, I sent recordings of all the non-English interviews to the ever-talented Sani to ensure I understood as much as possible. While I have spent the past three months studying and practicing Indonesian, the language barrier was the biggest challenge I encountered during my field study. It is important to recognize that nuances have inevitably been lost in translation and that comes with the territory. I aim to share the

ideas and beliefs of my participants in the most accurate way, but by no means does this work claim objectivity.

Brief Overview of Volcanoes

“Volcanoes assail the sense. They are beautiful in repose and awesome in eruption; they hiss and roar; they smell of brimstone. Their heat warms, their fires consume; they are the homes of gods and goddesses” (Robert Decker 1991).

Volcanoes have fascinated people for decades as they wield intense powers for destruction, while at the same time have shaped our landscape, atmosphere, and oceans into what they are today. Volcanoes are vents in the Earth’s crust that allow lava, ash, and steam to be released. Over time as the lava cools and hardens, it produces the mountains that we consider to be volcanoes. Volcanoes exist because of tectonic plates which consist of the Earth’s crust and the uppermost part of the mantle. Volcanoes are usually formed when these plates converge and diverge with one another forming plate boundaries. When two plates collide, the denser one will be submerged under the lighter one and is subsequently melted thereby creating a subduction zone. When two plates pull away from each other, the space formed can be filled by material from molten magma. When this takes place in the sea, mid-ocean ridges are formed. A prime example of this is the Mid-Atlantic Ridge located along the Atlantic Ocean seafloor. At divergent boundaries, underwater volcanoes are also common. Underneath most volcanoes are large bodies of magma in the form of magma chambers and magma reservoirs. John Lockwood, a well-known American volcanologist, defines “magma ‘chambers’ as single bodies of fluid melt” and “magma ‘reservoirs’ as the overall magmatic system underlying a volcano or volcanic crater--a

system that may well consist of several separate magma chambers and feeder conduits (Lockwood 2010: 25).

There are generally two types of volcanoes: red and grey. Lockwood explains that “red volcanoes’ are those volcanoes that are mostly found on mid-oceanic islands and are characterized by effusive activity (flowing red lava). The ‘grey volcanoes,’ generally found near continental margins or in island chains close to the edges of continents, are characterized by explosive eruptions that cover vast surrounding areas with grey ash” (Lockwood 2010: 5). There are exceptions to these categories as some volcanoes have both effusive and explosive eruptions.

Volcanic material comes out of single vents or long fissures. In the case of an effusive eruption, the volcano mainly spews fluid lava. Effusive eruptions are associated with shield (red) volcanoes. Lockwood writes, “shield volcanoes, such as those characteristic of Hawai’i and most other mid-oceanic islands, include the largest volcanoes on Earth, have very long lives, and are mostly made up of long, thin lava flows that form broad, gently sloping shield-shaped mountains. Many eruptions occur on the flanks of these volcanoes tens of kilometers from their summits, in some instances localized along radial fracture zones termed rift zones” (Lockwood 2010: 26).

When eruptions are explosive, the volcano blows out fragmented pyroclastic debris. Explosive eruptions come from composite or stratovolcanoes (grey). Lockwood defines stratovolcanoes as the “massive, steep sided, ‘point’ mountains of classical shape like Mt. Fuji or Kronotsky. These volcanoes are built up over long periods of time from hundreds or thousands of eruptions. They are composed of layers of pyroclastic material, primarily volcanic ash, interbedded with lava flows” (Lockwood 2010: 26). This material “may be

deposited by pyroclastic density currents (PDCs) or by material falling from above--airfall, or simply fall deposits” (Lockwood 2010: 26). While explosive eruptions are more few and far between, their effects tend to be more extensive. Ultimately, eruptions are invariably driven by the expansion of dissolved gases (volatiles) within the magma as it nears the surface. Some eruptions show mixed explosive and effusive characteristics, in some instances taking place simultaneously on different parts of the same volcano” (Lockwood 2010: 26).

“Volcanic eruptions are the most exciting, awe-inspiring phenomena of all of the Earth’s dynamic processes, and have always aroused human curiosity and/or fear” (Lockwood 2010: 5).

Gunung Merapi

Gunung Merapi or Mt. Merapi is Indonesia’s most active volcano located between the provinces of Central Java and Yogyakarta. Its nickname is “Fire Mountain” and is 9,551 feet or 2,911 meters tall. It is situated at a subduction zone where the Indo-Australian Plate is subducting under the Sunda Plate. As a result, Merapi’s activity is affected by tectonic earthquakes via stress transfer (Walter, Wang, Zimmer, Grosser, Lühr, Ratdomopurbo 2007: 1-9). Merapi is classified as a stratovolcano (composite volcano) which means it is made up of many layers of hardened materials. In contrast to shield volcanoes, like Kilauea in Hawaii, the lava of Merapi is high in viscosity and often leaves the mountain during violent explosions. Eruptions in the Merapi area began roughly 400,000 years ago and the volcano was formed during the late Pleistocene/Early Holocene period. Scientists believe

its eruptions were initially effusive due to the presence of basaltic magma. Nowadays explosive eruptions are the norm.

Volcanic Hazards

Merapi's eruptions are particularly dangerous because of the frequency of pyroclastic flows. Pyroclastic flows are currents of hot gas and tephra (volcanic matter) that barrel away from a volcano downhill. Merapi's eruptions typically include lava dome growth and collapse that trigger these currents. Pyroclastic flows can reach speeds up to 430 mph/700 km/h and temperatures of 1,830 degrees Fahrenheit/1,000 degrees Celsius. Pyroclastic flows can wipe out most anything in their path and Merapi's flows have caused much damage to the communities living on and around the volcano.

Pyroclastic flows are extremely dangerous and their potential for destruction does not end after they have hit the ground. Many of Merapi's deposits are in the position to be re-channeled into a river valley and form lahars. Lahars are volcanic mudflows or debris flows and the term is of Javanese origin. Merapi's lahars are usually water initiated because of heavy rainfall. The rainy season in Java is from November-April and traditionally the rainiest months are December, January, and February when rainfall can total to 800 mm per month. Lahars present a major hazard to the 120,000 people living along the thirteen rivers that drain the volcano (Charbonnier and Gertisser 2008: 971-974, Lavigne et. al 2000: 423-435).

Volcano Monitoring

Merapi has been very closely monitored for quite some time with the first mechanical seismograph being implemented in 1924. By 1982, a radio-telemetered seismograph network was put in place along with drum recorders at Merapi Volcano Observatory. On the morning of Tuesday, April 23rd, I visited *Balai Penyelidikan Dan Pengembangan Teknologi Kebencanaan Geologi* (BPPTKG) which is the Center for Research and Development of Geological Disaster Technology located 27 km from Mt. Merapi. I was able to speak with Hanik Humaida, the Head of the Volcano Observatory and Naning Aisyah, a staff member on the Merapi Research Team (Deformation). They explained to me that there are three sections within BPPTKG: laboratory services, the Merapi section, and the development of geological hazard mitigation technology (Personal communication, April 23, 2019). There is a geochemistry laboratory that “provides services for analyzing gas, solid, and liquid samples in major, minor, and trace-element concentrations” (BPPTKG 2016). There is also a petrology laboratory where “thin incision and analysis is carried out to find out the variety, type, and composition of minerals/chemicals” (BPPTKG 2016). This information helps scientists to understand the processes that trigger eruptions and produce volcanic materials.

BPPTKG operates five observatories located around the slopes of Merapi. The posts are as follows: Selo (north), Jrasah (northwest), Babadan (west), Ngepos (southwest), and Kaliurang (south). They are located between 4-12 km of the summit with Babadan being the closest and Ngepos being the furthest. I received a brief tour of the center’s monitoring room where real-time data is continuously coming in. BPPTKG focuses on monitoring Merapi’s seismicity, geochemistry, deformation, and visual/meteorological changes. While

a lot of the information comes in automatically, staff members must enter electronic distance meter (EDM), rain gauge, and gas sample data manually. Geochemists also make trips out to the field to collect samples. The Electronic and Instrumentation Laboratory works to develop better technologies for hazard mitigation. According to the website, this includes “the development of analog and digital data transmission systems [and] creating programs for interfaces of various instrumentation equipment accompanied by software development” (BPPTKG 2016).

Perceptions of Mt. Merapi

Education

Most of my interviewees were undergraduate students from Universitas Gajah Mada (UGM) who grew up in the Yogyakarta area. I began almost every interview with the question, “What do you know about volcanoes? /*Apa yang bapak/ibu/kamu tahu tentang gunung berapi?*” Overall, I received very similar answers with most students mentioning that “there are many active volcanoes in Indonesia” and that “*Gunung Merapi* is one of the most active” (Personal communications April 9 and April 16, 2019). Since Indonesia has the most active volcanoes of any country in the world, I became curious about the level of volcanological education that takes place in schools. After speaking to well over twenty university students, I was surprised to hear that they did not learn very much about the geological makeup of their home country. Most of them only learned about the very basics in junior high school when students are roughly 13-16 years old. Furthermore, none of the students who grew up in the Yogyakarta area remembered learning any specifics about Merapi and its continuous impacts on society.

On the morning of April 16, I had a very informative discussion with two professors from the Geological Engineering department at Universitas Gajah Mada who shed some light on the education situation and its relationship to hazard mitigation efforts. I spoke with Professor Esti Handini, a scholar of volcanology, petrology, and geochemistry and Professor Hendy Setiawan, a specialist in geotechnics, geological engineering, and water-geo-disaster management. Esti explained that “our [Indonesian] basic science education definitely needs improvement” (Personal communication, April 16, 2019). Many Indonesians not only lack an understanding of the danger of natural disasters, but also what to do when they happen.

Hazard Mitigation

All four specialists I spoke with cited the lack of volcanological education as a major challenge when it comes to hazard mitigation. One of the biggest challenges scientists face is how to disseminate information in an accessible way. The goal is to provide citizens with accurate information without confusing or scaring them too much. Esti and Hendy shared some stories about the chaos that has ensued surrounding the past few disasters due to a lack of public awareness. In 2004, a massive tsunami struck the province of Aceh. A disaster of that scale had not happened in so long that there was “a gap in generations” about how the tsunami happened and what to do afterwards. Esti highlighted that the people of Aceh “never thought it could happen to them so they felt safe. But then it happened and they did not know what to do” (Personal communication, April 16, 2019).

Without a baseline understanding of natural disasters, people are also more susceptible to hoaxes. In 2006, there was an earthquake in Yogyakarta. Since the tsunami in

Aceh had happened just two years prior, chaos broke out as people feared a tsunami was on its way. People tried to run to the north even though the city is far from the coastline and would not likely be hit in the event of a tsunami. Furthermore, around this time there was an inundation of water in Malioboro due to a drainage issue which also caused people to panic and think that a tsunami was well on its way. People tried to draw parallels between the two events even though they were very different. By 2010, the presence of smartphones had increased making it easier for people to access information online. Unfortunately, increased accessibility also made it easier for false information to be spread. After the 2010 eruption of Mt. Merapi, a hoax was started which claimed there would soon be an even bigger eruption. The ash column was supposedly going to reach a height of 60 km and spread throughout Central Java and all the way to West Java.

Javanese Knowledge

Esti mentioned that she was at a hearing with Parliament and some people asked if Merapi was connected to *Kraton* and the South Sea. Hendy added that those people thought “that Merapi had an underground chamber” and they both agreed “that is not scientific at all” (Personal communication, April 16, 2019). Even though that phenomenon is “metaphysically” impossible, the question reflects more deeply rooted cultural beliefs about Merapi. Furthermore, it is an example of the tension between scientific and local/cultural knowledge.

In Javanese culture, and specifically in Yogyakarta, Merapi is considered a sacred mountain. As a result of a well-known Javanese myth, many people believe there is a

connection, in fact a metaphorical line between Mt. Merapi (north), *Kraton* (center), and the sea (south).

According to Judith Schlehe, a scholar from the Institute for Social and Cultural Anthropology, the myth surrounding the three entities goes as follows: “Ratu Kidul - the queen or goddess of the South Sea, ruler of all the spirits of Java - once promised to the founder of the kingdom of Mataram that she would protect him, his dynasty, and the realm forever, especially against the eruptions of the nearby volcano, Merapi. When the kingdom of Mataram was divided in 1755 into the two Sultanates of Yogyakarta and Surakarta, both rulers claimed the mystical connection to her. To this day the ritual traditions are still performed by both palaces, especially by the *Kraton* Yogyakarta. Once a year an elaborate ceremony, called *Labuhan*, takes place at the South coast and at Mt. Merapi. Many offerings are made, among them the cut hair and clipped fingernails of the Sultan of Yogyakarta” (Schlehe 2011: 113, 115).

An important figure to highlight at this point is the *juru kunci* which translates to “guardian of a sacred place” (Personal communication, April 19, 2019). The *juru kunci* serves as the bridge between the spirits and humans. He essentially has the power to communicate with the spirits of the mountain. Many people believe that the *juru kunci* will be warned through a vision if there is going to be an eruption and will warn the surrounding villages if it is necessary to evacuate. The guardian is responsible for orchestrating and leading the annual *Labuhan* ceremony that is held to maintain the strong relationship between Mt. Merapi, *Kraton*, and the South Sea.

When I asked my informants whether there was a discussion of Merapi in Javanese culture, they all told me about *Mbah Maridjan*, who was the *juru kunci* until 2010. He lived in the village of Kinahrejo roughly 5/6 km from the peak of Merapi. *Mbah Maridjan* was a major icon because of his loyalty and commitment to *Kraton* and the Sultan. He was named *juru kunci* under Sultan Hamengkubuwono IX in 1982. His undying loyalty and commitment to *Kraton* and the Sultan lasted until his death. He refused to evacuate many

times during his twenty-eight year reign which inspired others to follow suit. In a 2001 interview he said, “if Merapi erupts and I die, I will accept it with all my heart and soul. I am not afraid of dying for the sake of responsibility. Dying is a divine decree, isn’t it? If God wants me to die, I will die, no matter where” (Heru Prasetya 2001: 1 Jakarta Post). During the 2006 eruption, he suffered serious burns after refusing to leave, but his martyrdom garnered even further support from the masses. He refused to evacuate again in 2010 prompting several individuals to stay behind to try and convince him otherwise. According to a report by Susanna F. Jenkins et al., “39 people remained at Kinahrejo with *Mbah Maridjan*. Twenty-five of them died at the scene, including *Mbah Marijan*, and 14 were hospitalized with only four survivors” (Jenkins et al. 2016: 263). After his death, his son Asih Lurah Surakso took his place.

Mbah Maridjan was perhaps revered even more after his noble sacrifice. This fact intrigued me, and I asked my informants the question: “How do you feel about the fact that *Mbah Maridjan* chose to stay near Merapi and as a result died?” Nearly everyone I asked agreed that *Mbah Maridjan* did the right thing by staying with the mountain. Vincent and Ichsan, two engineering students from UGM, highlighted that he did the right thing “by fulfilling his duty as *juru kunci*” and that “it was his destiny” (Personal communications, April 15, 2019). Armand, a philosophy student from UGM, explained that when it comes to natural disasters “many people tend to hold on to tradition and approach that kind of stuff spiritually, instead of scientifically. It is because tradition is very important in Indonesian society. People in the Cangkringan area really trusted him” (Personal communication, April 9, 2019).

Even if we lived in a perfect world where only accurate and up to date information was available, scholars, hazard mitigation organizations and governments cannot usually force people to abandon their beliefs. Understanding how people conceive and perceive Merapi and its eruptions is critical for improving disaster mitigation practices. I had a conversation with Esti Anantasari, an anthropologist who focuses on disaster risk reduction (DRR), who beautifully emphasized that, “if you talk about disasters, we also need to talk about local knowledge because we cannot rely on scientific knowledge” (Personal communication, April 18, 2019). She does work with the START Network, a large UK based humanitarian aid initiative with one of its focuses being DRR. She is part of a five-person team in which the other four members are male engineers. She explained that she constantly reminds them to think about local cultures. She highlighted that, “we cannot rely only on engineering issues. They can produce super great technology, like an early warning system, but if they do not communicate with the locals, then it will be useless” (Personal communication, April 18, 2019).

The 2010 Eruption of Mt. Merapi

On October 26, 2010, Merapi began a series of violent eruptions that lasted until November 30. Up until that point, Merapi had erupted relatively regularly on a four to five year cycle and the communities living on and around the volcano were used to managing the after-effects. The 2010 eruption was the largest eruption in over 100 years and naturally came as quite a shock to everyone involved. Geologically speaking, “the 2010 eruption did not only extrude lava domes, but it also produced several explosions heard up to the southern city of Yogyakarta, vertical eruption columns to 17 km altitude and

numerous pyroclastic density currents that extended into populated areas at distances of up to 16 km from the summit” (Jousset et al. 2013: 1). According to Jenkins et al., 396 people were killed during the eruption with at least half dying due to PDCs. The report notes that “the majority of fatalities were associated with (1) damage in Kinahrejo, 4.5 km from the volcano, during the initial 26 October eruption (34 died out of 38 who refused to evacuate), and during the climactic stage of 5 November (~170 died due to failure to evacuate in time)” (Jenkins et al. 2016: 263). The report further highlights that “the atypical explosivity of the 2010 eruption was the result of rapidly intruding and ascending gas-rich magma of contrasting rheology that led to recurrent pressurization and explosive disintegration of lava domes, with escalating activity that gave little time to issue warnings” (Jenkins et al. 2016: 268).

All my informants were alive during the 2010 eruption and remember the darkness, high temperatures, and widespread ash fall. Schools were closed for many days and most people stayed indoors as much as possible. Roughly 400,000 people had to evacuate their homes, some for just a few days and others for weeks (Otani 2012: 1279). I asked all my informants whether they were afraid of Merapi and was surprised to hear so many resounding “no’s.” When I asked for further elaboration, my interviewees cited positive impacts of Merapi such as soil enrichment and the economic benefits of sand mining. Pak Nur, a villager from Kaliurang (13.5 km from Merapi) even said, “*Gunung Merapi adalah sahabat saya*/Mount Merapi is my best friend” (Personal communication, April 13, 2019). Merapi is a giver of life to so many who live on and around the mountain. Esti A. conducted research with some communities near Merapi and said, “we cannot fight or hate Merapi.

Merapi is part of their life. For the local people, living in harmony is the best way to describe their relationship with the mountain” (Personal communication, April 18, 2019).

Adaptability

Instead of leaving the area, people living around Merapi have found new ways to maintain their livelihoods. Hendy, who has worked closely with communities on the flanks of Merapi, really emphasized how “self-empowered” the people are. While Merapi’s eruptions can cause a lot of destruction, its presence has brought about many positive impacts. While many of the folks living near Merapi are farmers, since the volcano provides the soil with rich nutrients, eruptions can also destroy farms and plantations. One of the reasons why people resist evacuating is because they do not want to abandon their land and livestock, essentially their livelihoods. However, especially after 2010, people have adapted to their circumstances and created alternative ways to make money. The sand from Merapi is particularly high quality and many farmers temporarily become miners and sellers of the coveted sand. It is also common for people to sell volcanic products like hardened lava and welded pyroclastic materials. In nearby Magelang, artists make statues and pottery from old basalt and andesite (Personal communication, April 16, 2019).

After 2010, tourism really started to flourish in the Merapi area. In fact, it has become so popular that there is a fee for driving on the main road once one is 7 km from the mountain. In February, I went on a Jeep Lava Tour that included stops at a bunker and the remnants of a wrecked house. Most of the drivers are people who have been affected by eruptions but have been able to make new careers for themselves (Personal communication, April 16, 2019). Many hotels and resorts also use Merapi as their major

selling point (Personal communication, April 18, 2019). I was able to visit two museums in the area as well. *Museum Gunungapi Merapi* is state-run and has lots of information about Merapi, volcanoes, and the geological makeup of Indonesia in general. I visited the space on a Saturday morning and there were a bunch of school and tour groups there. Information is presented in several ways including scientific explanations, lived experiences, photographs, volcanic materials, and interactive dioramas. *Mbah Maridjan's* old house has been turned into a private museum appropriately titled *Museum Rumah Mbah Maridjan*. There is a memorial set up in his honor, photographs of him through the years, and remnants of a car, motorbikes, tables, chairs, and various household items. The guide who took me around said that ceremonies are still held in the village's *Pendopo Agung* (grand building).

Increasing Volcano Education Efforts

Beyond innovative economic means, the 2010 eruption also inspired people to learn more about their environment. When there is a disaster, more attention and resources will be allocated to the issue. If there are long periods of repose, disaster mitigation education and work will be slow. One of the reasons people were caught off guard by the 2010 eruption is that up until then all of Merapi's eruptions had been of roughly the same caliber. No one expected that there could eventually be something worse or out of the ordinary. Since national science education is lacking, knowledge of eruptions is mostly transmitted through personal stories. However, these lived experiences can end up dying with generations (Personal communication, April 16, 2019).

Hendy noted that the key to disaster management is two-way communication and action between citizens and the government. He also highlighted that the collective nature

of Indonesian society is ideal for community-based mitigation efforts. After the 2006 earthquake, people from the north flocked to the south to try and provide assistance. Then after the 2010 eruption, people from the south went to the north to do the same thing. Even though they did not know exactly how to help, they went to the government and found ways to provide aid. Hendy has observed that after the 2010 eruption people living near Merapi took initiative and started asking the authorities about how both sides could work together to improve disaster mitigation practices. He said, “people are eager and willing to engage. They want to actively participate, not just receive information. In our university, we do community service projects because we want our students to feel this atmosphere in society. We want them to see how people bond together to solve problems together” (Personal communication, April 16, 2019). The women of BPPTKG echoed this sentiment as they noticed increased interest in Merapi immediately following the eruption. Naning expressed that, “before 2010, people did not really care to learn about Merapi. However, since the 2010 eruption impacted so many areas, it made people want to be more aware. Many people came here [BPPTKG] to ask questions and learn more” (Personal communication, April 23, 2019).

Since 2010, there has been an increase in government funded trainings in villages close to Merapi. Hanik and Naning talked about the “*Wagiplatih*” disaster prevention program that is compulsory for those living in Hazard Zone III. In 2012, 1,725 people participated. Since then the number of participants has gone down partially due to the budget and partially due to increased awareness. The program started out as a three-day endeavor which covered topics such as the role of BNPB/BPPD, volcanic hazards and their risks, hazard mitigation, early warning systems, and rehabilitation plans. As of last year, the

training only takes place for one day and focuses on providing people with the latest information on Merapi and going to the field for simulated eruption drills. Hanik and Naning agreed that this aspect is the most important part so that people know what do when an eruption occurs. This training serves to make people feel safer as well as increasing overall awareness (Personal communication, April 23, 2019).

Esti H. and Hendy agreed that these drills are super beneficial and noted that the local government has done a great job working with communities. Esti H. stressed the importance of locally rooted practices and hopes that the central government follows in the footsteps of the local governments. Since Indonesia is so culturally, demographically, and environmentally diverse it is very difficult to establish universal standards and practices. They must be tailored slightly to meet the needs of different locations (Personal communication, April 16, 2019).

Overall, Merapi is critically important to those who live on and around it. People conceive the volcano in different ways. Some understand eruptions as the result of the expansion of dissolved gases while others see it as a warning from the gods. Ultimately, as my friend Armand so nicely put, “we need to bridge scientific and cultural knowledge” (Personal communication, April 9, 2019). Locals should be well-informed about volcanic hazards and disaster mitigation organizations should be aware and acknowledge local beliefs. It is important to understand the history of a place, not just the environmental and the geological history, but the socio-cultural one as well.

Perceptions of Mt. Agung

While I spent the majority of my time in Yogyakarta focusing on Mt. Merapi, I spent a couple days talking to people from Bali about their perceptions of Mt. Agung, an active stratovolcano and the highest point on the island (Personal communication, April 28, 2019). Volcanoes are sacred places within the realm of Balinese Hinduism. It is believed that the mountains are home to gods whether in Bali or on other islands. It also appears that knowledge of volcanoes is directly tied to the Balinese idea of “*Tri Hita Karana*,” harmony with people, harmony with nature, and harmony with gods. Gung Cak, a 19 year old IHDN student, explained to me that the Balinese use the sand and stone from Mt. Agung to build houses, temples, and other various buildings on the island. He sees eruptions as “a gift, not a disaster” (Personal communication, April 28, 2019). When Mt. Agung erupts, the gods are providing people with more resources/more material with which to construct buildings. While it is certainly a disaster when people are killed, he believes that people have the tools and resources to survive eruptions and subsequently benefit from them. Furthermore, an eruption is seen as a reminder from the gods to acknowledge the relationship between humans and nature. After an eruption, people will make their way to *Besakih* Temple located on the slopes of Mt. Agung and apologize for their wrongdoings. Sometimes cows, goats, geese, and roosters are led up the mountain and sacrificed as well.

Pasabaya

I also had the opportunity to visit Gung Cak’s home in the village of Duda Timur located in the Karangasem Regency (12 km away from Mt. Agung) (Personal communication, April 28, 2019). In September of 2017, Mt. Agung began vigorously

erupting and the residents of Duda Timur and the other twenty-seven villages located within the danger zones of the volcano had to evacuate. The three danger zones are as follows: III (1-6 km from Mt. Agung), II (6-9 km), and I (9-12 km).

Just as the 2010 eruption was a surprise for the communities near Merapi, the 2017 eruption of Mt. Agung was a wake-up call for many Balinese. The severity of the eruptions caught people off guard and they were left scrambling. Many people realized they had never learned what to do in the event of an eruption and wanted to become more informed (Personal communication, April 28, 2019). While in Duda Timur, I spoke with Guru Gede who helped create *Pasabaya*, a volunteer service organization formed to educate villagers about Mt. Agung as well as manage and coordinate evacuations. The organization was formed in the fall of 2017 and since then volunteers visit all twenty-eight villages twice a year to share information about Mt. Agung and its associated risks. *Pasabaya* runs an annual simulation drill in every village where people are able to practice evacuating from their homes. The organization is in close communication with BNPB and BPPD and their employees will usually partake in village visits. Furthermore, *Pasabaya* has mapped out evacuation plans specifically tailored for each village in the Karangasem Regency. I was shown a chart that laid out how many people are in each village and their assigned evacuation location. Besides coordinating the literal evacuations, *Pasabaya* volunteers are also the main actors setting up and running the refugee camps. The organization's home base is located at Guru Gede's house. There are massive hazard maps and a few monitoring systems from BNPB that track Mt. Agung's activity. The machines operate twenty-four hours a day, seven days a week. In the event of an eruption, Duda Timur would be responsible for disseminating information to the other twenty-seven villages.

The reason why *Pasabaya* is so effective is because it is run by the people of Karangsem for the people of Karangsem. Gung Cak, who is Guru Gede's son, emphasized that the members of the organization "always think about what we can do for others" (Personal communication, April 28, 2019). It truly is a humanity-centered effort. Furthermore, over time it has grown into a general service organization. Even though its initial focus was educating people about volcanic matters, *Pasabaya* volunteers now also help out with wonky telephone poles, locating missing people, rescuing "naughty" tourists, and cleaning up fallen trees (Personal communication, April 28, 2019).

Conclusion

Overall, this project was a brief exploration into the dynamics of scientific knowledge and local/cultural knowledge. I became drawn to this topic after taking a volcanology course during the spring semester of my sophomore year. Early on, we learned about conflict that exists between many Native Hawaiians and the US government when it comes to disaster mitigation efforts. Many Hawaiians believe in the goddess Pele who is considered the creator of the islands. As a result, they see volcanic eruptions as Pele "cleaning house"/cleansing the island. Tension always arises when hazard mitigation organizations suggest and implement practices that interfere with the lava's/Pele's natural behavior. For example, Hawaiian lava flows are often slow-moving, but still have the ability to take out houses and infrastructure. The government usually wants to divert the lava to protect homes and buildings, but some Hawaiians believe Pele's activities are sacred and should not be messed with.

While studying volcanoes in Indonesia, I observed similar dynamics in regard to how people engage with volcanoes. At the end of the day, my biggest takeaway and the theme that I would argue links scientific knowledge to local/cultural knowledge is the importance of place. Hanik, Naning, Esti H., Hendy, and Guru Gede all highlighted the importance of understanding a person's place from a scientific perspective. After the 2010 and 2017 eruptions, it definitely appears that there has been a positive spike in volcano education among the communities nearby the mountains. The villages have been self-driven to learn more, and government organizations have helped by supplying information and implementing trainings.

At the same time though, it is crucial for volcanologists, hazard mitigation teams, and government organizations to understand that people do not just think about volcanoes from a strictly scientific perspective. Both Mt. Merapi and Mt. Agung are central to peoples' existence from how they orient themselves in space, to how they navigate on a day to day basis, to the economic opportunities the volcanoes provide. I asked several people whether they had ever thought about moving further away from the mountains and most had never considered it. Surtini, a 55 year old woman from Kaliurang highlighted that as a farmer, Merapi has contributed to years of successful harvests. She told me, "I have never thought about leaving. I have been here since birth and find comfort in living here" (Personal communication, April 22, 2019). Guru Gede noted that in the Balinese Hindu tradition at least one son must stay in the family house to fulfill community obligations (Personal communication, April 28, 2019). Lucky for his family, that is just what his son wants to do. Gung Cak explained to me that after university he wants to live and raise his own family in

Duda Timur and hopefully take over his father's job when he retires. His identity is directly tied to his sense of place.

At the end of our conversation, Esti H. commented that it is important for scholars and government organizations to understand that "the one thing we cannot change is the people who live near volcanoes. We cannot change their way of life. We can only change how the government and hazard mitigation organizations operate. We can improve our methods and increase our standards" (Personal communication, April 16, 2019). This sentiment sums this project up magnificently. With a more holistic understanding of how people conceive volcanoes, Indonesian disaster mitigation policies and practices can be improved to better suit the needs of the impacted communities.

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Suggestions for Further Research

A more comprehensive study of the communities that live on and around Mt. Merapi and Mt. Agung. I unfortunately was only able to interview a very small number of people and this work calls for more in-depth research with the various villages located in the hazard zones.

A deeper look into the creation and impact of *Pasabaya*. This would include village visits, conversations with volunteers, and ideally witnessing an actual teaching session and eruption drill.

One of the best ways to expand this research is to do site-specific (volcano-specific) case studies. There are 127 active volcanoes in Indonesia spread throughout many islands. Just as they are all geologically different, the communities/culture around them vary as well.

Appendix A: Gung Cak Interview

What is your name? (*Siapa namanya?*)

Gung Cak.

How old are you? (*Berapa umurnya?*)

19.

What is your religion? (*Apa agama bapak/ibu/kamu?*)

I am Hindu.

What do you know about volcanoes? (*Apa yang bapak tahu tentang gunung berapi?*)

I live 12 km away from Mt. Agung in the village of Duda Timur. My dad is the head of the village and communicates with BNPB on a walkie-talkie when there are weather concerns. During the 2017 eruption, our village had to evacuate to a refugee camp in Tabanan.

Is there discussion of volcanoes in Hinduism? (*Apakah di agama Hindu membahas tentang gunung berapi?*)

Mountains are sacred places within Balinese Hinduism. *Tri Hita Karana*: harmony with humans, harmony with nature, and harmony with gods. We believe *Gunung Agung* gives us a warning before it erupts. People exploit the mountain when we take sand/stone from its slopes. This sand/stone is used on every building in Bali. After an eruption, people will go to *Besakih* Temple and apologize for their collective wrongdoings. Sometimes animals will be led up the mountain and sacrificed to the gods.

Did you learn about volcanoes in school? (*Apakah bapak belajar tentang gunung berapi di sekolah?*)

I learned a little about volcanoes in school. I learned about them in general, but not what to do if one erupts.

Are you afraid/concerned about volcanoes? (*Apakah bapak takut dengan gunung berapi?*)

I think people are smart and we know to stay safe and evacuate when necessary. I worry about the Balinese economy. Eruptions affect tourism, the *sawah*, and the airlines.

If Mt. Agung erupts, do you know what to do? (*Jika Gunung Agung meletus apakah bapak tahu apa yang harus kalian lakukan?*)

If Mt. Agung erupts, my father, the head of the village, would be notified via walkie-talkie. There are four warning phases (*Aman, Waspada, Siaga, and Awas*). *Aman* means everything is normal and *Waspada* means we should pay attention, but there is no major concern yet. *Siaga* means we should prepare for a potential evacuation and *Awas* means we need to

evacuate. There are about 518 people in my village and it takes about 2-3 hours to evacuate. The people in my village have experience evacuating.

Do you have a story about a volcanic eruption? (*Apakah bapak punya cerita tentang gunung berapi meletus?*)

In 2017, I learned that Mt. Agung was erupting through social media (Instagram). People started to panic, and the roads got all jammed. I was part of a volunteer organization at the time and helped to move the village animals to safety. I then helped at the refugee camp. Also, after the eruption in 2017, people wanted to learn more about the mountains. My father and others created a service organization called *Pasabaya* to help inform villagers about volcanic hazards.

Appendix B: Pak Nur Interview

What is your name? (*Siapa namanya?*)

Nurkadiyono/Pak Nur.

How old are you? (*Berapa umurnya?*)

53.

What is your religion? (*Apa agama bapak/ibu/kamu?*)

I am Muslim.

What do you know about volcanoes? (*Apa yang bapak tahu tentang gunung berapi?*)

I have lived near Merapi, the most active volcano in the world since birth. I have lived through many eruptions in 2010, 2006, 2002, 1996, 1992, 1979. 2010 was the biggest eruption of them all.

Is there discussion of volcanoes in Islam? (*Apakah di agama Islam membahas tentang gunung berapi?*)

Not really. I do not know of any discussion of volcanoes in Islam.

What do you know about *Mbah Maridjan*? (*Apa yang bapak tahu tentang Mbah Maridjan?*)

Mbah Maridjan was the guardian of Merapi. We would usually wait for his instruction before evacuating our homes. He used to come to this village and he also has a brother here. I knew him so well. I used to visit him. During the *Labuhan* Ceremony, I would join the *lek-lakan* (ritual that involves staying up all night) even though I did not go to Merapi. *Mbah Maridjan* passed away during the 2010 eruption. There were also many victims (around 40) in the same area that passed away as well.

Did you learn about volcanoes in school? (*Apakah bapak belajar tentang gunung berapi di sekolah?*)

When I was in school I was never taught about volcanoes specifically. I learned a little bit about their history.

Are you afraid/concerned about volcanoes? (*Apakah bapak takut dengan gunung berapi?*)

I am not afraid. *Gunung Merapi* is my best friend.

Why? (*Kenapa?*)

Merapi is profitable. When it erupts, the ash becomes fertilizer for the land. Also, the sand can be used/sold by residents. The weather is also cooler here and I think being closer to the mountain and nature is better.

Do you have a story about a volcanic eruption? (*Apakah bapak punya cerita tentang gunung berapi meletus?*)

Before the 2010 eruption, there was an earthquake and the windows trembled. I initially stayed at my house, but then there was instruction from BPPD to evacuate to an evacuation camp. The center was in *Maguwoharjo* Stadium. My house is 13.5 km from Merapi. The villagers here believe that if animals come down from the mountain an eruption is going to happen soon.

How long did people stay in the evacuation camp? (*Berapa lama orang-orang tinggal di evakuasi?*)

For the first three days, no one dared to go out because it was still very hot. After five days, the firefighters opened the way by watering the road. At that point, all the people from the north fled to Jogja and it caused chaotic traffic. I was so lucky that I knew a shortcut, so I did not get stuck. BPPD announced we could go home 15 days after the evacuation. During that time though, I went to and from Jogja every day to check on my livestock. Those from the danger zone closest to the volcano were not able to return home for about two months. Most of their homes were destroyed.

Maybe you can share more about the eruption based on your experience? Can you talk about your experience evacuating? (*Mungkin om bisa cerita aja, selama berkali-kali erupsi. Dan erupsi yang paling dahyat adalah 2010. Bagaimana certain aja? Mungkin bisa diceritakan mengenai evakuasinya?*)

It was just an ordinary evacuation. No one was really panicking because eruptions happen often. The reason why there were so many casualties in 2010 is because *Mbah Maridjan*, the spiritual guardian of the volcano, had evacuated, but then went back to his house. He felt that it was his responsibility to stay with the mountain and other people followed him. Then Merapi erupted and emitted hot gas and ash which killed them all. No one dared to rescue them because it was still very hot. When Merapi erupted I wanted to stay. However, I realized that was not a good idea because of the children. Then some rocks ended up hitting our home. Even in the northern area, rocks injured many people even when they were wearing jackets. And we can see how horrible the disaster was in the Gendol River. The distance between this village and the river is about 12 km to the east. The color of the stream at that time was red because of the lava and all the trees burnt down.

