Comparing risks at different volcanoes Unit 4: In-Class Key

Kaatje van der Hoeven Kraft (Whatcom Community College) & Rachel Teasdale (California State University – Chico)

*Answer the following questions with other group members who are examining the same volcano.*

*Scoring Guide for questions:*

* 2 points for each question in which student fully answers the question
* 1 point for partial answers or partially incorrect but fully answered
* 0 points for totally wrong or left blank

Scoring Guide for the table:

* 5 points for all of the volcano categories accurately answered
* 3 points for most of the volcano categories accurately answered
* 1 points for missing information, but some of it is accurately captured
* 0 points for not completing the table and/or all incorrect information

# Part 2. Your volcano is: \_\_\_\_\_Mauna Loa\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. What are the primary hazards for your volcano?

Eruptions would be relatively low VEI (0-1, maybe 2), with smaller amounts of ash/gas and maybe build cinder cones, but the real hazard would be if an eruption produces large lava flows

1. In the reading about your volcano, the MRI calculation was discussed in terms of using historical events, only some of which were confirmed and others that are considered uncertain. The MRI of all events was provided. Calculate the second possible MRI using only confirmed events (noted in the reading). Which do you think is a more realistic number (the MRI you calculated or the MRI provided)? Explain.

With only confirmed events, MRI = 187/33= 5.67, which is much smaller than the MRI determined with all events (even unconfirmed). The more realistic is the smaller number even if it slightly under represents some eruptions before good records started being kept because it doesn’t over-exaggerate the possible frequency of eruptions.

1. How large of a population may be impacted by the hazards of your volcano? What are the primary towns impacted by these hazards

A small eruption with small lava flows would impact only about 45 people within 5-10 km of the volcano but if longer lava flows are produced and they travel west, they could reach Kona very quickly (within 3 hours) so would be a big problem, especially for tourists who don’t know what to do if there’s an eruption (and they’d probably try to get close to the lava flows instead of staying a safe distance away). If the flows moved very far, they could affect Hilo, so even more people (165,000)

Kona coast and Hilo area

1. How much time do these populations have to respond?

Kona could have only a few (3) hours; Hilo would likely have more like weeks or days notice

1. Population density and poverty both play a role in how vulnerable a population is, how do these factors play a role with your volcano and how does that impact the potential vulnerability to volcanic eruptions?

The population is a bigger factor if flows go towards Kona because they could get there so quickly. Hawaii may be relatively low income for the US but this is a well studied volcano so evacuations could occur relatively smoothly

1. How might the corruption index for the country influence the impact of a volcanic eruption?

The corruption index in the US is 16 so relatively low on the corruption scale and probably not a big factor in evacuating people or helping them after a disaster

1. Volcano monitoring helps to alleviate some of the possible risk to a region. What instruments are available and what do they tell us about the volcano for monitoring purposes?

Mauna Loa is one of the best monitored volcanoes in the world, so we will know from earthquakes that magma is intruding into the volcano and breaking rocks in the subsurface (plus we’ll know how deep that is happening so can track it towards the surface). We’ll know from GPS and tiltmeter data if the volcano is inflating with new magma. We’ll know from gas emissions if gases are getting close to the surface as magma rises into the volcano.

1. Fill in the details in table 1 for your volcano below.

|  |  |  |  |
| --- | --- | --- | --- |
| **Table 1** | **Mauna Loa** | **Fuego** | **Rinjani** |
| Country | USA | Guatemala | Indonesia |
| Type of volcano | Shield | Stratovolcano | Stratovolcano |
| Possible hazards | Lava & Gas | Ash, Pyroclastic Flows & Lahars | Lava Flows, Ash, Gas, Pyroclastic Flows |
| MRI (use most realistic version) | 92.4 or 5.67 | 45.34 or 8.98 | 124.71 or 10.18 |
| Population density | 45 within 10km, 1900 within 30 km | More than 1 million within 30 km | More than 1 million within 30km |
| Poverty index | 10.9%, 16.8% “supplemental poverty” due to high cost of living | 59% in poverty | 10% in poverty, 21% at risk of dropping into poverty |
| Infrastructure | Roads are limited in rural areas, lava flows could close off access quickly in certain regions | Bridges, roads and railroads vulnerable to lahars; ash can travel far and impact millions depending on the time of year. | Bridges and houses poorly constructed to earthquakes, so likely also vulnerable to volcanic eruptive products. Highly reliant on tourism, which could be impacted |
| Corruption Index | 16/180 (low) | 143/180 (high) | 96/180 (medium) |
| Monitoring available | Well monitored with seismographs, InSAR, and tiltmeters along with well detailed hazard maps | Visual observations, webcams and 5 seismographs, well detailed hazard maps | Limited, one seismograph and access to portable instruments (seismographs and tiltmeters) |
| *Based on the information from above, assess the risk when considering Risk = Hazard x Value x Vulnerability* | | | |
| Hazard (High, Medium, Low) | Low or Medium | Medium or High | Medium or High |
| Value (High, Medium, Low) | Low or Medium | Medium or High | Medium or High |
| Vulnerability (High, Medium, Low) | Low or Medium | High | Medium or High |
| Risk (highest, middle, lowest) | Lowest | Highest (or middle) | Middle (or highest) |

# Part 3.

*In mixed groups, fill in the details on table 1 from the other two volcanoes.*

## Select one of these volcanoes to focus on for the following questions: (Mauna Loa)

1. Based on the monitoring available, how confident would you be to determine an alert level, and why? (Note, see more information on alert levels at the end of this handout).

There is so much monitoring at Mauna Loa that I am confident I could characterize the possible eruption indicators with Seismic, tilt and GPS

1. Based on the instrumentation available at the volcano, what data signal(s) would be observed if magmatic activity were increasing?

We would see more earthquakes with seismic (magma breaking through rocks in the subsurface)

We would see inflation from Tilt and GPS data

We would see increased gas emissions from the volcano as gases in the magma are released

1. What additional data or instrumentation would you want to install at this volcano to increase your confidence level? Explain why.

I would add more seismometers or GPS pairs in areas that have more inflation (e.g. a North flank if that’s where EQ are happening) to target that specific area in hopes of being able to understand where the eruption will occur and if it will go towards Kona or Hilo or other directions

1. As an emergency planner, what would you need to know to make decisions about evacuations?

I would need to know:

* How much warning the volcanologists can give me (so how much time to evacuate people if necessary)
* More about the road conditions and evacuation routes that are available, how many people would use those roads and how long an evacuation would take
* I would set up more emergency communications with officials and businesses in Kona and Hilo and provide information they could give to tourists (but we don’t want to do too much because we don’t want to destroy the tourism industry)

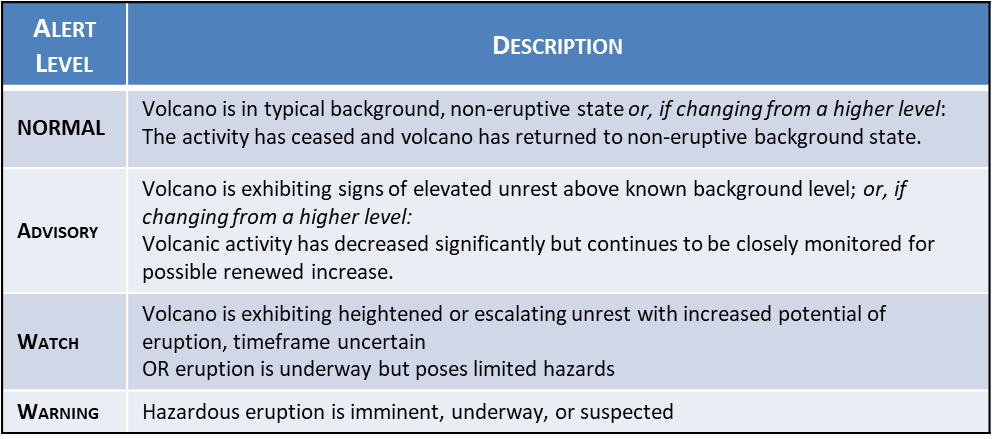
1. Combine the volcanology information with the issues addressed by the emergency planner to describe and explain some next steps for responding to the volcanic activity (include possible data collection, communication strategies, infrastructural considerations, economic costs of evacuation, etc…).

1. I would focus on trying to determine if the eruption might affect the Kona area because lavas would get there so fast, we wouldn’t have much time to evacuate people

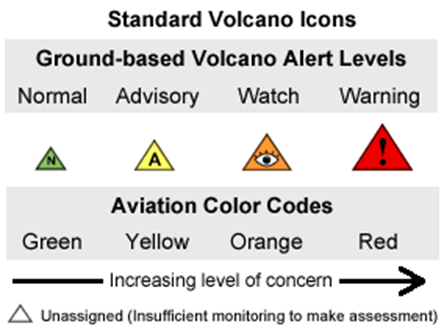
2. I would establish best evacuation routes and try to install more options/procedures for evacuating quickly (e.g. Kona)

All of this would take time, but I would enlist the help of local businesses to help with #2 and in educating tourists and residents.

USGS Alert Levels: *USGS established an alert level system to communicate the likelihood of increasing or decreasing volcanic activity.* [*https://volcanoes.usgs.gov/vhp/alert\_icons.html*](https://volcanoes.usgs.gov/vhp/alert_icons.html)



*USGS Alert Level Descriptions*



Monitoring Volcanoes Unit 4: In-Class Worksheet

Kaatje van der Hoeven Kraft (Whatcom Community College) & Rachel Teasdale (California State University – Chico)

*Answer the following questions with other group members who are examining the same volcano.*

# Part 2. Your volcano is: \_\_\_\_\_Fuego\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. What are the primary hazards for your volcano?

Eruptions would be ranging from low to moderate explosivity (VEI 1-4) that includes some lava, ash (that could spread far and near, but somewhat dependent on wind direction), pyroclastic flows, lahars and flooding

1. In the reading about your volcano, the MRI calculation was discussed in terms of using historical events, only some of which were confirmed and others that are considered uncertain. The MRI of all events was provided. Calculate the second possible MRI using only confirmed events (noted in the reading). Which do you think is a more realistic number (the MRI you calculated or the MRI provided)? Explain.

With only confirmed events, MRI = 494/55= 8.98, which is much smaller than the MRI determined with all events (even unconfirmed). even if it slightly under represents some eruptions before good records started being kept because it doesn’t over-exaggerate the possible frequency of eruptions.

1. How large of a population may be impacted by the hazards of your volcano? What are the primary towns impacted by these hazards

If the ash blows during the dry season (June to December), it could blow in directions that are more heavily populated that if it blew during the wet season in which case it would blow more westward (Dec to May). Smaller towns would likely be impacted by pyroclastic flows like Altenongo, the lahars would reach a wider, longer range and impact many small towns like Guadelupe, El Rodeo, Finca de los Diamentes, etc… Flooding and more distal lahars might reach further into more heavily populated areas like Escuintla and Siquinala

1. How much time do these populations have to respond?

Pyroclastic flows and lahars can be incredibly fast, as can ash, so not a lot of time.

1. Population density and poverty both play a role in how vulnerable a population is, how do these factors play a role with your volcano and how does that impact the potential vulnerability to volcanic eruptions?

Ash can collapse roofs to a really highly densely populated area if it blows the wrong way (and if it rains, it could make it like concrete) and many of these smaller towns lack solid communication to do know when/where to evacuated. This region is both densely populated in certain regions near the volcano and the poverty index is high, so this raises their vulnerability.

1. How might the corruption index for the country influence the impact of a volcanic eruption?

The corruption index in this country is really high (143/180), which means that people are even more vulnerable to impact from a volcanic eruption.

1. Volcano monitoring helps to alleviate some of the possible risk to a region. What instruments are available and what do they tell us about the volcano for monitoring purposes?

Mostly seismographs and webcams—seismographs can tell us if the magma is moving underground and if it is getting closer to the surface. Webcams and direct observations can provide a visual of what is happening at the volcano and if it is active at the surface.

1. Fill in the details in table 1 for your volcano below.

|  |  |  |  |
| --- | --- | --- | --- |
| **Table 1** | **Mauna Loa** | **Fuego** | **Rinjani** |
| Country | USA | Guatemala | Indonesia |
| Type of volcano | Shield | Stratovolcano | Stratovolcano |
| Possible hazards | Lava & Gas | Ash, Pyroclastic Flows & Lahars | Lava Flows, Ash, Gas, Pyroclastic Flows |
| MRI (use most realistic version) | 92.4 or 5.67 | 45.34 or 8.98 | 124.71 or 10.18 |
| Population density | 45 within 10km, 1900 within 30 km | More than 1 million within 30 km | More than 1 million within 30km |
| Poverty index | 10.9%, 16.8% “supplemental poverty” due to high cost of living | 59% in poverty | 10% in poverty, 21% at risk of dropping into poverty |
| Infrastructure | Roads are limited in rural areas, lava flows could close off access quickly in certain regions | Bridges, roads and railroads vulnerable to lahars; ash can travel far and impact millions depending on the time of year. | Bridges and houses poorly constructed to earthquakes, so likely also vulnerable to volcanic eruptive products. Highly reliant on tourism, which could be impacted |
| Corruption Index | 16/180 (low) | 143/180 (high) | 96/180 (medium) |
| Monitoring available | Well monitored with seismographs, InSAR, and tiltmeters along with well detailed hazard maps | Visual observations, webcams and 5 seismographs, well detailed hazard maps | Limited, one seismograph and access to portable instruments (seismographs and tiltmeters) |
| *Based on the information from above, assess the risk when considering Risk = Hazard x Value x Vulnerability* | | | |
| Hazard (High, Medium, Low) | Low or Medium | Medium or High | Medium or High |
| Value (High, Medium, Low) | Low or Medium | Medium or High | Medium or High |
| Vulnerability (High, Medium, Low) | Low or Medium | High | Medium or High |
| Risk (highest, middle, lowest) | Moderate-low | Highest (or middle) |  |

# Part 3.

*In mixed groups, fill in the details on table 1 from the other two volcanoes.*

## Select one of these volcanoes to focus on for the following questions: (Fuego)

1. Based on the monitoring available, how confident would you be to determine an alert level, and why? (Note, see more information on alert levels at the end of this handout).

There is very little monitoring available at Fuego that I am not confident that I could characterize the possible eruption indicators with only seismic, although I could probably get a sense of when things were really starting to get active.

1. Based on the instrumentation available at the volcano, what data signal(s) would be observed if magmatic activity were increasing?

We would see more earthquakes with seismic (magma breaking through rocks in the subsurface) and a change in depths of the earthquakes

1. What additional data or instrumentation would you want to install at this volcano to increase your confidence level? Explain why.

I would add more seismometers, GPS (ideally in pairs so I could see the inflation/deflation), tilt to see how the ground surface is changing, and increase use of InSAR to be able to better detect change over time with inflation and deflation.

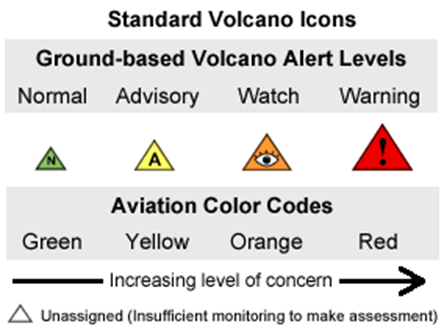
1. As an emergency planner, what would you need to know to make decisions about evacuations?

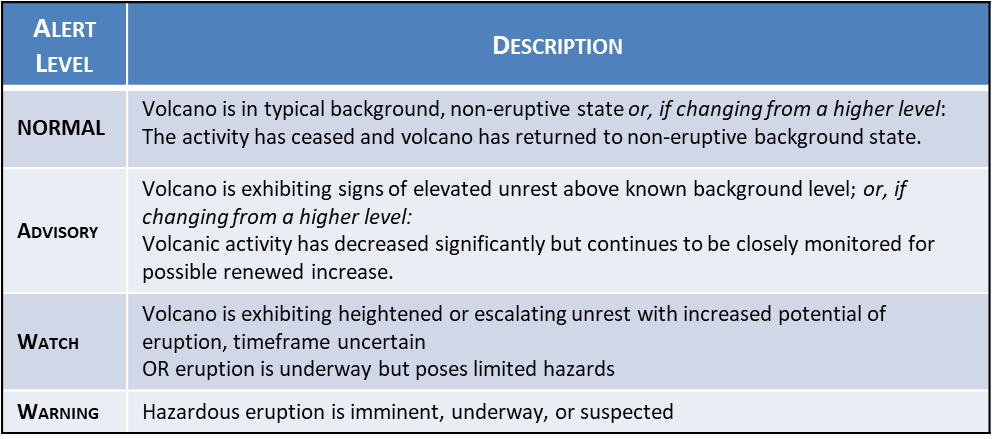
I would need to know:

* How much warning the volcanologists can give me (so how much time to evacuate people if necessary)
* More about the road conditions, other types of transportation needs/concerns and evacuation routes that are available, how many people would use those roads and how long an evacuation would take
* I would need to know what the current ability to communicate with local communities is and how to better improve that based on the limitations they had within their community.

1. Combine the volcanology information with the issues addressed by the emergency planner to describe and explain some next steps for responding to the volcanic activity (include possible data collection, communication strategies, infrastructural considerations, economic costs of evacuation, etc…).
2. I would work on improving monitoring of the volcano so there would be a greater response time to communicate the need to evacuate.
3. I would work with local officials to improve lines of communication in how more rural regions can evacuate

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*USGS Alert Level Descriptions*

Monitoring Volcanoes Unit 4: In-Class Worksheet

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*Answer the following questions with other group members who are examining the same volcano.*

# Part 2. Your volcano is: \_\_\_\_\_Rinjani\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. What are the primary hazards for your volcano?

Either a large eruption (VEI = 4+) or more likely smaller eruptions from the Barujari cone in the caldera (VEI 0-3), which could include lava flows or small pyroclastic flows

1. In the reading about your volcano, the MRI calculation was discussed in terms of using historical events, only some of which were confirmed and others that are considered uncertain. The MRI of all events was provided. Calculate the second possible MRI using only confirmed events (noted in the reading). Which do you think is a more realistic number (the MRI you calculated or the MRI provided)? Explain.

With only confirmed events, MRI = 173/17 = 10.176, which is much smaller than the MRI determined with all events (even unconfirmed). The more realistic is the smaller number, even if it slightly under represents some eruptions before good records started being kept because it doesn’t over-exaggerate the possible frequency of eruptions.

1. How large of a population may be impacted by the hazards of your volcano? What are the primary towns impacted by these hazards

A small VEI eruption would likely only impact people within 5 km, which is 10,289 people but if a large VEI eruption occurred it could impact a larger area (30 km) so 1.3 million people

We don’t know the names of towns that would be affected

1. How much time do these populations have to respond?

If there is sufficient monitoring, a large eruption would have more signal of magma movement so could be weeks of seismic unrest but the impact would be very big very quickly (e.g. within a day).

A smaller eruption (lavas, small pyroclastic flows) would also have some deformation and seismicity for a week or days before an eruption and wouldn’t have an impact to towns, but more of a concern to hikers and volcanologists monitoring the Barujari

1. Population density and poverty both play a role in how vulnerable a population is, how do these factors play a role with your volcano and how does that impact the potential vulnerability to volcanic eruptions?

A small eruption wouldn’t have a big impact on towns so not really a factor

A large VEI eruption would impact large populations (more than 1.5 million) of people who are relatively poor so they would have a harder time getting out of harms way and may have crops or livestock they need to protect for their livelihood so they might be more resistant to evacuating.

Bringing food/water/medical relief would be harder in impoverished areas where roads/bridges may be more susceptible to damage and less likely to repairs

1. How might the corruption index for the country influence the impact of a volcanic eruption?

The corruption index in Indonesia is 96 so in the middle of the scale and would probably play a role in making recovery/relief/rebuilding more difficult and would take longer

1. Volcano monitoring helps to alleviate some of the possible risk to a region. What instruments are available and what do they tell us about the volcano for monitoring purposes?

There is only 1 seismometer (which will tell us that rocks are moving as magma intrudes into the volcano) so this won’t help very much, especially because there are tectonic earthquakes in this area (subduction zone) so it will be hard to distinguish volcanic vs. tectonic activity.

1. Fill in the details in table 1 for your volcano below.

|  |  |  |  |
| --- | --- | --- | --- |
| **Table 1** | **Mauna Loa** | **Fuego** | **Rinjani** |
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| Infrastructure | Roads are limited in rural areas, lava flows could close off access quickly in certain regions | Bridges, roads and railroads vulnerable to lahars; ash can travel far and impact millions depending on the time of year. | Bridges and houses poorly constructed to earthquakes, so likely also vulnerable to volcanic eruptive products. Highly reliant on tourism, which could be impacted |
| Corruption Index | 16/180 (low) | 143/180 (high) | 96/180 (medium) |
| Monitoring available | Well monitored with seismographs, InSAR, and tiltmeters along with well detailed hazard maps | Visual observations, webcams and 5 seismographs, well detailed hazard maps | Limited, one seismograph and access to portable instruments (seismographs and tiltmeters) |
| *Based on the information from above, assess the risk when considering Risk = Hazard x Value x Vulnerability* | | | |
| Hazard (High, Medium, Low) | Low or Medium | Medium or High | Medium or High |
| Value (High, Medium, Low) | Low or Medium | Medium or High | Medium or High |
| Vulnerability (High, Medium, Low) |  |  | High |
| Risk (highest, middle, lowest) |  |  | Med-high |

# Part 3.

*In mixed groups, fill in the details on table 1 from the other two volcanoes.*

## Select one of these volcanoes to focus on for the following questions: (Rinjani)

1. Based on the monitoring available, how confident would you be to determine an alert level, and why? (Note, see more information on alert levels at the end of this handout).

Given there is currently only 1 seismometer available to monitor this volcano (plus visual observations from large # of people who live nearby), I am not at all confident in being able to provide an alert level for the volcano. Rinjani is also located at a convergent plate boundary so earthquakes there could be tectonic or volcanic, which makes monitoring the volcano very difficult without other monitoring methods.

1. Based on the instrumentation available at the volcano, what data signal(s) would be observed if magmatic activity were increasing?

With the single seismometer, we would see increased earthquake activity to signal magma moving in the subsurface, potentially on its way to the surface to erupt

1. What additional data or instrumentation would you want to install at this volcano to increase your confidence level? Explain why.

I would install tilt meters and GPS stations on the outer flanks of Rinjani and on Barujari to detect inflation

1. As an emergency planner, what would you need to know to make decisions about evacuations?

I would need to know:

* More data from the volcanologists about how much time there would be between detecting that a big/small eruption and when the eruption would actually occur (e.g. days? Hours?)
* More about the road conditions and evacuation routes that are available, how many people would use those roads and how long an evacuation would take
* More about how many people live around the volcano and what communications I could use to signal the need to evacuate (e.g. cell phone, social media, church bells etc)

1. Combine the volcanology information with the issues addressed by the emergency planner to describe and explain some next steps for responding to the volcanic activity (include possible data collection, communication strategies, infrastructural considerations, economic costs of evacuation, etc…).

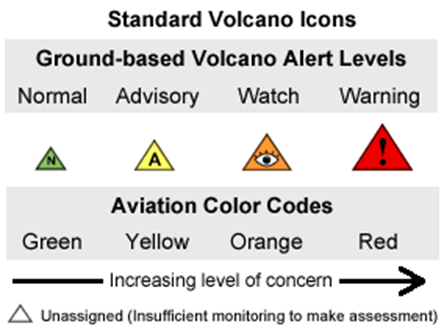
1. I would first spend time/money installing more monitoring devices and maybe train some locals to maintain/protect them (to prevent vandalism/change batteries etc)

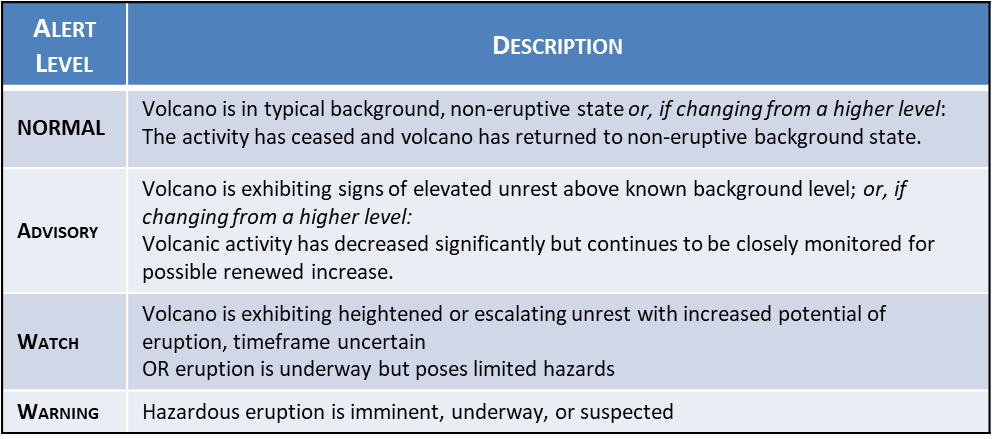
2. I would get more information about the population (how many/how mobile/how to communicate with them)

3. I would get more information about the roads and evacuation routes

All of this would take time, but I would enlist the help of local groups/churches to help with #2 and 3 so they are communication centers during a crisis and also can help gather information to help develop emergency plans

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