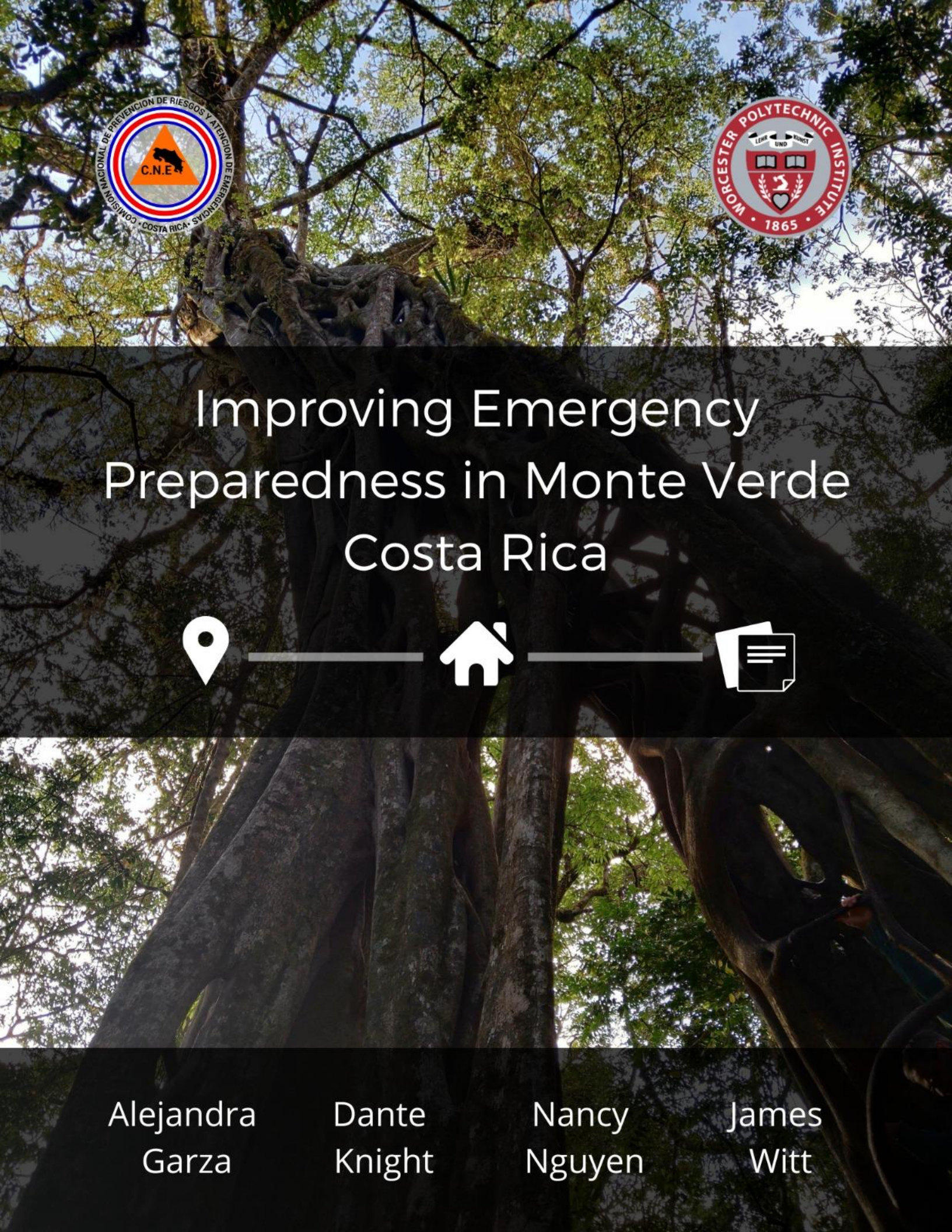

# Improving Emergency Preparedness in Monte Verde Costa Rica


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47-WSM-C203

# Improving Emergency Preparedness in Monte Verde Costa Rica

An Interactive Qualifying Project

**Submitted to:**

*The Faculty of Worcester Polytechnic Institute*
*in Partial Fulfillment of*
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*Sponsor:* Maricella Solís, Comisión Nacional de Prevención de Riesgos y Atención de Emergencias Costa Rica

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**Submitted by:**

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# Abstract

Due to extensive damage from Tropical Storm Nate in October 2017, the community of Monte Verde, Costa Rica, realized they needed to improve their approach to handling emergencies. We worked with Monte Verde's emergency sub-committee to establish a foundation for emergency preparedness plans and identified areas that need improvement. These improvements consisted of a map containing important locations in Monte Verde, detailed supplies and warehouse plans, and an emergency protocol for educating residents about emergencies using an app and infographics.

# Acknowledgements

This project would not have been possible without the support and guidance of the following individuals and organizations:

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  **We really appreciate her enthusiastic, friendly demeanor and her tremendous amount of support throughout our time in Monte Verde.

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- **Alexander Badilla S. (Field Doctor from the Health Clinic):** for helping us understand the clinic's population map and adding houses to the GIS map.
- **Sue Gabrielson (Head of the Friends School) and Deborah Hamilton (Head of the Monteverde Institute):** for their support in our project and our warehouse idea.
- **Professor Peet and San Martín (our project advisors):** for supporting our project and giving us weekly feedback, checking in with us every week and asking how we are doing after weekly presentations.
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# Authorship

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*Table 0.1: Authorship Table*

| **Role** | **Primary Author(s)** | **Co-Author(s)** |
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| Paper Drafting | **All** | |
| Paper Editing | AG & NN | DK & JW |
| Paper Formatting | NN | |
| Map | DK | |
| Warehouse Supply List Compilation | **All** | |
| Warehouse Supply List Calculations | DK (total cost and total volume of supplies on a per capita basis) | NN (use percentage of each item and final estimated sizing from population count) |
| Warehouse Design | NN | |
| Infographics | AG & NN (research and design) | DK & JW (research) |
| App Development | JW (back end development) | |
| App Design | AG (front end design and development) | DK, JW, & NN (format) |
| Presentation Graphics and Design | AG | |
| Translator | AG | |

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# Executive Summary

Nations all around the world face environmental threats, and they must develop emergency plans that are specifically tailored to the natural disasters that are common in their areas. Costa Rica experiences hurricanes/tropical storms, earthquakes, and volcanic eruptions (Anders, 2017a). For Monteverde, a small community located at a high elevation (4,662 feet) in the mountainous region just west of the continental divide, the most common threats are tropical storms and earthquakes. These result in flash floods and landslides, which can lead to road blockages, destroyed or washed away houses, as well as the loss of power and communication lines (Anders, 2017b).

After Tropical Storm Nate occurred in October of 2017, which had devastating effects on Monte Verde (a town in Monteverde), the Comisión Nacional de Prevención de Riesgos y Atención de Emergencias (National Commission for Risk Prevention and Emergencies Care), or the CNE (2019f), worked to establish a local emergency sub-committee in the area. Members of this sub-committee (see Appendix E) agree that while the CNE is efficient at reacting to emergencies, it needed a better preparedness and mitigation plan. The sub-committee and this project aimed to serve this purpose.

Tropical Storm Nate made evident the vulnerability of the region. Landslides and road destruction left this community isolated for four days. Throughout this period, the CNE was unable to send resources, and residents were left with limited access to food, clean water, and medication. The disaster presented a difficult challenge for the CNE and the community but provided the sub-committee with a clear path to develop an integrated preparedness and mitigation plan.

With the support from Monte Verde's emergency sub-committee, this project aimed to establish the foundation of an emergency preparedness plan for the region. Using semi-structured interviews with the sub-committee members and local experts, and surveys with residents and tourists, we accomplished the following objectives: 1) Identify the major risks in different areas within Monte Verde; 2) Identify possible locations for warehouses and meeting points, and design warehouses including any necessary supplies; 3) Determine the most effective plans for addressing Monte Verde's major threats; and 4) Identify and create better public awareness protocols.

We organized our project into three deliverables:

**Our first deliverable was an integrated risk map using ArcGIS.** We worked closely with Geiner Alvarado Huertas (from the Monteverde Reserve), Jorge Torres (from the emergency sub-committee), and Alexander Badilla S. (a Field Doctor from the Health Clinic), in order to create an integrated GIS map including all relevant information that every organization could use. The base map (Geiner's map) included information about roads, infrastructure, rivers, and areas of landslide risk in the region of Monteverde. We then added information regarding

private roads, homes, helicopter landing zones, potential emergency meeting points, and the potential location for two warehouses (see Appendix K).

We recommend that the emergency sub-committee use the map to educate Monte Verde's residents about these locations through public awareness protocols, share the map between the departments in the committee to ensure that everyone is aware of the risk areas, and use the map when working with outside organizations. We also recommend that organizations work to keep the map updated frequently.

**Our second deliverable included warehouse plans, containing potential locations, designs, and necessary supplies.** Local experts agree that the bridge Puente Arbóreo has a high chance of collapsing during the next major natural disaster. This would separate the town of Monte Verde into two sides: one north of the bridge and one south of the bridge. After their experience with Tropical Storm Nate, our sponsor's main contact, Maricella Solís (personal communication, January 17, 2020), suggested building two warehouses, one on each side of the bridge, that could maintain their respective population in case the area becomes isolated. We initiated conversations with the leaders of the Monteverde Institute and the Friends School (two important centers of communication in the community) to gauge the possibility of constructing a warehouse on their property. Using Google sheets, we created a supply list, which can calculate the total cost and volume of supplies on a per capita basis (see Appendix I). With the estimated volume, we provided the designs for the two warehouses through SolidWorks. See Section 4.2.5 for details and screenshots of the models.

For the layout of the warehouses, we recommend that the combustibles be stored in a separate housing unit to prevent fire hazards. We also recommend that the mattresses be stored elsewhere if possible, as it takes up significant space in the warehouse compared to the other supplies. We also recommend that the sub-committee continues working with these two institutions to move forward with the construction of the warehouses.

**The third deliverable included emergency and public awareness protocols.** We surveyed locals and tourists to gather information on general knowledge of public emergency protocols and experiences during Tropical Storm Nate. We learned that the community needs more education on natural disasters and emergency response. We identified that infographics and a mobile application are the best ways to inform Monte Verde's inhabitants about emergency preparation and response.

The infographics are suited for the people who do not feel comfortable using technology and are available in Spanish and English. Based on our interviews with emergency sub-committee members, we decided to create six types of infographics: landslides, flash floods, tremors and earthquakes, fires, secondary effects of volcanic activity, and emergency preparedness.

We recommend printing out the infographics, putting them up in common public places, and distributing them in hotels. It is ideal to distribute them to each family, but this will cost a significant amount of money and waste paper. Therefore, we recommend that our sponsor works closely with organizations that create annual calendars, which we learned are common in

homes, to compile relevant information from the infographics to put in the calendar and update them annually.

Based on our survey results, a large number of people were comfortable enough with technology, so we also decided to design a mobile application. Furthermore, the app allowed us to reach across the language barrier of the tourists. From our surveys, we determined that the most popular languages are English, Spanish, French, and German, and therefore, our app will be offered in these languages. We were able to fully include the information in the app in English and Spanish; however, French and German needed work. The content is similar to the content in the infographics (see Appendix M).

We recommend that our sponsor continues to refine information in the app and work with professionals to improve the translation of the content, possibly adding more languages. We also recommend collaborating with hotels, Airbnbs, and homestays to distribute the application to tourists.

The new outlook on emergency preparedness started after Tropical Storm Nate. This perspective is increasingly important as Monte Verde continues to grow and experience changes in climate. The people are committed to reducing the impact of natural disasters, and we hope to lay the foundation for an emergency plan that will continue to develop and become more integrated into the community. We also hope that further research made on this problem will be able to use our findings to make improvements to the plan.

# Chapter 1: Introduction

Natural disasters are an issue all nations around the world must face, and they can range from hurricanes to the fires threatening California's forests (Wolters 2019). Furthermore, over the last couple of decades, these disasters have become more frequent and increasingly impactful due to climate change, and it is predicted these abnormalities will continue to grow in the future (Ramirez, 2010). Each nation must develop emergency plans that are specifically tailored for the disasters in their area. The effectiveness of these emergency plans varies and can be influenced by many factors including the terrain (affecting its accessibility) as well as the amount of resources the government has available to deal with emergencies. Another factor that influences how countries are able to deal with emergencies is how much their culture values preparedness for these events.

In 2016 alone, Costa Rica faced two hurricanes, numerous tremors, one major earthquake, and several small volcanic explosions (Arias, 2016a). Each event had devastating effects on the region, which seriously affected the population both economically and physically. The Comisión Nacional de Emergencias, or CNE (2019h), oversees national level response to emergencies. However, Costa Rica's regional diversity requires unique plans for different areas. In order to address the diversity of challenges there are local sub-committees that create specialized plans for their regions. Monte Verde, a small town in a mountainous region of Costa Rica, has historically become isolated during emergencies due to road blockages caused by flooding and/or landslides. This has made it extremely difficult for the government or other agencies to send supplies to the area during times of need (Andres, 2017b). Thus, our sponsor, Monte Verde's local emergency sub-committee, must develop its own preparation and mitigation plans, mostly without outside resources.

A substantial amount of research has been conducted on disaster response and mitigation, most of which uses past cases, such as the San Francisco earthquake in 1906. Historical cases are essential to learn from the mistakes of others and to see what could have been done better (Valcik, 2013). As seen in Section 4.1, historical data can also offer relevant information on risk areas and the role of community members and organizations in past emergencies. A major theme among these studies is the importance of pre-disaster preparations and planning. These preparations and plans include aspects such as water and food storage, communication plans and logistics for every possible scenario, knowledge of local emergency facilities, and adequate evacuation routes and transportation for stranded individuals. Common shortcomings of these plans include poor risk assessment and mitigation strategies as well as preparation that don't properly prepare for less frequent disasters.

In Monte Verde, there have certainly been weaknesses and gaps in the previous emergency plan. In 2017, Tropical Storm Nate struck the area and made those weaknesses and gaps evident. According to Anders (2017a), Monte Verde was subjected to landslides, in addition to flooding and high winds due to its geographic location in a mountainous area. As a consequence, the main access road to the town was cut off as well as the town itself being divided in two, leaving two completely isolated communities without access to assistance and

communications. Although the support from the community was “remarkable” (Burlingame, 2018, p. 2), the time needed for recovery revealed that Monte Verde did not plan well to address the consequences of isolation. Before Nate, their approach had been more reactive than proactive, focusing on recovery and relief instead of risk reduction and prevention. Since then and after seeing the challenges that Nate left, community members and key organizations have agreed on the need for a more proactive emergency plan for Monte Verde.

The goal of this project was to design proactive emergency plans for Monte Verde in collaboration with the local sub-committee. Our objectives to accomplish this goal were to identify the major risks in different areas within Monte Verde, identify potential locations for warehouses and emergency meeting places, improve the plans for addressing Monte Verde’s major threats, and identify and create better public awareness protocols. We accomplished our goal and objectives by conducting interviews, visiting different locations and areas, coordinating with key stakeholders, and conducting archival research. By achieving our objectives, we helped Monte Verde’s local sub-committee establish a more informative, proactive emergency plan that should hopefully help the region handle its next emergency much more successfully.

# Chapter 2: Background

In order to create a proper emergency plan, it is important to identify what the current situation is in both Costa Rica and the rest of the world with regard to emergency planning. In this chapter we will review disaster and emergency management plans from around the world and in Costa Rica to identify potential ways to prepare for disasters, as well as determine the most effective methods for storing emergency supplies. We will discuss the general health problems related to disasters and associated health care recommendations to determine some potential effects of disasters and how they should be managed. Finally, we will analyze what disasters might occur in Monte Verde, its current preparedness protocols, as well as the stakeholders who are currently involved in Monte Verde's emergency planning.

## 2.1 Four Phases of Emergency Management

In our interview with WPI's Emergency Preparedness Director, Ronald Bashista (personal communication, November 25, 2019), he discussed the four phases of emergency management shown in Figure 2.1.

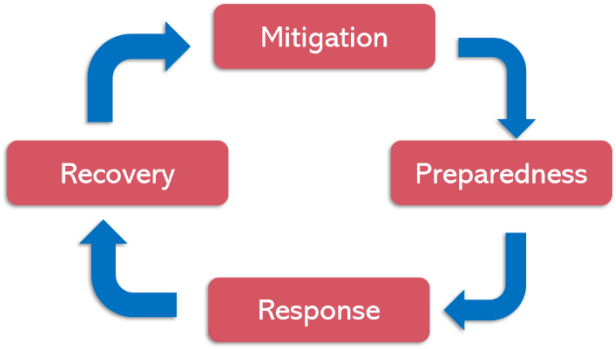



*Figure 2.1:* Four Phases of Emergency Management

These phases are standardized by the Massachusetts Emergency Management Agency (2019), and the agency defines them as the following:

- ✓ Mitigation and Prevention: measures taken to reduce risks and prevent or limit damage and injuries from disasters, usually in the form of policies, plans, and analysis; it can happen before or after emergencies.
- ✓ Preparedness: measures taken in advance in the form of evaluating, planning, training, and educating the public in order to have the operational capability to respond to an emergency or disaster.
- ✓ Response: actions and operations taken right after an emergency, implementing response plans developed beforehand, in the form of support system coordination, resource mobilization, and public notification.
- ✓ Recovery: the process of restoring services and damaged infrastructure through individual and public assistance.

In our next section, we will outline the importance of the phases through some examples. It will highlight the importance of preparedness and mitigation in comparison to response and recovery. As well as emphasize why Monte Verde should change its cultural and functional norm, which centers around response and recovery.

## 2.2 Examples of Emergency and Disaster Management

In order to improve Monte Verde's current emergency plans, it is important to look at disaster responses in different countries as well as their best practices.

### *2.2.1 Chile's Response to an Earthquake in 2014*

An example of a good emergency response plan is the one carried out by Chile during a series of earthquakes in April 2014 (IFRC, 2014). When the first earthquake hit on April 1st, the Chilean Red Cross immediately jumped into action and convened to monitor the emergency. In their strategy to mitigate risks, they proposed to offer psychological first aid, promote sanitation and hygiene, and provide aid to the immigrant population. The management of the affected population's mental health is often overlooked, and Chile decided that in order to improve the quality of life of those affected by a disaster, they needed to provide resources to lift people's spirits. In addition, bridging the gap between rescue efforts and the affected immigrants is often overlooked: undocumented immigrants are often afraid to contact assistance services due to fear of bringing attention to their undocumented status. Chile included this vulnerable population in its response plan. Chile's case highlights the importance of addressing all aspects of the population's needs, including those, such as mental health, that are often overlooked.

### *2.2.2 Japan's Emergency Preparedness and Response Technical Knowledge Exchange*

Other examples of good emergency preparedness practices can be taken from a technical knowledge event hosted by Japan, that involved a discussion between representatives from Bolivia, Indonesia, Myanmar, Nepal, and Uzbekistan (The World Bank, 2017). This event, which occurred in 2017 from August 28th to September 3rd, was intended to teach the participants about disaster preparedness and response systems as well as enhancing their understanding on risk communications and public awareness activities. This was done through active engagement and sharing of knowledge and ideas amongst the six countries. Good practices that were covered involve early warning systems for flooding, seismic reinforcement of buildings and other infrastructure, drills for reacting to various emergencies, an emergency operations center, and disaster preparedness plans for utilities, including gas and oil. Summits like these help to ease the spread knowledge to countries that need better emergency planning and response.

### *2.2.3 Poor Disaster Management*

There are also well documented cases of response plans that involved practices one must avoid during natural disasters. One interesting example is the San Francisco earthquake in 1906 (Valcik, 2013), which highlights how unpredictable natural disasters can be, as well as why planning is extremely valuable. Early in the morning at 5:12am, an earthquake struck San Francisco, causing most of the buildings in the city to collapse and leaving various citizens trapped in the rubble. Furthermore, there were fires caused by the earthquake and as well as those intentionally caused by citizens (for insurance purposes) that began breaking out all over the city. To make things worse, the earthquake had shifted and redirected a river, causing the flooding of some residential areas. San Francisco did not have solid emergency plans to deal with all these issues at the same time, which led to the earthquake having a heavy and lasting impact in the city: 80% of the city burned down. This example shows that threat assessment and proportional resource allocation to each threat are important to a successful response plan.

## 2.3 The Storage of Supplies Using Warehouses

An important aspect of emergency preparedness is the use of warehouses for the storage of food and supplies. According to Cosgrave (2008), it is needed for three reasons in emergency planning: 1) for overnight storage when the method of supply transportation needs to change to get to the destination (ex. switching from land to sea transportation), 2) to have available resources in case the delivery of emergency supplies are delayed, and 3) for the purpose of final storage, which will hold the supplies until they have to be distributed to the people who need them.

Cosgrave (2008) has investigated the optimization of these storage spaces in terms of capacity, and Rawls (2010) has investigated their location in a community using mathematical modeling. The location of a warehouse must be strategically located so that it can be easily accessed. This is especially important for a place like Monte Verde that becomes cut off from other towns due to landslides and flash floods. There are warehouses that have been designed for the storage of emergency relief supplies (U.S. Patent No. 20090106102A1, 2008), as well as some that have been developed for making warehouses multifunctional. For example, there have been warehouses designed to concurrently collect meteorological data (Japan Patent No. 2016035724A, 2014) and others that provide toilets in times of need (Japan Patent No. 2018158765A, 2017). Therefore, there is the potential to develop multi-purpose warehouses for a specific region, such as Monte Verde, and the potential to optimize the placement of these warehouses.

## 2.4 Health Effects from Disasters and Medical Care

Aside from the physical damage natural disasters can cause in an area, it is also important to consider the effects they have on people themselves.

### 2.4.1 Natural Disasters and Mental Health

One side effect that is overlooked by reports and news, as it is not clearly visible, is the impact disasters have on mental health (Armstrong, 2017). A lot of people face a wave of negative emotions during and after these events, including grief, shock, anxiety, and depression. Depending on the extent of the damage caused, as well as the person's personal mental health prior to the disaster, these feelings can last long after the event. These emotions are caused by various factors, including the loss of a loved one, the loss of a home, the loss of material property, the stress of evacuating, and the stress of being injured; however, it truly depends on the person facing these scenarios. Different people react differently to various situations, and the effects disasters can have on their mental health can be unpredictable. In order to minimize the possibility of this effect, it is important to provide people with a calm environment after the event, as well as offer therapeutic services to those in need.

### 2.4.2 The Risk of Epidemics after Natural Disasters

Another effect disasters can have on people is the higher risk of an epidemic outbreak. Many areas face a shortage of fresh food right after a natural disaster due to the destruction of roads, and it can lead to malnutrition and weakening of the immune system (Armstrong, 2017). Aside from fresh food, areas might face a lack of access to clean water since water supplies are either contaminated or isolated during the event. This might cause people to drink untreated water, which has the risk of carrying dangerous pathogens and/or toxic chemicals. Furthermore, many people lose their homes and are therefore forced to spend time at crowded shelters with poor hygiene. Malnourishment, contaminated water, crowded spaces, and poor hygiene levels all combine to increase the risk of an epidemic in the affected areas. It is therefore important to provide shelters and homes with fresh food and water for those affected by disasters, as well as encourage hygiene through the distribution of sanitary products and access to bathrooms and showers.

### 2.4.3 The Hazards of Infections

Aside from epidemics, there is also the possibility of being exposed to infections and the escalation of pre-existing health conditions. Earthquakes are known to result in a large number of injuries that, although not immediately fatal, can cause infections if not treated properly or quickly enough. According to Rattue (2011), it is estimated that around 2% to 15% of the affected population suffer from crushing injuries from debris or heavier objects, which can lead to permanent damage such as kidney problems and amputations. Considering that a lot of areas have limited access to emergency treatment during these times, the effects of the previously mentioned injuries have the potential to elevate to more life-threatening levels, especially in developing countries or isolated regions. Furthermore, people who are not directly injured by the disaster can still suffer health problems days or even weeks after the event. For example, an earthquake in Northridge, California, caused "heart attacks [to rise] by 35% in the week following the disaster" (para. 6).

Hurricanes are known for causing flooding and physical damage to properties, which can be extremely dangerous. According to Armstrong (2017), damage to power lines and gas lines can cause electric shocks, carbon monoxide poisoning, and fires, while broken glass and splintered wood can cause further injuries. Furthermore, flooding usually results in contaminated water caused by exposure to sewage and toxic chemicals. If people with injuries are exposed to the water, their injuries can become dangerously infected. Another common result from floods is mold and mildew, which can grow within 48 hours of the event. Not only can mold affect people's homes, but it can also have effects on the health of the occupants since it can "trigger a variety of allergy symptoms and other serious health issues" (para. 14). In order to prevent infectious diseases, regions should be provided with as much emergency care as possible. Furthermore, people should be strongly discouraged from visiting flooded areas or houses with mold, which can be done by providing them with comfortable shelters.

## 2.5 Costa Rica: Common Natural Disasters

In this section we will discuss the natural disasters that are the most common in Costa Rica. We will also discuss the disasters that, although not very common, have the potential to cause a lot of damage to the nation.

### *2.5.1 Hurricanes and Tropical Storms in Costa Rica*

According to PreventionWeb's (2019) Costa Rica Disaster and Risk Profile, some of the most devastating disasters in Costa Rica's recent history include landslides, earthquakes, and floods. Both landslides and floods are caused by hurricanes or tropical storms, which are known to affect the region on a regular basis. However, Waldron (2019) interestingly notes that "in all of recorded history, a hurricane has never actually made direct landfall on Costa Rican territory" (para. 3). The term "landfall" is described as "the location where the eye of the storm first strikes the land" (para. 3), which means that while hurricanes may affect Costa Rica, none have actually gone directly through it. Tropical storms, however, are quite common in Costa Rica with two to three storms occurring in each area of the country every year. According to Caroline Burke (2019), the only difference between tropical storms and hurricanes is their wind speed, with hurricanes being 74 mph or above and tropical storms being 73 mph or less. Both types of storms can cause flooding and landslides, which can have major effects on the population, such as the destruction of homes and the suspension of transportation due to debris blocking the road/tracks or roads being washed out.

### *2.5.2 Earthquakes and Tremors in Costa Rica*

Earthquakes can also have a big effect on Costa Rica's population, and they occur frequently. Arias (2016b) mentions that "monthly data from the University of Costa Rica's Volcanological and Seismological Observatory (RSN) state that there were 3,303 tremors between January and November" (para. 21). However, most of these tremors usually go unnoticed. For example, according to RSN, out of the 3,303 earthquakes previously mentioned, only 191 were reported by the residents of the area. Unfortunately, for the earthquakes that

are noticed, their effects can be quite severe, resulting in landslides and the destruction of houses. Furthermore, the region surrounding Costa Rica is also known to have a lot of underwater earthquakes, which can cause tsunamis, another natural disaster that Costa Rica is subjected to.

### *2.5.3 Potential Threat of Tsunamis in Costa Rica*

Around 85% of Costa Rica's coastline faces the Pacific Ocean, which makes that coast especially vulnerable to tsunamis since 83% of recorded tsunamis around the world, have occurred in the Pacific Ocean (Chacón-Barrantes & Protti, 2011). Tsunamis can have devastating effects, such as flooding and the destruction of homes and infrastructure, which is a recurring problem in Costa Rica. However, the last recorded case of a tsunami in Costa Rica happened in 1854 (Fernández-Arce & Alvarado-Delgado, 2005). Regardless, the possibility of a tsunami happening exists and the effects could be devastating. For example, while there is no data on the number of deaths the previously mentioned tsunami caused in Costa Rica, it is known that it completely destroyed a coastal village.

### *2.5.4 Volcanic Activity in Costa Rica*

Volcanic eruptions are another major natural disaster that Costa Rica faces since it currently has five active volcanoes (Arias, 2016b). In addition to lava, eruptions result in the emission of harmful substances such as ash, vapor, and incandescent rocks. One of Costa Rica's most recent volcanic incidents was the 2016 Turrialba Volcano, which had several explosions ranging from a few hundred meters to four kilometers. Due to these explosions, ash traveled through several areas, causing the closure of several airports as well as a huge loss in agriculture and tourism. Furthermore, even after the ashes had cleared, there was a reported sulfur smell after the incident that lasted several months, resulting in a further decrease in tourism.

## 2.6 Costa Rica: Current Emergency Plan

The CNE (2019b) is an organization that was established by the Costa Rican government to handle any national emergency that occurs in Costa Rica. Since its inception in 2006, the CNE's (2019f) mission has been to promote, direct, organize, and coordinate the National Risk Management System and execute its response plan. To accomplish this mission, multiple bills and laws have been passed to increase its power. This has allowed the CNE to interact with many different entities, both regional and international, as well as gather the resources it deems necessary to provide emergency care in case of disasters.

The CNE (2019d) has developed multiple procedures that go into effect depending on the emergency. It utilizes the national radio station to both coordinate with entities that are helping them and broadcast their alert system. There are three alerts that the CNE (2019a) will broadcast during emergencies. The information alert state (green alert) indicates there is the possibility of an emergency, when it would strike, and which regions it would affect. During this state, the CNE (as well as local emergency committees and the organizations that work with

them) begin checking their resources and ensuring everything is ready to act in the case of an emergency unfolds. For example, we learned from Monte Verde's emergency sub-committee that during their green alert, departments such as firefighters and the health clinic, check their firetrucks/ambulances have full tanks and are ready in case they need to respond (see Appendix E for more details on the interviews).

The preparation alert state (yellow alert) indicates that the danger of the emergency continues to grow and is likely to strike. During this state, local sub-committees and the CNE meet and discuss their plans to deal with the emergency. They establish committees for both organizations and locals that are attended by representatives. These committees allow the affected communities to be part of the disaster response process and allow the information to spread faster. Finally, the evacuation alert state (red alert) indicates that the danger is imminent and evacuation plans should start being executed. During emergencies, the CNE (2019g) also provides basic necessities to people such as bottled water, food supplies, and shelter. They are also involved with the restoration and reconstruction of the area after a disaster, such as rebuilding roads and bridges.

The CNE has been proven to be effective at reacting to emergencies, which we learned after discussing CNE's role during Tropical Storm Nate with Monte Verde's emergency sub-committee. However, as mentioned previously, the CNE undergoes most of its emergency planning during yellow alerts: once the possibility of the disaster striking is almost confirmed. This is also the stage where they begin providing local emergency committees with resources to combat the disaster. For Monte Verde, an area that tends to become isolated during emergencies, this means that emergency provisions are most likely to be delayed. This is exactly what occurred during Tropical Storm Nate in 2017, where Monte Verde was isolated for four days with little access to clean water, medical supplies, and food. Having an emergency plan and better infrastructure established in advance, is thus critical to support the work of the CNE and the Monteverde sub-committee.

## 2.7 Monte Verde's Emergency Plan

It is important to point out that Monteverde is the term used to describe a region in Costa Rica that includes Santa Elena, San Luis, Cerro Plano, and the town Monte Verde, which is the area this project focused on. Since Monte Verde is a mountainous area in an isolated region within Costa Rica, people there are not exposed to all the natural disasters continuously affecting Costa Rica. Monte Verde's most impactful disasters are tropical storms, since they lead to flash floods, washouts and the temporary blockage of roads (Cobb, 2017). Being such a remote region, Monte Verde is extremely dependent on its roads for the transportation of resources, and they cannot afford to lose access to them for an extended period of time. Furthermore, tropical storms cause landslides within Monte Verde (Pan American Health Organization, 2018), which not only destroys properties and roads, but can be extremely dangerous for its residents.

We reviewed what happened in Monte Verde in terms of emergency management using a recent example of a disaster that occurred on October 5, 2017, when Costa Rica was hit by

Tropical Storm Nate (Anders, 2017a). According to a local CNE representative, Maricella Solís (personal communication, January 17, 2020), the tropical storm was originally not expected to hit Monte Verde, but it took an unexpected turn at the last minute. Monte Verde had no specific plan for dealing with these types of storms, as it had been nearly 30 years since the last major storms, Juana and Gilbert, had hit the Monteverde area (J. Torres, personal communication, February 17, 2020). At that time, the region was mostly rural, unlike now when the town has a multitude of hotels, restaurants, shops, etc. Therefore, disasters can have much more noticeable impacts with increased development. The lack of previous protocols, as well as Tropical Storm Nate's unexpected turn, led to one of the most devastating disasters Monte Verde had experienced. According to Maricella (personal communication, January 17, 2020) the storm's impact on Monte Verde led to the creation of the local emergency sub-committee in Monte Verde. Before this, different departments, such as the health clinic and the police force, would meet after a yellow alert was announced from the CNE to create a response plan for the emergency.

According to members of the Monte Verde's emergency sub-committee (Appendix E), the effects of Tropical Storm Nate on the town were devastating. Monte Verde was first hit with multiple days of intense rain and winds, which caused a large number of trees to fall on roads and houses. Furthermore, due to its mountainous terrain, the storm caused various landslides throughout the region. According to Jorge Torres (personal communication, January 20, 2020), a member of Monte Verde's local emergency sub-committee, there were well above 100 landslides. A series of flash floods also completely destroyed houses and buildings. The combination of fallen trees, landslides, and floods led to Monte Verde's isolation for four days. Furthermore, a flooded river destroyed Puente Arbóreo bridge within Monte Verde, dividing the community and its resources even further.

Homes were destroyed, and people suffered from a lack of services such as electricity, water, and cell phone service (Burlingame, 2018). However, according to Burlingame, support from the community was "remarkable" (p. 2). Major organizations, community members, and volunteers came together to provide relief. In terms of communication, the Monteverde Cloud Forest Preserve (MCFP) lent out radios to the emergency responders, and the local radio in Monte Verde, Radio Zona Alta, kept people up to date using Facebook and the internet. Furthermore, by Oct. 17th, Cobb (2017) points out that due to the efforts of the community, major roads had reopened, reserves, attractions, and most hotels and restaurants in Monte Verde had reopened, and water, service, food, gas, and public transportation had been restored. However, the effects on people whose homes had been destroyed were physically and mentally long lasting.

### *2.7.1 Public and Private Sectors Involved*

In the Monteverde region, the CNE works with public organizations such as the Red Cross, the health clinic, the fire department, and the police department for emergency relief (Park, 2009). The CNE coordinates with other sectors of the government too, depending on the situation. For example, in the aftermath of Tropical Storm Nate, the CNE coordinated with the Tourism Board and the Ministry of Public Works and Transportation because tourism and

transportation were affected (Cobb, 2017). The private sector is also involved in emergency response. According to Cobb, private organizations and companies often donate food and money in times of need, and both people from inside the community and people from areas outside of the Monteverde region often volunteer to provide the manpower.

## 2.8 Monte Verde's Local Population: Ticos, Quakers, and Expatriates

Monte Verde's population is incredibly diverse: it includes Ticos (what Costa Rican people call themselves), Quakers (from the original group of American migrants to this area), expatriates, students (also known as homestays since most reside with Ticos during their time in Monteverde), scientists, and tourists (Monteverde Friends School, 2020). Expatriates stay for a year or more for work, while homestays' and scientists' time here can vary depending on their projects and research. Tourists visit to explore the area and learn more about the culture and physical environment connected to cloud forests. During its peak seasons, Monte Verde can have more tourists than locals, who are mainly Ticos and Quakers. In other words, Monte Verde's population is constantly changing in size, and the people themselves come from various cultures and speak different languages. Therefore, when designing emergency plans for Monte Verde, the CNE and local emergency sub-committee must device methods for communicating with this diverse population.

## 2.9 Summary

Costa Rica, as well as many other countries around the world, have a large amount of issues it must address during and after natural disasters. In addition to the physical damage caused to buildings and roads, there is emotional and mental damage caused by the loss of loved ones, the disruption of life, and the destruction of personal property (Armstrong, 2017). There can also be health risks, such as contaminated drinking water, volcanic ash rendering the air unbreathable, and an increase in mosquitoes.

Due to the CNE (2019a, 2019b, 2019d, 2019f, 2019g) and the local commissions in each region, Costa Rica currently has many systems in place to deal with emergencies. They have plans that they can execute in different cases of natural disasters. They also have access to resources, such as national funding, international aid, and a national radio broadcast channel, during natural disasters. The radio, in particular, helps to communicate and coordinate with participating parties for the execution of their plans. However, so far, their plans have been more reactive than proactive.

In Monte Verde, the residents can become isolated during disasters, and they can lose electricity and cell phone service. This means that they cannot communicate to others about which resources they need, nor can they receive these resources from the rest of Costa Rica. While Monte Verde has been able to recover from these challenges in the past, its expanding population may not be able to be reached by the CNE for an extended period of time. Therefore, Monte Verde's emergency sub-committee has begun working on creating emergency preparedness plans independent from the national CNE. In the next chapter, we

discuss the methods we used to help Monte Verde create the base for an effective emergency response plan.

# Chapter 3: Methodology

The goal of this project was to help Monte Verde's newly created emergency sub-committee (see Section 2.7) to design the base of an emergency preparedness plan for the town. Maricella Solís, our on-site liaison for the Monte Verde's emergency sub-committee (our sponsor), recommended we accomplish this through the completion of three deliverables. The first was a map of Monte Verde that highlighted important locations during emergencies. Next were plans for the construction of two warehouses in Monte Verde, as well as a suggested provision sheet. Finally, an emergency protocol that educated Monte Verde's population about what they should do during different types of disasters. Our objectives to achieve the completion of these aspects of the emergency preparedness plan were:

- Identify the major risks in different areas within Monte Verde
- Identify possible locations for warehouses and meeting points, and design warehouses including any necessary supplies
- Determine the most effective plans for addressing Monte Verde's major threats
- Identify and create better public awareness protocols

In this chapter, we explain the research methods that we employed to achieve each objective.

## 3.1 Identify the major risks in different areas within Monte Verde

In order to properly help the local emergency sub-committee create an effective emergency plan, it was important to first identify and understand the natural disasters threatening the region. Members of Monte Verde's emergency sub-committee Maricella Solís, Jorge Torres, and Siria Ugalde (personal communication, January 17, 2020) identified the top risks currently threatening Monte Verde as: tropical storms, earthquakes, fires, and volcanic eruptions. Our job was to understand the impact these natural disasters could have in the region, which we did by identifying the different types of areas in Monte Verde, such as areas at the top of cliffs, at the bottom of cliffs, and near rivers, that had the higher chance of being affected during these events (also referred to as "high risk areas"). This allowed us to decide how resources should be spread throughout the community as well as where the community could locate the warehouses and meeting points. In this section we describe the methods we used to identify the major risks in different areas within Monte Verde.

### *3.1.1 Visit different areas in Monte Verde*

We went around Monte Verde with Siria Ugalde, a member of the emergency sub-committee, where she showed us all of the neighborhoods and explained the risks threatening each area. She also showed us specific places, such as bridges and roads, that were likely to be damaged or destroyed during the next major disaster. Through our tour of the area, we identified which houses were at risk of the four major disasters threatening Monte Verde described above.

With Siria's help, we also identified the different types of people who lived in the areas we visited. Differentiating the population of Monteverde and knowing where they live helped us provide more accurate emergency response plans, tailored in a manner that best fits their needs. These necessities might be related to the language they speak, their age, or their comfort level with technology.

### *3.1.2 Archival & literature research at Monteverde Institute's library*

We went to the library at the Monteverde Institute in order to obtain information that had not been available to us in the United States about the effects disasters had had on the community. This enabled us to have a deeper and more accurate understanding of how various disasters have affected different areas in Monte Verde historically. This research also showed us what improvements and changes the community had made in each area to try to minimize the impact of future disasters. We were able to identify what strategies have already been tried in the past so we could help our sponsor to avoid making the same mistakes and use only what had worked. This information was used to improve our understanding of Monte Verde's population and history. This information was integrated into our Background chapter.

### *3.1.3 Identify areas and homes at risk using Monteverde Reserve's GIS map*

We used the detailed GIS (Global Information System) map compiled by Geiner Alvarado Huertas from the Monteverde Reserve to identify different neighborhoods and high-risk areas. This map enabled us to identify points of failure for different utilities as well as areas where road blockages could cause the most disruption.

The map itself contained all of Monte Verde's public roads, rivers, a large amount of buildings (which included stores, hotels, and houses), and the landslides that occurred during Tropical Storm Nate (or "areas of risk"). However, it was not up to date. Siria Ugalde (personal communication, January 22, 2020) mentioned people have built new houses in remote areas since this map was created, so the map needed to be updated often to reflect these changes. Unfortunately, some residents actively hide their properties from authorities in order to avoid paying certain taxes and other expenses. Nevertheless, this map was useful for identifying the major areas of risk.

## 3.2 Identify possible locations for warehouses and meeting points, and design warehouses including any necessary supplies

Warehouses serve as a storage facility for food and supplies, which is critical during emergencies. In addition, meeting points are important in the event that communications go down, which is precisely what occurred during Tropical Storm Nate. Our sponsor's main contact, Maricella Solís requested that we investigate the possibility of building warehouses in Monte Verde, as well as identifying the best places for meeting points in the area. In order to identify best practices and recommendations for warehouses, we used the following methods.

### 3.2.1 Interviewed members of the local sub-committee and local experts

We conducted semi-structured interviews with 8 members of the local emergency sub-committee that operates in Monte Verde based on recommendations by Maricella. We interviewed representatives from the Red Cross, Health Clinic, Fire Department, the Minister of Health, Monteverde's district intendente municipal (roughly translates to "mayor") Francisco Vargas, a public security police representative, a transit police representative, and a tourist police representative (see Appendix E). We also interviewed 3 local experts: a representative from ASADA (organization in charge of clean water management in Costa Rica), a retired engineer from the municipality, and the coordinator for Corclima Katy VanDusen. See Appendices F.2, F.1, and F.3 respectively for more details.

In the interviews, we focused on learning more about the effects Tropical Storm Nate had on Monte Verde as well as the role of the department in question during emergency. We asked questions in regards to their opinions and recommendations on locations of meeting points and warehouses as well as the emergency supplies needed. For the engineer, we also asked about technical details of warehouses and buildings in Monte Verde to help us with the design of the warehouse. We used the responses to gauge the general opinions and recommendations of the people in the sub-committee and compare and contrast any differences they had (see Appendix G).

### 3.2.2 Use Monteverde Reserve's GIS map to find ideal locations

Using the GIS map provided by the Monteverde Cloud Forest Reserve (see Section 3.1.3) we evaluated possible locations for potential warehouse sites and meeting points. We evaluated the accessibility to these locations and their risk potential. Furthermore, during Tropical Storm Nate, Puente Arbóreo bridge was destroyed by a flash flood, dividing Monte Verde in two. Afterwards, the bridge was rebuilt with enough support to withstand another major disaster; however, other bridges in the area that did not break during that tropical storm are still at the risk of falling during another major event. Therefore, we used the map to determine possible locations where the town of Monte Verde could be divided into two sections again. We used this information to ensure that each section would have its own warehouse and meeting point, as well as compared it to the responses of the members of the local sub-committee.

### 3.2.3 Interviewed the head/director of the potential locations to see if their space can be used

Once we finished identifying potential locations for our warehouses, we consulted with people from the two top sites that fit our guidelines for warehouse locations and meeting points: the Monteverde Institute and the Friends School (see Appendices F.4 and F.6 respectively for more details). The goal of our meeting was to help the local emergency sub-committee gauge whether or not these locations would be willing to let the town use their spaces. As part of the consultations, we discussed with these site owners about how they

would want the spaces to be used. Furthermore, we also discussed the potential size and materials needed for the warehouse, which were based on our next subsection.

### *3.2.4 Created a spreadsheet with the estimated quantity and costs of the supplies in each warehouse*

We created a spreadsheet with the estimated quantity and costs of the supplies in each warehouse and calculated the total cost per warehouse, including the cost to build the warehouse. Furthermore, the list contained the estimated size of each supply, and it automatically calculated the estimated size of the warehouse, which helped with discussion in Section 3.2.3. We gathered the necessary information about the estimated population from the Health Clinic's residential population estimates and Monteverde's Chamber of Tourism's tourist data. We collaborated with Maricella, as well as the members of the local emergency sub-committee (the same interviews mentioned in Section 3.2.1), to determine the necessary emergency that people would normally not have in their homes. We also identified supplies we encourage residents to have in their home with our emergency protocol, but we did put into consideration the fact that not everyone would be able to afford them.

We then estimated the required quantity for each warehouse and researched the cost of both the supplies that would be stored in the warehouse and the materials that would be used to build the warehouse. These cost estimates were done through online research once we had an understanding of the supplies needed in the warehouse, and the materials used to build the warehouse was determined through our interview with the retired engineer from the Municipality. This online research was done by looking at local construction material websites and since we couldn't find price estimates for most other items here, we used Walmart and Amazon to estimate the rest. These stores are available here and if they are off from the local prices they are most likely a bit more expensive.

### *3.2.5 Created SolidWorks models for the organization and layout of each warehouse*

Once we had identified the number of warehouses needed, their potential locations, the populations each would be expected to provide for, and their estimated size, we created SolidWorks models for each warehouse to depict the organization and layout of the supplies. This helped us determine and analyze the final area needed for the warehouse, as well as how the materials would be stored. Maricella Solís also wanted to have specific sections in the warehouse be designated to store medicines, animal supplies, and combustibles (which would include propane and gasoline). In particular, she wanted the animal supplies in a separate room, and she wanted the combustibles in its own separate unit outside the warehouse: its size was based on the estimated volume calculated in Section 4.2.5 for the combustibles

## 3.3 Determine the most effective plans for addressing Monte Verde's major threats

After identifying the “high risk” areas in Monte Verde, and the effects different natural disasters could have in the region, we then determined the most effective procedures for dealing with these threats. In this section we describe the methods we used to device the most effective plans for reacting to Monte Verde’s major natural threats: tropical storms, earthquakes, fires, and volcanic eruptions (identified in Section 3.1).

### *3.3.1 Interviewed members of the local sub-committee and local experts*

By interviewing 11 professionals recommended by Maricella Solís, we were able to identify current strategies dealing with the threats defined earlier. These members represent the Red Cross, the Health Clinic, the Fire Department, the Ministry of Health, the Municipality, the Police, ASADA (who is not part of the emergency sub-committee, but played a major role during Tropical Storm Nate), and Corclima, as described in Section 3.2.1. During these interviews, we asked about each department's role during these types of emergencies, as well as the best methods for dealing with these events. This was important because we needed to first identify what strategies already existed before we could suggest any improvements. We also asked them what they believed could be improved about their existing plans based on their professional knowledge and experience during Tropical Storm Nate. See Appendices E and F for more details of the interview protocol we used.

### *3.3.2 Created plans for current residents for each threat*

After conducting our interviews (Section 3.3.1) as well as having a proper understanding of the natural disasters in Monte Verde, we created plans for each threat Monte Verde faces, specially tailored to different areas in Monte Verde. Furthermore, to ensure they were as effective as possible, we conducted additional online research on the methods used in other nations for these specific disasters. The plans were organized as a set of instructions and they contain vital information such as what resources to have in order to prepare for emergencies, who to contact during emergencies, and where to go during emergencies (see Appendix L for these instructions).

## 3.4 Identify and create better public awareness protocols

After creating a set of plans that specified what residents and visitors should do in case of one of the four major natural disasters in Monteverde (disasters identified in Section 3.1) it was important to determine the best methods for distributing this information to the public. Monte Verde’s inhabitants are extremely varied, ranging from permanent residents to tourists, and the number changes based on the time of year. In addition to these differences, the inhabitants also speak a wide variety of languages. Therefore, we needed to ensure we created unique protocols that catered to the different groups in order to properly communicate the

actions individuals must take in cases of emergencies. In this section we discuss the methods we used to identify and create better public awareness protocols.

### *3.4.1 Interviewed members of the local sub-committee and local experts*

Our first step was to understand the public awareness protocols that were currently established in Monte Verde. We wanted to know which aspects of these protocols had worked well in past emergencies and which had not. Therefore, in the previously mentioned interviews with different members of the local sub-committee (see Section 3.2.1), we also asked these individuals questions regarding public awareness strategies. We first discussed examples of these protocols being used in the past, with a particular focus on Tropical Storm Nate due to its devastating impact on the region, and we asked about their successes or failures. We then discussed the changes they had made to those protocols since then, and what they personally believed our team should focus on when trying to improve the protocols. See Appendices E and F for more details.

### *3.4.2 Visited different areas in Monte Verde*

Monte Verde's population consists of different groups of people who have different languages and values. In order to create plans for all of these people, we first needed to identify who they were. Therefore, as mentioned previously (see Section 3.1.1), Siria Ugalde, was kind enough to take us on a walk around all of Monte Verde, during which she explained the history of the land with extended details. She described the current residents living in each area, as well as the current social issues the community was facing. Lastly, she highlighted the environmental risks the houses and hotels in each area had (therefore helping us identify what type of emergency protocol each location required).

### *3.4.3 Archival & literature research at Monteverde Institute's library*

The Monteverde Institute's library was a great source of information for identifying the risks Monte Verde had had previously and was currently facing. The library also contained information about the people and their history, which helped us understand their mindset and help us design protocols specifically tailored to them.

### *3.4.4 Surveyed tourists in Monte Verde*

Our initial idea for a public awareness protocol tailored specifically to tourists was to create a mobile application that allowed them to select their language and the area they were currently living in. In theory this app would resolve language barrier issues when trying to inform tourists about the procedures they should follow during disasters. However, we first needed to know if they were familiar enough with technology to properly obtain and use the app, which is what most of our interviews with tourists focused on.

We conducted surveys on two random Fridays between January 27, 2020 and February 21, 2020, in front of a farmer's market frequented by tourists. This farmer's market occurs

every Friday between 12:00 pm and 5:30 pm and it was recommended to us by Maricella Solís. We surveyed a total of 23 respondents and our questions centered around how comfortable they felt using their smartphones (if they owned one). Furthermore, we also asked tourists which area of Monteverde they were currently staying in so we could get a more accurate picture of the distribution of tourists within the region. We were also interested in how prepared tourists were to face emergencies in Monte Verde and asked if they were aware of some of the risks in the areas in which they were currently staying. See Appendix D for more details.

### *3.4.5 Surveyed Monte Verde's locals*

In order to inform Monte Verde's residents on natural disaster protocols, it was important to understand their current familiarity with it. We gathered data by going to the weekly farmer's market in Santa Elena and surveyed locals in person. These surveys were done at the same time we conducted the tourist survey described in Section 3.4.4: we created a survey specifically tailored for tourists and another for locals. We conducted a total of 45 resident surveys, and our questions centered around the local's familiarity with the local emergency sub-committee and the current emergency protocols. We questioned them on their current sources for news on natural disasters, as well as the main challenges they faced during Tropical Storm Nate (if they experienced it). We were also interested in their comfort level with smartphone technology since we were considering the possibility of using the app for residents as well. See Appendix C for more details.

## 3.5 Summary of Methods

Through these methods outlined above, we were able to achieve our four objectives:

**3.1** Identify the major risks in different areas within Monte Verde

**3.2** Identify possible locations for warehouses and meeting points, and design warehouses including any necessary supplies

**3.3** Determine the most effective plans for addressing Monte Verde's major threats

**3.4** Identify and create better public awareness protocols

In the next chapter, we will share our results of these methods and how they aided in completing our three deliverables for this project: a risk map of Monteverde, a warehouse proposal, and public awareness protocols. We also provide analysis on these results and our recommendations to our sponsor.

# Chapter 4: Results and Analysis

As per our sponsor's request, this chapter is divided based on our project's three final deliverables:

**4.1** An integrated digital map including relevant information regarding landslide risks of each area, infrastructure and population distribution, and potential helicopter landing zones

**4.2** A detailed proposal with potential warehouse locations, estimated costs, recommended supplies they should store, and designs

**4.3** Public awareness protocols that target different demographics within Monte Verde, which include infographics and an app

Figure 4.1 highlights each of the objectives we discuss in Chapter 3 and which deliverables they helped to achieve.

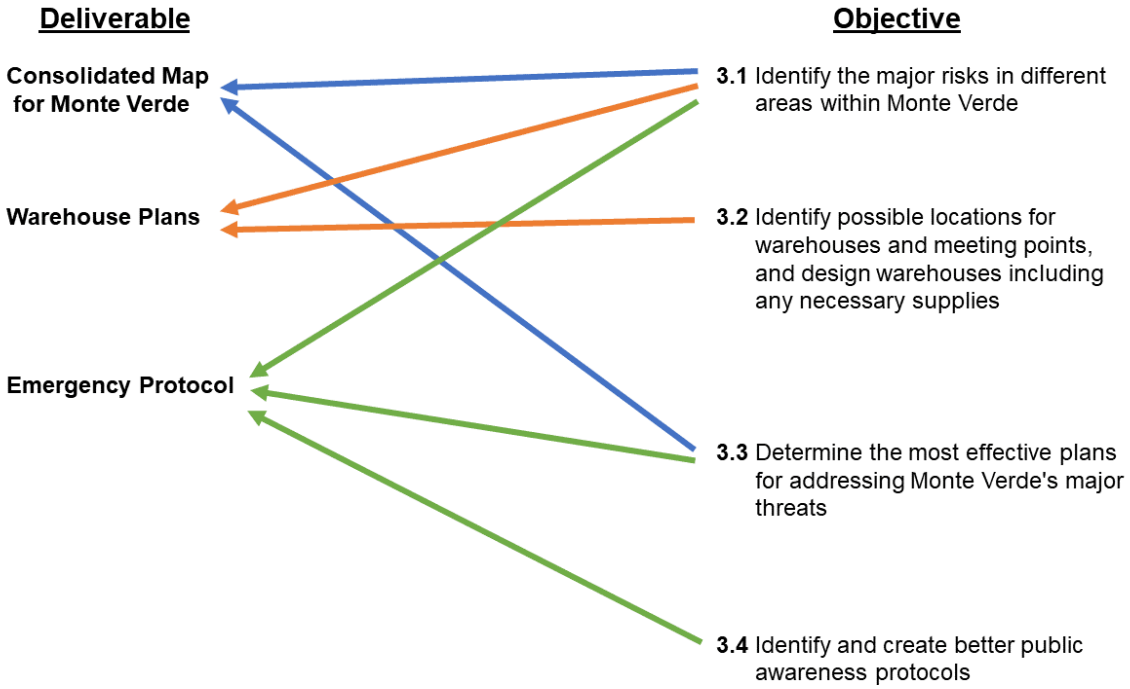



*Figure 4.1: Deliverables and their relation to our objectives*

In the following subsections we discuss the results of our objectives and how they shaped our deliverables.

## 4.1 Digital Map

Our first deliverable for this project was an integrated digital map of Monte Verde, which included risk areas for landslides, infrastructure, population distribution, proposed warehouse locations, helicopter landing zones, and water supply lines. Our sponsor conveyed that various organizations within Monte Verde's emergency sub-committee had been using the maps they personally created to complete their everyday tasks. However, during emergencies, there was no consolidated map these organizations could all use to collaborate with one another since a lot of roads and houses do not appear on Google Maps. Additionally, it's been reported that external organizations attempting to aid with relief efforts have trouble finding some locals because they live on unmarked roads and very secluded areas within the forests and mountains. Only people who are familiar with the area could find those secluded locals and giving directions to outsiders is very difficult because addresses are not used in Monte Verde (S. Ugalde, personal communication, January 21, 2020). Our goal was to create a multi-layered map using a GIS (Global Information System) software that could be used by the sub-committee and outside organizations to facilitate collaboration. The following are the two objectives that helped complete this deliverable:

**3.1** Identify the major risks in different areas within Monte Verde

**3.3** Determine the most effective plans for addressing Monte Verde's major threats

### *4.1.1 Maps from Different Organizations*

To complete this map, we requested different organizations within the sub-committee to provide us with their unique maps. Each organization focused on different goals, such as population or risks in each area. Some organizations had their maps in digital form, others had their maps in physical form, and some had both formats. Table 4.1 highlights different organizations that would provide us their map, details on what aspects of the region each map focused on, and the format in which the map was given to us.

*Table 4.1: Organizations and their Original Maps*

| Organization | Details of Their Map | Format of Their Map |
|---|---|---|
| Monteverde Reserve | • Created by Geiner Alvarado Huertas after Tropical Storm Nate in 2017<br>• Geiner's map identifies areas with landslide risks in the whole region of Monteverde (including the town of Monte Verde) | • Digital<br>• PDF and file formats supported by ArcGIS |

| | | |
|---|---|---|
| | • Based on how they were previously affected by landslides during Tropical Storm Nate<br>• Also contains other layers, such as infrastructure and rivers in Monteverde | |
| Health Clinic | • The Health Clinic visits houses to do regular check-ups in person, instead of having families come to the clinic, because the clinic is very small and is currently under construction<br>• Their map contains all of the houses in Monte Verde, which is crucial since some houses are in hidden and secluded locations | • Physical<br>• Hand drawings of each neighborhood |
| ASADA | • ASADA provides clean water to various areas in the region of Monteverde<br>• Their map provides the location of water lines and natural springs/reservoirs in Monte Verde<br>• Provides us additional information on areas of risk, as we can analyze which parts are vulnerable to extended periods of water loss | • Digital<br>• PDF |

### *4.1.2 Consolidating the Maps into ArcGIS*

Once we had obtained these maps, we consolidated them digitally through the software ArcGIS. We used the map provided by Geiner Alvarado Huertas from the Monteverde Reserve as the base. This map contained all public roads in Monte Verde, most of the infrastructure (which included shops, hotels, and houses), rivers, and the areas where landslides occurred during Tropical Storm Nate. From Geiner's suggestions during our first interview, we decided to add a layer for helicopter landing zones, a layer for potential warehouse locations, and a layer for potential meeting points (see Appendix F.5 for more details on the interview and Section 4.2 for more details on warehouse locations and meeting points).

When adding the Health Clinic's map into ArcGIS, we ran into difficulties lining up the houses with the already existing infrastructure in Geiner's map. However, in collaboration with Alexander Badilla S. from the Health Clinic, we were able to correctly add the houses into the

software. In another meeting, Geiner and Jorge worked with us to add private roads and additional houses that were missing. The map provided by ASADA did not contain the information we needed, and a new map could not be integrated due to the time limitations of the project. Below, Figure 4.2 shows the added houses as light blue circles and the added private roads as red lines. The other layers can be seen in Appendix K. These include proposed emergency meeting points (see Section 4.2.2 for more details), proposed warehouse locations (see Section 4.2.1 for more details), and helicopter landing zones.

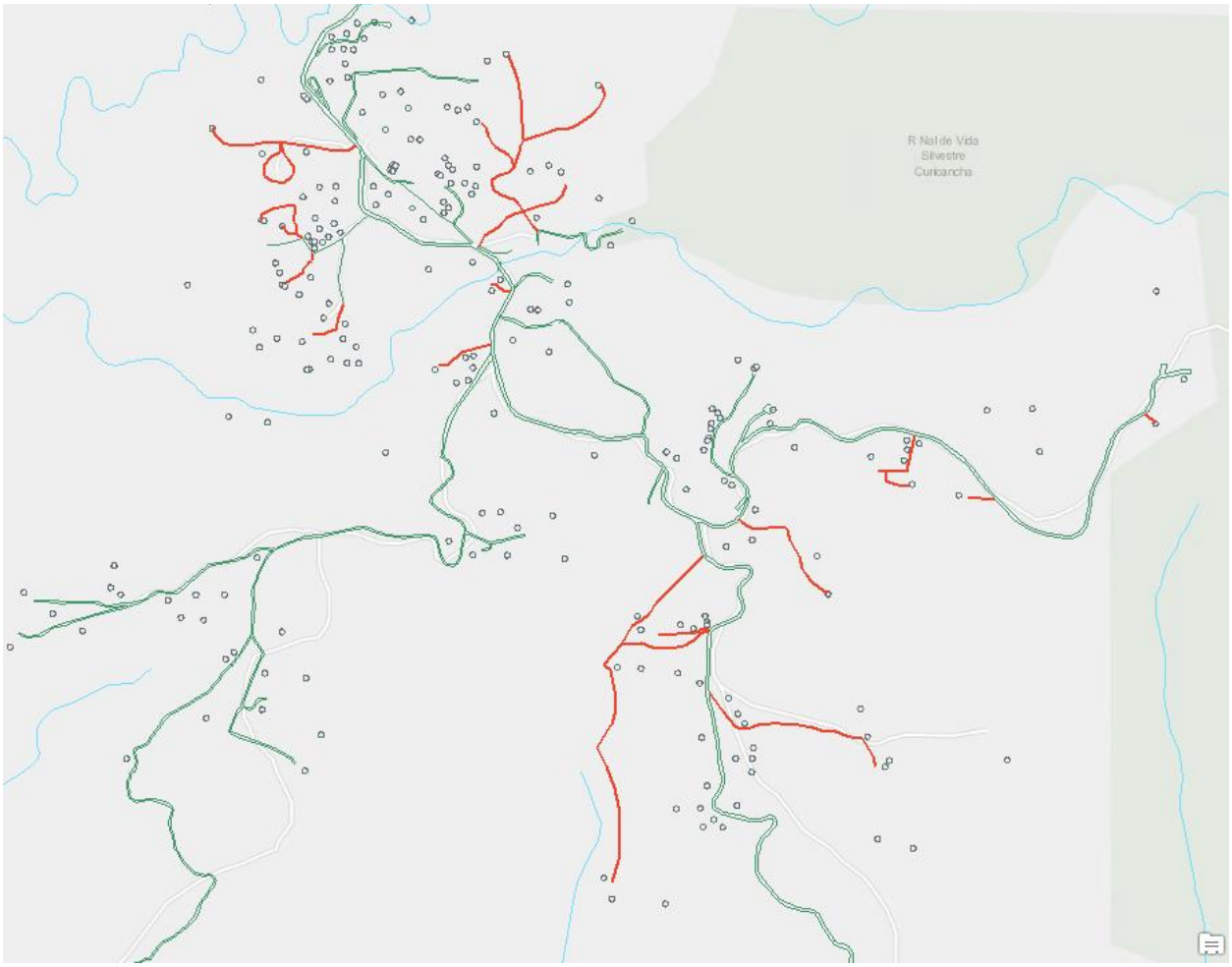



*Figure 4.2: Layer of houses from Clinic Map in Monte Verde*

This digitized map was not only a useful deliverable for the local emergency sub-committee, but it also helped us with the emergency protocol as the map was used in the app and the infographics (see Section 4.3 for more details). However, it is important to keep in mind that the information may not be complete and may change over time. Regardless, the map helped us with our next deliverable: developing plans for a warehouse and identifying the best locations to build the warehouses.

## 4.2 Detailed Proposal for Meeting Points and Warehouses in Monte Verde

Our second deliverable was a detailed proposal for possible locations of meeting points and warehouses in Monte Verde and possible warehouse designs, which should include a list of supplies. Maricella Solís wanted the emergency plans to specifically include two warehouses, since it had been predicted by the municipality's now retired engineer that Puente Arbóreo (shown below in Figure 4.3) would most likely collapse during Monte Verde's next major disaster. This bridge is located between the Monteverde Institute and the Friends School, as seen in Figure 4.4. If it were to be destroyed, it would split the town of Monte Verde into two parts. The main goal of having two warehouses was so that these two areas of Monte Verde would be able to survive on their own for a week. The following are the objectives that contributed to the completion of this deliverable:

**3.1** Identify the major risks in different areas within Monte Verde

**3.2** Identify possible locations for warehouses and meeting points, and design warehouses including any necessary supplies

*Figure 4.3: Picture of Puente Arbóreo by Alejandra Garza*

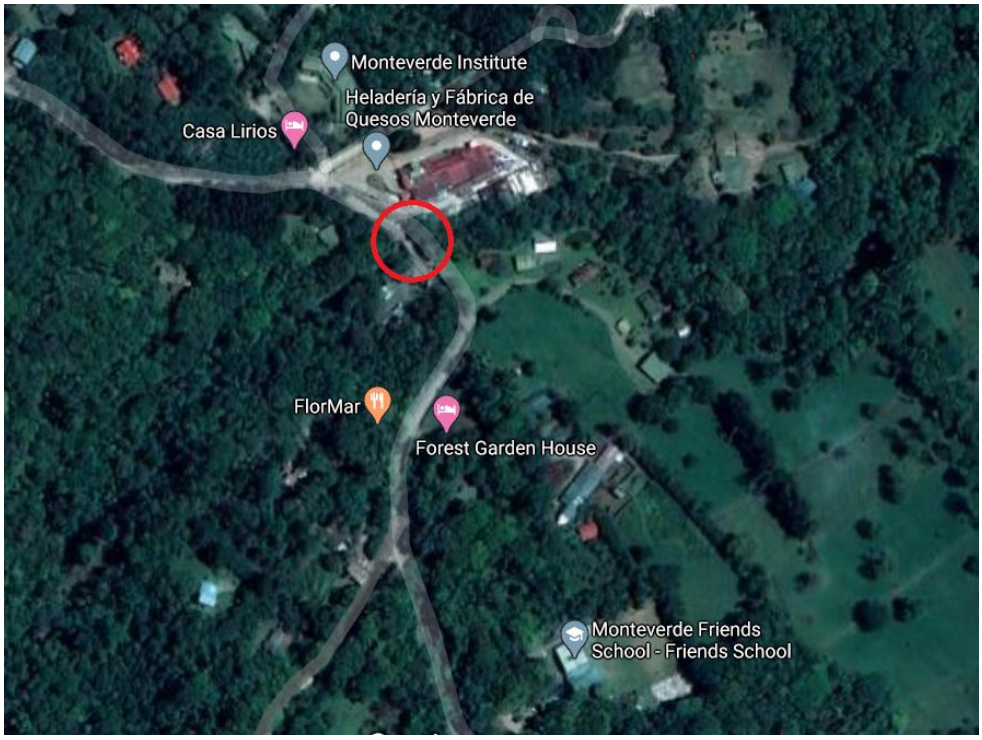



*Figure 4.4: Location of Puente Arbóreo. Google Maps. (2020). [Puente Arbóreo]. Retrieved from https://www.google.com/maps/@10.3040228,-84.8089555,624m/data=!3m1!1e3*

### *4.2.1 Best Locations for Warehouses*

By examining the map, we were able to recognize how Monte Verde would be split in half during different emergencies and choose locations that would be able to provide supplies to both halves of the community. With the help of Maricella Solís and from the suggestions of different members of the local sub-committee, we identified four possible locations for warehouses: CASEM, the Monteverde Institute, the Cheese Factory, and the Friends School (see Appendix G for details on the ideas shared in the interviews). Table 4.2 shows the criteria we used to select two of these locations for the warehouse.

*Table 4.2: Criteria Checklist for Potential Warehouse Locations*

| | **Monteverde Institute** | **Friends School** | **CASEM** | **Cheese Factory** |
|---|---|---|---|---|
| Has at least 5 by 4 m of space available (3 m high) | Yes | Yes | No | No |
| Has space for doors that open outwards (one in the front, one in the back) | Yes | Yes | No | No |

| | | | | |
|---|---|---|---|---|
| No large trees with a risk of damaging the warehouse | Yes | No | Yes | Yes |
| Close to an area where helicopters can land | No | Yes | No | No |
| Close to backup water supply | Not sure | Yes, they also have a water tank, but it is not clean enough to drink | Not sure | Not sure |
| Easy to access by trucks | Yes | Yes | Yes | Yes |
| Easy to access by the majority of the population | Yes | Yes | Yes | Yes |
| Minimal risk of landslide damage | Yes | Yes | Yes | Yes |

The Friends School was the only location south of the Puente Arbóreo, so it had the greatest weight in our choices. It fortunately fit our criteria—the only exception being the trees nearby. However, there was already a small shed nearby, and there had never been a problem before. Furthermore, the open area was large enough, and the trees were just on the perimeter. If the warehouse needs to be moved further from the trees, that would be possible. The Monteverde Institute fulfilled most of our criteria as well, and it was located north of the Puente Arbóreo. The Institute, however, lacked two of them (being close to a helicopter landing zone and being close to backup water supply), but these did not carry as much weight as having enough space to build the warehouse, which the Institute did have over CASEM and the Cheese Factory. After several more discussions with our sponsor and other members of the local sub-committee, and after visiting each area, we decided that the best two options were the Monteverde Institute and the Friends School.

One important consideration we received from a community leader was that instead of trying to house emergency supplies for Monte Verde, we should instead try to encourage people to keep their own supplies on hand (see Appendix F.3). We were informed that land in Monte Verde is precious and expensive; therefore, it would be difficult to convince organizations to have new warehouses built on their property. It would make more sense to decentralize the storage of supplies by having citizens keep certain supplies, while organizations store other supplies in existing spaces and rooms. However, based on our interviews with the other members of the local sub-committee and discussions with our sponsor, the majority of interviewees believed that the warehouse was advantageous (see Appendix G for shared ideas in our interviews with members of the local sub-committee). Furthermore, in our interviews with the Head of the Monteverde Institute and the Head of the Friends School (see Appendices F.4 and F.6 for details), they supported the idea of having a warehouse built on their premises. Therefore, we decided to incorporate these two options as potential locations for warehouses.

We added self-preparedness steps to our emergency protocol plans (see Section 4.3) while continuing forward with the warehouse plans.

### *4.2.2 Best Locations for Meeting Points*

For the location of emergency meeting points, we based our decision on the accounts of members of the local emergency sub-committee (see Appendix E) as well as from other members of the community (see Appendix F). After Tropical Storm Nate passed and residents were finally able to leave their homes, a large portion of residents gathered at CASEM to figure out a plan of action since the internet was not available and cell phone service was down. The residents agreed to use the Monteverde Institute and the Friends School as the locations to hold daily meetings and spread news/updates through the word of mouth (in the Institute's case, there was also a board where people would post updates). Furthermore, both provided shelter to those that needed a place to stay. The Friends School also ran day camps for children to allow the adults time to work on relief efforts. Due to the importance of these locations during Tropical Storm Nate, the three locations we chose for emergency meetings points were: CASEM, the Monteverde Institute, and the Friends School.

### *4.2.3 Warehouse Supply List*

Using Google sheets, we created an extensive supply list for each warehouse, where the items were decided based on our discussions with Maricella, our interviews with several members of the local sub-committee (see Appendix E), our interviews with the head of the Monteverde Institute and director of the Friends School (see Appendices F.4 and F.6), and our understanding on the basic needs people have from our research. We designed the Google sheets to calculate the total cost and volume of the supplies on a per capita basis so that we could adjust the population numbers as needed. We included a section to input the population and columns for the cost per item, the quantity (which could be auto populated depending on the item), the volume, and the source where we got the prices. We categorized the list into warehouse necessities, medical supplies, non-perishable food, water supplies, animal supplies, energy sources, bedding, communication and navigation, and hygiene products. We gave our sponsor access to the Google sheet, and Appendix I details how to use it.

Through our interview with a local engineer (see Appendix F.2), we were able to identify specific materials and design elements for the warehouses. We found that concrete slab walls and metal panel roofs would be best for the uses of a warehouse due to their strength, cost, and ease of construction. We also learned that a floor plan with a walking space across the middle with rows of shelves on the sides was the most space and traffic efficient design. The engineer also suggested safety considerations like having a separate area for combustibles and having doors that open to the outside.

### *4.2.4 Estimated Number of People to Provide For*

In order to determine the amount of supplies the warehouses would require, as well as the estimated volume needed for the warehouse, we needed the number of residents and

tourists in Monte Verde during high seasons. Maricella also wanted to consider the possibility of including the residents in San Luis in the warehouse south of Puente Arbóreo. She obtained the number of residents in each neighborhood in Monte Verde and San Luis for us. Our calculations for Table 4.3 show the estimated number of residents north and south of Puente Arbóreo.

*Table 4.3: Estimated Population Distribution in Neighborhoods*

| | **Neighborhood** | **Approximate Population** |
|---|---|---|
| **North of Puente Arbóreo** | Gringo Hill | 20 |
| | Cascada | 48 |
| | Monteverde | 96 |
| | Bajo Tigre | 47 |
| | Fabrica | 60 |
| **Total** | | **271** |
| **South of Puente Arbóreo** | Rockwell | 127 |
| | Villa Verde | 68 |
| | Traap | 20 |
| | La Trocha | 68 |
| | San Luis | 131 |
| | San Luis - Invu | 131 |
| | San Luis - Altos | 159 |
| **Total without San Luis** | | **283** |
| **Total with San Luis** | | **704** |

The Chamber of Tourism also provided us with the average number of tourists during various times of the year, which can be seen in Figure 4.5.

**Monteverde Tourists in 2019**

- **Average of 34,800**
- Jan, Feb, Mar, April, June, Aug, Dec
  - 120 /day (average)
  - 120 x 30 = 3,600 /month
- May, June, Sept, Oct
  - 58 /day (average)
  - 58 x 30 = 1,740 /month
- Nov (unusual)
  - 88 /day (average)
  - 88 x 30 = 2,640 /month

**Monteverde Tourists in 2018**

- **Average of 250,000**

*Figure 4.5: Average number of tourists in Monteverde throughout the year*

Based on this data and several other considerations (see the following paragraph), we estimated 271 people could seek refuge in the Monteverde Institute warehouse and 283 in the Friends School warehouse (the local Monte Verde population estimate). We used these numbers to calculate the quantity of supplies, the cost, and the volume for storage needed.

We decided to use the number of Monte Verde locals for our estimated numbers because we learned through our interviews with members of the local sub-committee (see Appendix E) that the tourists would be evacuated immediately by the CNE (National Emergency Commission) in the event of a disaster. If they do end up staying for a couple of days, like what happened during Tropical Storm Nate, the hotels/Airbnbs/homestays would most likely have enough supplies to provide for them for a couple days. If they are not able to, we would have to provide for, at most, 120 tourists during the high season (about 60 tourists north of Puente Arbóreo, and about 60 south of Puente Arbóreo). Since in our surveys for the locals, we found that only about half of the locals (12 out of 25) evacuated during Tropical Storm Nate, providing for the whole population of Monte Verde should be enough to cover the tourists if necessary.

We also decided against including San Luis in our estimations for supplies. We found through our interview with the Head of the Friends School, Sue Gabrielson, that the road between the towns is long and vulnerable to landslides, and San Luis would most likely be cut off from Monte Verde. She also stated that San Luis does have resources at their disposal, such as a medical clinic, a store, and a community center. So, it would be more beneficial to encourage San Luis to have their own method of supply storage. However, we did consider them in our warehouse design. We included extra shelves in case we later wanted to get more supplies to support more people (see Figure 4.9).

### *4.2.5 SolidWorks Models and Design*

Finally, we created a visual representation of the warehouse through SolidWorks. Figures 4.6 and 4.7 show screenshots of the model for the Monteverde Institute and its layout, and Figures 4.8 and 4.9 show screenshots of the model for the Friends School and its layout.

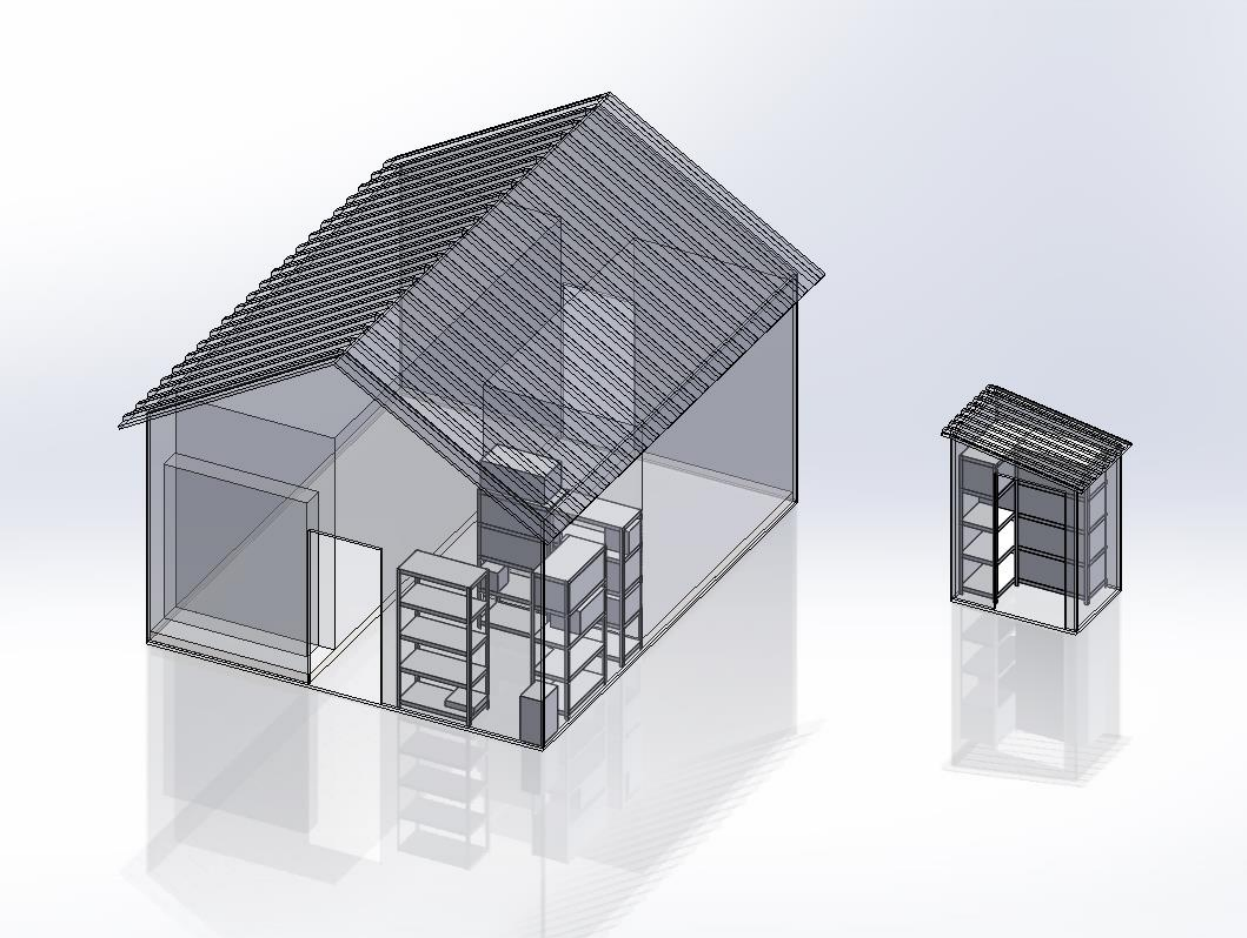


*Figure 4.6: SolidWorks model for the Monteverde Institute warehouse*

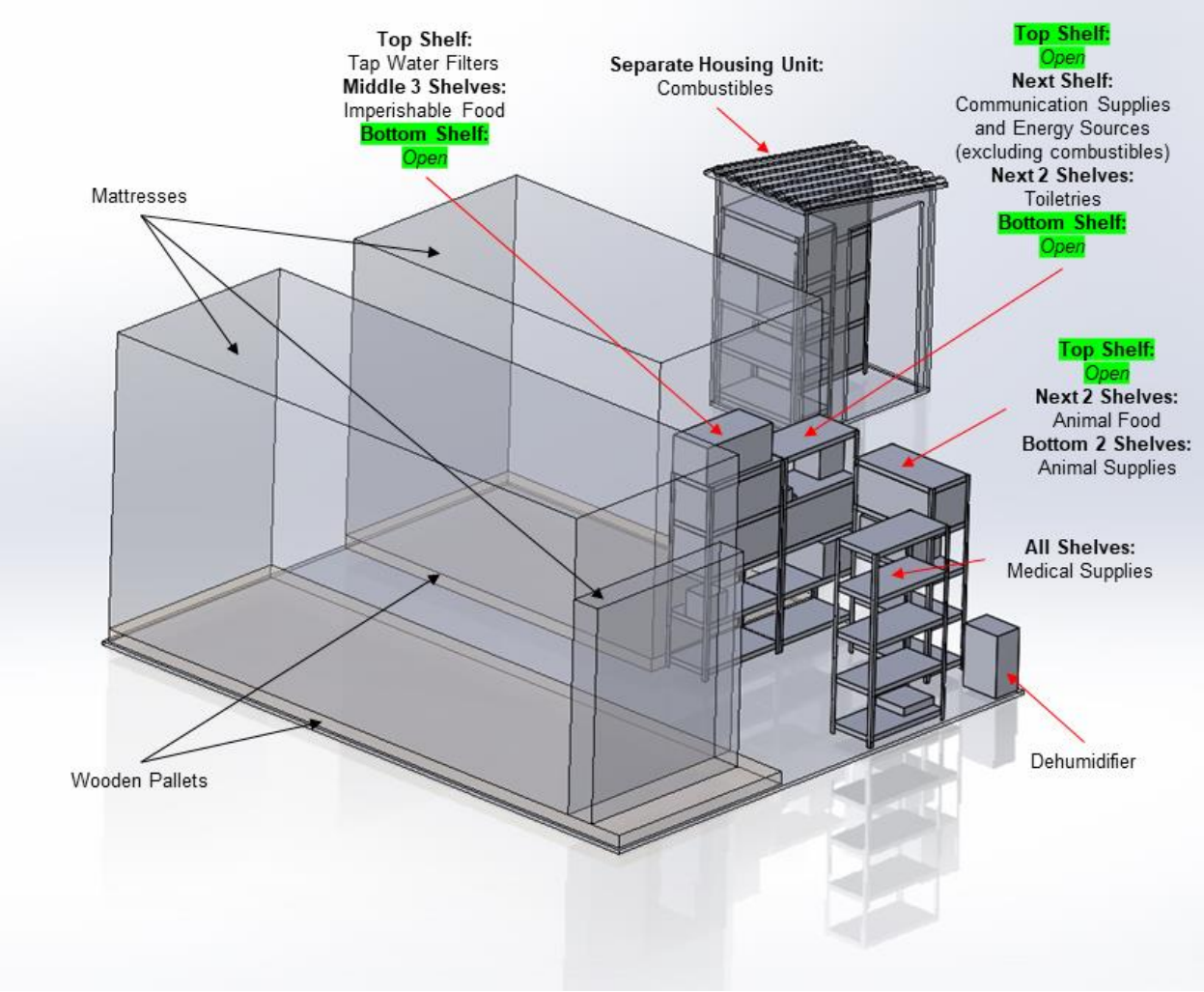



*Figure 4.7: Layout of the Monteverde Institute warehouse*

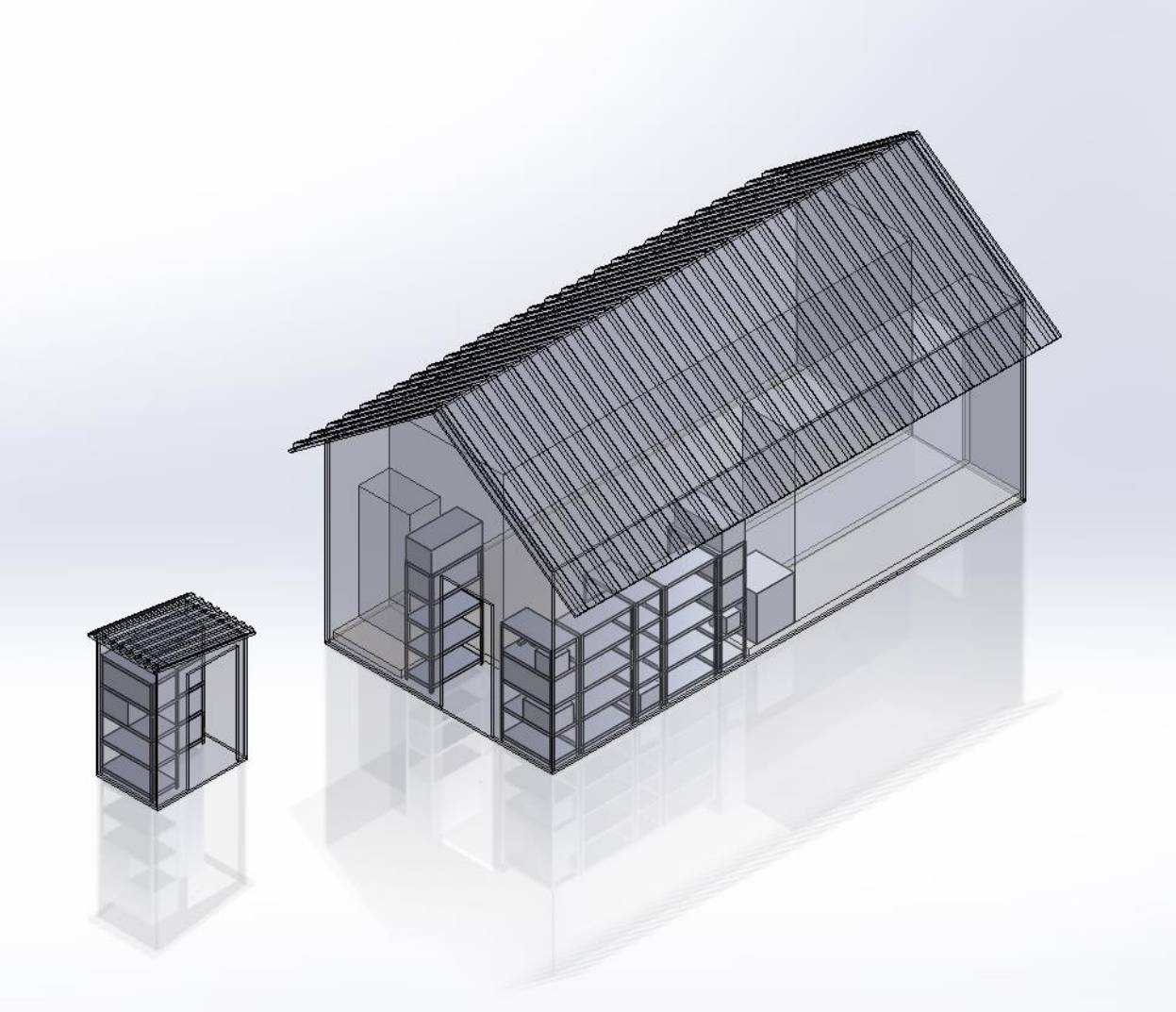


*Figure 4.8: SolidWorks model for the Friends School warehouse*

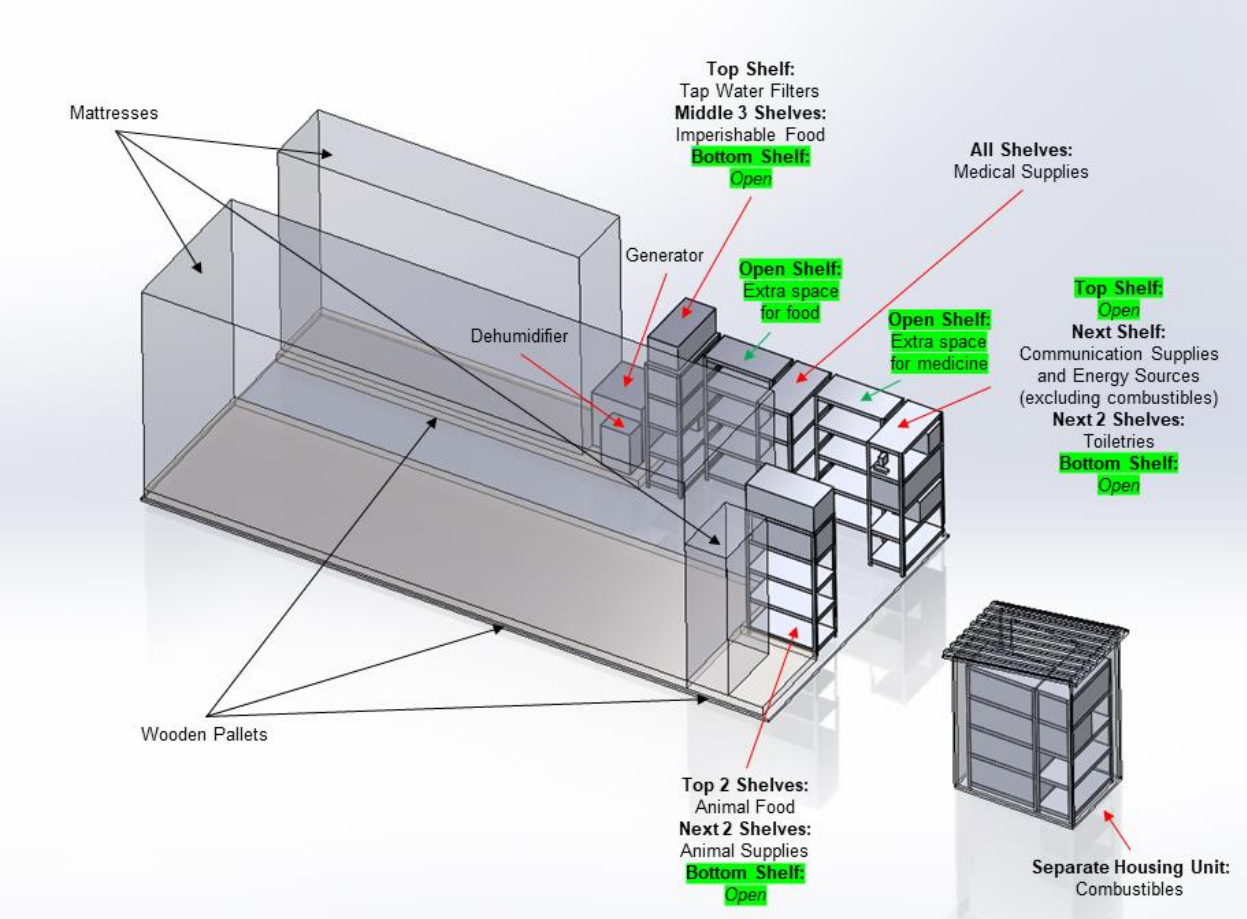



*Figure 4.9: Layout of the Friends School warehouse*

As seen in the screenshots, the combustibles would be stored in a separate unit to prevent fire hazards and ensure that nothing gets damaged if a fire does occur. We also noted that the mattresses take up most of the space. If the mattresses were stored elsewhere, it would greatly reduce the size of the warehouses. Below are the dimensions of the warehouses for several cases:

**Monteverde Institute Warehouse**

*Separate Housing Unit:* 1.6L x 1.1W x 1.9H meters

*Warehouse with Mattresses:* 6.1L x 5W x 3H meters (dimensions inside)

*Warehouse without Mattresses:* ~3L x 2.5W x 3H meters

**Friends School Warehouse**

*Separate Housing Unit:* 1.6L x 1.1W x 1.9H meters

*Warehouse with Mattresses:* 8.4L x 4W x 3.1H meters (dimensions inside)

*Warehouse without Mattresses:* ~3.3L x 2.5W x 3H meters

## 4.3 Public Awareness Protocols for All Demographics Found in Monteverde

Our last deliverable was to create public awareness protocols for the different demographics and areas of Monte Verde. This deliverable achieved the following objectives:

**3.1** Identify the major risks in different areas within Monte Verde

**3.3** Determine the most effective plans for addressing Monte Verde's major threats

**3.4** Identify and create better public awareness protocols

Through our interviews with members of the local sub-committee (see Appendix E) as well as through our surveys (Appendices C and D), we received recommendations and determined the most effective plans for addressing Monte Verde's major threats. We then incorporated this information into our public awareness protocols.

### *4.3.1 Survey and Interview Results and Analysis*

In our surveys, we saw that the local residents are split in their knowledge of what to do during emergencies. About 40% of the local population either have no idea what to do during emergencies or are not completely sure of what to do. By contrast, about 60% either have a better idea of what to do or know exactly what to do. This is likely due to a lack of public awareness campaigns, which has resulted in only the people seeking out the information knowing it. The people who are actively seeking out this information are most likely the individuals who were most affected during Tropical Storm Nate. This indicated that the sub-committee needed better public awareness protocols to sufficiently educate the locals. The results can be seen in Figure 4.10 shown below.

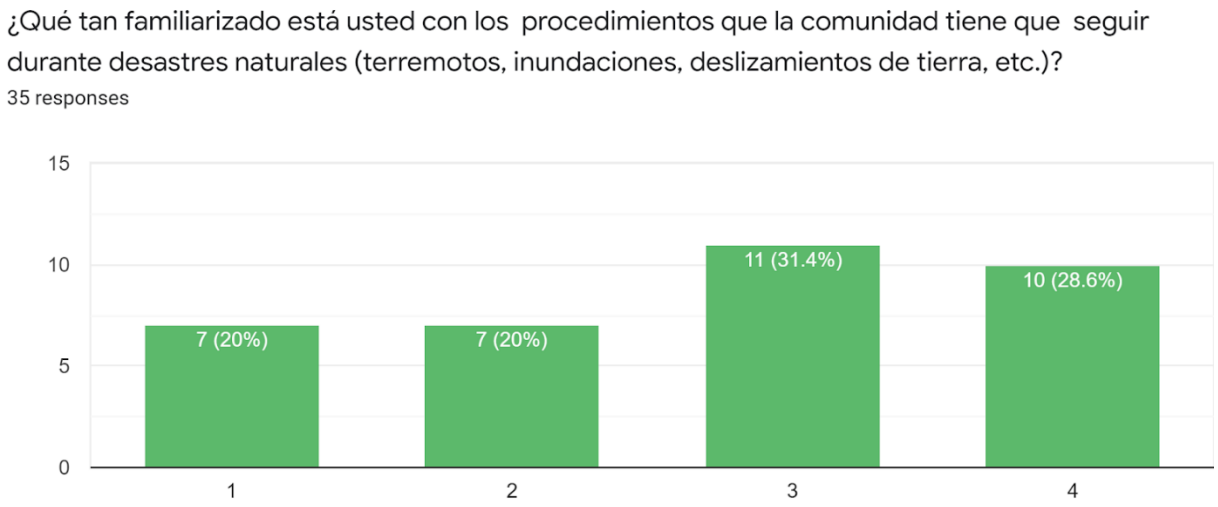



*Figure 4.10: Survey responses to how familiar locals are with what to do during natural disasters, on a scale of 1 to 4, 1 being "I have no idea what to do," 4 being "I know exactly what to do and what steps to take during emergencies"*

We also wanted to gauge how the locals usually stayed updated with information during emergencies. Figure 4.11 below shows the best communication methods to update local residents on the status of disasters.

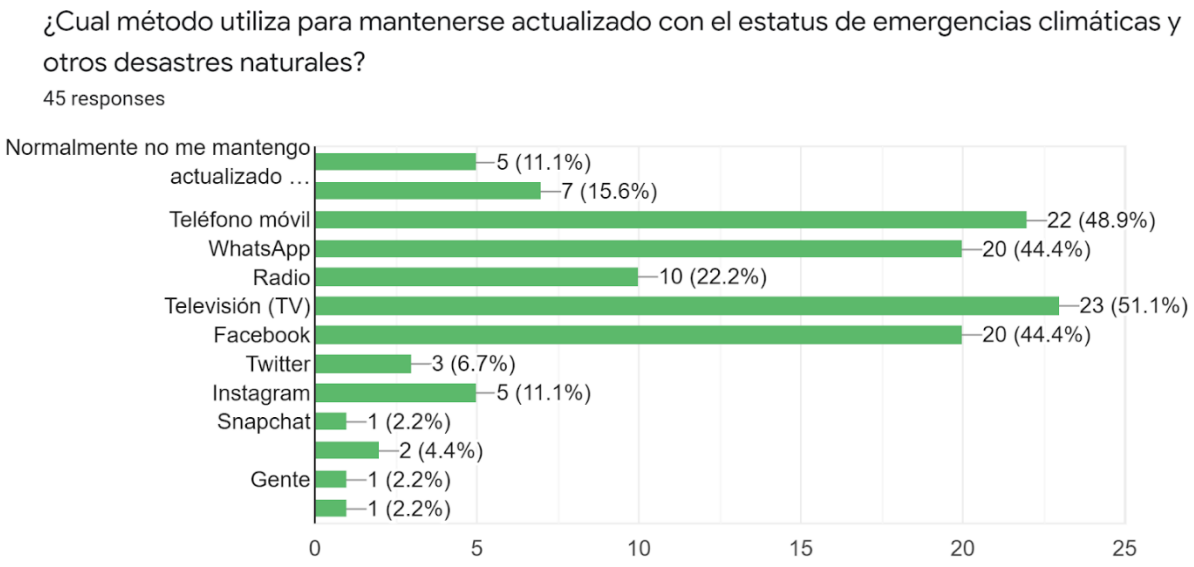
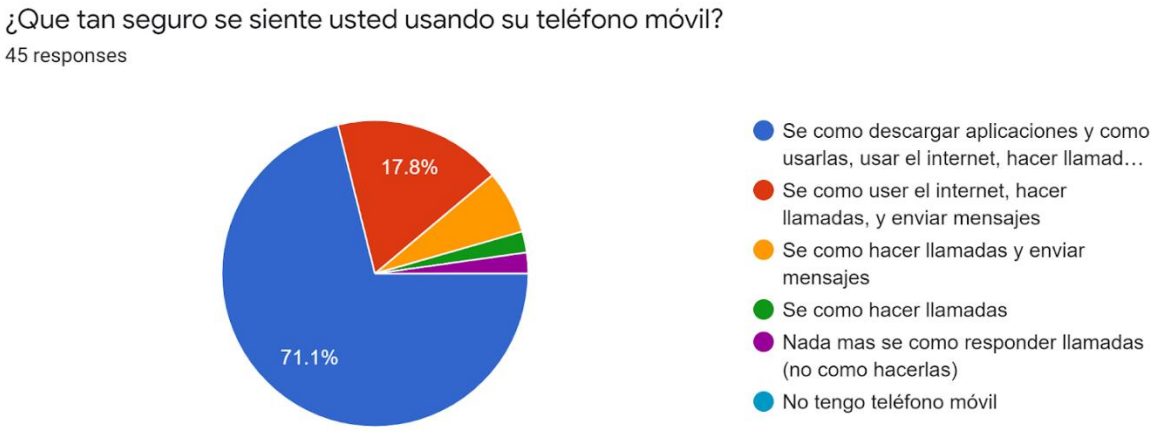



*Figure 4.11: What methods locals use to keep up to date with communications during emergencies*

We can see that TV, cellphones, WhatsApp, and Facebook are the common methods of communication. Further data as seen in Figure 4.12 revealed that people generally know how to use cell phones.




**Dark Blue:** I know how to download applications and how to use them, use the internet, make calls, and send messages
**Red:** I know how to use the internet, make calls, and send messages
**Orange:** I know how to make calls and send messages
**Green:** I know how to make calls
**Purple:** I only know how to answer calls, not how to make them
**Light Blue:** I don't have a mobile phone

*Figure 4.12: Pie chart showing comfort levels of cell phone use among locals*

About 70% of the local population know how to use apps on the phone while the rest may not be as comfortable using them. We wanted to create a public awareness protocol that could take advantage of app use as well as create other protocols that could be useful to the rest of the locals. After discussing ideas with Maricella Solís and some members of the local sub-committee, we found that calendar ads would be an excellent tool for locals who do not use their phone very much, as many locals have calendars in their homes. See Appendix E for interview details and Appendix G for shared ideas among members. We also found that infographics would be a good idea for locals who may not want to download apps but would use Facebook, WhatsApp, their phones, and the internet.

For tourists, we saw that most brought their phones with them, as shown in Figure 4.13, and most are comfortable or okay with using their phones, as shown in Figure 4.14.

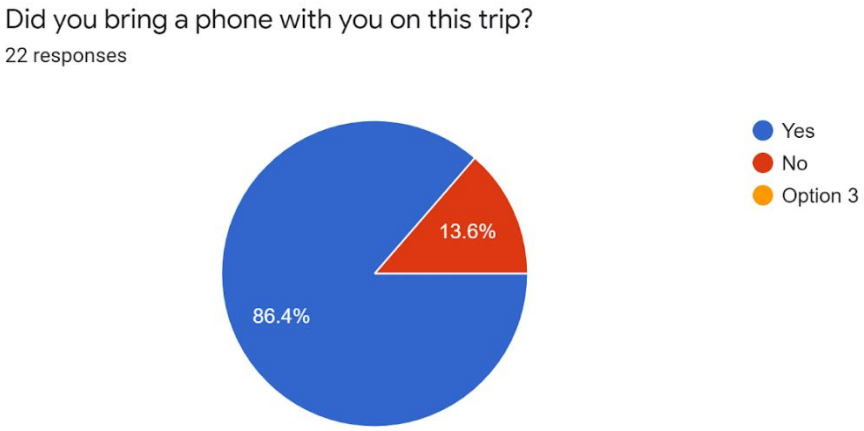



*Figure 4.13: Percentage of the tourists who brought phones with them*

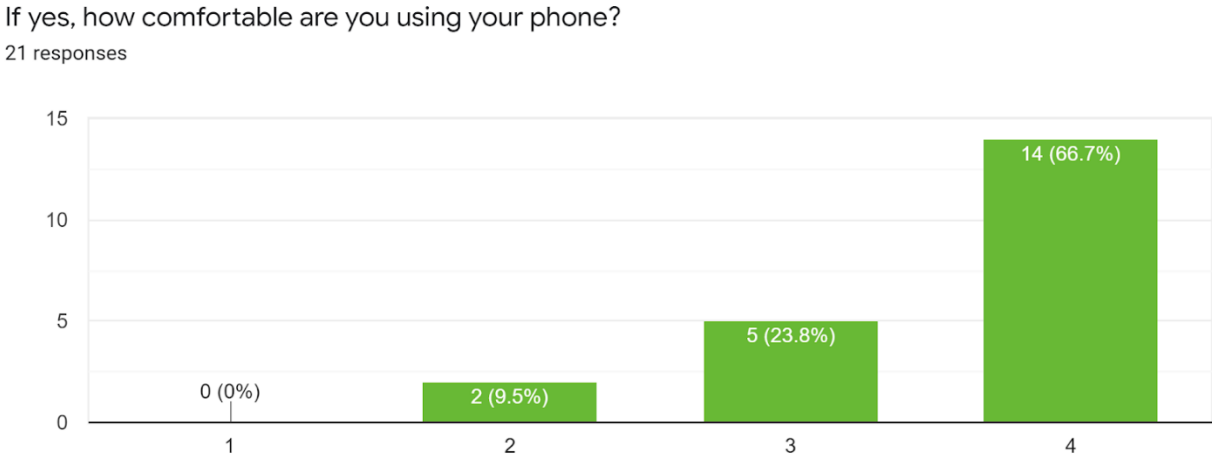



*Figure 4.14: Tourists' comfort level of phone use, on a scale of 1 to 4, 1 being "Very little," 4 being "Extremely comfortable" Y axis represents number of respondents.*

In terms of using an app for accessing information in the event of an emergency, the results were more split. About 30% are less comfortable with using an app. This is shown in Figure 4.15 below.

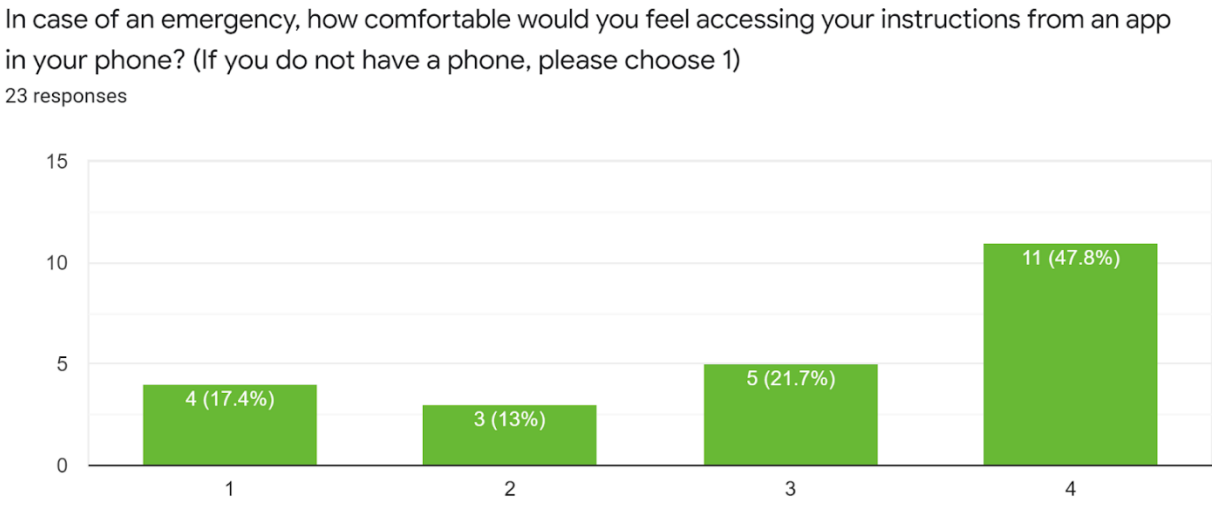



*Figure 4.15: Tourists' comfort level of using phone apps in an emergency, on a scale of 1 to 4, 1 being "Not comfortable," 4 being "Very comfortable"*

This suggested that Monte Verde would have to consider both people who would be willing to use apps and people who are not as comfortable. As seen in Figure 4.16 below, tourists also agreed that having physical pamphlets in Airbnbs, hotels, and homestays would be an effective method for informing tourists in emergencies, in addition to using an app on the phone.

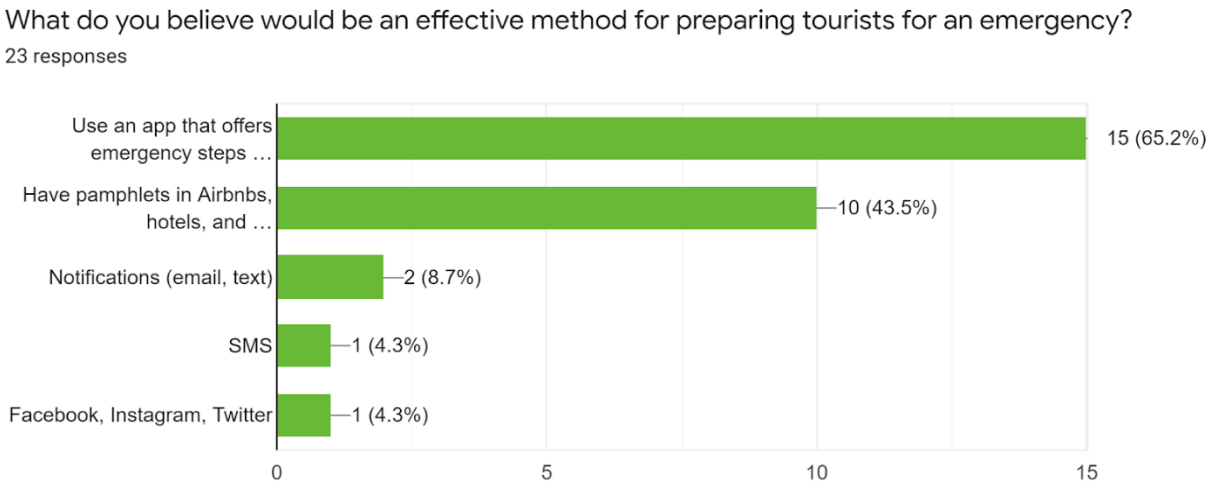



*Figure 4.16: What tourists believed would be the most effective methods to inform tourists during an emergency*

These surveys do have their limitations. By asking locals and tourists who frequent only certain places, such as the farmer's market and the shopping center (e.g. using convenience sampling), we lacked the opinions of people who were unable to get to these places easily, such as the elderly. Moreover, our tourist survey was only available in English, so we could not get people who spoke another language to fill out the survey due to language barriers. Therefore, our tourist survey did not include the opinions of those who do not speak English or Spanish, and our question about the languages they feel comfortable speaking most likely does not reflect the preferences of the whole tourist population. Lastly, the number of survey questionnaires we collected was relatively small (23 tourist surveys and 45 local surveys), especially the tourist survey. Thus, due to all of these limitations, the data from the surveys is not a complete measure of the opinions of the whole tourist population and the whole local population. However, it did at least give us a general idea of the thoughts of the people. A more systematic survey could be carried out by the sub-committee or by another research team.

### *4.3.2 Final Public Awareness Protocols*

Through our discussions with Maricella and our interviews with some members of the local sub-committee (see Appendix E for more details), we came to the decision that the following were the best approaches for a public awareness protocol:

- Create electronic infographics aimed at locals who use WhatsApp, Facebook, and the internet
- Create calendar ads aimed at both permanent and temporary residents who are not as comfortable with digital technology
- Create a mobile application with different language options aimed at both tourists and locals who are comfortable with such technology

Maricella told us that calendars are something people already have in their homes, and so creating an ad to insert at the end of a calendar rather than in new pamphlets would be more environmentally friendly. For the infographics, some of the best methods for spreading the information would be to distribute them online through services like Facebook and WhatsApp

However, with the time constraints we had, we decided to focus our efforts on creating the infographics and the app. The infographics would serve as a basis of information for the calendar ad and would have to be made available both physically as printouts and electronically to the locals. Therefore, our third deliverable is the following:

- Infographics aimed at all locals (see Appendix M)
- A mobile application with English, Spanish, French, and German language options aimed at tourists and locals who are comfortable with technology (see Appendix P)

In terms of the topics to focus on in our infographics and our app, our sponsor suggested the following was the most crucial:

- Landslides
- Flash floods
- Earthquakes

- Fires
- Secondary effects of volcanic activity
- Emergency supply list

As seen in our tourist survey shown in Figure 4.17, people are mostly only aware of landslides and flash floods. The other infographics would help increase awareness of those emergencies and prevent people from panicking.

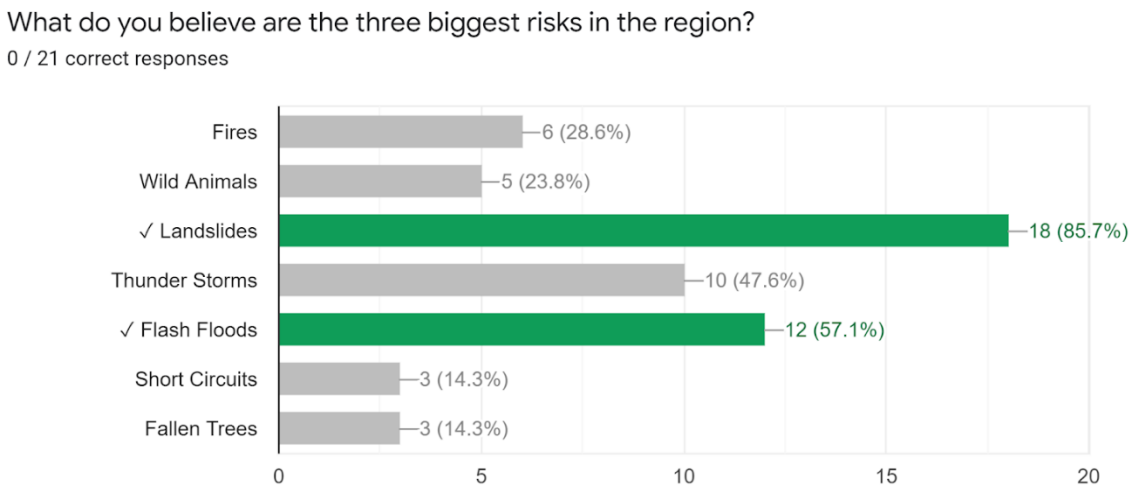



*Figure 4.17: What tourists think are the biggest risks in the region*

The information included in the app and infographics was gathered using a combination of research, discussions with our sponsor, and interviews with members of the local sub-committee (see Appendix E for interview details). Table 4.4 below shows the platforms used to make the app and infographics.

*Table 4.4: Platforms Used for Public Awareness Protocols*

| **Protocol** | **Platform** |
|---|---|
| App | Xamarin Forms |
| Landslides Infographic | Canva |
| Flash Floods Infographic | Canva |
| Tremors and Earthquakes Infographic | PowerPoint |
| Fires Infographic | Canva |

| | |
|---|---|
| Secondary Effects of Volcanoes Infographic | PowerPoint |
| Emergency Supply List Infographic | PowerPoint |

A different perspective we received from one of our interviewees was that pressing tourists to download an app about emergency preparedness might scare them away from the area instead of making them feel more secure. They suggested distributing this app to only the organizations that handle tourists like hotels and Airbnbs. Even with this consideration, we decided with our sponsor that the safety of the tourists that come here is more important than the potential negative effects to tourism numbers. Furthermore, based on our interviews with various people and the survey distributed to the tourists as discussed in Section 4.3.1, we have concluded that tourists are very open to downloading an app in order to obtain general information about potential emergencies.

## 4.4 Summary of Results

With the help of the community leaders in Monte Verde as well as residents and tourists, we were able to create deliverables designed to have a positive impact in the community. The final compiled map to be distributed to organizations in the local sub-committee included layers of:

- Landslide risk areas (in Geiner's original ArcGIS map)
- Rivers (in Geiner's original ArcGIS map)
- Roads (in Geiner's original ArcGIS map)
- Private roads (in collaboration with Jorge and Geiner)
- Infrastructure (in Geiner's original ArcGIS map)
- Homes (adapted from the Health Clinic's map and in collaboration with Alexander, Geiner, and Jorge)
- Helicopter landing zones (from the interview with Geiner)
- Potential emergency meeting points
- Potential warehouse locations

Screenshots of these layers can be seen in Appendix K. The warehouse proposal, which will help maintain the population of Monte Verde if they are isolated again, included:

- The two suggested locations
- Suggested supply lists for each, with cost and volume estimators (see Appendix I on how to use the Google sheet)
- Suggested size for each
- Suggested layout and design for each

Finally, the emergency protocols, which were designed for both local residents and tourists, included:

- Infographics for landslides, flash floods, tremors/earthquakes, fires, secondary effects of volcanoes, and emergency supplies (see Appendix M for details)
- A mobile application with English, Spanish, French, and German language options (see Appendix P for details)

During our sixth week in Monte Verde, we held a presentation at the Red Cross center in Cerro Plano for Monte Verde's emergency sub-committee, where we presented our results and deliverables. Those who attended the meeting were Red Cross representatives, Health Clinic representatives, Fire Department representatives, the Minister of Health, the Monteverde's district intendente municipal (roughly translates to "mayor") Francisco Vargas, an engineer for the municipality, a public security police representative, and a transit police representative. Throughout the presentation, we received feedback on our deliverables, including a suggestion to translate the infographics to English as well as suggestions on the information to be added to the application. Throughout our last week in Monte Verde, we worked to implement their feedback into our final deliverables.

*Figure 4.18: Presentation at the Red Cross office in Cerro Plano on February 27, 2020 (photo taken by Maricella Solís)*

In the next chapter we will discuss our final recommendations on how our sponsor could use our deliverables, as well as some of the future challenges the community might face.

# Chapter 5: Conclusion

The goal of our project was to help Monte Verde's emergency sub-committee design different aspects of their emergency preparedness plan. Our objectives to accomplish this goal were:

- Identify the major risks in different areas within Monte Verde
- Identify potential locations for warehouses and meeting places
- Improve the plans for addressing Monte Verde's major threats
- Identify and create better public awareness protocols

Through the completion of our objectives, we were able to present our sponsor with three deliverables:

- A GIS map file that contains detailed information about Monte Verde
- A warehouse proposal that indicated a suggested size, location, design, and a suggested supply list for two warehouses in Monte Verde.
- An emergency protocol that contains information on what to do during certain emergencies, which is composed of infographics and a mobile application

## 5.1 GIS Map of Monte Verde

While we were able to create a map that combined the information given to us by the Monteverde Reserve and the Health Clinic (this information is highlighted in Table 4.1 in Section 4.1.1), we recommend that our sponsor continue to work with these organizations, as well as other members of the emergency sub-committee to improve the accuracy of the maps. Due to time constraints, we were unable to include ASADA's map in ours, so we also recommend our sponsor works with them to add it. Furthermore, we were able to add information regarding meeting points for each region, as well as the location of warehouses and helicopter landing zones. We recommend that this information be made available to the public in some capacity. Lastly, we recommend the local emergency sub-committee use this map when working with outside organizations in order to make it easier for them to navigate the region.

## 5.2 Warehouse Plans

Our next deliverable involved plans for building two warehouses in Monte Verde. Based on multiple interviews with various sub-committee members, we recommend that a warehouse be built at both the Friends School and the Monteverde Institute. At this point, we have only received verbal confirmation from the leaders of these institutions that they would be willing to have warehouses in these properties. Although we have not yet met with the governing administrations of these institutions (which represent the community), we at least introduced the idea to the leaders to establish a connection. Therefore, we recommend that our sponsor continues working with them to ensure the development of these plans. We also provided to our sponsor a cost analysis on the type of water supply that we recommend. We

recommend getting tap water filters over other water options, such as water jugs, for reasons detailed in Appendix J. We also recommend that our sponsor obtains enough supplies to maintain Monte Verde for at least a week in order to withstand isolation during extreme circumstances.

For the design of the warehouses, which can be seen in Figure 4.6 - 4.9 in Section 4.2.4, we recommend that our sponsor organize the supplies similarly to what is shown in the figures. We also recommend that the combustibles be placed in a separate, smaller unit, as well as for medicine supplies and animal supplies to be stored in separate shelves. Furthermore, mattresses take significant space, so we recommend them be stored elsewhere, such as existing rooms in the Monteverde Institute, so that the warehouses can be made smaller.

While the Monteverde Institute and the Friends School have verbally shown support for these warehouses being built, we are aware that a change in leadership or other factors could lead to them changing their minds. Therefore, an alternative idea to building a new warehouse, as suggested to us during an interview with a community leader, would be to have all the supplies dispersed throughout these institutions in various pre-existing rooms (see Appendix F.3 for more details). While this is a more reachable goal, we believe having a physical warehouse is better for the community because having a designated space will guarantee these supplies will always be available for the community. Several members of the emergency sub-committee have also expressed this concern, and we therefore strongly recommend the warehouses be built.

## 5.3 Emergency Protocol

Our last deliverable involved designing an emergency protocol focusing specifically on Monte Verde's residents. Our emergency protocols took the form of six infographics (which are displayed and explained in Appendix M) as well as a mobile application (Appendix P). For more information on what kind of information these protocols provide, please see Appendix L.

If our sponsor wants to modify the information on the infographics, we have provided them with the permissions and files necessary to do so. Three of the infographics (emergency preparedness, earthquakes, and volcanic activity) were created using PowerPoint. The other three (landslides, flash floods, and fires) were created using a software called Canva. All six infographics were given or made available to Mericella Solís, granting her full access to edit them in the future. We recommend that the infographics be printed and distributed only in public areas and institutions (that are willing to have them) due to the large amount of money and resources it would take to distribute them to the individuals.

Our original plan was to use the information in our infographics to make annual calendars in order to distribute the information to residential households. However, due to the lack of time, we were unable to create the calendar design. We encourage our sponsor to keep looking into the possibility of doing annual calendars, since it is one of the best methods for distributing the information amongst the community.

We recommend the mobile application be used for residents and locals who feel comfortable using their phone. For now, our application is offered in Spanish and English, and while we were able to translate some of the features to French and German (Appendix N) we recommend our sponsor hires professional translators to finish the rest. Furthermore, we recommend that our sponsor continue adding languages in order to increase the accessibility of the app.

Maricella Solís was able to find individuals in the Monte Verde community that know how to use Visual Studio's Xamarin.Forms, which is the software we used to create the application. We recommend the emergency sub-committee works with these individuals to polish the application and add more languages. Furthermore, our sponsor has expressed interest in working with future WPI teams, and we believe WPI's Computer Science students are capable of adding additional features to the app in the future. These additions could include a feature that allows users to add the number of people in their party, where they are staying, and for how long (which would require the implementation of a database). This would help our sponsor keep track of the number of tourists currently staying in Monte Verde, making it much easier to organize emergency responses. Furthermore, we also recommend our sponsor to create a tutorial for the application in order to encourage more people (especially those who are uncomfortable with technology) to use it.

Our deliverables were handed to our sponsor in different forms, which are highlighted in Table 5.1.

*Table 5.1: Ownership Transfer of Deliverables*

| **Deliverable** | **Individual(s)** | **File Type** |
|---|---|---|
| GIS Map of Monte Verde | **Jorge Torres** | .mxd and zipped folder with all layers (through USB) |
| Warehouse Supply List | **Maricella Solís** (editing permissions)<br><br>**Deborah Hamilton** (viewing permissions)<br><br>**Sue Gabrielson** (viewing permissions) | Shared through Google Sheets |
| Warehouse SolidWorks Models | **Maricella Solís** (editing permissions) | Zipped folder with SolidWorks 2018 files (through USB) |
| Infographics (Landslides, Flash Floods, Fires) | **Maricella Solís** (editing rights) | Shared through Canva |

| | | |
|---|---|---|
| | **Katy VanDusen** (in viewing formatt) | .pdf and .png (shared through email) |
| Infographics (Earthquakes, Volcanic Activity, Emergency Supply List) | **Maricella Solís** (editing permissions)<br><br>**Katy VanDusen** (in viewing formatt) | .pptx (through USB)<br><br>.pdf and .png (shared through email) |
| Mobile Application | **Maricella Solís** (editing permissions) | Zipped folder with Visual Studio's Xamarin Forms files (through USB) |

Tropical Storm Nate served as a wake-up call on the new effects natural disasters can have in a continuously growing area like Monte Verde. This led to the immediate need for efficient preparedness plans. Throughout our time in Monte Verde, we were able to witness the community's commitment to reducing the impact natural disasters could have in the region. In providing our deliverables and making our recommendations, we hope to lay the foundation for an emergency plan that will continue to develop and become more integrated into the community. We also hope that people working on this problem in the future can use our research and findings to develop new improvements to the plan.

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# Appendix A: Sponsor Description

Our sponsor, the Comisión Nacional de Prevención de Riesgo y Atención de Emergencias (CNE), or National Commission of Risk Prevention and Emergency Care, is an organization which has a purpose to organize resources and manpower during times of national emergencies. Their mission statement, as stated by the CNE (2019f), is: “La Comisión Nacional de Prevención de Riesgos y Atención de Emergencias es la institución rectora de la política del Estado en Gestión del Riesgo, promueve, organiza, dirige y coordina el funcionamiento del Sistema Nacional de Gestión del Riesgo y la ejecución de su Plan Nacional. Contribuye a reducir la vulnerabilidad, salvaguardar la vida humana y el bienestar de los habitantes del país”, which translated to English means (translated using Google Translate) The National Commission for Risk Prevention and Emergency Care is the governing institution of the State's policy on Risk Management, promotes, organizes, directs and coordinates the operation of the National Risk Management System and the execution of its National Plan. It helps reduce vulnerability, safeguard human life and the well-being of the country's inhabitants. CNE (2019e) is a publicly funded, non-profit organization. To accomplish their mission statement, they are allotted a budget of billions of dollars a year, 59% of which comes from a regional tax, 20% from a fund directly from the government, and 21% from other sources (CNE, 2018). The CNE was established in 1974 after the eruptions of three volcanoes in the 1960s, and ever since then it has been growing in resources and manpower in order to accomplish its mission of combatting the damage of national emergencies and providing support for those affected.

The company, which employs 153 people, is composed of many different committees and governing bodies (Alvarado, 2018). There is the directory group, which is the highest governing body in the organization and represents multiple key aspects of Costa Rica. The group, and therefore the company, is led by president’s office. There are many ministries represented on the board, including a ministry representative for health, public security, transportation and civil engineering, finance, social services and housing, and environment and energy. There are also state institutions represented on the board, including the Head of the Mixed Institute for Social Assistance and the Head of the National Insurance Institute. Additionally, the Costa Rican Red Cross is represented on the board. The remaining employees are divided into three main groups (Gallardo, 2008). There is the Prevention and Mitigation group, which works to reduce the risk of national emergencies and reducing the impact of emergencies when they do occur. There is the Preparedness and Response group, which is tasked with allocating the company’s available resources and executing response procedures during an emergency. Finally, there is the Recovery and Rehabilitation group that handles post emergency operations to help restore the community to its what it was before the emergency

In order to accomplish their goals, CNE have access to a lot of resources and coordinate with many different entities. They partner with USAID (2017), America’s office of foreign disaster assistance, who supplies CNE (2019c) with donations in the form of money and manpower that support relief efforts and programs that aim or reduce disaster risks through preparation, the US military which aids them with search and rescue missions as well as supply delivery (Park, 2009), the World Food Program, which supplies them with food and nutrition

during times of emergency (Mena Report, 2018), and the World Bank, which loans millions of dollars to aid with the aftermath of natural disasters (M2 Presswire, 2008). In addition to international organizations and entities, the CNE works locally with communities and regionally with businesses and other regional entities. They work with fire departments, police departments, hospitals, Red Cross, local businesses, and local communities during times of crisis (Park, 2009), and they have an agreement with CANARA (Zervaas, 2006), the National Chamber of Radio Stations in Costa Rica, to link all radio stations and broadcast messages during emergencies that will communicate warnings and instructions to people, that according to the CNE (2019d) reaches 90% of the country.

Due to their reach and connections, the people at the CNE (2019g) have a multitude of resources at their disposal to aid them in achieving their mission. They are in constant communication with scientific-technical entities in order to stay up to date on technology. They coordinate efforts to organize evacuation, rescue, shelter authorization, damage assessment, needs analysis, air operations, and distribution of humanitarian assistance. They distribute food supplies, bottled water, and supplies for temporary shelters. They use their Emergency Fund to support other institutions also aiding the community. They organize and run committees consisting of representatives of businesses in the area that are willing and able to help with the emergency, as well as committees of representatives of the local communities that are being affected. In addition to the resources and manpower they provide, they also provide information to the public during and leading up to an emergency. They utilize the national broadcast system to transmit one of three alert states to inform people on what to do and what the situation is (CNE, 2019a). There is the information alert state, indicating that there is the possibility of an emergency, when it would strike, and which regions it would affect. There is the preparation alert state, indicating that the danger of the emergency continues to grow and is very likely to strike. Finally, there is the evacuation and response alert, indicating that the threat has become severe enough to require mobilization of resources and population.

The Comisión Nacional de Prevención de Riesgo y Atención de Emergencias works to achieve its mission using all of the combined resources, committees, manpower, and connections, at its disposal.

# Appendix B: What is an IQP and Why this Project is an IQP

The Interactive Qualifying Project is an interdisciplinary project that intersects science, technology, and society to solve a problem in the community, often delving into a topic that matters to the local people and that isn't well studied or, at the very least, needs more research. In our case, we will implement the aspect of science through the use of qualitative data from our interviews with the locals, quantitative data from our survey, survey analysis, and vulnerability/risk analysis for identifying high risk areas. Because these analyses require input from the locals for our analysis, it fulfills part of the IQP that requires the involvement of the people. We will also be using science as a foundation for providing the best recommendations for warehouse designs. The technology that we will be using and have already used include the internet, cell phones, computers, and software that goes along with all that, especially in the case of data analysis and visual representation. The ability to use technology to store and analyze data, which in this case will be our survey responses, is often underappreciated. The amount of time it takes to comb through survey results by hand from tens or hundreds of individuals and represent them visually would be way too long for our stay of seven weeks.

To maximize the use of science, technology, and society in an IQP to its full potential, they are done by students who are not necessarily in the same major. In our case, we have three computer science majors and one mechanical engineering major, allowing us to apply our understanding and skills in software and engineering. We will be working with our sponsor as well, giving us the opportunity to apply another area of expertise and efficiently utilize the team's resources.

IQPs often result in a product that will positively influence the lives of individuals for years to come and will require the continued use of science, technology, and societal involvement. Our project will result in suggestions to improve Costa Rica's emergency plans for Monteverde, which will hopefully reduce or eliminate damage and loss in the area. Any changes made due to our research will persist for some time and may be built upon in the future by the local people to develop a better plan. The work we put in during this project will be important in Costa Rica's mission to be better prepared and protected from disasters, especially for Monteverde, as it needs special considerations that have not been fully noted before.

No matter what, our research will always require both science/technology and the involvement of local people to carry out the emergency plans. To be specific, the warehouses that will eventually be built, the public communication protocols that will be implemented, and the use of risk maps to identify areas of importance fall under science and technology. However, the local people behind the implementation of these technologies and the people required to mitigate and respond to emergencies fall under the intersection of society. This is what makes our project an IQP.

# Appendix C: Survey for the Residents in Monte Verde and Key Results

**These questions were translated from English into Spanish by Alejandra Garza to be distributed to the residents.**

**Survey**

1. How old are you?
    a. Younger than 18
    b. 18-25
    c. 26-40
    d. 40-60
    e. Older than 60
2. How long have you lived in Monte Verde?
    a. Less than 1 year
    b. 1-5 years
    c. 5-10 years
    d. 10-20 years
    e. More than 20 years
3. Do you have a leadership position in the community?
    a. Yes
    b. No
4. If yes, please indicate which organization you work for: _____
5. How familiar are you with the responsibilities of the emergency response committee?
    a. I recognize the organization and know its responsibilities in the community
    b. I know who they are but it's not clear what exactly they do
    c. The organization sounds familiar to me
    d. I've never heard of them before
6. How familiar are you with the procedures that the community has to follow during natural disasters (earthquakes, floods, landslides, etc.)?

| | 1 | 2 | 3 | 4 | |
|---|---|---|---|---|---|
| I have no idea what to do | ○ | ○ | ○ | ○ | I know exactly what to do and what steps to take during emergencies |

7. What method do you use to keep up to date with the status of weather emergencies and other natural disasters?
    a. I usually don't keep up with emergencies or disasters
    b. I want to stay informed, but I can't because of internet connection problems
    c. Mobile phone

d. WhatsApp
e. Radio
f. Television (TV)
g. Facebook
h. Twitter
i. Instagram
j. Snapchat
k. Other

8. How comfortable do you feel using your mobile phone?
    l. I know how to download applications and how to use them, use the internet, make calls, and send messages
    m. I know how to use the internet, make calls, and send messages
    n. I know how to make calls and send messages
    o. I know how to make calls
    p. I only know how answer calls, not how to make them
    q. I don't have a mobile phone
9. Did you live here during Tropical Storm Nate?
    r. Yes
    s. No
10. **If they lived here during Tropical Storm Nate:**
11. How did you evacuate during the tropical storm?
12. How destructive was the tropical storm in the area that you lived in at that time?

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Insignifcant | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | Severe |

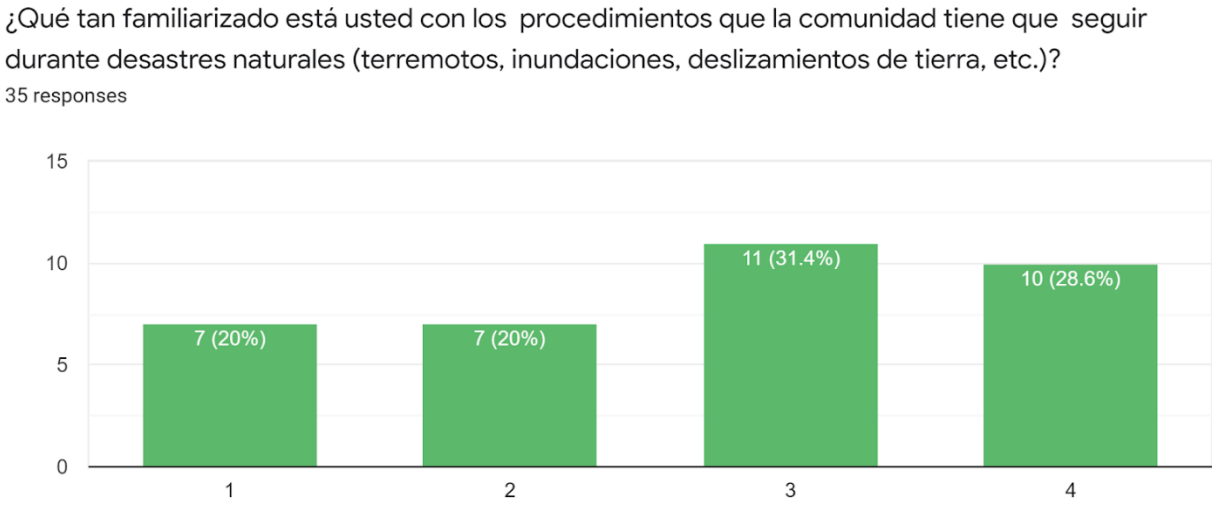
13. What area do you live in and how did the tropical storm affect it?

**Key Results**

5.

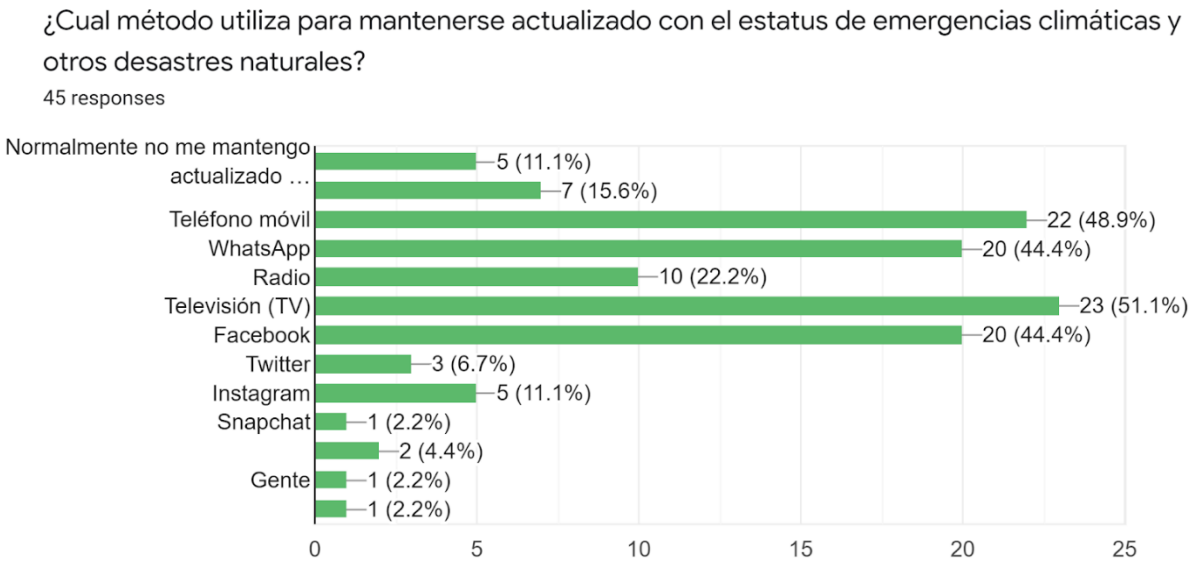

**Blue:** I recognize the organization and know its responsibilities in the community
**Red:** I know who they are but it's not clear what exactly they do
**Orange:** The organization sounds familiar to me
**Green:** I've never heard of them before

6.

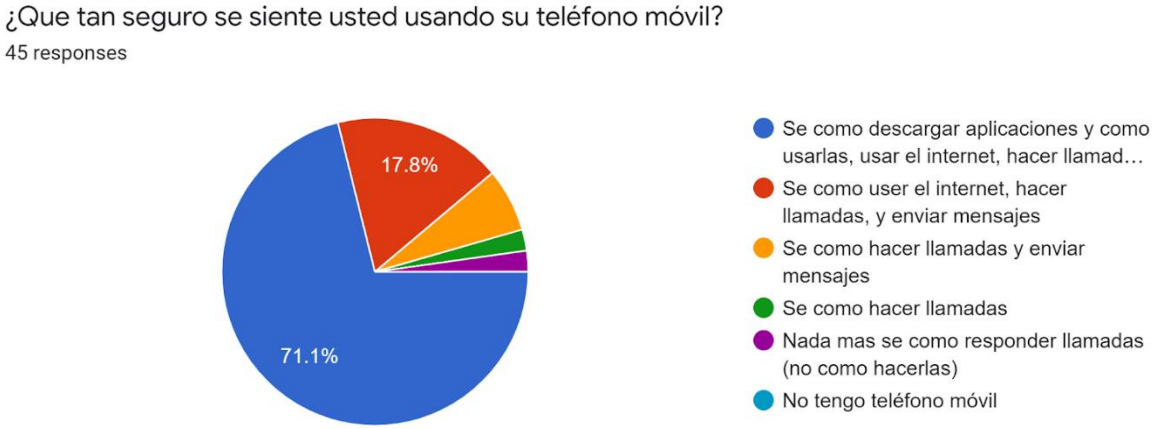



On a scale of 1 to 4, 1 being "I have no idea what to do," 4 being "I know exactly what to do and what steps to take during emergencies"

7.

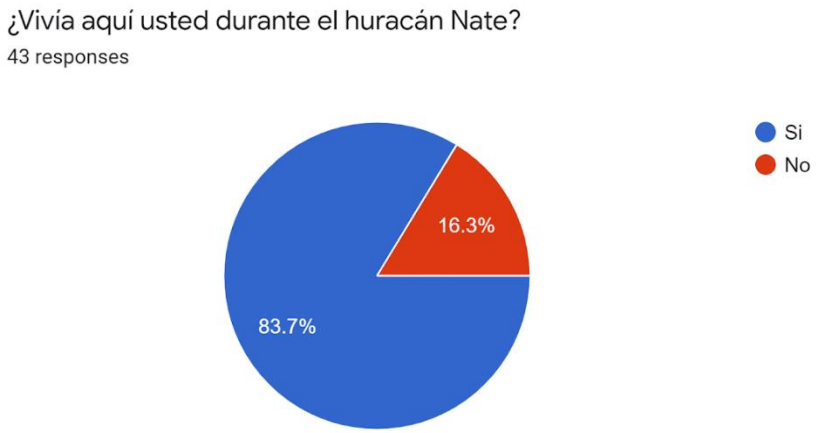



8.

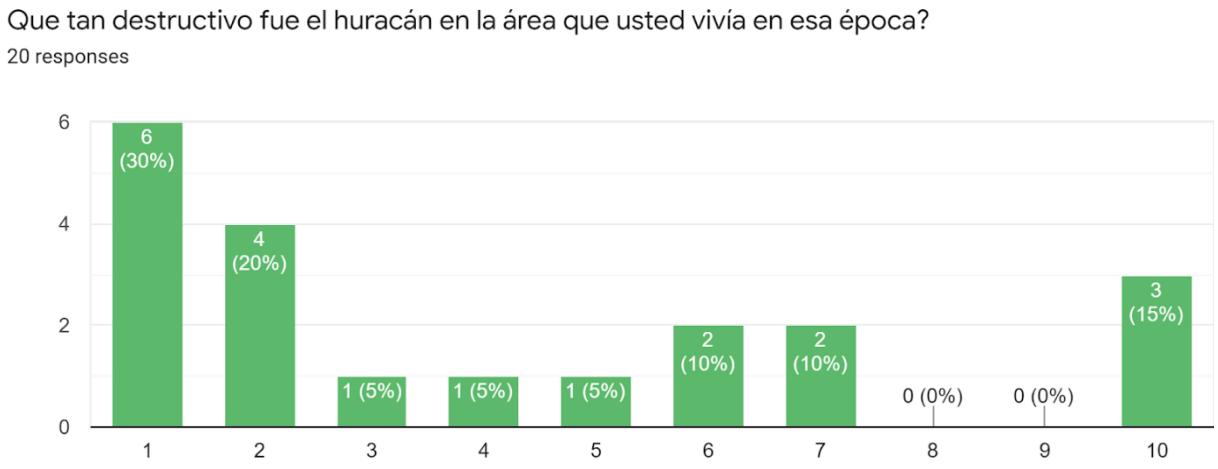



**Dark Blue:** I know how to download applications and how to use them, use the internet, make calls, and send messages
**Red:** I know how to use the internet, make calls, and send messages
**Orange:** I know how to make calls and send messages
**Green:** I know how to make calls
**Purple:** I only know how answer calls, not how to make them
**Light Blue:** I don't have a mobile phone

9.




11.




On a scale of 1 to 10, 1 being “Insignificant,” 10 being “Severe”

# Appendix D: Survey for Tourists and Key Results

**Survey**

1. Where are you from?
2. Where are you currently staying?
    a. Monte Verde
    b. Santa Elena
    c. San Luis
    d. Other
3. What do you believe are the three biggest risks in the region?
    a. Fires
    b. Wild animals
    c. Landslides
    d. Thunder storms
    e. Flash floods
    f. Short circuits
4. What language(s) do you feel most comfortable speaking (think in terms of receiving instructions in case of an emergency)?
    a. English
    b. Spanish
    c. French
    d. German
    e. Other
5. Did you bring a phone with you on this trip?
    a. Yes
    b. No
6. If yes, how comfortable are you using your phone?

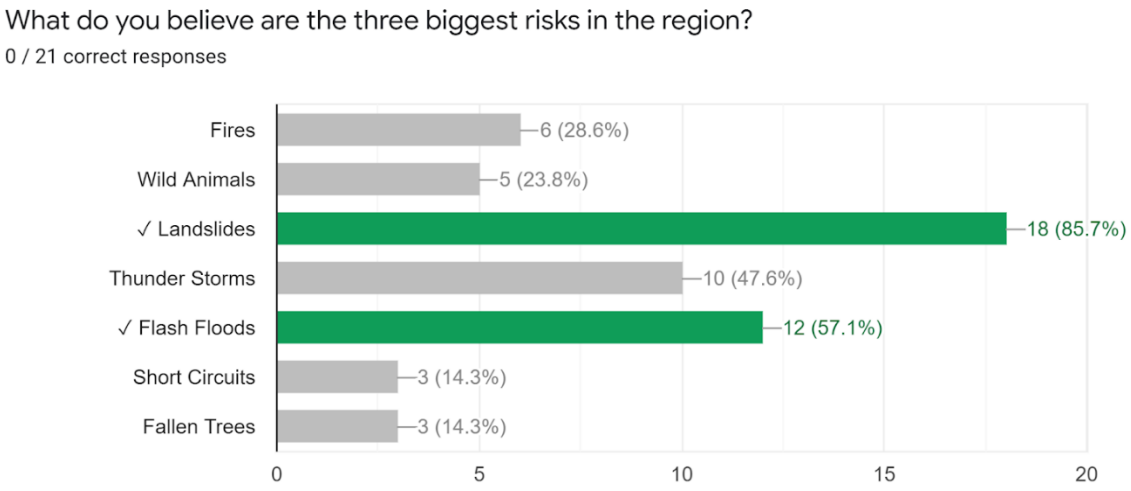
| | 1 | 2 | 3 | 4 | |
|---|---|---|---|---|---|
| Very little (only use it for its basic functions) | ○ | ○ | ○ | ○ | Extremely comfortable (use it often for multiple purposes) |

7. In case of an emergency, how comfortable would you feel accessing your instructions from an app on your phone? (If you do not have a phone, please choose 1)


8. What do you believe would be an effective method for preparing tourists for an emergency?
    a. Use an app that offers emergency steps in multiple languages
    b. Have pamphlets in Airbnbs, hotels, and homestays with the steps written in the most common languages in Monteverde
9. Thank you for taking this survey! Is there anything else you would like to add?

**Key Results**

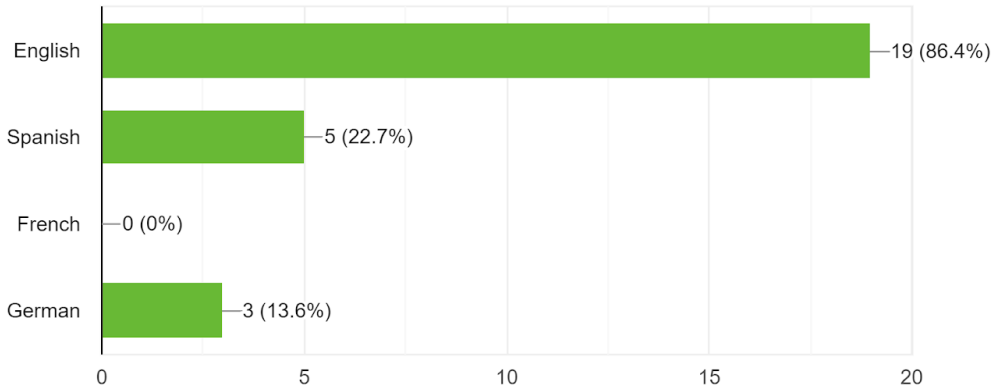
3.



4.

What language(s) do feel most comfortable speaking (think in terms of receiving instructions in case of an emergency)?

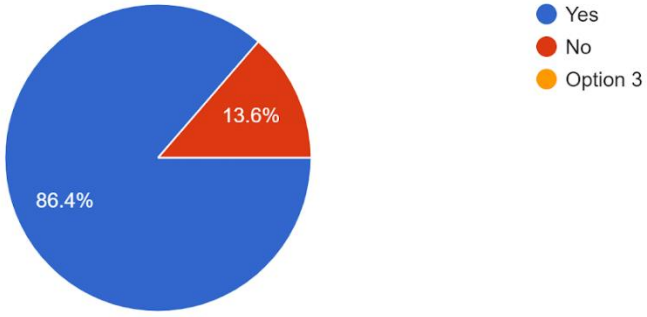
22 responses



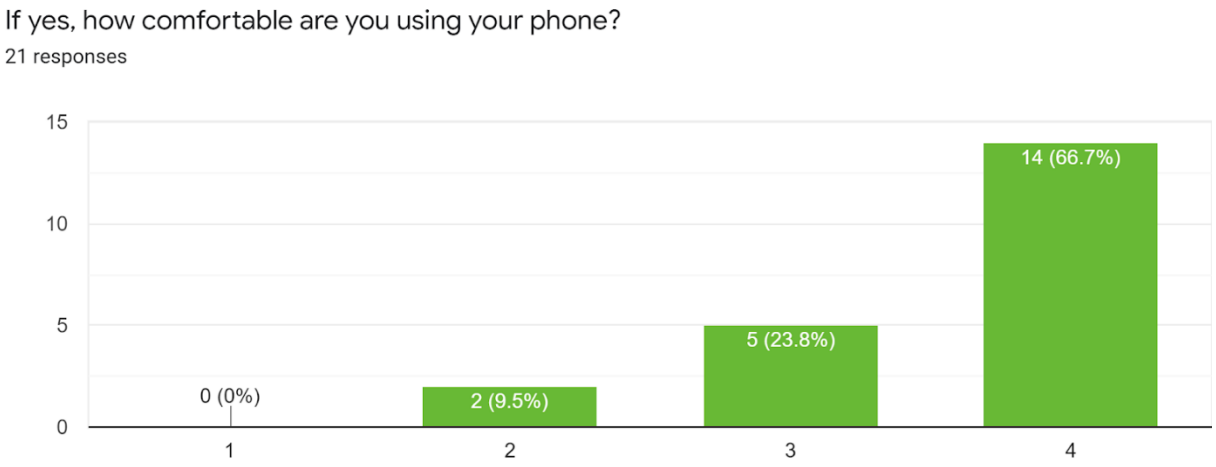

5.

Did you bring a phone with you on this trip?

22 responses

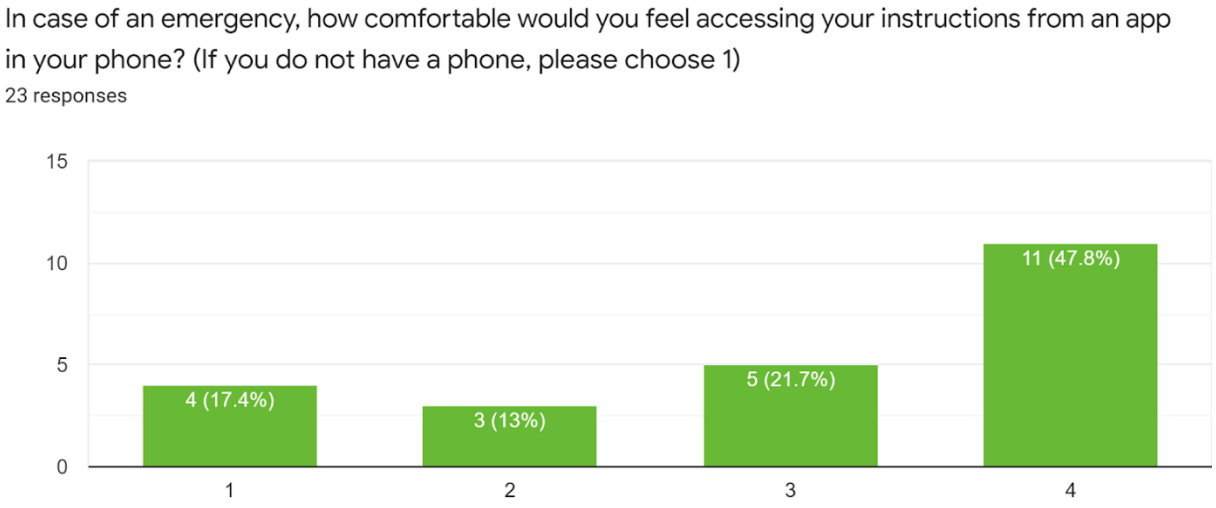


6.



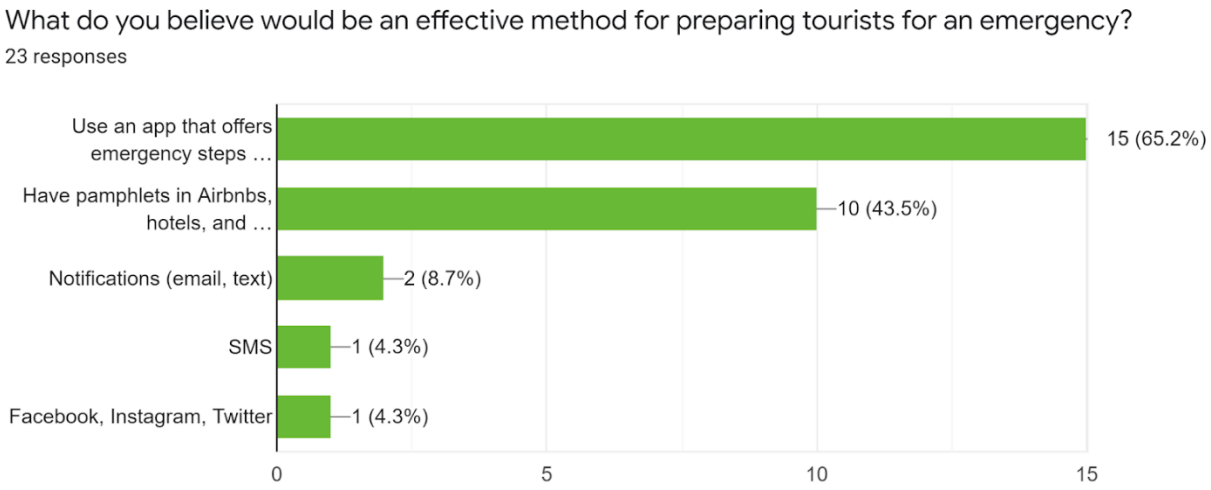

On a scale of 1 to 4, 1 being “Very little,” 4 being “Extremely comfortable”

7.




On a scale of 1 to 4, 1 being “Not comfortable,” 4 being “Very comfortable”

8.


What do you believe would be an effective method for preparing tourists for an emergency?
23 responses
Use an app that offers emergency steps ...
15 (65.2%)
Have pamphlets in Airbnbs, hotels, and ...
10 (43.5%)
Notifications (email, text)
2 (8.7%)
SMS
1 (4.3%)
Facebook, Instagram, Twitter
1 (4.3%)
0
5
10
15

# Appendix E: Interviews with Members of the Local Sub-Committee

**Before Every Interview**

1. Let them know we will use information given in the interview in our report.

2. Do we have your permission to associate your name with your answers in our report? Or would you rather remain anonymous?
    - Red Cross Representative - didn't ask
    - Health Clinic Representative - didn't ask
    - Firefighter Representative - yes
    - Minister of Health - yes
    - Mayor of Monte Verde (Municipality) - yes
    - Police Force Representatives - didn't ask

3. Can we record this interview? We will only use the recording for reviewing what was said in case we miss something. The voice recording will not be released at all.
    - Red Cross Representative - didn't ask
    - Health Clinic Representative - didn't ask
    - Firefighter Representative - didn't ask
    - Minister of Health - didn't ask
    - Mayor of Monte Verde (Municipality) - yes
    - Police Force Representatives - didn't ask

**We had informal interviews at the Red Cross, the Health Clinic, and the Fire Department, so we had not prepared questions. The following are the notes.**

## 1. Red Cross (Wednesday 1/22/20)

- First responders
- Rely on a dispatch that is in another area
- Understaffed
    - They need more staff but it has to be in the form of volunteers
    - They are trying to make it so everyone calls 911 instead of the local Red Cross number
- Two areas: response and administration
- When Tropical Storm Nate occurred, they were the first that needed to evacuate because they were in a dangerous area
- Their radio tower is located in a different location, so they were able to communicate

- Most of their resources come from other areas
- 1 ambulance

## 2. Health Clinic (Wednesday 1/22/20)

- When there is a storm, it gets flooded
- Took 15 years to change the roof
- Cannot deal with an emergency right now
- Individually moving departments
- 1 ambulance
- Only 2 ambulances in Monte Verde (the other is Red Cross)
- 4 doctors
- They were stuck here without knowing what to do
- Only 24/7 weekends
- Closes at 7 pm on weekdays

## 3. Firefighters - Gabriel (Wednesday 1/22/20)

- 3 forms of communication
- They have a WhatsApp group
- 6 permanent
- 9 volunteers
- They have a census of the current houses in Monteverde
- Short circuits cause by wind and storms
- Help with fallen trees
- Cannot cut trees without permission
- Do not have gas regulation in some areas
- Cars are catching on fire
- Gasoline in roads
- They evacuate people
- Rescue lost people
- Rescue animals as well
- Have protocols for dealing with forest fires
- Have specialists for dangerous materials
- There was a lot of psychological damage
- Some people were not trained to deal with being isolated
- Are getting budget cuts
- Feel confident with their team

## 4. Minister of Health - Esteban Aguilar (Friday 1/24/20)

**Note:** The answers to these interviews were originally in Spanish and have been translated by Alejandra to English.

1. What are your major responsibilities in the health clinic? (¿Cuáles son sus mayores responsabilidades en la clínica?)
    - This organization has been here for around 90 years
    - Three levels in the clinic
        - Central in San José - organize policies and laws
        - Regional - in charge of specifying the technical aspects of policies
        - Local rectory - in charge of implementing policies
    - Main role of the Emergency Committee and the local sub-committee is to identify and categorize risks
        - Threats - come from nature, such as landslides
        - Vulnerabilities - controlled by humans, such as houses being built in high risk areas
    - Three alert levels in Costa Rica
        - Green Alert - different departments that are part of the Emergency Committee check their resources and ensure everything is ready to be used in the case of an emergency
        - Yellow Alert - the committee meets and decides what each department is going to be in charge of
        - Red Alert - departments take action in an emergency
    - If there is an emergency and residents need to evacuate an area, the Ministry of Health is in charge of identifying the proper shelters
    - They make sure the shelter provides
        - Security
        - Psychological support
        - Access to water
        - Sanitation
        - Access to medicine
        - Mattresses and blankets
    - Warehouses need to have separate showers and bathrooms for males and females
        - Rate of sexual abuse increases during these times, people should take precautions
    - When we design our warehouse, we can talk to them about how it will be organized and the type of food we should have there
    - They inspect houses and determine whether people can live there again
        - If people cannot come back, the Ministry coordinates with an institute to support and give money to the residents for 3 months

- They are also in charge of reporting the type of people that are currently in the shelter (age, gender, any disabilities they may have, etc.)
- They are in charge of reporting the status of the shelter
- After the event they are also in charge of cleaning and fixing stuff
- During a Red Alert, departments are not allowed to perform actions if they are a risk for their members
    - Part of the reason Monteverde was isolated for so long.
- They make sure that if someone is sick, they can take them outside the shelter

2. How does the Ministry of Health get rid of used mattresses and blankets?
    - Our sponsor, Maricella, who was present during the interview asked this question
    - They usually throw away used mattresses and blankets, they say it is a little difficult and expensive to sanitize these items
    - Maricella was interested in finding a different solution

3. What are the major issues you faced during Tropical Storm Nate, and what changes have you guys made to avoid these issues? (¿Cuáles son los mayores desafíos con los que ustedes tuvieron que lidiar durante Tropical Storm Nate? ¿Han hecho cambios para evitar estos problemas?)
    - There was no Yellow Alert
    - Went directly to Red Alert, which meant they had little time to prepare
    - Other issues he mentioned
        - Isolation, mountains, poor communication, population is spread out, luckily this happened when there was a low tourist population

4. What are some important aspects of shelters that we should keep in mind when designing our plans for the warehouse?
    - They have a couple of shelters that they will use
        - Continuously revised to make sure they are in good condition
    - They believe that the Monteverde Institute is currently the best option but they need two options due to the bridge
        - The Friends School is also another good option (has space for a helicopter to land)
    - The shelter must accept everyone
        - The population of Monteverde is divided into various groups, however, they all get along with one another pretty well

5. What would you do differently this time (if Tropical Storm Nate were to occur again)? (¿Qué harían diferente si esto volviera a pasar otra vez?)
    - They widened sewers to decrease the risk of flooding
    - They cleaned rivers (had a lot of debris after Tropical Storm Nate)

- Sub-committees were created
- They are keeping track of rivers, especially when it is raining
- They identified areas of risk
- They identified the bridges that are most likely to break, the people that should be evacuated first, and the people in the area
- He mentioned the same thing about being reactive and less prepared and the lack of a good recovery plan
- They are trying to change the culture, which is preparing for things after they have already happened once
- Due to climate change, summers and rainy season are more intense
- In the committee, it is very common to plan but never execute the plan

6. What are your main forms of communication? (¿Cuáles son sus mayores medios de comunicación?)
    - Whatsapp and through their office phone

7. Background
    - 10 years working in this position
    - Specializes in Environmental Health
    - Gives college classes

## 5. Mayor of Monte Verde (Municipality) - Francisco Vargas (Thursday 1/30/20)

**Note:** The answers to these interviews were originally in Spanish and have been translated by Alejandra to English.

1. What are your responsibilities in the local emergency sub-committee? (¿Cuales son sus responsabilidades en la comisión?)
    - It has become more of a municipality, before it was the local emergency commission
    - He talked about how the CNE is more reactive than prepared
    - The municipality's job is to regulate where things can be built based on the amount of risk in an area
        - Sometimes they give permissions in areas that are high risk because they did not thoroughly check it due to challenges in the area
    - The committee is made of the public organizations in Monte Verde
    - They mentioned that Monte Verde does not currently have a territorial planning plan
        - Usos de suelo

            - People need to make sure that the land they buy is able to be used for the purpose they want it for. If there are no local regulations, higher level (provincial, national) regulations apply
        - Identify areas of risk
        - Need a map of high risk areas
        - This would help the municipalities
    - We currently have three maps available (which we want to combine for our project)
        - Map from the Monteverde Reserve
            - Areas of risk
            - Things that happened during Tropical Storm Nate
        - Health Clinic
            - Population oriented
        - Bomberos
            - Not sure what their focus was, know they used GPS mapping

2. What departments are in the local emergency sub-committee? (¿Cuales organizaciones son parte de la comisión?)
    - The following may not be their official names, but how he described them:
        - Institute of Electricity
        - ASADA
        - Ministry of Health
        - Red Cross
        - Firefighters
        - Police Force
            - Public
            - Turistic
            - Transit
        - Social security of the Health Clinic
        - Development Associations
        - Representatives from the community (represent specific groups in the community)
        - Ministry of Public Education
        - Ministry of Agriculture
    - There are subcommittees
        - The municipality are the ones who name these subcommittees
        - There are currently two: San Luis y Monte Verde
        - Representative from this subcommittees are in the commission

3. What were the biggest issues the municipality had to face during and after Nate (¿Cuáles fueron los desafíos mayores con los que la municipalidad tuvo que lidiar durante y después de Nate?)
    - Houses in high risk areas

- Communication

4. If a department needs money, for example the health clinic fixing the roof, is the commission in charge of discussing it and then providing the budget if it is approved? (Si una organización que es parte de la comisión necesita dinero, por ejemplo la clinic médica que ahorita está arreglando su techo, ¿la comisión está encargada de discutir el presupuesto?)
    - Most departments are considered independent, so they are expected to be in charge of their own financial needs
    - The health clinic's roof was a different issue since it affected the welfare of Monte Verde's residents

5. What do you think about asking the Monteverde Institute and the Monteverde Friends School to serve as warehouses for emergency supplies? Do you have any other places in mind? (¿Qué piensa usted de usar el Instituto y la Escuela de Amigos como bodegas para recursos para emergencias? ¿Usted tiene otros lugares en mente que pudiéramos user?)
    - He said it would be ideal if we could design a plan that builds a warehouse from scratch
        - It is risky to make deals with organizations since leadership can change
    - Maricella, who was present during this interview, wants to create small donation areas throughout the Monte Verde in order to gather the supplies of the warehouse
        - Currently they meet at the Red Cross
        - They want a place that is more solid, which could possibly be where the warehouse is
    - He said that if we submit a more solid proposal for the warehouse, the municipality can maybe take it over

6. What do you think we should do to have the biggest impact?
    - Having a diagnostic of the population
    - The warehouse
    - He thinks the pamphlet/app is also very important
    - He agreed that anything we do will have an impact

7. Additional topics discussed throughout the interview:
    - The commission helps with machines for building and they want the municipality to have a budget to help with basic projects
    - They want to change Monte Verde from district to canton
        - He is saying this project will help with this distinction
    - The warehouse in the Friends School will help take care of San Luis so it will have the most resources

        - Possibly be slightly bigger than the other one

## 6. Police Force Representatives (Tuesday 2/4/20)

**Note:** The answers to these interviews were originally in Spanish and have been translated by Alejandra to English.

**Interviewed with the following subsections of the police force at the same time:** Public Security, Transit, and Tourist

1. Can you explain what your department does and what are your responsibilities? (¿Nos puede explicar que es lo que hacen ustedes, y cuales son sus responsabilidades?)
    - Public Security
        - Has only been here two months
        - Collaborate with the Health Clinic for the security of shelters
        - After people evacuate there is a lot of robbery in the empty houses
        - Work both as a police force and a humanitarian force during emergencies
        - They collaborate together when there are emergencies instead of being divided by departments
        - They aid in giving out food
        - Collaborate with the Red Cross
        - Depending where the risk is, they ask other police forces from other areas to come help
        - They were students in the police force at the time of Tropical Storm Nate, the police supervised them to help with the emergency
        - They don't have helicopters to move people, borrow from Colombia and Panama
            - They have helicopters that are used for different things
    - Tourist Police
        - People identify themselves more with the tourist force rather than the public force - they believe this is because the public is more used to seeing them
        - He was not working during Nate, but his house got flooded
            - There was no water or light
            - There were very few people so everyone was very tired
            - There are only around 5 officers in Monte Verde
                - Due to budgeting
    - New leadership is more united than before
        - Last boss was very divisive

2. Maricella (our sponsor who was also present during the interview): What do they do with the different alerts? Are they under the commission or individual?
    - They use the same alerts

3. What do you believe were the biggest issues during Nate? (¿Cuáles cree usted que fueron los mayores desafíos durante Nate?)
    - Tiredness - they couldn't stop until the emergency was over
    - They would sleep in chairs because they couldn't reach the police department building, their operation center was the clinic (which was flooding)
    - Communication
        - First two days - no communication
        - The police car had good radio communication after a couple of days - they used it to tell people that they were ok
    - People did not evacuate their homes in high risk areas
        - They had to take them out by force
        - They take out children by force whether the parents want to or not

4. What would they do differently?
    - It would unfortunately be the same
    - They said they have done nothing to change the preparedness of the police force

5. What is one piece of information you wish the public knew during emergencies? (¿Cúal es lo que usted desearía la gente supiera durante emergencias?)
    - The app needs to have an option to input stuff about the amount of people at an Airbnb and for how long they will stay there
    - They mentioned that having a resource checklist of what residents should have beforehand would be useful
    - They say it is hard to have a meeting point
        - Every area has a risk
    - Stay calm
    - Take out children if you are inside an area of risk
    - In areas where people have to evacuate, make it clear that they have to evacuate
    - When they evacuate people they take them to schools and churches
        - Work with the health ministry
        - The gym

6. Does your department keep any record of a map? How is it used? (¿De casualidad tu organización usa un mapa? ¿Cómo lo usan?)
    - No map
    - Data poll - they see the emergencies and where they are

7. How do you deal with increased crime during the vulnerable times during and after emergencies? (¿Cómo usted lidia con el incremento de crimen durante tiempos de emergencia?)
    - There was a group stealing stuff from houses
        - When they were giving out food they caught them
        - Used the path criminals used to start sending food
    - They need more people

8. How do you normally communicate with the public? (¿Normalmente cómo se comunica usted con la comunidad/el público?)
    - National frequency radio
        - Best one, but it did not work during Nate
    - Playa Coco has a radio that connects directly to CNE
    - They agree that satellite radio will be better for the warehouses
    - Location for warehouse
        - Casém - close to population
        - Cheese Factory
        - Friends School
        - Monteverde Institute

# Appendix F: Interviews with Local Experts

**Before Every Interview**

1. Let them know we will use information given in the interview in our report.

2. Do we have your permission to associate your name with your answers in our report? Or would you rather remain anonymous?
    - ASADA Representative - didn't ask
    - Veteran Engineer from Municipality - didn't ask
    - Coordinator for the Comisión hacia la Resiliencia al Cambio Climático en Monteverde - yes, but she would like to review what we write
    - Head of the Monteverde Institute - yes
    - Head of Control and Surveillance (Monteverde Reserve) - didn't ask
    - Head of Monteverde Friends School - yes
3. Can we record this interview? We will only use the recording for reviewing what was said in case we miss something. The voice recording will not be released at all.
    - ASADA Representative - didn't ask
    - Veteran Engineer from Municipality - didn't ask
    - Coordinator for the Comisión hacia la Resiliencia al Cambio Climático en Monteverde - didn't ask
    - Head of the Monteverde Institute - didn't ask
    - Head of Control and Surveillance (Monteverde Reserve) - didn't ask
    - Head of Monteverde Friends School - didn't ask

## 1. ASADA Representative (Wednesday 2/5/20)

**Note:** The answers to these interviews were originally in Spanish and have been translated by Alejandra to English.

1. Can you explain what your department does and what are your responsibilities? (¿Nos puede explicar que es lo que hacen ustedes, y cuáles son sus responsabilidades?)
    - The aqueduct from the tower to the Cheese Factory
    - The other one is much smaller
    - 70 km of water line
    - 6 thousands habitants in Santa Elena, tourists not included
    - Very complex - six sister companies connected with one another
        - They each have a certain amount of water
        - They have a system based on gravity and pump
        - Some use both systems
    - The environmental commission is very important to them

- They want people to appreciate the water quality
    - It's drinkable
- Costa Rican Institute of Aqueducts and Sewers (AyA)
    - They give each aqueduct a grade
    - Based on quantity, quality, etc.
- They are very involved in environmental programs
- Biggest issues they have is buying territories where sources are owned by locals
- 26 water sources
- 35 liters per second
- There is one under Monte Verde that they are trying to protect against contamination
    - They are trying to move animals

2. What resources do you have at your disposal? (¿Cuáles son los recursos que usa esta organización?)
    - Two warehouses
    - Budget
    - 5 staff members

3. What are some weaknesses of the ASADA you wish could be improved? (¿Cuáles son algunas debilidades de ASADA que usted desearía mejorar?)
    - How decisions are made

4. How long does it take to repair water lines when they break during emergencies? (¿Cuánto tiempo se tardan en reparar los conductos de agua cuando son destruidos durante emergencias?)
    - Response time is usually very fast

5. We are planning to design a warehouse with supplies. Should we have clean water stored in the warehouse before you are able to distribute clean water yourself? (¿Estamos planeando en diseñar planes para bodegas en Monteverde, usted cree que deberíamos tener una reserva de agua en las bodegas? Si, si ¿cúal sería la mejor manera de mantener esta reserva?)
    - Santa Elenda ASADA have two warehouses
    - Large water jugs - they need to buy them

6. Where should we build the warehouses?
    - After Selina Hotel, near Aqueduct of Monteverde, towards Monteverde Reserve
        - Sonia y Raúl

7. How do you deal with the water shortages while repairing lines? (¿Cómo usted lidia con el inacceso al agua mientras reparan los conductos?)
    - They are extremely vulnerable against emergencies since they are built in the forest
    - To prepare against it, they go every year to check the risks of each aqueduct and identify vulnerabilities
    - There are a lot of things that cannot change

8. Do you by any chance have a map of the water flow in the town of Monteverde? (¿De casualidad tiene usted un mapa de las tuberías en Monteverde?)
    - Zonas de riesgo
    - The location of the aqueducts

9. What are the emergencies in which water shortages would most likely happen? (¿Cuáles son las emergencias que sea más probable que causen inacceso al agua?)
    - Landslides
    - They have no way to protect it since they have to be built there
    - It is extremely dangerous to repair them

10. How would you recommend we prepare people for emergencies in which these water shortages may happen? (¿Que usted recomienda que le digamos a la gente para prepararse para estas emergencias?)
    - They need to know where to repair
    - Need people to notify ASADA when their area is affected

11. If a storm like Nate were to happen again what would you do differently? (Si una tormenta como Nate fuera a pasar otra vez, ¿qué haría diferente?)
    - They realized that none of their systems did not work during Tropical Storm Nate
    - They need a backup system
    - They have a personal plan for emergencies
    - They are saving up money in order to do so

12. What happened during Nate?
    - Water pumps are expensive
    - There was a lot of rain
        - It took everything and covered a lot of tubes in dirt
        - The area was unrecognizable
    - The response was great
        - They only have 5 people on staff for repairment
        - They would have been unable to fix anything without the help of the community

- The 4 systems were really damaged
- More than 100 volunteers

## 2. Veteran Engineer from the Municipality (Monday 2/11/20)

**Note:** The answers to these interviews were originally in Spanish and have been translated by Alejandra to English.

1. Explain our project, particularly the warehouse.

2. Where do you recommend we build the warehouses? (¿Dónde usted recomienda que construyamos las bodegas?)
    - Size considerations - 30 meter squared of space
    - Casem - not a great idea, takes away from the playground area in front of it
    - Cheese Factory - not enough space
    - Friends School center of attention, and Monteverde Institute is a good option, have enough space

3. Can you explain what type of codes and rules would apply for the construction and design of this building? We are having a hard time finding this information online. (¿Puede explicar que tipos de reglas aplicarán a la construcción y diseño de estas bodegas? Nos está costando un poco encontrar esta información en línea.)
    - Use website for productos de concretos
    - Explain rules and have models

4. What type of materials are waterproof roofs made out of? (¿Cuáles son los mejores materiales para construir techos contra agua?)
    - Metal
    - For light - you could do it through the ceiling

5. What common type of materials are the walls made out of? (¿Cuáles son los materiales de que los paredes son hecho normalmente?)
    - Concrete slabs and pillars
        - Slabs are 1.5 x .5 m
    - Metal door that push outwards, 1 meter long

6. What are the best types of walls and roofs that would last in a hurricane? (¿Qué son los mayores paredes y techos que van a quedar durante un huracán o tormenta tropical?)

- Metal and concrete should be fine

7. Do they require windows or can we build them without windows? (¿Necesita ventanas o podemos hacerlas sin ventanas?)
    - Don't need windows, objects need to avoid sunlights
    - But need ventilation

8. How should the layout for the warehouse be? We were thinking rows of shelves with a walkway in the middle (like the bookshelves at the library). (¿Cómo debemos diseñar los planos de las bodegas? Pensamos en unas filas de shelves con un espacio en la mitad para caminar como una biblioteca?)
    - Good idea to have walkway in the middle with shelves on the side, with side walkways made by shelves

9. Is there anything you recommend about the placement of supplies (like putting combustibles in a separate location)?
    - Putting combustibles in a separate location
    - Sorting out supplies to find easily

10. How tall should the warehouse be?
    - 3 meters

11. Other information
    - Software that's easy to use - SketchUp
    - 5 million colones for typical warehouse costs
    - Don't need to consider flooding if built in the right place

## 3. Coordinator for the Comisión hacia la Resiliencia al Cambio Climático en Monteverde - Katy VanDusen (Monday 2/11/20)

**Note:** This interview was conducted in English.

1. What are your responsibilities in the community?
    - Coordinator for the commission for resistance against climate change
    - Teaches yoga
    - President of the board that owns CASEM
    - Corclima, their goal is to:
        - Reduce carbon emissions, get community to adapt to climate change

    - Resources - people and goodwill, students

2. What are the types of natural disasters that will affect Monteverde in the future?
    - 1957 - measuring rainfall, precipitation was well distributed
        - 25 dry days per year, 2 ½ meters of rain per year
    - Now we have more dry months
        - 110 dry days per year, more rainfall, stronger gusts
    - El Niño years make it more dry
        - Usually at the time where there are a lot of tourists
    - Landslides are one of the biggest things
    - Easily a hundred landslides in the region after Nate
    - Fire will become a bigger
        - There was a huge fire in March of last year, burned 400 hectares of land
    - Earthquakes she says are hard to prepare for in part of the trails
    - Falling rocks caused by
        - Earthquakes
        - Intense weather
    - Combination of earthquake and storm will wreak havoc on soil, leads to massive landslides
    - Winds cause objects to fall and hit your head, can kill
    - Drought might be dangerous as well
    - Climate change leads to
        - Extreme weather events
        - Fire
    - 2008 - citizens united, corporations can function as people

3. What do you think should be our priorities when designing an emergency plan for this region?
    - Talking and listening to people
    - Understanding why people do things and what they perceive as their immediate needs
    - Being ready when the electricity go out
        - Luci-lights - solar powered, might be a good idea to add to the warehouse or the preparation plan
        - Solar panels
    - Five-gallon containers of water in personal houses
    - Producing your own energy - solar panels
    - Generators use fossil fuels and are noisy
        - Able to run out of fuel
    - Batteries - a way to start a system
    - How to prevent a disaster in the first place
        - Cable back trees
    - Make sure water is not flowing in a way that it might saturate soil

- Zoning laws – regulated plan
    - Monteverde will have individual regulations
- Not being able to build on top or below hillsides
- Local faults caused by earthquakes
- Institute has a study on many aspects - we should check it out

4. What do you think Monteverde residents should do to prepare for these kinds of threats?
    - Cable back trees to avoid fallen trees
    - Have extra water on hand
    - Solar phone chargers
    - Solar panels not connected to grid
    - Have extra vital medicine on hand
    - Have batteries

5. What do you think is a priority to include in our emergency plan?
    - TV towers are extremely vulnerable

6. We are planning on building two warehouses in Monte Verde, our possible locations are The Monteverde institute, Friends School, CASEM, and the cheese factory, what are your opinions? Do you have any recommendations for potential locations?
    - Some of these places have the stuff that we need
    - Institute has more space than here
    - Friends School should be one place where we store supplies 9
    - Not the reserve - easily cut off
    - Best places would be the Institute and the Friends School
        - Solar panels not connected to the grid
        - The Butterfly Garden will have some type of energy
        - The Institute is a good meeting place
        - Kitchen
    - Basic needs
        - Water
        - Storage space
        - Kitchen
        - Place where people can have mattresses
    - Dairy plant had a different water source
    - Dry composting toilet - people can go to the bathroom without having to use water
    - CASEM does not have much space
    - It would be possible to do it, but we need to figure out how much space we need
    - Institute will be interested in having a satellite phone

- People themselves should have the water and other basic supplies
- She did not agree on us to have one for San Luis
- Maybe we could have San Luis build it
    - Land is not as expensive

7. Do you have any special considerations we should keep in mind for the warehouse?
    - She disagreed with building a warehouse
    - Says land in Monteverde is scarce and therefore people are going to be unwilling to build stuff on their property.
    - Also not a good idea to have a centralized distribution source

8. How willing do you think these organizations will be to have a warehouse on their property? What do you think we can do to convince these potential organizations?
    - It depends on size
    - Maybe we can have supplies housed in existing places at the sites
        - Possibly still have smaller warehouse because of the storage elsewhere

9. Anything you would like to add?
    - Know the available resources
    - Know who has water
    - Know who has solar panels
    - Know who has frozen food
    - Know who has what knowledge
        - Who can give medical aid
        - Who can fix things
        - Who knows how to communicate

## 4. Head of the Monteverde Institute - Deborah Hamilton (Thursday 2/13/20)

1. Explain our project.

2. What are some recommendations you would make for an emergency protocol?
    - Visual indicators for instructions is key
    - Make sure electronics are charged
    - Make sure cars are filled with gas
    - A lot of the staff is already trained
    - They already have a lot of the supplies
    - Composting toilet
    - They have a write up of everything they have

- Make sure tourists have a safe spot in San Luis
- Know where to go, have a safe space
- Have a network of people to call
- Since there a lot of locals trained, there should be a list so the institute and other centers knew who to send

3. What do you believe would be the best way to distribute the plan?
    - Having brochures distributed through tourist agencies and hotels
    - They can even fund a building

4. What are your thoughts on building a warehouse on your grounds?
    - They are building a new workshop
        - Sustainable futures workshop
    - They are interested on having our supply list when we are done
    - They have 1 generator

5. What did the institute do during Tropical Storm Nate?
    - Center of information - main meeting point
    - Safe place
    - Had water, had cooking gas, had food
    - Now has generator and solar panels

6. Is there anything you wish the Institute could do/wish the Institute had access to?
    - More funding
    - Battery backups
    - Energy source for emergencies
    - Satellite phone
        - Need to be obtained in pairs
        - Suggested getting one in each center

7. How long do the generators last for?
    - Not sure how long it lasts

## 5. Head of Control and Surveillance (Monteverde Reserve) - Geiner Alvarado Huertas (Friday 2/14/20)

1. What software did you use to compile this map?
    - ArcGIS

2. What do you believe are the best uses of the map?
    - Organizations would use same map
    - Speak the same language

3. What things need to be improved about the map?
    - Updates to the map
    - Wants locations for helicopter sites

4. What organizations would benefit most from the map?
    - Police, firefighters, Health Clinic
    - Map also shows regions outside of Monte Verde

5. What other methods should people use to identify areas of high risk?
    - Yellow is landslides, doesn't know what red is on the top of his head (buildings?)
    - Coordinates for helicopter landing sites - Plaza de Santa Elena (football field), bull fighting arena, Plaza de San Luis, Friends School
    - Will give layers to us to put in ArcGIS

## 6. Head of Monteverde Friends School - Sue Gabrielson

1. What did the Friends School do during Hurricane Nate?
    - Offered place as a shelter, but most people stayed home on this side of Monte Verde
    - Ran "camp" during Tropical Storm Nate
        - Took care of kids
        - Freed adults so that they can work on infrastructure
    - Took in some people from San Luis
    - Ziplined people and supplies across the river
2. What supplies and resources do you already have in the Friends School?
    - Water tank for flushing and cleaning
        - 2000 liters
        - But not drinkable
    - Tap water filter would be a good idea
        - She lives in Bajo del Tigre and she did not have water for 3 weeks
        - She did have a lot of water from her rainwater collection system
        - Not drinkable, but a tap water filter would solve that problem
    - Have 12 solar panels but line goes to the grid
        - Cannot be used directly

    - Would need a battery or inverter
  - Dry composting toilets
  - 1 tank of propane and 2 burners
    - Does not have a gas line though
  - Kitchen
3. What kind of supplies are needed during emergencies?
  - Food and water
  - Emergency first aid kits
  - Gas
    - Do not have a gas line
  - Electricity - generator
4. Would you be willing to have a warehouse on your premises?
  - They are okay having a warehouse
  - Have 2 large open spaces
    - Ready to have it be used by the emergency sub-committee, but it has yet to be used
    - Recommends the one near the soccer field
  - Can not fund it though
  - Are willing to check our supply list
  - Prefers warehouses over storing supplies in already existing rooms
5. We know that the Friends School is also a place where helicopters could land. Would there be a conflict with that?
  - Helicopters are allowed to land there, but some politics prevented helicopters from doing so during Tropical Storm Nate
    - Had to land in field behind (Eric Rockwell's field)
6. Would it be okay if we house supplies for San Luis as well, since the bridge will cut them off?
  - San Luis can easily be cut off from Monte Verde
    - The road to San Luis is long and landslides are likely to occur
  - During Tropical Storm Nate, they were able to reach San Jose for supplies before Monte Verde
  - Is ok with providing supplies to support San Luis, but San Luis probably needs to have their own warehouse
    - Can easily be cut off from Monte Verde
    - The road to San Luis is long and vulnerable to landslides
    - Has enough resources - a store, a medical clinic, community center
7. Is there anything you want the community to know about the Friends School?
  - They are ready to be a shelter, has the capacity to house people
    - Can be advertised that they are a shelter in infographics and app
8. What do you think is the best way to inform and communicate with the community?
  - WhatsApp
  - Facebook
  - In-person meetings when there is no internet
9. Other recommendations and information

- Establish meeting times and meeting points during times of emergencies
    - Put in infographics and app
- Can put infographics in the library in the school
    - Quakers who do not like using technology would visit there often
- Landlines still work during emergencies
    - Could use that instead of satellite phones
    - Didn’t try to contact others outside during Tropical Storm Nate though

# Appendix G: Response Comparison for the Interviews in Monte Verde

*Table G.1: Response Comparison Table for Interviews in Monte Verde*

| Idea | Red Cross | Health Clinic | Firefighter | Minister of Health | Municipality | Police |
|---|---|---|---|---|---|---|
| Near Monteverde Institute and Friends School for warehouse locations | Didn't ask | Didn't ask | Didn't ask | | | Also Casem and Cheese Factory |
| WhatsApp and phone for main form of communication | Didn't ask, use radios | Didn't ask | Also radio | Also office phone | Didn't ask | Didn't mention WhatsApp, use hand and car radios |
| **Communication was a big issue during emergencies** | Their radio tower in another location during Nate | | | | | |
| Warehouse is a good idea | Didn't ask | Didn't ask | Didn't ask | | | Implied |
| App and calendar ad are good ideas | Didn't ask | Didn't ask | Didn't ask | Didn't ask | | Implied |
| Diagnostic map is a good idea | Didn't ask | Implied | Implied | Didn't ask | | Implied |
| Understaffed | 2 responders | 4 doctors | | Didn't mention | Didn't mention | 5 |
| **People are more reactive to emergencies than prepared, lack good recovery plan** | Didn't ask | Implied | Implied | | | Implied |
| Landslides are a major problems in emergencies | Didn't ask | Didn't ask | Didn't ask | | Didn't ask | Didn't ask |

*Table G.2: Response Comparison Table for Interviews in Monte Verde (continued)*

| Idea | ASADA | Engineer | Katy | Head of MVI | Geiner | Friends School |
|---|---|---|---|---|---|---|
| Near Monteverde Institute and Friends School for warehouse locations | After Selina Hostel, near Aqueduct of Monteverde, towards Monteverde Reserve, for location near School of Friends | | | | Didn't ask | |
| WhatsApp and phone for main form of communication | Didn't ask | Didn't ask | Didn't ask | Didn't ask | Didn't ask | Also Facebook and in-person meeting when there is no internet |
| **Communication was a big issue during emergencies** | | Didn't ask | Didn't ask | Recommend sat phones | Implied | Implied |
| Warehouse is a good idea | Implied | Implied | Land is expensive and difficult to obtain | They might want to store some supplies in existing rooms | Didn't ask | |
| App and calendar ad are good ideas | Didn't ask | Didn't ask | Also infographics | Mentioned need for visual instructions or infographics | Didn't ask | Implied |
| Diagnostic map is a good idea | Implied | DIdn't ask | Didn't ask | Didn't ask | | Didn't ask |
| Understaffed | 5 | Didn't mention | Didn't mention | Didn't mention | Didn't mention | Didn't mention |
| **People are more reactive to emergencies than prepared, lack good recovery plan** | Didn't specifically ask, their organization in particular could only do so much to prepare | Implied | Implied | Implied | Didn't ask | Didn't ask |
| Landslides are a major problem in emergencies | Implied | Implied | | Didn't ask | Implied | Implied |

**Map**

- Organizations with Maps
  - Geiner
    - Risk map
  - Firefighters
    -
  - Health Clinic
    - Population oriented
- Collaborate all maps together (municipality)

**Warehouse**

- Warehouse designed from scratch, making deals with organizations is risky since leadership changes often (municipality)
- Locations
    - Casem - close to population (police)
    - Cheese Factory (police)
    - Monteverde Institute (Minister of Health, Municipality, police, ASADA)
    - Friends School (Minister of Health, Municipality, police)
    - Somewhere after Selina Hostel, near Aqueduct of Monteverde, towards Monteverde Reserve (ASADA)
- Satellite radio (police)
- Large water jugs (ASADA)
- Work with Minister of Health for type of food

**App**

- Resource checklist for emergencies (police)
- An option to input length of stay and number of people staying at an Airbnb (police) - next year
- Need to notify ASADA when water doesn't work (ASADA)

**Calendar**

- Resource checklist for emergencies (police)
- Need to notify ASADA when water doesn't work (ASADA)

# Appendix H: Interviews with Emergency Personnel in the United States

## 1. Interview Protocol and Interview Notes for Meghan Gomes

**Our primary contact was Meghan Gomes, the deputy director of Worcester Emergency Management. Two other people accompanied her during the interview: the head director Michael Shanley and a staff member Zach O'Neil. Below is the protocol we followed.**

**In Advance of the Interview**

1. Determine location, day, and time for the interview
    - December 4, 2019

**Before Starting**

2. Introduce ourselves
3. Thank them for the interview
4. Permissions before we start
    - "Do you give us permission to use your name in our report, which would be available to the public, or would you like to remain anonymous? We will also ask you this again after the interview in case you change your mind."
        - Yes
    - "Do we have your permission to voice record and transcribe the interview? We will be taking notes during the interview in either case."
        - No
    - "Any other information you give us may be used in our report. If you have any sensitive information that you are not allowed to share, you are not required to tell us. Just let us know when we ask the question."

5. Introduction
    - Background of the National Emergency project and how the interviewee will help us with understanding typical emergency prevention, protocols, response, and best practices

**Questions**

6. "Can you give us a little background on who you are and how you became involved in emergency response and your current position as the Director of Worcester Emergency Management?"
    - Meghan
        - Undergraduate Degree in Criminal Justice
        - Worked in 911 dispatching for Worcester right after college

    - Started graduate emergency response degree in Worcester but was unable to finish the career
    - Has been in current position for 5 year and main focus include: Emergency planning, coordination with partner organizations, and liaison with stakeholders
- Michael
    - Similar background to Meghan with criminal justice degree and background working for 911 dispatch (in position for 10 years)
- Zach
    - Recent college graduate from Massachusetts Maritime with emergency management degree
    - Recently started working for Worcester Emergency Management
    - Has EMT license
    - Worked as a firefighter for boots on ground experience

7. "Can you give us an overview of the plans you have in place in the case of natural disasters/emergencies?"
    - Ask follow-up questions about things that aren't clear in the steps
    - Worcester has a master plan: Comprehensive Emergency Management Plan (CEMP).
        - Contains guidelines for departments on what they are each meant to do before, during, and after an emergency
        - Guidelines for their department include
            - Family unification
            - Emergency shelter
            - Hazardous Materials
            - Terrorist attacks
        - The Natural Hazard Mitigation Plan
            - Outlines what hazards are in our community
            - What our community is made up of
            - Different ethnic populations
            - Critical analysis of what could happen
            - Gives them strategies on how best to mitigate the effects of the disasters
                - Can be found online
            - Highlight different strategies different departments have worked on
                - E.g. improving storm drains
            - How do you prioritize this?
                - Liaison that works directly with the city
                - Each department highlights their priorities
                - As a community they identify what is more important
                - Put it out to the public

8. "We know that there are four phases of emergency management: preparedness, mitigation, response, and recovery. Can you give an example of what didn't work in the past for each phase and why didn't they work?"
    - "What did work for each phase and why did they work?"
    - To investigate municipal vulnerabilities and improve preparedness the Worcester Emergency Management decided to meet with city departments and stakeholders
        - Together they decided what the biggest vulnerabilities of the city are- flooding was a big deal
        - A workshop day with around 78 people, they discussed
            - Where is the problem happening
            - Possible solutions
            - The effects of the solutions
        - Like to involve the community - very important but challenging
    - Most challenging phases are mitigation and preparedness
        - Cost -benefit analysis
        - Need a lot of money and need to know where to spend it
    - Additional Question: "Role of community?"
        - They have different venues the community can participate in
        - They (community) are not very interested
        - Part of the problem is outreach
        - Surveys out of 180,000 they only got 300 responses
        - It's tough to get community input if they are not currently being affected by it
        - Input is extremely valuable because the department had their own priorities and need to know what the community is thinking and the biggest issues they are facing
        - Most of the time priorities are determined by the amount of people it affects - especially when it comes to money
    - Additional Question: "Does community understand prioritization?"
        - Usually not
        - When community allows the organization to explain, most people understand it
    - Additional Question: "What did work for each phase and why did they work?"
        - Preparedness
            - The department doesn't have the ability to fix problems, but they have partnerships with people that can solve the issue
            - Building relationships is most important
            - Form partnerships with school departments and churches for places people can gather
            - Every department usually does their own thing without much communication
                - What this organization is trying to do is to connect people and break walls

        - Building relationships includes working on them and checking up with people (even if there is no emergency)
        - Make sure you call them beforehand
    - Additional Question: “How do you deal with unpredictable events?”
        - Plans can be used - have as many plans as possible
        - Analyze the things that need to be done once the dust settles
        - Need to know who to call and how to react
        - Have good relationships with other organizations beforehand
        - Know what resources each department has
        - Have drills and exercises asking people what they would in different scenarios
        - Invite everyone even if you don’t think their resources could be useful because you never know if they have ideas and resources we are unaware of
    - Best practices for each of the phases
        - Preparedness
            - Public education
            - Know the different types of communities
                - E.g. people that don't speak English sometimes don't trust the government
            - Picking out most vulnerable populations and figure out how to reach them
            - Community outreach
            - Exercising different emergency response plans
        - Mitigation
            - They have a planning department in the city who assess what the vulnerabilities
    - Definition for each step
        - Mitigation - eliminate threat before it happens
        - Response - response to the problem
        - Recovery - bring things back to how they were
9. “For a town in a mountainous region like Monteverde, what characteristics do you think makes a good preparedness and mitigation plan?”
    - Generators - high likelihood of power outages
    - Make sure they have time to prepare themselves
    - See what they care about and what they are used to
        - Cultural aspect and different priorities
    - Need to see where resources normally come from
        - Electricity
        - Water
    - Need to know the different types of people that live there
        - Is everyone ok being placed in shelters with people of different religions?
10. “How are warehouses organized to be used in an emergency?”
    - N/A

11. “What makes a good warehouse and why?”
    - “We were thinking about designing a warehouse with a secondary function for the community. The primary function would be for emergency uses. What recommendations do you have for a secondary function and why?”
    - Zach
        - Worked on a typhoon project
        - Priorities are different in different cultures
        - Analyze the priorities of other countries
        - Some resources are not valuable for them
        - Focus on their concerns
            - Leadership
            - Common people
        - Study their infrastructure and their day to day cultures
    - Meghan
        - Analyze how they warn tourists
        - How they would personally do it
            - Communicate with areas that work with tourists
                - Hotels
                - Transportation
            - Educate them without scaring them
        - They could buy trailers that could be pre-staged instead of warehouses
        - Must make sure to warn the locals because they could be personally prepared
    - Mike
        - Suggested to check out ready.gov
        - Easier than making something from scratch - in reference to the trailers
        - Point of distribution (POD) - warehouse
            - Do not want it to be shelter
            - Do not want other people to put something in their warehouse
            - Can talk to partners to store stuff
                - schools
            - Leave it up to sponsor and community what other uses they want for the warehouse
                - Could talk to locals
                - Consider asking for shelters for animals
12. “How do you educate and prepare people who might be involved in an emergency?”
    - Partially answered in question 8
        - Public education
        - Know the different types of communities
            - E.g. people that don't speak English sometimes don't trust the government
        - Picking out most vulnerable populations and figure out how to reach them
        - Community outreach

    - Exercising different emergency response plans
13. “Is there anyone else you recommend we should interview or contact?”
    - Christopher Rae, can see interview details in Appendix H
14. “Is there any other information you have that may help us with our project?”
    - N/A - not enough time to ask

**End**

15. “Thank you for allowing us to interview you.”
16. “Do we still have your permission to use your name?” or “Do you still want to remain anonymous?”
    - Can use names

**After the Interview**

17. Follow up email the day after to thank them and ask any questions that were unanswered
18. Possibly ask for another interview or ask if she can respond to emailed questions

## 2. Interview Protocol and Interview Notes for Ronald Bashista

**Ronald Bashista is the emergency preparedness director of WPI. Below is the protocol we followed.**

**In Advance to the Interview**

1. Ask for permissions and consent
    - “Do we have your permission to voice record and transcribe the interview? We will be taking notes during the interview in either case.”
        - No
2. Ask about accommodations
    - “Would you like to see the list of questions before the interview?”
        - Yes
3. Determine location, day, and time for the interview
    - November 25, 2019

**Before Starting**

4. Introduce ourselves
5. Thank him for allowing us to interview him
6. Permissions before we start

- "Any information you give us may be used in our report. If you have any sensitive information that you are not allowed to share, you are not required to tell us. Just let us know when we ask the question."
- "Do you give us permission to use your name in our report, which would be available to the public, or would you like to remain anonymous? We will also ask you this again after the interview in case you change your mind."
    - Yes

7. Introduction

    - Background of the National Emergency project and how the interviewee will help us with understanding typical emergency prevention, protocols, and response

**Questions**

8. "Can you give us a little background on who you are and how you became involved in emergency response and your current position as the Emergency Preparedness Director of WPI?"

    - Military service, emergency manager for the city of Boston, now is the emergency preparedness director of WPI

9. "What do you do on a daily basis that relates to emergency protocols?"

    - Introduces four steps of emergency management
        - Preparation, mitigation, response, recovery
        - Mitigation and recovery are the two that are more significant

10. "Can you give us more detail on the plans you have in place in the case of natural disasters/emergencies?"

    - Ask follow-up questions about things that aren't clear in the steps
    - Plans in place in case of emergencies
        - WPI's Emergency Preparedness Manual available near exits on campus

11. "In terms of prevention and response, what protocols didn't work in the past and why didn't they work?"

    - "What protocols did work and why did they work?"
    - Good practices and examples
        - Analyzing both known threats and non-apparent threats
        - Evacuation and a "shelter and place"
            - Can move people to shelters or can have them stay in their homes
            - Build schools and community centers with the intention to have it be a shelter for emergencies
        - Having mass shelter plans
        - Having a point of distribution
            - Food, medical supplies, etc.
        - Having a motivation to get people to follow the plan

        - Snowstorms - city of Boston able to get people to stay out of the roads because of enforcement of fines
        - Watertown manhunt, Boston marathon bombing - city of Boston able to get people to stay inside and shut down businesses because people were well informed that the "threat was real"
        - Florida during hurricanes - people are always evacuating, cars are always lined up on the roads prior to its landfall because they were used to hurricanes and knew how serious it can be
    - Having multiple methods for communication and having multiple set plans in place
        - Social media, notices on people's doors
        - WPI - notification texts, calls, RAVE alert
    - Having face to face communication during emergencies
        - If not possible, video teleconference
    - Effectively educating the public
        - WPI - not possible to fully educate everyone, WPI's preparedness manual is in every room but students are not required to read it, more training is only given to facilities, staff, and people who will be around for a while
- Bad practices and examples
    - Not communicating how bad the threat was
        - Hurricane Sandy - Manhattan tried to evacuate people but few listened
            - Why - never had to evacuate before, people didn't believe the threat was serious, Manhattan is densely populated
            - Need to be shown what to do every step of the way
    - Not having a mass shelter plan
        - Hurricane Katrina - New Orleans' "superdome nightmare", shelter had no sanitation, medical care, or place to sleep, some people died
- Favorite quote
    - "Plans are nothing, planning is everything" -Eisenhower

12. "Can you describe examples of past emergencies that you or your colleagues had to deal with and tell us what went well and what were the main challenges?"
    - Covered in #11
13. "How do you educate and prepare people who might be involved in an emergency?"
    - N/A already described in #10 and covered in good practices in #11
14. "How does the government respond and cooperate with WPI?"
    - Did not ask
15. "For a town in a mountainous area like Monteverde, what characteristics do you think makes a good prevention and response plan?"
    - Did not ask

16. “Is there any other information you have that may help us with our project?”
    - Annexes
        - Communication
        - Hazard - fire dept, police, etc.
        - Support - evacuation plans, etc.
17. “Is there anyone else you recommend we should interview or contact?”
    - Meghan Gomes, see Appendix H.1 for interview
        - Director of Worcester Emergency Management
        - Manager of the local emergency planning council/committee

**End**

18. “Thank you for allowing us to interview you.”
19. “Do we still have your permission to use your name?” or “Do you still want to remain anonymous?”
    - Can use name

**After the Interview**

20. Follow up email the day after to thank them and ask any questions that were unanswered
21. Possibly ask for another interview or ask if he can respond to emailed questions

## 3. Interview Protocol and Interview Notes for Christopher Rae

**Christopher Rae is the Disaster Program Manager for the Red Cross in Worcester, MA. Below is the protocol we followed.**

**In Advance of the Interview**

1. Determine location, day, and time for the interview
    - December 5, 2019

**Before Starting**

2. Introduce ourselves
3. Thank them for the interview
4. Permissions before we start
    - “Do you give us permission to use your name in our report, which would be available to the public, or would you like to remain anonymous? We will also ask you this again after the interview in case you change your mind.”

    - Yes, but wants to make it clear that it is on the basis of his own experience, not the Red Cross
- "Do we have your permission to voice record and transcribe the interview? We will be taking notes during the interview in either case."
    - N/A, did not voice record
- "Any other information you give us may be used in our report. If you have any sensitive information that you are not allowed to share, you are not required to tell us. Just let us know when we ask the question."

5. Introduction
    - Background of the National Emergency project and how the interviewee will help us with understanding typical emergency prevention, protocols, response, and best practices regarding the Red Cross

**Questions**

6. "Can you give us a brief background on how you became involved in emergency management and your current position as the Disaster Program Manager of the Red Cross?"
    - Professional relations in emergency disasters
    - "Sphere project" for each sector
        - Global humanitarian movement
        - Target populations
    - Nowadays have to get a college degree for emergency management
    - Has international disaster experiences
    - Has managerial capabilities
    - Does domestic, local counseling
7. "Can you give us an overview of the plans the Red Cross has in the case of natural disasters and emergencies?"
    - Architecture
        - International Council of Red Cross - established from Geneva case
        - International Federation of the Red Cross – governing body
            - Independence
            - Neutrality
            - Unity
            - Universal
            - Voluntary
            - Impartial – will provide aid based on need alone
            - Humanity
        - Usually do local, but on large scales, will get help from IFRC
            - Surge capacity
            - Sustained – grant making, government liaising
            - Money and budget
    - Example with floods
        - Assess need - key informants (municipal, peers), impact zone, logistics, infrastructure, population

        - Ex. health more important the schools
    - Design program, response plan
    - Coordinating bodies and agencies need to convene
- Need capabilities and assets from CNE
    - Who's going to do what
- If no one on staff, need to look at other partners
    - Importance of communication and connections
- Worcester Management Director Meghan Gomes analogous to the CNE
    - Focus on drills, practices, and workshops
    - CNE may not have enough drills
    - Need to know who to call
    - Who can deploy during different periods of time

8. "Using past examples of disasters you had to deal with, what went well and why?"
    - "What didn't go so well and why?"
    - Philippines affected by tropical storms
        - Comparable to CNE
        - Need to consider
            - Hazards, people, infrastructures, municipal evacuation shelters
            - Social, governing, evacuating infrastructures
            - Good communication system
        - Typhoon Haiyan in 2013
        - He traveled to the Philippines a few days after
            - No American emergency presence or contacts in country
            - Wanted to look for opportunities for how to help and develop presence
        - Went with logistician and social science demographic person to assess the people's need
        - Typhoon was powerful but not big (~25 miles across)
        - Huge impact on local economy
        - Pushed water in passageway between two islands
        - 10,000 people lost lives
        - Homes damaged, need to rebuild them
        - Industries needed to feed families need to recover
        - Humanitarian response turned to recovery (longer term)
        - Person with business connections can be useful
            - Economic side of disaster response
            - Textiles to replace sewing machines
            - But still need to take time for things to grow back
        - There is a need for recapitalization, sourcing materials, having a shelter in place
        - Important question to answer in these cases: How do we restart the community?
        - 15 years for refugee camps

        - In Middle East, the third largest city of Jordan have a lot of refugees
            - Safety concerns associated
            - Became a district in the city
        - Settlement and refugee camps
            - Might not have people move back to original location
            - Often permanent solutions
            - Some populations are "so at risk" that they cannot go back
        - Juliette Kayyem - Red Cross board member
            - Evacuate human habitat
        - Black Stone Canal under Worcester (Water Street near Kelley Square)
            - Part collapsed
            - Need to look at settlement patterns
    - "Build back better"
        - Abaco does not want to rebuild houses, political implications

9. "We know that there are four phases of emergency management: preparedness, mitigation, response, and recovery. What are some good practices for each phase and why (what should we keep in mind when trying to improve emergency plans)?"
    - Understand the hazards
    - Analyze and evaluate exposure and risks
        - Geography and population, minority groups
            - Tailor accordingly
        - Infrastructure
        - Governance, if there will be enough staff members
        - What to do with people and children
    - Consider the framework and timeline
    - Put mitigation plans in place
        - Radios, communications
        - Command center
        - Moving vehicles for higher ground
    - "What didn't work and why?"
        - Did not cover
    - "For a town in a mountainous region like Monteverde, what characteristics do you think makes a good preparedness and mitigation plan?"
        - Did not ask
10. "How does the Red Cross communicate between countries?"
    - Communicate for the mobilization of resources
    - Winter, ice storm, damage to infrastructure
    - Need sustained response and recovery
    - Need to have a plan
    - Ask state first, then FEMA (local, then national)
        - Send request to IFRC for additional support outside the country

- Example with tectonic plate that moves every 300 years in Washington/Vancouver area

11. "We heard from Meghan Gomes that you've been abroad for your work. Have you ever been to Costa Rica?"
    - "How are the operations of the Red Cross there similar and how are they different?"
    - "How have they dealt with the storage of supplies?"
    - N/A, has not been to Costa Rica
12. "In general, for the Red Cross, how are warehouses and/or supply storage locations organized to be used in an emergency?"
    - Shelter trailers, local stores for frontline resources
    - Then call down to larger storage places
    - Need to manage points of importance - "choke points"
        - Airports
    - Managing NGOs
    - Assess infrastructure and exposure
    - Example with traveling through 50 bridges in Nepal
        - Will be choked off from supply transport if one bridge goes down
    - Restricted infrastructure can limit response plan
13. "What makes a good warehouse and why?"
    - Congregate shelter
    - Having stock on hand and prepositioned
    - BBR – building a better response
    - Architecture has to be useful
    - Predetermined people and governing bodies for communication for accessing and storing supplies
    - "Do you think it's better to build a new warehouse, or use a community space (e.g. schools, churches, hospitals) for storing supplies?"
        - "We were thinking about designing a warehouse with a secondary function for the community. The primary function would be for emergency uses. What recommendations do you have for a secondary function and why?"
        - Did not think having a secondary purpose for warehouses is a good idea
14. "How do you educate and prepare people who might be involved in an emergency?"
    - Did not ask
15. "Is there any other information you have that may help us with our project?"
    - Covered the importance of community relationships
        - Colleges, churches, etc.
    - How to find distribution of risks
        - Example with principle hazard as house fires
            - Obvious risk - triple deckers
            - Not so obvious risk involves demographics – older people without housing renovations
        - Abaco, Bahamas case

        - Places are not structurally good, undocumented immigrants
        - Did not want to rebuild due to political considerations
        - Should be based on need only not political reasons
        - Be aware that municipal may have different implications
        - Hurricane Harvey and Florence were unexpected
    - Solicit relations with parties
        - UN OCHA, USAID
        - Need to understand the architecture of humanitarian community to better understand emergency management
16. "Is there anyone else you recommend we should interview or contact?"
    - Recommends contact people from before (him and Meghan)
        - After having a better scope of project

**End**

17. "Thank you for allowing us to interview you."
18. "Do we still have your permission to use your name?" or "Do you still want to remain anonymous?"
    - Can use name but do not refer to Red Cross for where the info comes from

**After the Interview**

19. Follow up email the day after to thank them and ask any questions that were unanswered
20. Possibly ask for another interview or ask if he can respond to emailed questions

# Appendix I: Warehouse Supply Sheet Manual

The warehouse supply sheet is a list of supplies that we think need to be stored for the inhabitants for Monte Verde. They are categorized to provide better insight on what types of items we think are important. Item names that are in blue cells represent items that we believe could be reasonably provided by the people themselves in emergency situations. The sheet is very customizable in order to help with the decision process of what items to have as well as how many of each item to have. There are many columns with different data in them which will be explained in this list:

- Real quantity
  - The quantity of the item rounded up to the nearest 1
  - This is necessary for items that can sustain multiple people and come out with a remainder
- Ideal quantity
  - The quantity of the item needed without being rounded
    - For items that are either Per person or Per day, this number is calculated
    - For items that neither of these are true for, the number must be input and likely has some math in the Notes column
- Cost per item
  - The cost for each unit of the item which is linked in the Source column
- Real cost
  - The total cost for all the items of that type using the Real quantity
- Ideal cost
  - The total cost for all the items of that type using the Ideal quantity
- Include?
  - 1 for include, 0 for not include
    - Example: if one does not want to include an item in the total cost or volume for testing purposes, one could make the column for that item 0
  - Helps with cutting costs and exploring different possibilities
  - Certain items in blue cells are items we believe could be reasonably excluded due to people bringing them
- Per person?
  - 1 for per person, 0 for not per person
    - Example: a generator would not be a per person item, so it would have a 0 in this column to prevent scaling with the number of people
- Per day?
  - 1 for per day, 0 for not per day
    - Example: emergency lanterns are not used up every day even though they probably want to be scaled with the number of people, so that column would be set to 0 because they are not expended every day
- Cost (per person) (per day)

    - Different depending on the Per person and Per day columns
        - If an item has both the Per person and Per day columns as 0, this column would simply be the total cost of all of the units of that item
        - If the Per person column is 1 and the Per day column is 0, then it is simply the cost per person for that item, and similar in cases where only the Per day column is 1
        - In the case where both columns are 1, this column is the cost per person per day
- Use percentage
    - Used in cases where one wants to scale an item with people or days but only by a fraction
        - Example: if one wanted to have emergency lanterns but only one for each family, one could set this column to something like .25 so that only every 1 in 4 people get one
- Item dimensions
    - The dimensions of the item in inches
- Volume per item
    - The volume of the item in inches cubed
- Total volume per item
    - The total volume of all of the units of the item in inches cubed
    - Note that at the bottom of the spreadsheet there are total volume calculations for all of the items in both inches cubed and meters cubed
- Notes
    - Normally contains calculations for how much of an item is needed per person, per day, or both
    - Can also contain other requirements for the item
- Source
    - The link to the website where we got the cost, dimensions, and other information for the items from

In addition to these columns, there are total calculations at the bottoms of the Real cost, Ideal cost, and Total volume columns.

At the bottom of the supply list in the sheet, there are a few fields that can be changed in order to customize the needs for the warehouse. These fields are:

| | | |
|---|---|---|
| 62 | **People** | 750 |
| 63 | **Cats** | 800 |
| 64 | **Dogs** | 100 |
| 65 | **Days** | 4 |

- People
  - The number of people that need to be sustained with these supplies
- Cats
  - The number of cats that need to be sustained with these supplies
- Dogs
  - The number of dogs that need to be sustained with these supplies
- Days
  - The number of days that these supplies need to last for

One can change these values manually to explore different scenarios for cost and for volume, but there is a helpful tool to let you explore the different possibilities with their costs and volumes automatically. One constraint to this explorer is it only changed the number of days and people. One could run this explorer after changing some of the column values to quickly explore different people and day scenarios. The cat and dog values also must be changed automatically.

**Cost Explorer**

The cost explorer has some of its own variables that can be changed. These variables are:

| | |
|---|---|
| **People Inc** | 50 |
| **People Factor** | 15 |
| **Max Days** | 4 |

- People Inc
  - The number of people to be incremented by the explorer
- People Factor
  - The max number to be multiplied by the increment
    - Example: if the increment is 50 and the factor is 5, then the population numbers explored would be 50, 100, 150, 200, and 250
- Max Days
  - The max number of days to be explored
  - The explorer only explores days in increments of 1 because of how low the max number is likely to be

Under this set of cells is a very important cell that should not be edited. **EDITING THIS CELL WILL BREAK THE COST EXPLORER**. The explorer uses this cell to know which rows to take data from and where to clear and print the data it creates. If that exact phrase in that cell is

added anywhere else in the spreadsheet, the entire spreadsheet could be deleted if the cost explorer is run. A picture of this cell is provided below:


The explorer can be run by clicking on the Tools menu, and then the Script editor option. After you have loaded the new tab, click on the select function tab and choose explore costs. After this, click on the play button to run the code. This will start to change the values in the spreadsheet automatically and get the costs and values for each combination of days and people. While this is happening, do not change any cells or the resulting tables will be inaccurate. Depending on the range of possibilities being explored, the program should take between 30 seconds to 3 minutes to run. Once completed there will be two tables under the days field for the costs and volumes. The data cells will be color coded by cost or volume. The largest values will be red and the smallest values blue. The whole range is red, orange, yellow, green, and blue. An example image is provided below.

| Cost: People\Days | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 50 | 7274.8892 | 7605.1584 | 7939.9276 | 8319.9568 | 8692.766 | 9026.6452 | 9419.6744 | 9741.4436 |
| 100 | 10948.5492 | 11498.6784 | 12086.6976 | 12682.8268 | 13270.996 | 13829.4752 | 14505.2944 | 15062.5536 |
| 150 | 14660.6992 | 15464.0784 | 16276.9276 | 17088.1868 | 17942.606 | 18754.5652 | 19604.8344 | 20361.5936 |
| 200 | 18377.5292 | 19397.0084 | 20424.9876 | 21539.3968 | 22560.246 | 23579.7252 | 24703.8544 | 25730.6936 |
| 250 | 22127.7192 | 23362.5584 | 24656.7876 | 25937.6268 | 27223.586 | 28504.8152 | 29798.6544 | 31029.7336 |
| 300 | 25804.9892 | 27264.4284 | 28812.1376 | 30300.4968 | 31848.206 | 33307.6452 | 34892.7744 | 36350.8436 |
| 350 | 29574.7792 | 31317.0084 | 33039.1676 | 34801.3868 | 36518.806 | 38269.5352 | 40041.3044 | 41745.4136 |
| 400 | 33239.9392 | 35217.6584 | 37139.3176 | 39171.6168 | 41093.276 | 43070.9952 | 45088.8044 | 47024.9536 |
| 450 | 36998.7092 | 39193.0084 | 41386.8276 | 43569.8468 | 45815.266 | 47996.0852 | 50192.1044 | 52377.9036 |
| 500 | 40706.9592 | 43117.3584 | 45565.8776 | 47972.1268 | 50432.906 | 52843.3052 | 55324.2644 | 57684.5136 |

# Appendix J: Example Analysis on Water Supplies for 125 people (4 People per Family)

**Each choice by itself provides enough water to sustain a population of 125.**

*For Homes*

- $2233.28 for 5 gallon water jugs (each family gets one jug per day)
- $416 for tap filter (each family gets one, enough for a week)
- $640 for pitcher with filter (each family gets one, enough for a week)
- $984.20 for purification tablets (8 tablets per person per day, 2 tablets needed per quart)

*For Shelters*

- $1744.75 for water jugs
- $117 for tap filter
- $140 for 2 pitchers with filters
- $984.20 for purification tablets (8 tablets per person per day, 2 tablets needed per quart)

Tap filters for shelters highlighted in yellow are the best choice in terms of cost. However, we recommend having supplies for both places, as some people stay at shelters and others stay home.

During Tropical Storm Nate, 13 out of the 25 locals we surveyed stated that they did not evacuate and 12 did evacuate. So we recommend providing water to about 50% of the population in shelters and 50% of the population in their homes.

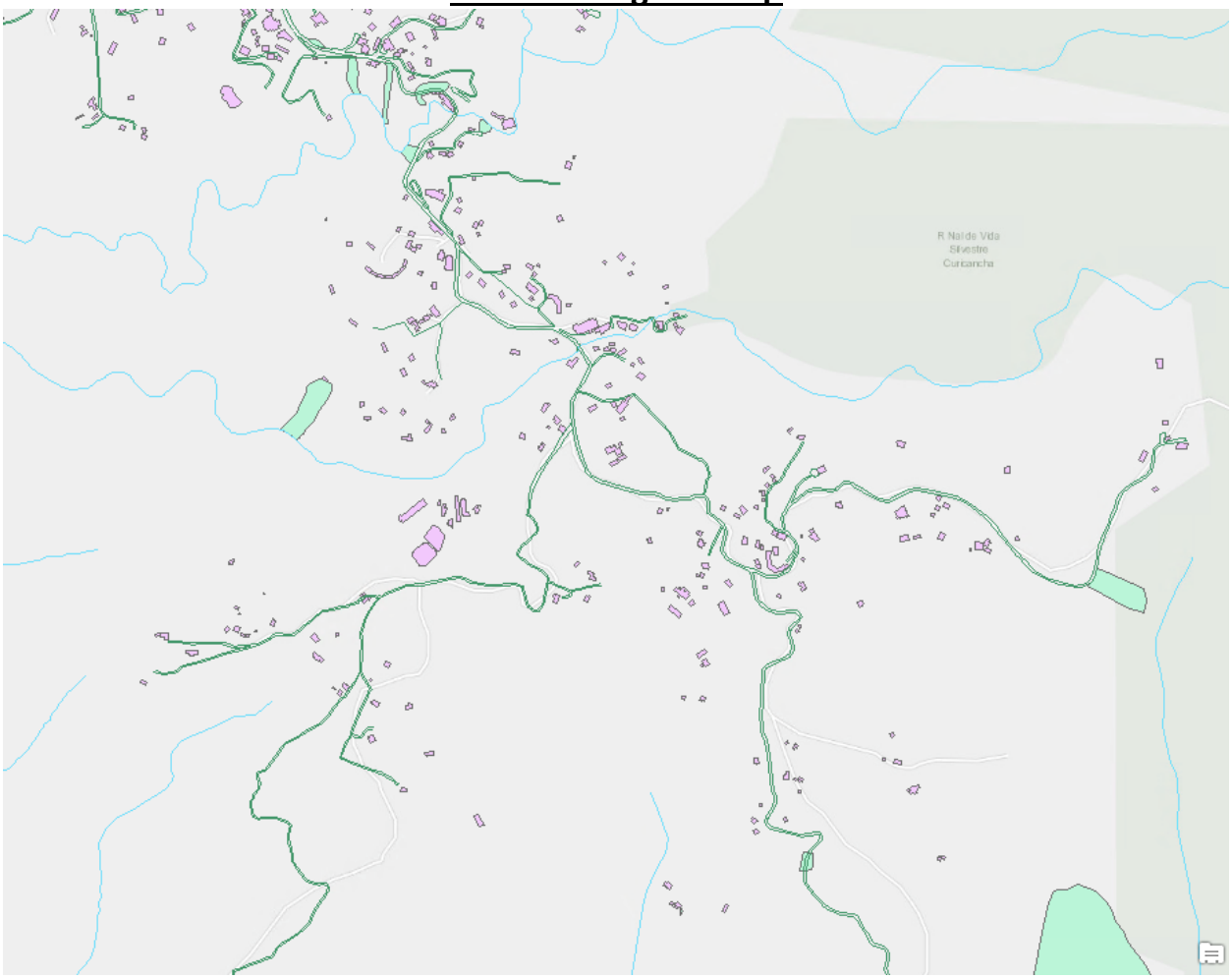
For shelters, using a combination of water jugs and tap filters is the best option. However, we recommend that warehouses do not store the water jugs themselves. Water jugs need to be switched out to maintain their quality, and to reduce maintenance costs, we instead recommend that shelters get their supply of water during times of emergencies from the donations of organizations, hotels, and restaurants that already have a stock of water jugs. Tap filters, on the other hand, can be stored indefinitely, so they are the best to stock in warehouses. As for the other options, the pitchers with filters are not needed, as the tap filter covers the need for filtered water. Purification tablets are difficult to split and distribute, and they are expensive, so they are not recommended. Water jugs do cost more, but since we recommend getting water jugs from donations and from pre-existing stock, it does not have to be budgeted.

For homes, tap filters are also the best option. It is more expensive than for shelters because each family gets one, which would last them for longer than a weeks' worth of time. Since we are recommending the same thing to stock in warehouses for shelters and homes, we recommend getting the number of tap filters needed to give every family one ($416). Some families would end up in the shelter, not needing their tap filter, so these extras would be for the shelters.

So to summarize, we recommend getting enough tap filters to provide each family one, which is highlighted in green.

# Appendix K: Important Layers of the ArcGIS Map

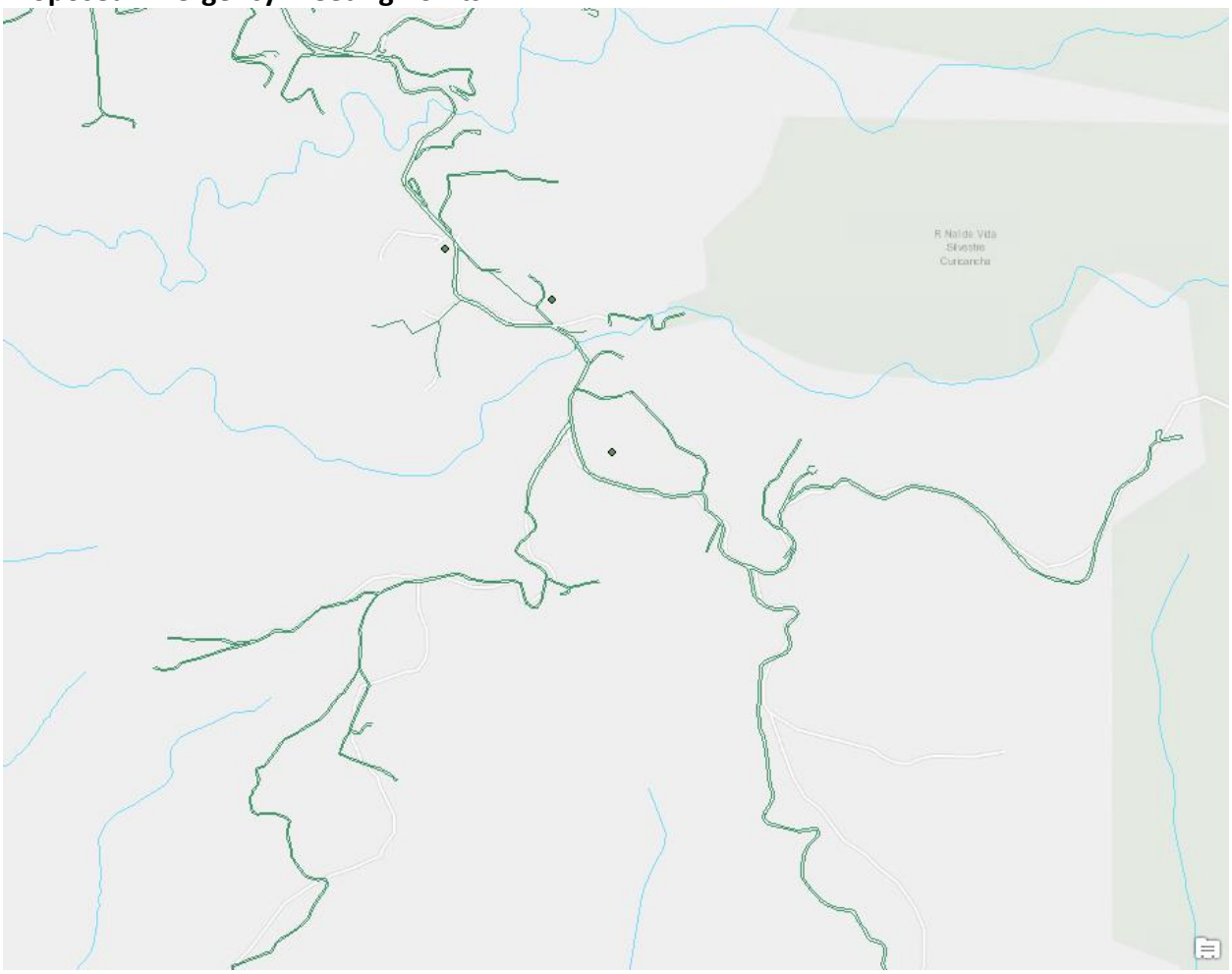
**Geiner's Original Map**




- Roads: green lines
- Rivers: blue lines
- Infrastructure: shaded purple areas
- Landslide risks: shaded green areas

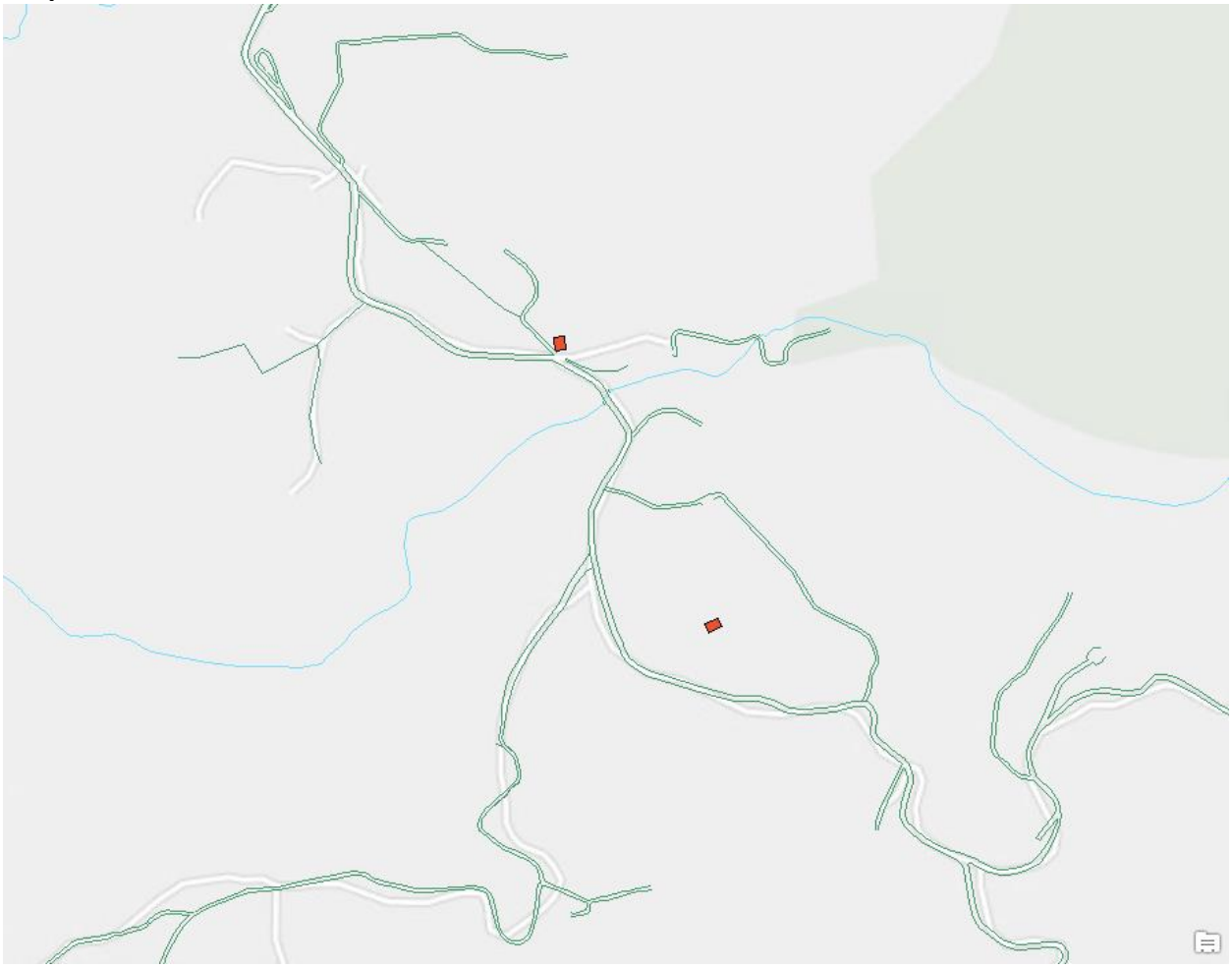
# Added Layers

**Proposed Emergency Meeting Points**



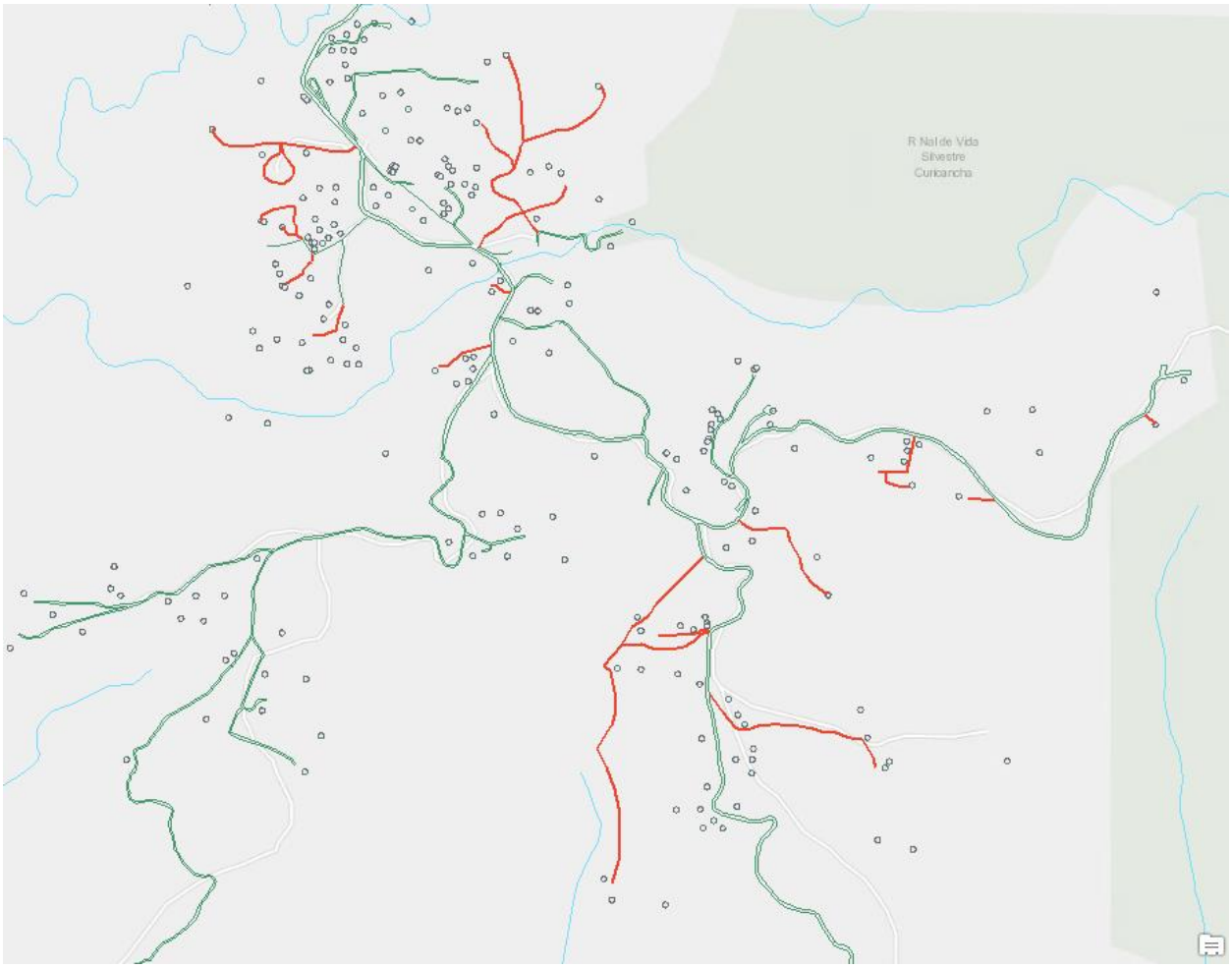
- Three green circles/dots
- Located at Casem, the Monteverde Institute, and the Friends School

**Proposed Warehouse Sites**



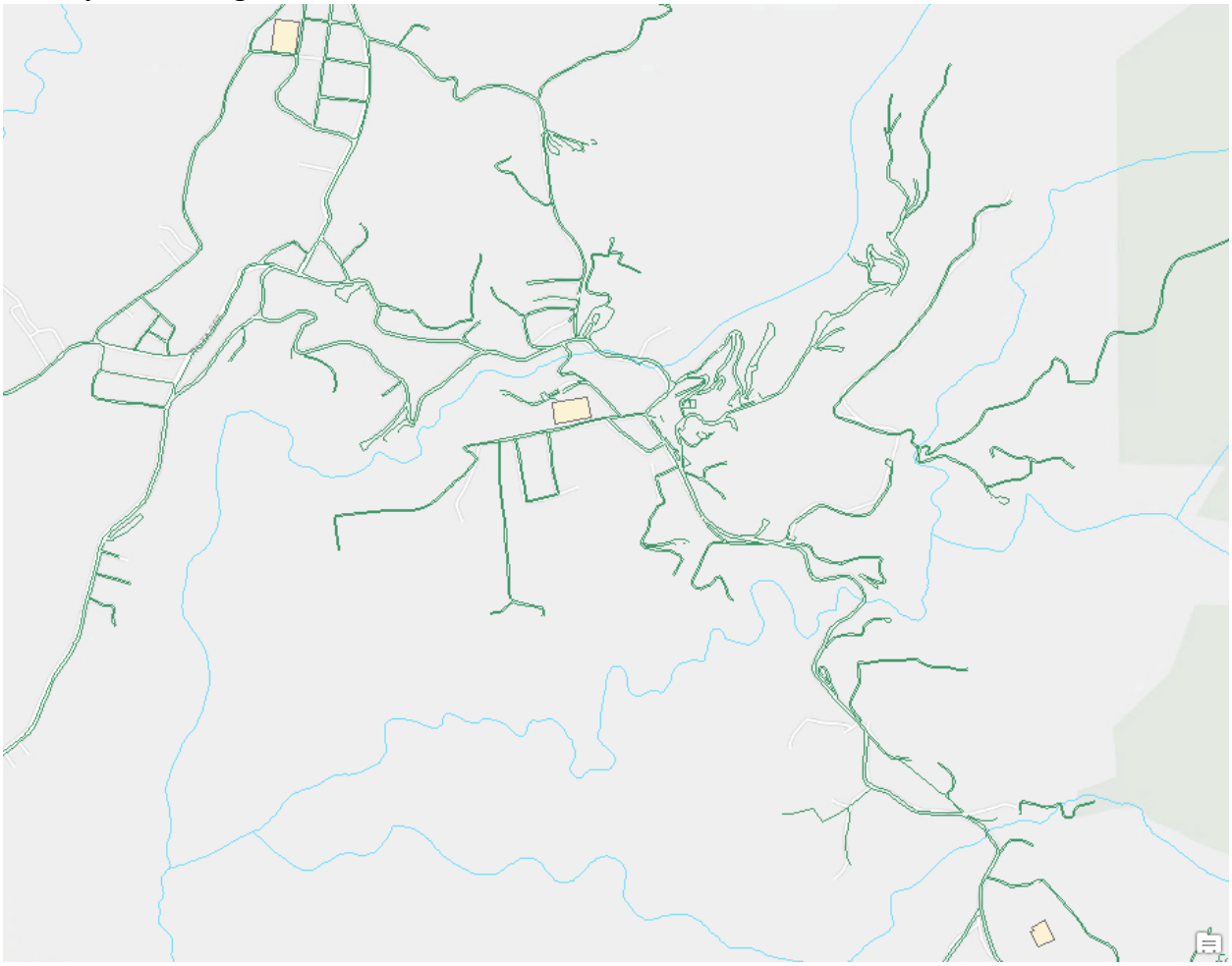
- Two red rectangles
- Located at the Monteverde Institute and the Friends School

**Local Houses and Private Roads**




- Local Houses: light blue circles/dots; adapted from the Health Clinic's Map, in collaboration with Geiner, Jorge, and Alexander
- Private Roads: red lines; in collaboration with Geiner and Jorge

**Helicopter Landing Zones**



- Three yellow rectangles
- Located in the soccer field in Santa Elena, the bullfighting arena in Cerro Plano, and the soccer field in the Friends School

# Appendix L: Emergency Protocol Information

Below is the information included in the mobile application. It includes descriptions of various disasters and their risks, as well as how to prepare and how to react to them.

**Risks**

- **Landslides**
  - What is it?
    - Landslides are a collection of fast-moving mud and debris flowing rapidly through an area. It starts off as a bunch of loose soil that becomes disturbed by wind or rain, and gravity starts to make it go faster. It can quickly gain a lot of force and will start picking up large branches, loose pavement, trees, and buildings.
  - What to do
    If there is a tropical storm/heavy rain or an earthquake occurs, please follow these instructions:
    - Resident
      - Evacuate if
        - The CNE announces a Red Alert
        - You live in a high risk area and you hear there is a high possibility of: a tropical storm, earthquake.
        - Do Not Forget Your Pets! If you have time, make sure they are safe as well.
      - Where to evacuate?
        - If there is a Red Alert or the police force has asked you to evacuate, go to the Monteverde Institute or the Friends School depending on your area
        - If there has not been an official order of evacuation, stay in the home of a friend or family member who is outside the area of risk.
      - If you have not evacuated:
        - Pay close attention to what is happening in the news and social media. Some of the best methods for staying informed are:
          - TV
          - Facebook
          - Radio
          - WhatsApp
        - Have your things ready to evacuate, some of the things you should consider include in your bag are:
          - Important documents
          - Phones and phone chargers

                - Granola bars and other food
                - Flashlights
                - Portable radio
                - Money
                - Medicine
        - Visitor
            - Avoid areas of risk, which you can view on the landslide risk map in the previous page.
            - If you are a homestay, pay close attention to your family's and institution's instructions.
            - If you are in a hotel:
                - Pay close attention to what staff members in the hotels you are staying at are saying
            - If you are staying in an Airbnb, talk to your landowner
                - Ask them if they have an emergency plan
                - If they say no, tell the landowner that there is an emergency plan in place and that they should look into it
    - How to prepare

      Even if there are currently no signs that this disaster might happen, it is important to lower the risks, therefore, please read through our recommendations for how to be prepared:
        - Resident
            - Check if you live in an area of risk
                - Be familiar with the level of risk in your area. You can view a landslide risk map in the previous page.
            - Stay informed with the status of storms and other natural disasters, as well as the change in levels of risk through the news and social media. Some of the best methods for staying informed are:
                - TV
                - Facebook
                - Radio
                - WhatsApp
            - Have a preparedness kit - here are some of our recommendations for its contents
                - Emergency Heat Blankets
                - Portable Radio
                - Batteries
                - Flashlight/Candles/Matches
                - Multitool
                - Solar Panel Phone Charger
            - Make sure you know where the following are:
                - Important Documents
                - Emergency Contacts

        - Visitor
            - If you are a homestay, show your family the “How to Prepare” section for residents.
            - If you are staying in a hotel, make sure you pay attention to any information given to you by the staff.
            - If you are staying in an Airbnb, talk to your landowner
                - Ask them if they have an emergency plan
                - If they say no, tell the landowner that there is an emergency plan in place and that they should look into it

- **Flash Floods**
    - What is it?
        - Flash floods are caused by a lot of water building up in an area that has loose soil. When enough water builds up in the area, the soil comes loose and all the water floods the lower areas at once.
    - What to do

      If you live close to a river and there have been heavy rains (or normal rain that lasts for more than six hours) please follow these instructions:
        - Resident
            - Stay informed
                - Stay informed with the status of storms and other natural disasters, as well as the change in levels of risk through the news and social media. Some of the best methods for staying informed are:
                    - TV
                    - Facebook
                    - Radio
                    - WhatsApp
            - Have your things ready to evacuate, some of the things you should consider including in your bag are:
                - Important documents
                - Phones and phone chargers
                - Granola bars and other food
                - Flashlights
                - Portable radio
                - Money
            - Turn off the electricity of your home
            - Disconnect all appliances
            - Evacuation
                - If there is an official evacuation order, go to the Monteverde Institute or the Friends School depending on your area

        - If there has not been an official order of evacuation, stay in the home of a friend or family member who is outside the area of risk
    - REMEMBER…
        - Avoid getting in the water at all costs.
        - If you have to cross water, make sure it is not moving and shallow, use a stick to check the depth and be careful not to slip
        - Avoid fallen power lines, especially the water touching them, to prevent electrocution
        - If you get swept away,
            - Always go over obstacles and never go under
            - Floating backwards (facing upstream) slightly on your back will help you push debris flowing downstream towards you
            - Point your feet downstream once you get a good grip on something and yell for help
    - After the emergency
        - Do not return to your home until the police says it is safe.
        - If you smell gas or hear a hissing noise, evacuate immediately and call the firefighters
        - Throw away any type of food that might have gotten in contact with water
- Visitor
    - If you are a homestay, pay close attention to your family's and institution's instructions.
    - If you live in a hotel, pay close attention to what staff members in the hotels you are staying at are saying
    - If you live in an Airbnb that is close to a river, call your landowner and ask them if there is an emergency plan in place.
        - If they say no, tell the landowner that there is an emergency plan in place and that they should look into it
    - REMEMBER…
        - Avoid getting in the water at all costs.
        - If you have to cross water, make sure it is not moving and shallow, use a stick to check the depth and be careful not to slip
        - Avoid fallen power lines, especially the water touching them, to prevent electrocution
        - If you get swept away,
            - Always go over obstacles and never go under
            - Floating backwards (facing upstream) slightly on your back will help you push debris flowing downstream towards you

        - Point your feet downstream once you get a good grip on something and yell for help
    - How to prepare
      Even if there are currently no signs that this disaster might happen, it is important to lower the risks, therefore, please read through our recommendations for how to be prepared:
        - Resident
            - Stay informed
                - Stay informed with the status of storms and other natural disasters, as well as the change in levels of risk through the news and social media. Some of the best methods for staying informed are:
                    - TV
                    - Facebook
                    - Radio
                    - WhatsApp
            - Have a preparedness kit - here are some of our recommendations
                - Emergency Heat Blankets
                - Portable Radio
                - Batteries
                - Flashlight/Candles/Matches
                - Multitool
                - Solar Panel Phone Charger
            - Make sure you know where the following are:
                - Important Documents
                - Emergency Contacts
        - Visitor
            - If you are a homestay, show your family the “How to Prepare” section for residents..
            - If you are staying in a hotel, make sure you pay attention to any information given to you by the staff.
            - If you are staying in an Airbnb, talk to your landowner
                - Ask them if they have an emergency plan
                - If they say no, tell the landowner that there is an emergency plan in place and that they should look into it

- **Fires**
    - What is it?
        - With global temperatures rising, there are more and more opportunities for dry weather and high temperatures to create forest fires. These forest fires lead to the rapid destruction of large areas
    - What to do
      If you see black smoke or detect an intense burning smell, you should immediately take action
        - Resident

- If the fire is small
    - If it is an electric fire (caused by cables or some other sort of electricity) you can use baking soda to attempt to put it out.
    - Never use water, there is a high possibility if being electrocuted
    - If it is a fire caused while cooking, turn everything off and try to put a metal lid on the pan being used.
        - You can also use a thick, inflammable blanket to try to put out the fire
- If the fire is big
    - NEVER GET IN THE SHOWER
        - During fires, the plumbing melts and prohibits water from flowing
        - Evacuation should always be your priority
    - Evacuate immediately with your family to an area far away from trees and other combustible structures
    - Once you have evacuated, call the firefighters: 2645-7512

- Visitor
    - If the fire is small
        - If it is an electric fire (caused by cables or some other sort of electricity) you can use baking soda to attempt to put it out.
        - Never use water, there is a high possibility if being electrocuted
        - If it is a fire caused while cooking, turn everything off and try to put a metal lid on the pan being used.
            - You can also use a thick, inflammable blanket to try to turn the fire off
    - If the fire is big
        - NEVER GET IN THE SHOWER
            - During fires, the plumbing melts and prohibits water from flowing
            - Evacuation should always be your priority
        - Evacuate immediately with your family to an area far away from trees and other combustible structures
        - Once you have evacuated, if possible let your hosts know, call the firefighters : (506) 2645-7512

- How to prepare

  Every second counts during a fire, in order to reduce the risks you could face in case of an emergency, please read our following recommendations:

    - Resident
        - Keep doorways clear - allow for quick evacuation

- Talk to your family members, particularly children about fire safety and the steps they should follow during these emergencies.
- Save the firefighter's number on your phone for quick access: (506) 2645-7512
- Practice safe cooking habits

▪ Visitor

- Keep doorways clear - allow for quick evacuation
- Talk to your family members, particularly children about fire safety and the steps they should follow during these emergencies.
- Save the firefighter's number on your phone for quick access: (506) 2645-7512
- If you are a homestay, show your family the "How to Prepare" section for residents..
- If you are staying in a hotel, make sure you pay attention to any information given to you by the staff.
- If you are staying in an Airbnb, talk to your landowner
  - Ask them if they have an emergency plan
  - If they say no, tell the landowner that there is an emergency plan in place and that they should look into it

**Natural Disasters**

- **Tropical Storms**
  - What is it?
    - Tropical storms are storms that are formed over tropical seas due to different temperatures in the atmosphere. They are extremely powerful and can cause landslides and flash floods due to their high winds and heavy rains.
  - What to do

    If you hear there might be the possibility of a tropical storm in your area, please follow these steps:
    - Resident
      - Evacuate if
        - The CNE announces a Red Alert
        - You live in a high risk area and you hear there is a high possibility of: a tropical storm. You are in a high risk area if your house is very close to a river or you are inside a landslide risk area
        - Do Not Forget Your Pets! If you have time, make sure they are safe as well.
      - Where to evacuate?
        - If there is a Red Alert or the police force has asked you to evacuate, go to the Monteverde Institute or the Friends School depending on your area

        - If there has not been an official order of evacuation, stay in the home of a friend or family member who is outside the area of risk.
    - If you have not evacuated:
        - Pay close attention to what is happening in the news and social media. Some of the best methods for staying informed are:
            - TV
            - Facebook
            - Radio
            - WhatsApp
        - Have your things ready to evacuate, some of the things you should consider include in your bag are:
            - Important documents
            - Phones and phone chargers
            - Granola bars and other food
            - Flashlights
            - Portable radio
            - Money
            - Medicine
- Visitor
    - Avoid areas of risk, which you can view under Risks -> Landslides
    - If you are a homestay, pay close attention to your family's and institution's instructions.
    - If you are in a hotel:
        - Pay close attention to what staff members in the hotels you are staying at are saying
    - If you are staying in an Airbnb, talk to your landowner
        - Ask them if they have an emergency plan
        - If they say no, tell the landowner that there is an emergency plan in place and that they should look into it

- How to prepare

  Even if there are currently no signs that this disaster might happen, it is important to lower the risks, therefore, please read through our recommendations for how to be prepared:
    - Resident
        - Check if you live in an area of risk
            - Be familiar with the level of risk in your area. You can view a landslide risk map under Risks -> Landslides
        - Stay informed
            - Stay informed with the status of storms and other natural disasters, as well as the change in levels of risk through the news and social media. Some of the best methods for staying informed are:

        - TV
        - Facebook
        - Radio
        - WhatsApp
    - Have a preparedness kit - here are some of our recommendations
        - Emergency Heat Blankets
        - Portable Radio
        - Batteries
        - Flashlight/Candles/Matches
        - Multitool
        - Solar Panel Phone Charger
    - Have additional storage of:
        - Food and Water
            - Have additional canned food
            - Extra water - Fun Fact: people need to drink around 3.8 liters of water every day.
        - Medicine - if possible have extra medicine
            - Have a First-Aid Kit
        - If you have pets
            - If possible have back-up food and medication if applicable
            - When calculating your water rations, take your pets into account!
    - Make sure you know where the following are:
        - Important Documents
        - Emergency Contacts
- Visitor
    - If you are a homestay, show your family the “How to Prepare” section for residents.
    - If you are staying in a hotel, make sure you pay attention to any information given to you by the staff.
    - If you are staying in an Airbnb, talk to your landowner
        - Ask them if they have an emergency plan
        - If they say no, tell the landowner that there is an emergency plan in place and that they should look into it

- **Volcanic Activity**
    - What is it?
        - The closest volcano to Monteverde is the Arenal Volcano. While its eruption would not have direct effects on Monteverde, the volcano’s ashes do have a high probability of reaching the region and they come with several risks. The highest risks are respiratory issues and damage to agriculture.

- James - maybe a map of all the volcanoes and close they are to Monteverde? Since i am pretty sure everyone knows what a volcanic eruption is

- What to do

  If you hear that a volcano in Costa Rica has erupted, follow these instructions:
  - Resident
    - Pay close attention to what is happening in the news and social media. Some of the best methods for staying informed are:
      - TV
      - Facebook
      - Radio
      - WhatsApp
    - If you hear there is a chance ashes will reach Monteverde, do the following:
      - Close all doors and windows in your home.
      - Turn off heaters, air conditioners, and driers.
      - Avoid driving - the ashes can hurt your car's motor
        - If possible protect cars by covering them up or parking them inside.
      - If you have pets or cattle
        - Make sure they are all inside your home, barn, or some other type of shelter.
        - The ashes will cover the sun and thus have a high chance of damaging grass and agriculture. Therefore, it is heavily recommended that you have a reserve of food for your cattle.
        - Examine your water reserve and make sure it is as filled up as possible.
      - Evacuate if
        - The CNE announces a Red Alert
        - Do Not Forget Your Pets! If you have time, make sure they are safe as well.
      - Where to evacuate?
        - If there is a Red Alert or the police force has asked you to evacuate, go to the Monteverde Institute or the Friends School depending on your area
      - If you venture outside:
        - Wear a filtering mask (N-95), or hold a wet rag to your mouth
        - Use protection glasses, or just wear any sort of glasses
        - Wear long sleeved shirts, sweaters, and pants
      - In order to clean up, here are some tips:

                - You can clean ashes by damping a cloth in water and sliding the ashes into a trash bag.
                - Make sure to wear protection while doing this so ash doesn't damage your eyes or lungs.
        - Visitor
            - Close all doors and windows in your home.
            - Turn off heaters, air conditioners, and driers.
            - If you venture outside:
                - While it is heavily recommended that you avoid going outside while the air is contaminated, we understand there are some cases where it is unavoidable:
                    - Wear a filtering mask (N-95)
                        - If you do not own a filtering mask, damp a cloth and put it over your mouth (water helps filter)
                    - Use protection glasses
                        - if you do not own protection glasses, try to wear other types of glasses that cover your eyes as much as possible
                    - Long sleeved shirts and sweaters
                    - Long sleeved pants
            - Cleaning up
                - You can clean ashes by damping a cloth in water and sliding the ashes into a trash bag.
                - Make sure to wear protection while doing this.
            - If you are a homestay, pay close attention to your family's and institution's instructions.
            - If you are in a hotel:
                - Pay close attention to what staff members in the hotels you are staying at are saying
            - If you are staying in an Airbnb, talk to your landowner
                - Ask them if they have an emergency plan
                - If they say no, tell the landowner that there is an emergency plan in place and that they should look into it
- How to prepare

  Even if there are currently no signs that this disaster might happen, it is important to lower the risks, therefore, please read through our recommendations for how to be prepared:
    - Resident
        - Stay informed
            - Stay informed with the status of natural disasters, as well as the change in levels of risk through the news and social media. Some of the best methods for staying informed are:

        - TV
        - Facebook
        - Radio
        - WhatsApp
    - Have a preparedness kit - here are some of our recommendations
        - Emergency Heat Blankets
        - Portable Radio
        - Batteries
        - Flashlight/Candles/Matches
        - Multitool
        - Solar Panel Phone Charger
    - Have additional storage of:
        - Food and Water
            - Have additional canned food
            - Extra water - Fun Fact: people need to drink around 3.8 liters of water every day.
        - Medicine - if possible have extra medicine
            - Have a First-Aid Kit
        - If you have pets
            - If possible have back-up food and medication if applicable
            - When calculating your water rations, take your pets into account!
    - Make sure you know where the following are:
        - Important Documents
        - Emergency Contacts
- Visitor
    - If you are a homestay, show your family the “How to Prepare” section for residents.
    - If you are staying in a hotel, make sure you pay attention to any information given to you by the staff.
    - If you are staying in an Airbnb, talk to your landowner
        - Ask them if they have an emergency plan
        - If they say no, tell the landowner that there is an emergency plan in place and that they should look into it

- **Earthquakes**
    - What is it?
        - Earthquakes are caused by plates in the Earth’s crust moving. Earthquakes occur multiple times per year in Monteverde, and they can lead to landslides and falling objects
    - What to do

      If you experience an earthquake, please follow these instructions:

- Resident
    - If possible stay inside - the structures in Monteverde are designed with earthquakes in mind, and there is a higher risk in the outside due to falling trees and debris.
    - Cover your head and neck with your arms and try to move to a table or other kind of furniture that can protect you from falling objects - try to stay away from shelves and chandeliers.
    - If you are unable to find a table, get close to a wall with no windows or shelves.
    - If you are in bed, cover your head and neck with your pillow.
    - If you are outside
        - Cover your head and neck with your arms and move to an area that is as open as possible.
        - There is a high probability for trees, rocks, and other debris in the mountains to become loose during earthquakes so make sure you watch out for that.
    - If you are in a car, stay inside and try to move to an open area.
    - After the earthquake
        - Evacuate your building if it was heavily damaged during the earthquake
        - Watch out for secondary waves, which can happen soon after an earthquake
- Visitor
    - If possible stay inside - the structures in Monteverde are designed with earthquakes in mind, and there is a higher risk in the outside due to falling trees and debris.
    - Cover your head and neck with your arms and try to move to a table or other kind of furniture that can protect you from falling objects - try to stay away from shelves and chandeliers.
    - If you are unable to find a table, get close to a wall with no windows or shelves.
    - If you are in bed, cover your head and neck with your pillow.
    - If you are outside
        - Cover your head and neck with your arms and move to an area that is as open as possible.
        - There is a high probability for trees, rocks, and other debris in the mountains to become loose during earthquakes so make sure you watch out for that.
    - If you are in a car, stay inside and try to move to an open area.
    - After the earthquake
        - Evacuate your building if it was heavily damaged during the earthquake
        - Watch out for secondary waves, which can happen soon after an earthquake

- How to prepare
  Even if there are currently no signs that this disaster might happen, it is important to lower the risks, therefore, please read through our recommendations for how to be prepared:
  - Resident
    - Stay informed
      - Stay informed with the status of natural disasters, as well as the change in levels of risk through the news and social media. Some of the best methods for staying informed are:
        - TV
        - Facebook
        - Radio
        - WhatsApp
    - When organizing shelves, put heavier objects at the bottom
    - If possible, try to tie or nail heavy objects (TVs, fridges, and shelves) to the wall.
  - Visitor
    - If you are a homestay, show your family the “How to Prepare” section for residents.
    - If you are staying in a hotel, make sure you pay attention to any information given to you by the staff.
    - If you are staying in an Airbnb, talk to your landowner
      - Ask them if they have an emergency plan
      - If they say no, tell the landowner that there is an emergency plan in place and that they should look into it

# Appendix M: Infographics

Below are our six types of infographic in both English and Spanish.

## Landslides

Due to Monteverde's mountainous region, tropical storms and earthquakes tend to cause landslides. These can be extremely dangerous, and our goal with this infographic was to spread awareness on the areas of risk.

We have two versions of the Landslides infographic, one showcases a map with the landslide risk areas in Cerro Plano and the other for Monte Verde. Other areas, such as Santa Elena, were not included since there were not recorded risk zones for them.

The following pages display these Landslide infographics in English and Spanish.

Designer: Alejandra Garza

**Landslides - Cerro Plano (English)**

# Landslides

## Map of Cerro Plano

areas of risk

## How to Prepare?

### 1 Do you live in an area of risk?

Stay informed on the risk level of your area.

### 2 Evacuate if....

The CNE announces a red alert

You hear there is the high posibility of a(n):

Tropical Storm

Earthquake

### 3 Where to evacuate?

If there is a red alert or the police has asked you to evacuate, please go to the Monteverde Institute or School of Friends.

If there has not been an official evacuation order...

Stay in the home of a friend or family member that is outside the area of risk.

### 4 If you have no evacuated...

Stay informed on the status of disasters through the news and social media.

TV

Have your things ready to evacuate quickly if needed.

### If you do not have water...

Call ASADA to report what is happening: 2645-5502

Ask if they need volunteers

**Emergency Numbers: 911 Firefighters: 2645-7512 Police: 2545-7074**

**Landslides - Cerro Plano (Spanish)**

# Deslizamientos

## Mapa de Cerro Plano
zonas de riesgo

## ¿Cómo prepararse?

### 1 ¿Vive en una zona de riesgo?

Manténgase informado acerca del nivel de riesgo de su zona.

### 2 Evacue si....

La CNE anuncia una alerta roja

Escucha que hay una alta posibilidad de un(a):

Tormenta Tropical

Terremoto

### 3 ¿Hacia dónde evacuar?

Si hay una alerta roja o una orden de evacuación, vaya al Instituto o a la Escuela de Amigos

Si no ha habido una orden oficial de evacuacion...

Quédese en la casa de un amigo o familiar qué esté afuera de las zonas de riesgo.

### 4 Si no ha Evacuado...

Manténganse atento de lo que esta pasando en las redes sociales y noticias.

TV

Tenga sus cosas listas y esté prepardo para evacuar rápido.

### Si no tiene agua...

Llame a ASADA para reportar: 2645-5502

Pregunte si necesitan voluntarios.

**Números de Emergencia: 911 Bomberos: 2645-7512 Policía: 2545-7074**

**Landslides - Monte Verde (English)**

# Landslides

## Map of Monte Verde

areas of risk

## How to Prepare?

### 1 Do you live in an area of risk?

Stay informed on the risk level of your area.

### 2 Evacuate if....

The CNE announces a red alert

You hear there is the high posibility of a(n):

Tropical Storm

Earthquake

### 3 Where to evacuate?

If there is a red alert or the police has asked you to evacuate, please go to the Monteverde Institute or School of Friends.

If there has not been an official evacuation order...

Stay in the home of a friend or family member that is outside the area of risk.

### 4 If you have no evacuated...

Stay informed on the status of disasters through the news and social media.

TV

Have your things ready to evacuate quickly if needed.

### If you do not have water...

Call ASADA to report what is happening: 2645-5502

Ask if they need volunteers

**Emergency Numbers:** 911 **Firefighters:** 2645-7512 **Police:** 2545-7074

**Landslides - Monte Verde (Spanish)**

# Deslizamientos

## Mapa de Monte Verde
zonas de riesgo

## ¿Cómo prepararse?

### 1 ¿Vive en una zona de riesgo?

Manténgase informado acerca del nivel de riesgo de su zona.

### 2 Evacue si....

La CNE anuncia una alerta roja

Escucha que hay una alta posibilidad de un(a):

Tormenta Tropical

Terremoto

### 3 ¿Hacia dónde evacuar?

Si hay una alerta roja o una orden de evacuación, vaya al Instituto o a la Escuela de Amigos

Si no ha habido una orden oficial de evacuacion...

Quédese en la casa de un amigo o familiar qué esté afuera de las zonas de riesgo.

### 4 Si no ha Evacuado...

Manténganse atento de lo que esta pasando en las redes sociales y noticias.

TV

Tenga sus cosas listas y esté prepardo para evacuar rápido.

### Si no tiene agua...

Llame a ASADA para reportar: 2645-5502

Pregunte si necesitan voluntarios.

**Números de Emergencia: 911 Bomberos: 2645-7512 Policía: 2545-7074**

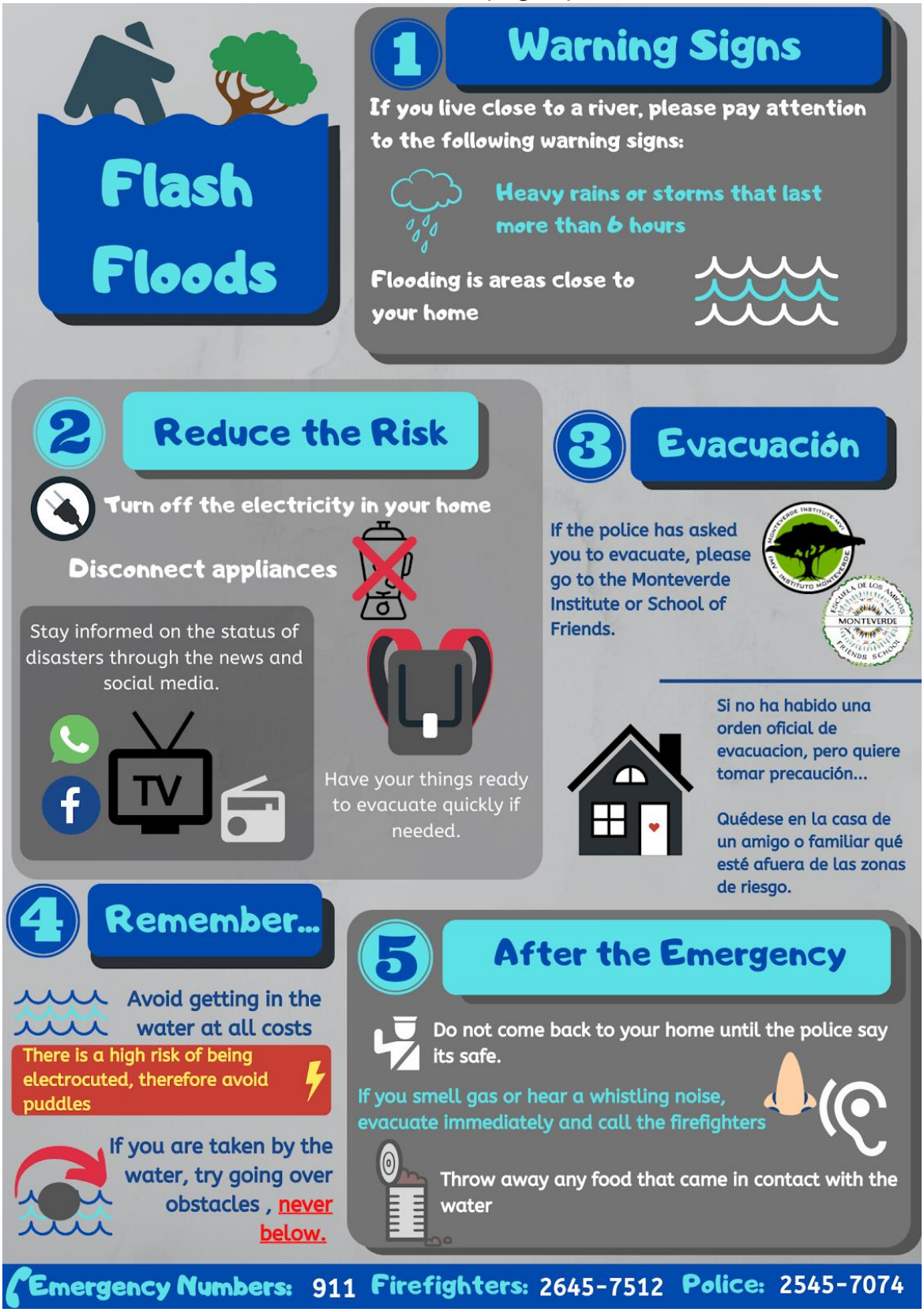
## Flash Floods

Similar to landslides, Monteverde's mountainous region allows tropical storms and earthquakes to cause flash floods (caused by a lot of water building up in an area that has loose soil). When enough water builds up in the area, the soil comes loose, and all the water floods the lower areas at once. Flash floods have cost people their homes, and we therefore want to encourage residents to be cautious, especially during natural disasters.

The following pages show our flash floods infographics in English and Spanish.

Designer: Alejandra Garza

**Flash Floods (English)**



**Flash Flood (Spanish)**

## Tremors and Earthquakes

Costa Rica constantly experiences minor tremors throughout the year; however, most are not usually noticed by residents. Yet major earthquakes have had negative impacts on the areas, and our goal with this infographic was to inform Monte Verde's residents on how they should react in one of these cases.

The following pages show our Tremors and Earthquakes infographics in English and Spanish.

Designer: Nancy Nguyen

**Tremors and Earthquakes (English)**

# Tremors and Earthquakes

## What to do before, during, and after

### 1. Prevention & Mitigation

- ✓ Put heavy or fragile objects on the lowest shelf.
- ✓ Secure furniture to the wall or the floor.

### 2. If you are inside...

- ✓ It is better to stay inside. There are more risks outside with...
- ✓ Cover your head and neck with your arms and crouch.
- ✓ Move towards a table to protect yourself from falling objects (be careful of tables that can break).
- If there are no tables, move towards a wall, away from windows.
- If you are in bed, turn around and cover your head and neck with your pillow.

### 3. If you are outside...

- ✓ Cover your head and neck with your arms and crouch.
- ✓ Move to an open area, away from objects that can fall.
- If you are in a car, stay inside and move away from objects that can fall.

### 4. After...

- ✓ Get out of damaged buildings immediately.
- ✓ Be careful of any aftershocks.
- ✓ Be careful of unstable infrastructure.
- ✓ Contact authorities for help if needed.

### If you are trapped...

- ✓ Protect your nose, mouth, and eyes with a piece of cloth.
- ✓ Tap on a tube or wall to let people know where you are.

Emergency Number: 911 | Police: 2645-7074 | Firefighters: 2645-7512 | ASADA (Water Service): 2645-5502

**Tremors and Earthquakes (Spanish)**

# Temblores y Terremotos

## ¿CÓMO PREPARARSE?

### 1. PREVENCIÓN Y MITIGACIÓN

- ✓ Ponga objetos pesados o frágiles en el nivel más abajo del estante.
- ✓ Asegure los muebles a la pared o al piso.

### 2. SI ESTÁ ADENTRO...

- ✓ Es mejor que se quede adentro. Hay más riesgos afuera con...
- ✓ Cúbrase la cabeza y el cuello con los brazos y agáchese.
- ✓ Muévase cerca de una mesa para protegerse de la caída de objetos (tenga cuidado, la mesa puede romperse).
- ▪ Si hay no mesas, muévase cerca de una pared, lejos de ventanas.
- ▪ Si está en la cama, cúbrase la cabeza y el cuello con su almohada.

### 3. SI ESTÁ AFUERA...

- ✓ Cúbrase la cabeza y el cuello con los brazos y agáchese.
- ✓ Muévase a un área abierta, lejos de objetos que le pueden caer.
- ▪ Si está en un carro, quédese adentro, lejos de objetos que le pueden caer.

### 4. DESPUÉS...

- ✓ Muévase afuera de edificios dañados inmediatamente.
- ✓ Tenga cuidado de los temblores secundarios.
- ✓ Tenga cuidado de las estructuras inestables.
- ✓ Contacte a las autoridades para ayuda si es necesario.

### SI ESTÁ ATRAPADO...

- ✓ Protéjase la nariz, la boca y los ojos con la ropa.
- ✓ Haga ruido golpeando una tubería o pared.

**Números de Emergencias:** 911 | **Policía:** 2645-7074 | **Bomberos:** 2645-7512 | **ASADA (Agua):** 2645-5502

## Fires

Fires are currently not very common in Monte Verde: most are small and easily handled. However, after speaking with various members of the community, we have learned that the dry season in Monteverde is becoming longer and drier. As we have mentioned throughout the report, Monte Verde's resident's approach towards disaster preparedness consists of reacting to emergencies that have already happened in the area. However, in an attempt to become more proactive and adopt an approach that focuses on prevention/mitigation, Maricella suggested to begin educating Monte Verde's residents about fires before a major one occurs. Furthermore, she wanted us to help tackle a very common and dangerous myth in Costa Rica: "if there is a home fire you should get in the shower begin." This myth has cost countless lives in Costa Rica, and one of our goals with this infographic was to dispute it.

The following pages show our Fires infographics in English and Spanish.

Designer: Alejandra Garza

Fires (English)

Fires (Spanish)

# Incendios

## 1 ¿Cómo Identifícalos?

Si huele o ve humo...

Durante un incendio, las tuberías se derriten, esto impide el flujo del agua y aumenta el peligro.

## 2 Evacue

Evacue immediatamente con su familia a un área lejos de árboles y estructuras combustibles

No olvide a sus mascotas

Nunca se meta en una regadera, evacuar siempre debe de ser su prioridad

## Si es un incendio pequeño...

Si es un incendio eléctrico, puede usar bicarbonato de sodio para apagarlo

Nunca use agua, hay una alta posibilidad de electrocutarse

Si empieza un incendio mientras está cocinando, cubra la sartén o la olla con una tapa de metal. Asegúrese de apagar todo primero.

## 3 Llame a los Bomberos

Llame a los bomberos para reportar su situación: 2645-7512

Número de Emergencias: 911

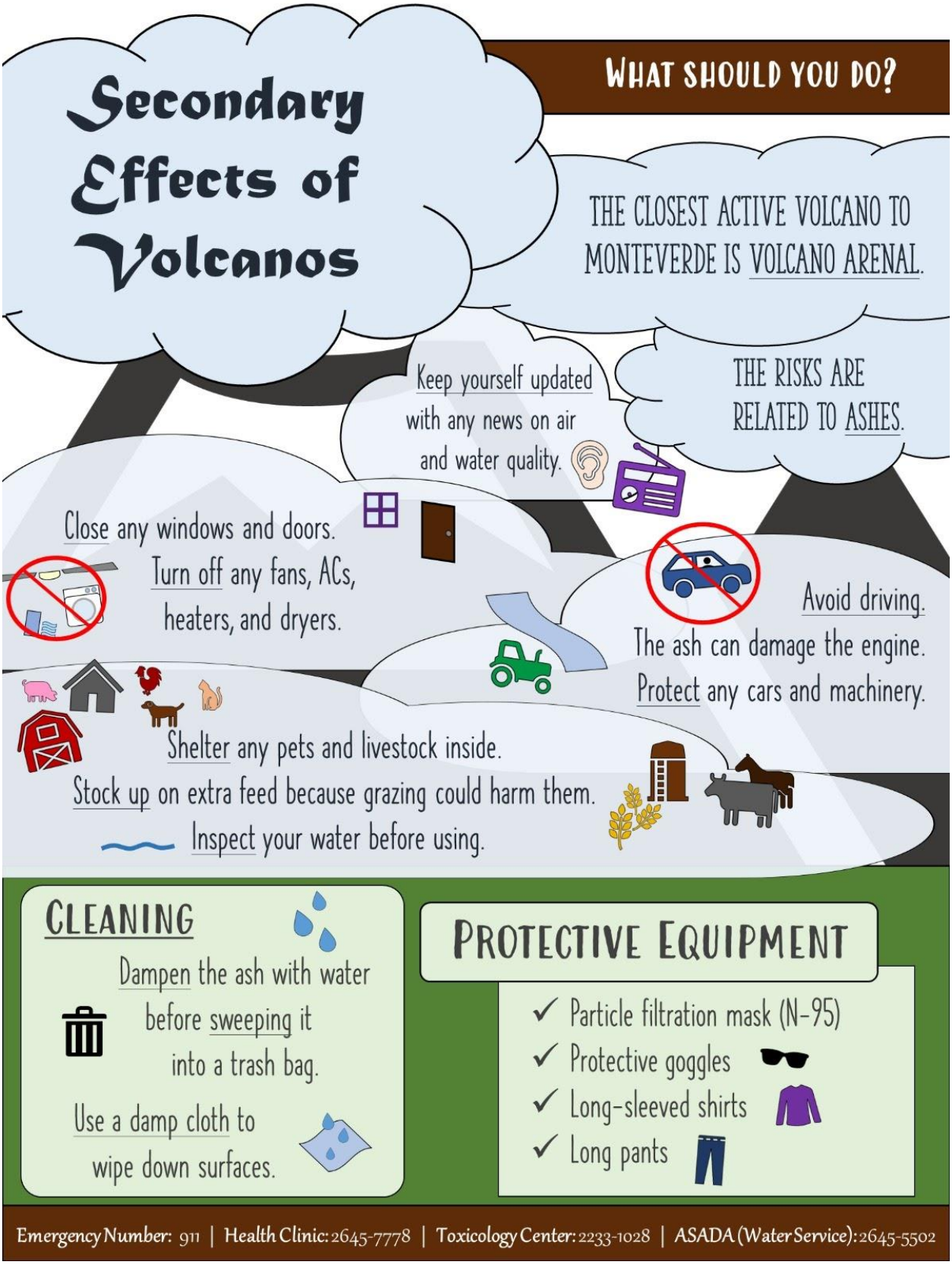
## Secondary Effects from Volcanic Activity

While no volcano in Costa Rica can have a direct effect on Monteverde, there are secondary effects that can occur due to the ashes. Our goal with this infographic was to bring awareness to yet another disaster that, although not very common, is very likely to occur.

The following pages show our Secondary Effects from Volcanic Activity infographics in English and Spanish.

Designer: Nancy Nguyen

**Secondary Effects from Volcanic Activity (English)**



**Secondary Effects from Volcanic Activity (Spanish)**

## 5.4 Emergency Protocol

Our last infographic does not relate to a natural disaster or risk, instead our goal was to educate Monte Verde's residents on what provisions they should have during emergencies. While our warehouses would hold most of these provisions, we want to encourage residents to have them to reduce the warehouse's size. This would allow the community to maintain more people in case of isolation.

The following pages show our Emergency Supplies infographic in English and Spanish.

Designer: Nancy Nguyen

**Emergency Supplies (English)**

**Emergency Supplies (Spanish)**

# Appendix N: App Translation Info

Below is a table of all of the information in the app and its translations. The Spanish and French needs to be refined, and the German is incomplete.

*Table N.1: Table of Translations for the App*

| English | Spanish | French | German |
|---|---|---|---|
| Emergency Numbers | Números de Emergencias | Les coordonnées | Kontaktdaten |
| Change Language | Cambiar Idioma | Changez de langue | Sprache ändern |
| What region are you from? | Escoja su Región | De quelle région êtes-vous? | Aus welcher Region kommen Sie? |
| Not sure | No Ahora | Pas certain | unsicher / nicht klar |
| Risks | Riesgos | Les risques | Risiken |
| Natural Disasters | Desastres Naturales | Les Catastrophes Naturelles | Naturkatastrophen |
| Landslide | Deslizamientos | Les glissement de terre | Erdrutsch |
| Flash flood | Cabeza de Agua | La inondation | Flutwasser |
| Fire | Incendio | Le feu | Feuer |
| Tropical storm | Tormenta Tropical | La tempête tropical | Tropensturm |
| Earthquake | Terremoto/ Temblor | Le tremblement de terre | Erdbeben |
| Secondary Effects from Volcanic Activity | Efectos Secundarios de Volcanes | Effets secondaire d'activité volcanique | Sekundäreffekte vulkanischer Aktivität |
| Change Location | Cambiar Region | Changez de lieu | |
| What is it | ¿ Que Es? | Qu'est-ce que c'est | |
| What To Do | Que hacer | Que faites-vous en cas d'urgence? | |
| How To Prepare | Como preparar | Comment preparez-vous? | |

| | | | |
|---|---|---|---|
| Emergency | Emergencia | L'urgence | Notstand |
| Police | Policia | La police | Polizei |
| Fire fighters | Bomberos | Les sapeurs pompiers | Feuerwehr |
| Water service | ASADA | Le service d'eau | |
| Health Clinic | Clínica de Salud | La clinique de santé | |
| Center of Toxicology | Centro de Toxicología | Le centre de toxicologie | |
| Red Cross | Cruz roja | La croix rouge | Rotes Kreuz |
| CPI | Centro Panamericano de Idiomas | CPI | CPI |
| Friends School | Escuela de Amigos | L'école des amis | Friends School |
| Back | Atrás | Retournez | zurück |
| Choosing a location will allow you to get more specific information | Elegir una ubicación le permitirá obtener información más específica. | Choisir un emplacement va vous permettre d'obtenir plus d'information spécifique | |
| Are you sure? | ¿ Esta seguro? | Vous-êtes sûr? | Sind Sie sicher? |
| Resident | Residente | Resident | Einwohner |
| Visitor | Visitante | Visiteur | |
| Landslides are a collection of fast-moving mud and debris flowing rapidly through an area. It starts off as a bunch of loose soil that becomes disturbed by wind or rain, and gravity starts to make it go faster. It can quickly gain a lot of force and will start picking up large branches, loose pavement, trees, and buildings | Los deslizamientos de tierra son una colección de lodo y otros objetos que se mueven rápidamente a través de un área. Comienzan como un montón de tierra suelta que se ven perturbadas por el viento o la lluvia, y la gravedad comienza a hacerlo más rápido. Pueden ganar mucha fuerza rápidamente y comenzarán a recoger | Les glissements de terre sont une collection de boue et débris se déplaçant rapidement qui traversent rapidement par une zone. Le glissement de terre commence comme un tas de sol meuble qui devient perturbé par le vent ou la pluie, et la gravité commence à le faire tomber plus vite. Il peut gagner rapidement beaucoup de force et va commencer à ramasser | |

| | | | |
|---|---|---|---|
| | ramas grandes, pavimento suelto, árboles y edificios. | les branches, perdre la chaussée, les arbres et les bâtiments. | |
| If there is a tropical storm/heavy rain or an earthquake occurs, please follow these instructions | Si hay una tormenta tropical / lluvia intensa o se produce un terremoto, siga estas instrucciones | S'il y a une tempête tropical ou forte pluie ou un tremblement de terre, suivez ces instructions s'il vous plaît | |
| Evacuate if | Evacúe si | Evacuez-vous si | |
| The CNE announces a Red Alert | La CNE anuncia una Alerta Roja | Le CNE annonce une alerte rouge | |
| You live in a high risk area and you hear there is a high possibility of: a tropical storm, earthquake | Vive en un área de alto riesgo y escucha que hay una gran posibilidad de: tormenta tropical, terremoto | Vous vivez en une zone à haute risque et entende qu'il y a une possibilité de: tempête tropical, tremblement de terre | |
| Do Not Forget Your Pets! If you have time, make sure they are safe as well | ¡No olive a sus mascotas!<br>Si tiene tiempo, asegúrese de que también estén seguros | N'oubliez pas vos animaux de compagnies! Si vous avez de temps, assurez-vous qu'elles sont sûr aussi. | |
| Where to evacuate? | ¿Hacia donde evacuar? | A où évacuer? | |
| If there is a Red Alert or the police force has asked you to evacuate, go to the Monteverde Institute or the Friends School depending on your area | Si hay una alerta roja o la fuerza policial le ha pedido que evacue, vaya al Instituto Monteverde o la Escuela de Amigos, dependiendo en su área | S'il y a une alerte rouge ou la force de police vous a demandé d'évacuer, allez à l'Institut de Monteverde ou L'école d'Amis selon votre région | |
| If there has not been an official order of evacuation, stay in the home of a friend or family member who is outside the area of risk. | Si no ha habido una orden oficial de evacuación, quédese en la casa de un amigo o familiar que esté fuera del área de riesgo. | S'il n'y a pas eu une ordre officiel pour l'évacuation, restez au domicil d'un ami ou d'un membre de famille qui se trouve en dehors de la zone à risque. | |
| If you have not evacuated: | Si no ha evacuado: | Si vous n'avez pas évacué: | |

| | | | |
|---|---|---|---|
| Pay close attention to what is happening in the news and social media. Some of the best methods for staying informed are: | Preste mucha atención a lo que este sucediendo en las noticias y las redes sociales. Algunos de los mejores métodos para mantenerse informado son: | Faites attention à que-ce qui se passe en les nouvelles et les médiaux sociaux.Certaines de meilleurs méthodes pour rester informé sont: | |
| TV | | La télé | |
| Facebook | | Facebook | |
| Radio | | La radio | |
| WhatsApp | | WhatsApp | |
| Have your things ready to evacuate, some of the things you should consider include in your bag are: | Tenga sus cosas listas para evacuar, algunas de las cosas que debe considerar incluir son: | Ayez vos affaires prêtes à évacuer, certaines de choses que vous devriez considérer inclure dans votre sac sont: | |
| Important Documents | Documentos Importantes | Documents Importants | |
| Phones and phone chargers | Celulares y cargadores para celular | Téléphones et chargeurs de téléphone | |
| Granola bars and other food | Barras de granola y otros alimentos. | Barres granola et autres aliments | |
| Flashlights | Linternas | Lampes de poches | |
| Portable radio | Radio portable | Radio portable | |
| Money | Dinero | Argent | |
| Medicine | Medicina | Médicament | |
| Avoid areas of risk, which you can view on the landslide risk map in the previous page. | Evite las áreas de riesgo, que puede ver en el mapa de riesgo de deslizamientos en la página anterior. | Evitez les zones à risque, que vous pouvez voir sur la carte des risques de glissement de terre à la page précédente | |

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| If you are a homestay, pay close attention to your family's and institution's instructions. | Si usted es un homestay, preste mucha atención a las instrucciones de su familia e institución. | Si vous êtes un famille d'accueil, faites attention aux instructions de votre famille et l'institut. | |
| If you are in a hotel: | Si esta en un hotel: | Si vous séjournez en un hôtel | |
| Pay close attention to what staff members in the hotels you are staying at are saying | Preste mucha atención a lo que dicen los miembros del personal en su hoteles. | Faites attention à ce que les membres du personnel en les hôtels dans lesquels vous séjournez disent | |
| If you are staying in an Airbnb, talk to your landowner | Si esta un Airbnb, hable con tu propietario | Si vous séjournez en un Airbnb, parlez avec votre propriétaires | |
| Ask them if they have an emergency plan | Pregúntele si tiene un plan de emergencia. | Demandez-leur s'ils ont un plan d'urgence | |
| If they say no, tell the landowner that there is an emergency plan in place and that they should look into it | Si dicen que no, explique que hay un plan de emergencia y que deben investigarlo. | S'ils disent non, dites le propriétaires qu'il y a un plan d'urgence et qu'ils devraient examiner | |
| Even if there are currently no signs that this disaster might happen, it is important to lower the risks, therefore, please read through our recommendations for how to be prepared: | Incluso si actualmente no hay signos de que este desastre pueda ocurrir, es importante reducir los riesgos, por lo tanto, lea nuestras recomendaciones sobre cómo prepararse: | Même s'il n'y a actuellement aucun signe que cette catastrophe pourrait se produire, il est important de réduire les risques. Lisez-vous nos recommendations pour savoir comment préparer | |
| Check if you live in an area of risk | Verifique si vive en un área de riesgo | Vérifiez-vous si vous vivez dans une zone à risque | |
| Be familiar with the level of risk in your area. You can view a landslide risk map in the previous page. | Familiaricese con el nivel de riesgo en su área. Puede ver un mapa de riesgo de deslizamientos en la página anterior. | Familiarisez-vous avec le niveau de risque dans votre région. Vous pouvez consulter une carte des risques de glissement de terrain à la page précédente. | |

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| Stay informed with the status of storms and other natural disasters, as well as the change in levels of risk through the news and social media. Some of the best methods for staying informed are: | Manténgase informado sobre el estado de tormentas y otros desastres naturales a través de las noticias y las redes sociales. Algunos de los mejores métodos para mantenerse informado son: | Restez informé de l'état des tempêtes et autres catastrophes naturelles, ainsi que l'évolution des niveaux de risque via les actualités et les réseaux sociaux. Certaines de meilleurs méthode sont: | |
| Have a preparedness kit - here are some of our recommendations for its contents | Tenga un kit de preparación: estas son algunas de nuestras recomendaciones: | Ayez une trousse de préparation. Voici quelques-unes de nos recommandations: | |
| Emergency Heat Blankets | Mantas termicas de emergencia | Couverture chauffantes d'urgence | |
| Portable Radio | Radio Portable | Radio portables | |
| Batteries | Baterias | batteries | |
| Flashlight/Candles/Matches | Linternas / velas / fósforos | Lampe de poche/bougies/allumettes | |
| Multitool | Herramienta multiple | Outil multiple | |
| Solar Panel Phone Charger | Cargador solar para celular | Chargeur de téléphone à panneau solaire | |
| Make sure you know where the following are: | Asegúrese de saber dónde están los siguientes: | Assurez-vous de savoir où se trouvent les éléments suivants: | |
| Important Documents | Documentos Importantes | Documents importants | |
| Emergency Contacts | Contactos de Emergencia | Contacts d'urgence | |
| If you are staying in a hotel, make sure you pay attention to any information given to you by the staff. | Si está en un hotel, Preste mucha atención a lo que dicen los miembros del personal en su hoteles. | Si vous séjournez dans un hotel, assurez-vous de faire attention aux informations qui sont données par le personnel | |

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| Flash floods are caused by a lot of water building up in an area that has loose soil. When enough water builds up in the area, the soil comes loose and all the water floods the lower areas at once. | Las cabezas de agua son causadas por la acumulación de mucha agua en un área con tierra suelta. Cuando se acumula suficiente agua en el área, el suelo se suelta e inunda las áreas más bajas. | Les crues soudaines sont causées par une forte accumulation d'eau dans une zone où le sol est meuble. Quand il y a assez d'eau s'accumule dans la zone, le sol se décolle et tous l'eau inonde les zones inférieures à la fois. | |
| If you live close to a river and there have been heavy rains (or normal rain that lasts for more than six hours) please follow these instructions | Si vive cerca de un río y ha habido fuertes lluvias (o lluvias normales que duren más de seis horas), siga estas instrucciones | Si vous habitez près d'une rivière et qu'il y a eu de fortes pluies(ou une pluie normale qui dure plus de six heures), suivez ces instructions s'il vous plaît | |
| Turn off the electricity of your home | Corte la electricidad | Eteignez l'électricité | |
| Disconnect all appliances | Desconecte todos los electrodomésticos | Débranchez tous les appareils | |
| Evacuation | Evacuación | Evacuation | |
| If there is an official evacuation order, go to the Monteverde Institute or the Friends School depending on your area | Si hay una orden de evacuación oficial, vaya al Instituto Monteverde o la Escuela de Amigos, dependiendo de su área. | S'il y a un ordre d'évacuation officiel, allez à l'Institut Monteverde ou à l'Ecole des Amis selon votre région | |
| If there has not been an official order of evacuation, stay in the home of a friend or family member who is outside the area of risk | Si no ha habido una orden oficial de evacuación, quédese en la casa de un amigo o familiar que esté fuera del área de riesgo. | S'il n'y a pas eu d'ordre d'évacuation officiel, restez au domicile d'un ami ou d'un membre de la famille qui se trouve en dehors de la zone à risque | |
| REMEMBER | RECUERDE | RAPPELEZ-VOUS | |
| Avoid getting in the water at all costs. | Evite, a toda costa, entrar al agua | Evitez de vous mettre à l'eau à tout prix | |

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| If you have to cross water, make sure it is not moving and shallow, use a stick to check the depth and be careful not to slip | Si tiene que cruzar el agua, asegúrese de que no se esté moviendo y que sea poco profunda, use un palo para verificar la profundidad y tenga cuidado de no resbalar | Si vous devez traverser par l'eau, assurez-vous qu'elle ne bouge pas et peu profonde, utilisez un bâton pour vérifier la profondeur et faites attention de ne pas glisser | |
| Avoid fallen power lines, especially the water touching them, to prevent electrocution | Evite las líneas eléctricas caídas, especialmente el agua que las toca, para evitar la electrocución. | Evitez les lignes électrique tombées, en particulier l'eau qui les touche, pour éviter l'électrocution | |
| If you get swept away, | Si el agua lo arrastra | Si vous êtes emporté par l'eau | |
| Always go over obstacles and never go under | Trate de pasar por arriba de los obstáculos | Dépassez toujours les obstacles et ne passez jamais sous | |
| Floating backwards (facing upstream) slightly on your back will help you push debris flowing downstream towards you | Flotar hacia atrás (mirando hacia arriba) ligeramente sobre su espalda lo ayudará a empujar los escombros que fluyan hacia usted | Flottez vers l'arrière(face à l'amont) légèrement sur le dos vous aidera à pousser les débris qui coulent vers l'aval vers vous | |
| Point your feet downstream once you get a good grip on something and yell for help | Apunte sus pies hacia abajo,y ya que tenga un buen control sobre algo,grite por ayuda | Pointez vos pieds en aval quand vous maîtrisez quelque chose et hurlez à l'aide | |
| After the Emergency | Después de la Emergencia | Après d'urgence | |
| Do not return to your home until the police says it is safe. | No regrese a su casa hasta que la policía diga que es seguro | Ne rentrez pas chez vous tant que la police dit que c'était sûr. | |
| If you smell gas or hear a hissing noise, evacuate immediately and call the firefighters | Si huele gas o escucha un silbido, evacúe inmediatamente y llame a los bomberos | Si vous sentez du gaz ou entendez un sifflement, évacuez immédiatement et appelez les pompiers | |

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| Throw away any type of food that might have gotten in contact with water | Tire cualquier aliment que haya tenido contacto con el agua | Jetez tous le type de nourriture qui aurait pu entrer en contact avec l'eau | |
| With global temperatures rising, there are more and more opportunities for dry weather and high temperatures to create forest fires. These forest fires lead to the rapid destruction of large areas | Con el aumento global de las temperatura, hay más oportunidades para que el clima seco y las altas temperaturas generen incendios forestales. Estos incendios forestales pueden destruir áreas grandes rápidamente. | Avec l'augmentation des températures mondiales, il y a de plus en plus d'occasions pour le temps sec et les températures élevées de provoquer des incendies de forêt. Ces incendies de forêt entraînent la destruction rapide de vastes zones | |
| If you see black smoke or detect an intense burning smell, you should immediately take action | Si ve humo negro o detecta un olor intenso a quemado, debe tomar medidas de inmediato. | Si vous voyez un fumée noire ou détectez une odeur de brûlure intense, vous devez immédiatement prendre des mesures. | |
| If the fire is small | Si es un incendio pequeño | Si le feu est petit | |
| If it is an electric fire (caused by cables or some other sort of electricity) you can use baking soda to attempt to put it out. | Si es un incendio eléctrico, puede usar bicarbonato de sodio para apagarlo. | S'il s'agit d'un feu électrique, vous pouvez utiliser du bicarbonate de soude pour tenter de l'éteindre. | |
| Never use water, there is a high possibility if being electrocuted | Nunca use agua, hay una alta posibilidad de electrocutarse | Jamais utilize l'eau, il y a une forte possibilité d'être électrocuté | |
| If it is a fire caused while cooking, turn everything off and try to put a metal lid on the pan being used. | Si empieza un incendio mientras está cocinando, cubra la sartén o la olla con una tapa de metal. Asegúrese de apagar todo primero. | S'il s'agit d'un incendie causé pendant la cuisine, éteignez tout et essayez de mettre un couvercle en métal sur la casserole utilisée | |
| You can also use a thick, inflamable blanket to try to put out the fire | También puede usar una manta gruesa e | Vous pouvez également utiliser une couverture | |

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| | inflamable para tratar de apagar el fuego. | inflammable épaisse pour essayer d'éteindre le feu | |
| If the fire is big | Si el incendio es grande | Si le feu est grand | |
| NEVER GET IN THE SHOWER | NUNCA SE META EN LA REGADERA | JAMAIS vous prenez la douche | |
| During fires, the plumbing melts and prohibits water from flowing | Durante un incendio, las tuberías se derriten, esto impide el flujo del agua y aumenta el peligro | Pendant les incendies, la plomberie fond et empêche l'eau de couler | |
| Evacuation should always be your priority | Evacuar siempre debe de ser su prioridad | L'évacuation doit toujours être votre priorité | |
| Evacuate immediately with your family to an area far away from trees and other combustible structures | Evacue inmediatamente con su familia a un área lejos de árboles y estructuras combustibles | Evacuez immédiatement avec votre famille a une zone éloignée des arbres et autres structures combustibles | |
| Once you have evacuated, call the firefighters | Ya que allá evacuado, llame a los bomberos para reportar su situación. | Quand vous avez évacué, appelez les pompiers | |
| Once you have evacuated, if possible let your hosts know, call the firefighters | Una vez que haya evacuado, si es posible, informe a sus anfitriones/propietario, llame a los bomberos | Quand vous avez évacué, si est possible, informez vos hôtes, appelez les pompiers | |
| Every second counts during a fire, in order to reduce the risks you could face in case of an emergency, please read our following recommendations: | Cada segundo cuenta durante un incendio, para reducir los riesgos que podría enfrentar en caso de una emergencia, lea nuestras siguientes recomendaciones: | Chaque seconde compte pendant un incendie, afin de réduire les risques auxquels vous pourriez être confronté en cas d'urgence, lisez nos recommandations suivantes: | |
| Keep doorways clear - allow for quick evacuation | Mantenga las puertas despejadas | Gardez les portes claires<br>• Permettez une évacuation rapide | |

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| | • permite una evacuación rápida | | |
| Talk to your family members, particularly children about fire safety and the steps they should follow during these emergencies. | Hable con los miembros de su familia, especialmente con los niños, sobre la seguridad contra incendios y los pasos que deben seguir durante estas emergencias. | Parlez avec vos membres de famille, en particulier les enfants sur la sécurité incendie et les étapes à suivre lors de ces urgences. | |
| Save the firefighter's number on your phone for quick access: (506) 2645-7512 | Guarde el número de los bombero en su teléfono para poder accederlo rápidamente: (506) 2645-7512 | Enregistrez le numéro du pompier en votre téléphone pour un accès rapide | |
| Practice safe cooking habits | Practica hábitos de cocina seguros | Pratiquez des habitudes de cuisine sécuritaires | |
| Tropical storms are storms that are formed over tropical seas due to different temperatures in the atmosphere. They are extremely powerful and can cause landslides and flash floods due to their high winds and heavy rains. | Las tormentas tropicales son tormentas que se forman sobre mares tropicales debido a las diferentes temperaturas en la atmósfera. Son extremadamente poderosos y pueden causar deslizamientos de tierra e cabezas de agua debido a sus fuertes vientos y lluvias. | Les tempêtes tropicales sont des tempêtes qui se forment sur les mers tropicales en raison des températures différentes dans l'atmosphère. Ils sont extrêmement puissants et peuvent provoquer des glissements de terrain et des crues soudaines en raison de leurs vents violents et de fortes pluies. | |
| If you hear there might be the possibility of a tropical storm in your area, please follow these steps: | Si escucha que existe la posibilidad de una tormenta tropical en su área, siga estos pasos: | Si vous entendez qu'il y a une possibilité d'une tempête tropicale dans votre région, suivez ces étapes s'il vous plaît: | |
| You live in a high risk area and you hear there is a high | Vive en un área de alto riesgo y escucha que | Vivez dans une zone à haut risque et vous | |

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| possibility of: a tropical storm. You are in a high risk area if your house is very close to a river or you are inside a landslide risk area | hay una alta posibilidad de: una tormenta tropical. Está en un área de alto riesgo si su casa está cerca de un río o está dentro de un área de riesgo de deslizamientos | entendez qu'il y a une forte possibilité d'une tempête tropical. Vous êtes dans une zone à haut risque si votre maison est proche d'une rivière ou vous êtes à l'intérieur d'un glissement de terre | |
| Have additional storage of: | Tenga suministros adicionales de | Ayez un stockage supplementaire de | |
| Food and Water | Comida y Agua | Nourriture et eau | |
| Canned Food | Comida Enlatada | Nourriture en conserve | |
| Extra water - Fun Fact: people need to drink around 3.8 liters of water every day. | Agua extra - Dato curioso: las personas necesitan beber alrededor de 3.8 litros de agua todos los días. | Eau supplémentaire - Fait amusant: les gens ont besoin de boire environ 3,8 litres d'eau chaque jour | |
| Medicine - if possible have extra medicine | Medicamentos: si es posible, tenga medicamentos adicionales | Medicament - si est possible ayez medicament supplementaire | |
| Have a First-Aid Kit | Tenga un botiquín de primeros auxilios | Ayez un trousse de premiers soins | |
| If you have pets | Si tiene mascotas | Si vous avez des animaux | |
| If possible have back-up food and medication if applicable | Si es posible, tenga alimentos y medicamentos adicionales | Si est possible, soutenez aliments de secours et médicaments | |
| When calculating your water rations, take your pets into account! | Al calcular sus raciones de agua, tenga en cuenta a sus mascotas | Lors du calcul de vos rations d'eau, tenez compte de vos animaux de compagnie | |
| The closest volcano to Monteverde is the Arenal Volcano. While its eruption would not have direct effects on Monteverde, the volcano's ashes do have a high probability of reaching | El volcán más cercano a Monteverde es el Volcán Arenal. Si algún día eructa no tendría efectos directos en Monteverde, pero las cenizas del volcán | Le volcan le plus proche de Monteverde est le volcan Arenal. Bien que son éruption n'aurait pas d'effets directs sur Monteverde, les cendres du volcan ont une forte | |

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| the region and they come with several risks. The highest risks are respiratory issues and damage to agriculture. | tienen una alta probabilidad de llegar a la región y conllevan varios riesgos. Los mayores riesgos son problemas respiratorios y daños a la agricultura. | probabilité d'atteindre la région et comportent plusieurs risques. Les risques les plus élevés sont les les problèmes respiratoires et les dommage à l'agriculture | |
| If you hear that a volcano in Costa Rica has erupted, follow these instructions: | Si escucha que un volcán en Costa Rica ha entrado en erupción, siga estas instrucciones: | Si entendez que le volcan en Costa Rica a éclaté, suivez ces instructions: | |
| If you hear there is a chance ashes will reach Monteverde, do the following: | Si escucha que existe la posibilidad de que las cenizas lleguen a Monteverde, siga estas instrucciones: | Si entendez qu'il y a une chance que les cendres atteignent Monteverde, faites ce qui suit | |
| Close all doors and windows in your home | Cierre todas las puertas y ventanas de su hogar | Fermez toutes les portes et fenêtres de votre maison | |
| Turn off heaters, air conditioners, and driers | Apague sus calentadores, aires acondicionados y secadoras | Eteignez les radiateurs, les climatiseurs et les sécheuses | |
| Avoid driving - the ashes can hurt your car's motor | Evite conducir: las cenizas pueden dañar el motor de su automóvil | Evitez de conduire: les cendres peuvent endommager le moteur de votre voiture | |
| If possible protect cars by covering them up or parking them inside. | Si es posible, proteja los automóviles cubriéndolos o estacionándolos adentro. | Si est possible, protéger les voitures en les couvrant ou en parquant à l'intérieur | |
| If you have pets or cattle | Si tienes mascotas o ganado | Si vous avez des animaux compagnies ou des vaches | |
| Make sure they are all inside your home, barn, or some other type of shelter. | Asegúrese de que estén todos dentro de su hogar, granero o | Assurez-vous qu'ils sont tous à l'intérieur de votre | |

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| | algún otro tipo de refugio. | maison, de votre grange ou d'un autre type d'abri | |
| The ashes will cover the sun and thus have a high chance of damaging grass and agriculture. Therefore, it is heavily recommended that you have a reserve of food for your cattle. | Las cenizas cubrirán el sol y tienen una alta probabilidad de dañar el pasto y la agricultura. Por lo tanto, se recomienda que tenga una reserva de alimentos para su ganado. | Les cendres va couvrir le soleil et va avoir un risque élevé d'endommager les excréments et l'agriculture. Par conséquent, il est fortement recommandé d'avoir une réserve de nourriture pour votre vache. | |
| Examine your water reserve and make sure it is as filled up as possible. | Examine su reserva de agua y asegúrese de que esté lo más llena posible. | Examinez votre réserve d'eau et assurez qu'elle est aussi remplie que possible | |
| If you venture outside | Si está afuera | Si vous vous aventurez à l'extérieur | |
| Wear a filtering mask (N-95), or hold a wet rag to your mouth | Use una máscara filtrante (N-95) o sostenga un trapo húmedo en su boca | Portez un masque filtrant ou portez un chiffon humide à votre bouche | |
| Use protection glasses, or just wear any sort of glasses | Use anteojos de protección o use cualquier tipo de lentes que puedan proteger sus ojos | Utilisez des lunettes de protection ou portez simplement n'importe quelle sorte de lunettes | |
| Wear long sleeved shirts, sweaters, and pants | Use camisas de manga larga, suéteres y pantalones. | Portez des chemises à manches longues, des chandails, et des pantalons | |
| In order to clean up, here are some tips: | Para limpiar | Pour nettoyer, voici quelques conseils: | |
| You can clean ashes by damping a cloth in water and sliding the ashes into a trash bag. | Moje la ceniza con agua, barrela y tirala dentro e una bolsa de basura. | Vous pouvez nettoyer les cendres en humidifiant un chiffon dans l'eau et en faisant glisser les cendres dans un poubelle | |

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| Make sure to wear protection while doing this so ash doesn't damage your eyes or lungs. | Asegúrese de usar protección para que las cenizas no dañen sus ojos o pulmones. | Assurez-vous de porter une protection en faisant cela afin que la cendre n'endommage pas vos yeux ou vos poumons | |
| Earthquakes are caused by plates in the Earth's crust moving. Earthquakes occur multiple times per year in Monteverde, and they can lead to landslides and falling objects | Los terremotos son causados por placas que se mueven en la corteza terrestre. Los terremotos ocurren varias veces al año en Monteverde, y pueden provocar deslizamientos de tierra y la caída de objetos. | Les tremblements de terre sont causés par le déplacement des plaques dans la croûte terrestre. Les tremblements de terre se produisent plusieurs fois par an à Monteverde, et ils peuvent entraîner des glissements de terrain et des chutes d'objets | |
| If you experience an earthquake, please follow these instructions: | En caso de un terremoto | Si vous subissez un tremblement de terre, suivez ces instructions | |
| If possible stay inside - the structures in Monteverde are designed with earthquakes in mind, and there is a higher risk in the outside due to falling trees and debris. | Si es posible, quédese adentro: las estructuras en Monteverde están diseñadas para terremotos, y existe un mayor riesgo en el exterior debido a la caída de árboles y escombros. | Si est possible de rester à l'intérieur, les structures de Monteverde sont conçues en pensant aux tremblements de terre et il y a un risque plus élevé à l'extérieur en raison de la chute des arbres | |
| Cover your head and neck with your arms and try to move to a table or other kind of furniture that can protect you from falling objects - try to stay away from shelves and chandeliers. | Cúbrase la cabeza y el cuello con los brazos e intente trasladarse a una mesa u otro tipo de mueble que puedan protegerlo de la caída de objetos; trate de mantenerse alejado de estantes y candelabros. | Couvrez-vous la tête et le cou avec vos bras et essayez de vous déplacer vers une table ou un autre type de meuble qui peut vous protéger contre la chute d'objets - essayez de rester à l'écart des étagères et des lustres | |
| If you are unable to find a table, get close to a wall with no windows or shelves. | Si no puede encontrar una mesa, acérquese a una pared sin ventanas ni estantes. | Si vous ne trouvez pas de table, approchez-vous d'un mur sans fenêtres ni etagères | |

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| If you are in bed, cover your head and neck with your pillow. | Si está en su cama, cúbrase la cabeza y el cuello con su almohada. | Si vous êtes au lit, couvrez votre tête et votre cou avec votre oreiller | |
| If you are outside | Si esta afuera | Si vous êtes à l'extérieur | |
| Cover your head and neck with your arms and move to an area that is as open as possible. | Cúbrase la cabeza y el cuello con los brazos y muévase a un área lo más abierta posible. | Couvrez-vous la tête et le cou avec vos bras et déplacez-vous vers une zone aussi ouverte que possible | |
| There is a high probability for trees, rocks, and other debris in the mountains to become loose during earthquakes so make sure you watch out for that. | Porfavor tenga cuidado, hay una alta probabilidad de que los árboles, rocas y otros objetos en las montañas se suelten durante los terremotos. | Il y a une forte probabilité que les arbres, les rochers, et autres débris des montagnes de détachent pendant les tremblements de terre, alors faites attention. | |
| If you are in a car - stay inside and try to move to an open area. | Si está en un automóvil, quédese adentro, lejos de objeto que pueden caer. | Si vous êtes en voiture, restez à l'intérieur et essayer de vous déplacer vers une zone dégagée | |
| After the earthquake | Después del terremoto | Après le tremblement de terre | |
| Evacuate your building if it was heavily damaged during the earthquake | Evacue su edificio si sufrió graves daños durante el terremoto. | Evacuez votre immeuble s'il a été fortement endommagé pendant le tremblement de terre | |
| Watch out for secondary waves, which can happen soon after an earthquake | Tengo cuidado de los temblores secundarios | Faites attention aux ondes secondaires qui peuvent arriver peu après un tremblement de terre | |
| When organizing shelves, put heavier objects at the bottom | Ponga objetos pesados o frágiles en el nivel más abajo del estante | Lors de l'organisation des étagères, placez des objets plus lourds en bas | |
| If possible, try to tie or nail heavy objects (TVs, fridges, and shelves) to the wall. | Asegure los muebles a la pared o al piso | Si est possible, essayez d'attacher ou de clouer des objets lourds(télés, | |

| | | | |
|---|---|---|---|
| | | réfrigérateurs, étagères) au mur. | |

# Appendix O: Application Maintenance Manual

The application is a way to convey information to both visitors and residents during emergencies. The application is not linked to the internet so all information and all features will be available offline all the time. It is crucial to maintain this application in order to keep all relevant information up to date. This manual is meant for programmers to maintain the application.

## General:

- .xaml files
    - These files are the front end for the application. No actual information is needed to be put in this page, the .xaml.cs files populate the page with information
    - **x:Name** object property
        - The name of the object that will be referenced in the .xaml.cs files to change its text and other properties
    - **<Scrollview>**
        - Wrap around all objects in contentPage.Content to ensure that page can is scrollable
    - **NavigationPage.HasNavigationBar="false"**
        - Add in <ContentPage> attributes to get rid of blue bar with back button at top of screen
- .xaml.cs
    - Backend of all the pages. Sets all of the information in its front end page
    - **protected override void OnAppearing()**
        - Method that executes while page is loading
        - Used currently to populate page with relevant information
    - **Navigation.PushAsyn(new Page());**

```
private async void LanguageButton_OnClicked(object sender, EventArgs e)
{
    await Navigation.PushAsync(new MainPage());
}
```

        - Used to navigate to new pages
    - **Switch(App.Lang)**
        - Used to input information in the correct language on front end pages
        - Used in all

```
switch (App.Lang) {
    case "e":
        label1.Text = "What region are you from?";
        notSureButton.Text = "Not Sure";
        popupName = "You sure?";
        popupText = "Choosing a location will allow you to get more specific information";
        yesButton = "yes";
        noButton = "no";
        changeLang.Text = "Change Language";
        contactInfo.Text = "contact info";
        break;
    case "s":
        label1.Text = "¿De qué región eres?";
        notSureButton.Text = "No estoy seguro";
        popupName = "You sure? But in spanish";
        popupText = "Spanish version of Choosing a location will allow you to get more specific information";
        yesButton = "Spanish yes";
        noButton = "Spanish no";
        changeLang.Text = "Cambiar idioma";
        contactInfo.Text = "Spanish contact info";
        break;
```

- **Switch(App.Loc)**

```
switch (App.Loc)
{
    case "monteVerde":
        img.Source = "monteVerde";
        break;
    case "cerroPlano":
        img.Source = "cerroPlano";
        break;
    case "santaElena":
        img.Source = "santaElena";
        break;
    case "sanLuis":
        img.Source = "sanLuis";
        break;
    default:
        break;
}
```

  - Used to switch images that appear on the MainRiskMapPage
- **Switch(App.Emergency)**

```
switch (App.Emergency)
{
    case "landslide":
        landslideText();
        break;
    case "flood":
        floodText();
        break;
    case "fire":
        fireText();
        break;
    case "tropicalStorm":
        tropicalStormText();
        break;
    case "volcano":
        volcanoText();
        break;
    case "earthquake":
        earthquakeText();
        break;
```

- Used to switch which information is displayed on the risk and natural disaster pages

## Pages:

- App.xaml
  - Base page to define application, not actual screen
  - Universal properties can be defined for objects

```
<Style TargetType="Label">
    <Setter Property="FontFamily" Value="{StaticResource BoldFont}" />
    <Setter Property="FontAttributes" Value="Bold" />
    <Setter Property="TextColor" Value="White" />
    <Setter Property="FontSize" Value="40" />
</Style>
```

    - Ex. for Labels, declare fontSize to be 25
    - These universal properties can be overwritten by local properties on an individual object
  - Custom fonts can be declared
- App.xaml.cs
  - Backend for App.xaml
  - Global variables declared - can be used across all .xaml.cs

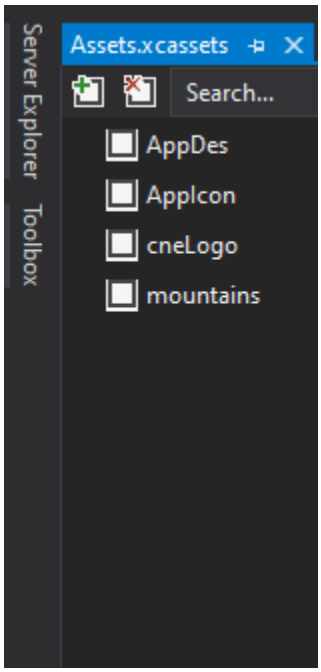
```
<OnPlatform x:TypeArguments="x:String" x:Key="NormalFont">
    <On Platform="Android" Value="OpenSans-Regular.ttf#Open Sans" />
    <On Platform="iOS" Value="OpenSans-Regular" />
</OnPlatform>
```

    - App.Lang = language that is currently in use
    - App.Loc = location currently in use
    - App.Emergency = emergency user currently wants information on

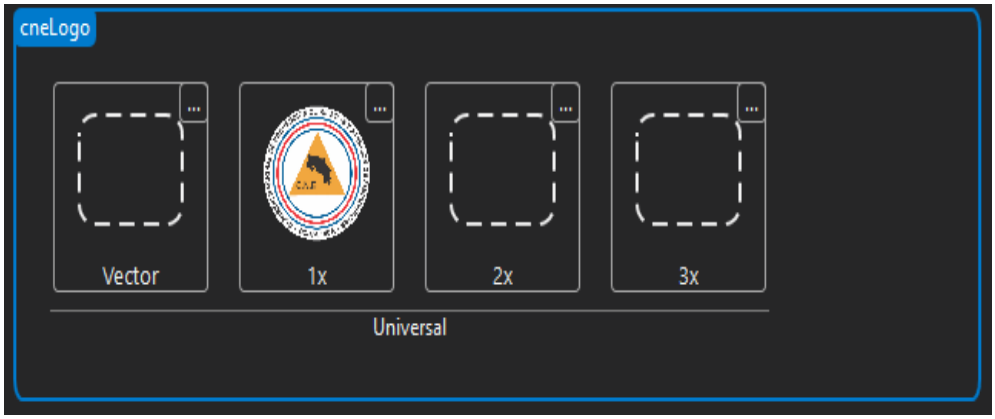
## Images:

- Android:
  - Place images in **emergencyPreparednessApp.Android/resources/drawable**
- iOS:

1. Open to emergencyPreparednessApp.iOS/Asset Catalogs/Assets
2. Click the box with the green plus and when the dropdown menu appears, choose “Add image set”




3. Drag your image into the 1x box



# Appendix P: Screens of the App

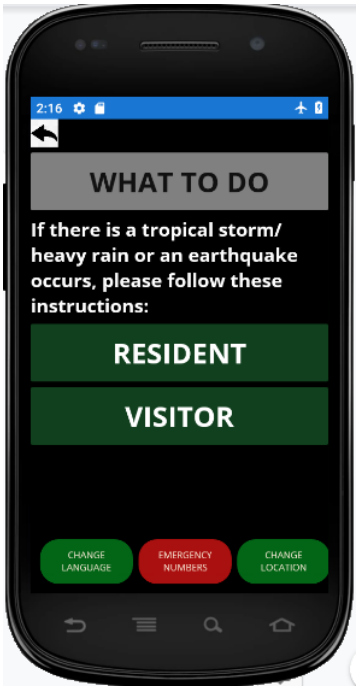
*Table P.1: App Screens*

| Page Name | Image | Description |
|---|---|---|
| ContactInfo |  | Contains emergency contact info for all emergency-related entities |

| | | |
|---|---|---|
| LocationPage |  | Page that allows user to choose what region they are currently in |
| MainPage |  | Allows user to choose the language for the application |

| | | |
|---|---|---|
| MainRiskMapPage |  | User gets to choose what risk or disaster they want information on |
| NaturalDisaster |  | Displays information for natural disasters |

| | | |
|---|---|---|
| Risk |  | Displays information for risks |
| RiskPrepare |  | Information for how to prepare for a disaster |

| | | |
|---|---|---|
| RiskWhatDo |  | Information for what to do during a disaster |
| RiskWhatIs |  | Information for what a disaster is |