

Research Question:

Is Rotorua, New Zealand, prepared for a major tectonic hazard?



Figure 1: Photo showing the Year 12 Geography students in Rotorua

Source: S. Bainbridge (2019)

Session: May 2020

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Introduction

New Zealand is a land of earthquakes, located on the plate boundary between Pacific plate and Indo-Australian plate. Therefore, tectonic activities which include earthquakes and volcanoes, are a high possibility. Indeed, there are more than 15,000 earthquakes annually (GNS Science, 2019). Located on the Pacific Ring of Fire, a place called Rotorua (shown in Figure 2) is one of the most incredible geothermal areas, thus, the many seismometers are located there (shown in Figure 3). The geothermal attractions of hotspots, spas and sights include, mud pools, coloured hot springs and naturally formed faults. This has resulted in 1.24 million tourists visiting Rotorua in one year (Do Businesses in Rotorua, 2019), while there are only 65,280 local residents who live in Rotorua (Rotorua Lakes Council, 2016). Since a large proportion of the community are tourists, they might have little or no knowledge and awareness of the tectonic hazards that might occur in Rotorua and this makes the community potentially vulnerable-where people may be affected negatively by a disaster. As the vulnerability gets higher, the risk increases as well since the risk is calculated by multiplying the annual hazard occurrence probability, population exposed and vulnerability (Nagle & Cooke, 2017).

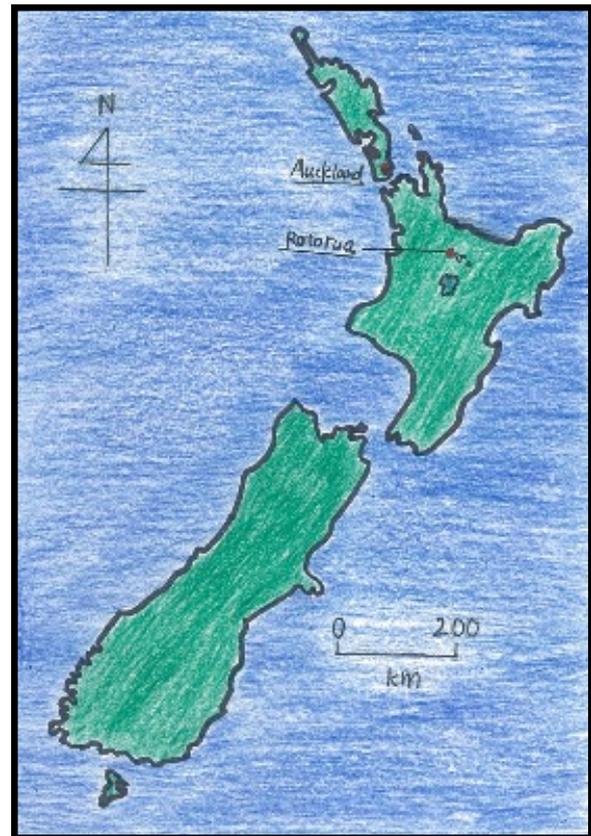


Figure 2: Map showing the location of Auckland (origin) and Rotorua (destination)

Source: Adapted from (McPherson, 2007)

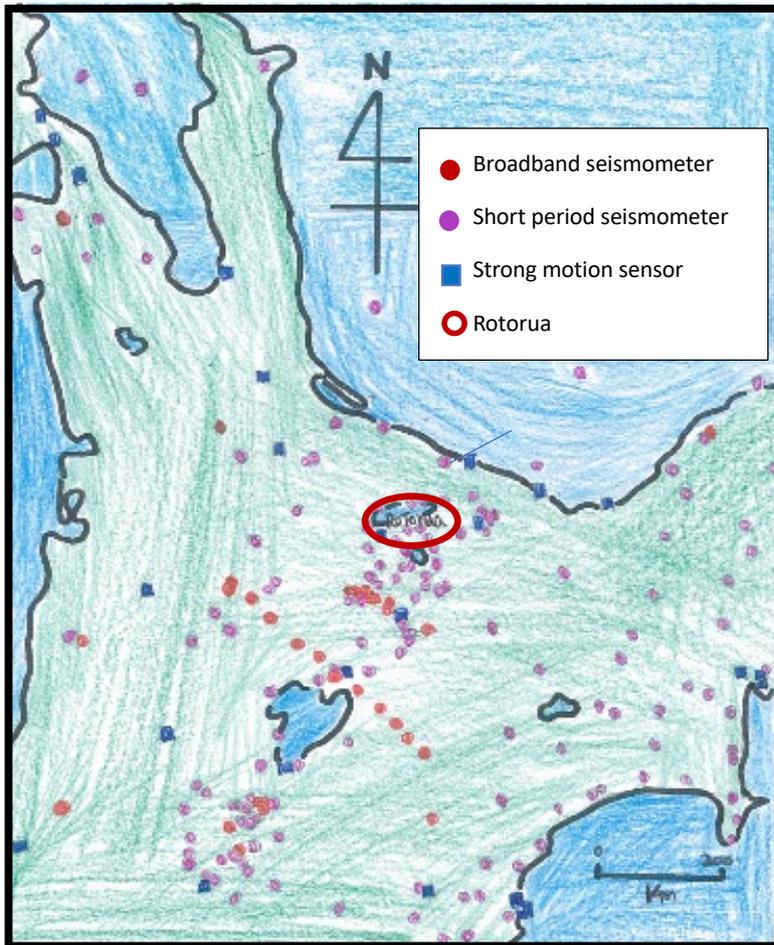


Figure 3: Map of seismometers in the center of North Island in New Zealand.
Source: Adopted from Google map

This leads to the Research question of

“Is Rotorua, New Zealand, prepared for tectonic hazards?”

This links to Option D: Geophysical hazards in the IB Geography syllabus.

Hypotheses:

To assess the research question, the following hypotheses were investigated.

1. Tourists will be unfamiliar with the risks of the area and so less prepared.
2. Education and instruction about the hazards are given to the locals to prepare them.
3. The local government takes a leading role in preparing people for tectonic hazards.

Methodology

Primary Sources

Quantitative

The main primary source was surveys. In total, of 221 responses were collected in several places: Skyline Rotorua, Civil Defense, Te Puia, Backyard Inn Hostel, Rotorua Visitors Centre and Waitotapu Geothermal Wonderland (shown in Figure 4). It targeted locals, tourists and tourist operators' in Rotorua during day time. The questions included asking the respondents about their preparedness and awareness of tectonic hazards in Rotorua to support all my hypotheses. The primary source was collected during the school trip from 13th to 15th, February 2019.

Within several sampling technics, stratified sampling, collecting data from different people (Field Studies Council, 2016) and opportunistic sampling when the researcher can make decisions of what sampling techniques to use during the data collection (Cohen & Crabtree, 2008) are used.

Qualitative

Interviews were also carried out in Skyline Rotorua, Civil Defense, Rotorua Museum, Te Puia, Backyard Inn and Redwood Treewalk (shown in Figure 4). The tourist operators and the local government's management skills, preparation and education when tectonic hazards occur were asked about to support hypotheses 1 and 3.

Additionally, photographs (qualitative) are used to illustrate how the local government are promoting the actions taken when hazards occur and how if communities have evacuation plans to prepare themselves. These are to back up hypotheses 1 and 3.

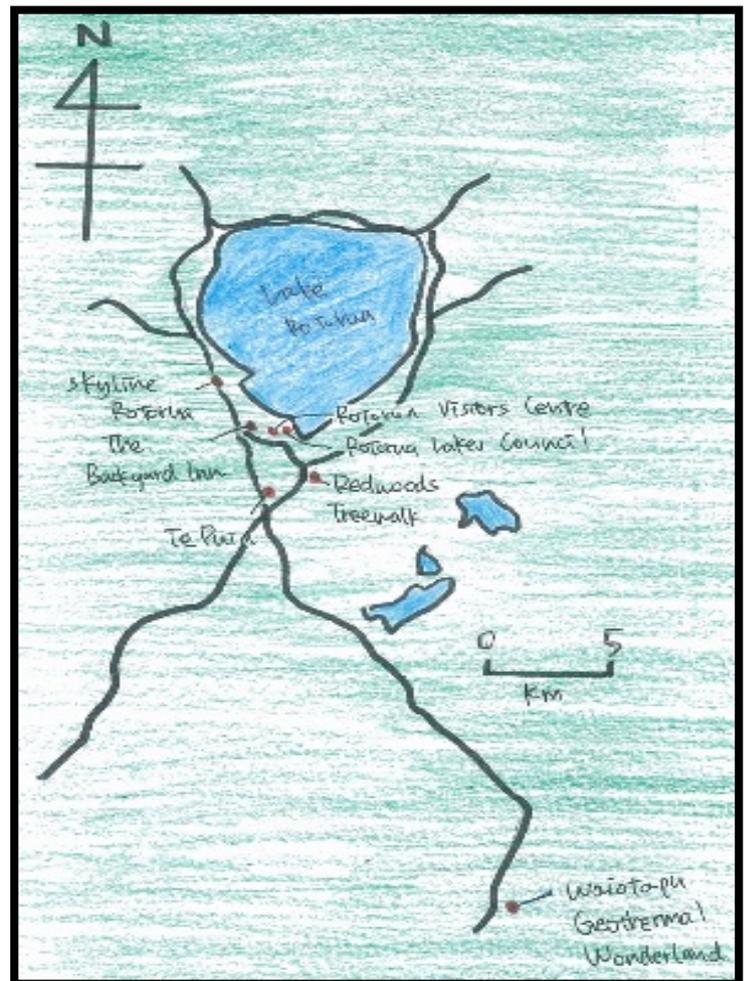


Figure 4: Map of where the survey and interviews were conducted

Source: Adapted from (Geonet, 2019)

Secondary Sources

Furthermore, secondly sources such as books and online resources (qualitative) were used to provide with the background information of why the whole investigation was carried in Rotorua and also were used to support all the hypotheses.

Data analysis and Interpretation

Hypothesis 1: “Tourists will be unfamiliar with the risks of the area and so less prepared”

The hypothesis was tested through the questions in the survey, “What kinds of dangers do you think happen here in Rotorua?” and “Do you have an emergency kit?”, and the pamphlets created by the Civil Defense.

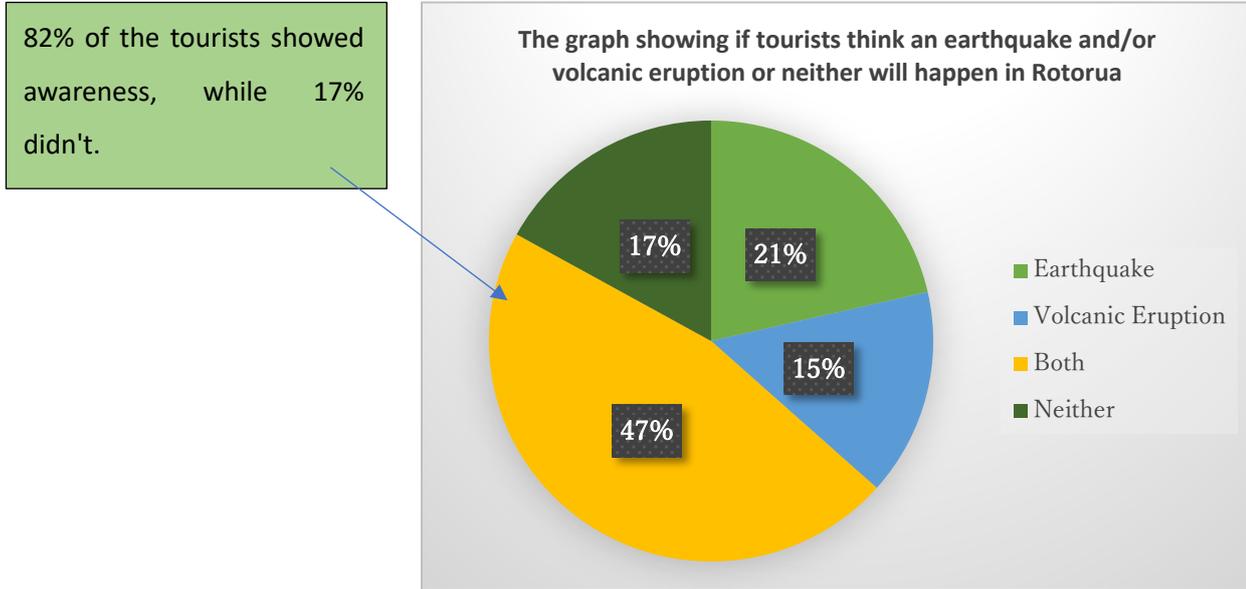
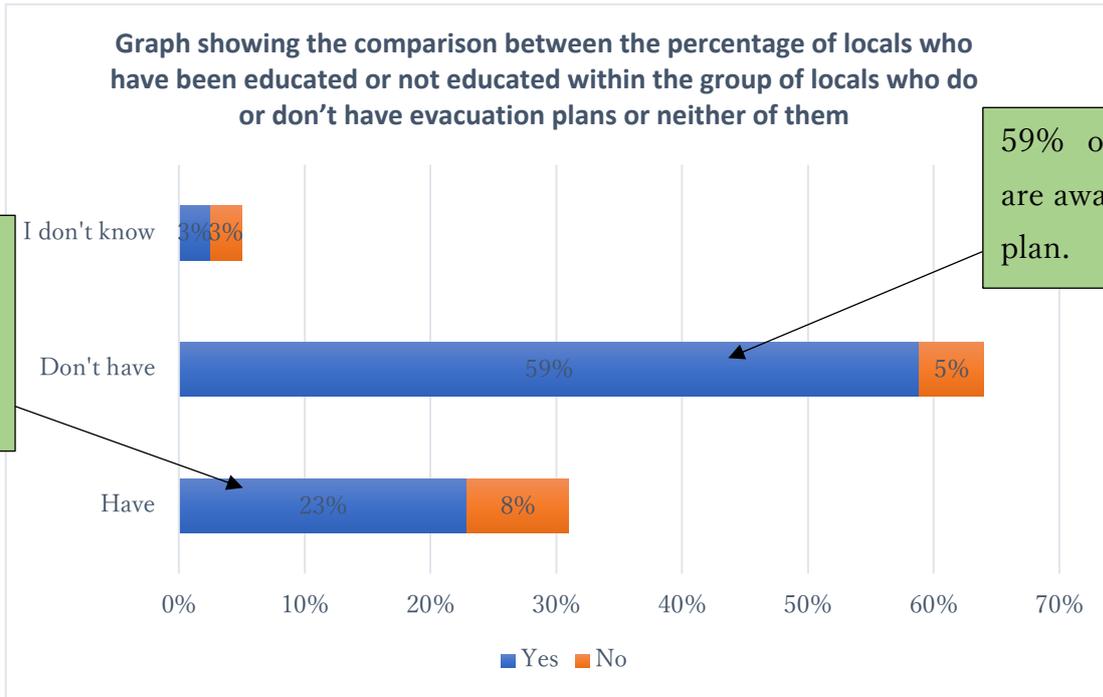


Figure 5: Graph showing if tourists think an earthquake and/or volcanic eruption or neither will happen in Rotorua

Figure 5 indicates that majority of the tourists are aware of the local tectonic hazards' dangerousness, thus, familiar with the risks.



23% of the tourists are aware and have plans.

59% of the tourists are aware but have no plan.

Figure 6: Graph showing the comparison between the percentage of locals who have been educated or not educated within the group of locals who do, don't have evacuation plans or neither of them

When looking at Figure 6, majority don't have the emergency plan when they are aware. Though Figure 5 supports the idea that the tourists are aware of the risks, Figure 6 shows that despite the proportion of people who know the risk, there were only small percentage of people who are actually prepared which was unexpected result. This is maybe because, given the low chance of large earthquake or volcanic eruptions occurring, the efforts and costs for preparation may outweigh the risk.

Since this question did not ask where you have the emergency kit, some might have answered “Yes, I do have it” because they have it at their home country. However, this will not be acceptable because this survey is investigating whether they are prepared in Rotorua. This question might not be reliable, so the question “Have you been told what to do during an earthquake or volcanic eruption in Rotorua?” can be another way to test if the tourists are prepared or not.

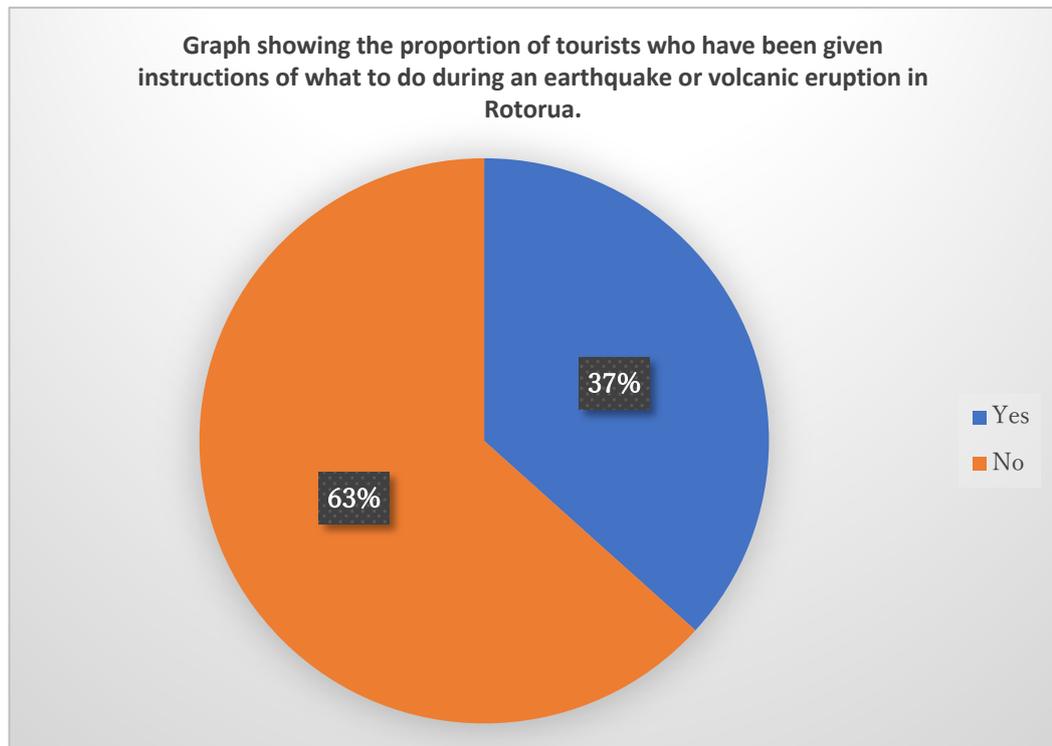


Figure 7: Graph showing the proportion of tourists who have been given instructions of what to do during an earthquake or volcanic eruption in Rotorua.

Referring back to Figure 5, though majority of the tourists were aware of the risks in Rotorua, obviously majority of the tourists (63%) are not given any instructions which may increase their vulnerability (Figure 7). This also supports the idea tourists are not actually prepared for the risks.

Although 63% of the tourists haven't given instructions in Rotorua, Nick Barnes, the emergency management advisor in Civil Defense noted that they have created several pamphlets (Figure 8 and 9) of action plans. The aims are to provide suggested action to take to keep oneself calm during disasters and courage them to a preparation for locals and tourists. However, unfortunately, these documents and pamphlets are hardly recognized by the tourists since it isn't displayed in a place where it attracts people's attention, so that it is not providing them with the knowledge needed when the disaster happens. This can be improved by placing the pamphlets in places where the tourists gather such as tourist center or airport.

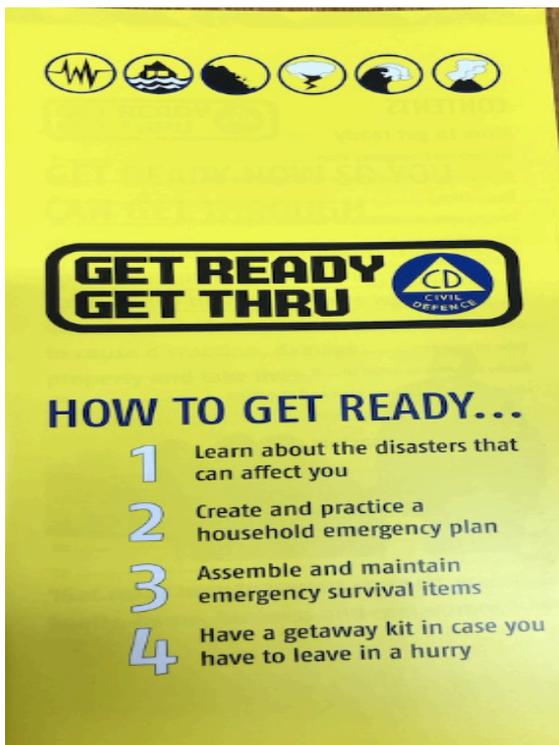


Figure 9: Photo showing a pamphlet to courage the community to get prepared for the possible disasters
Source: Own photo

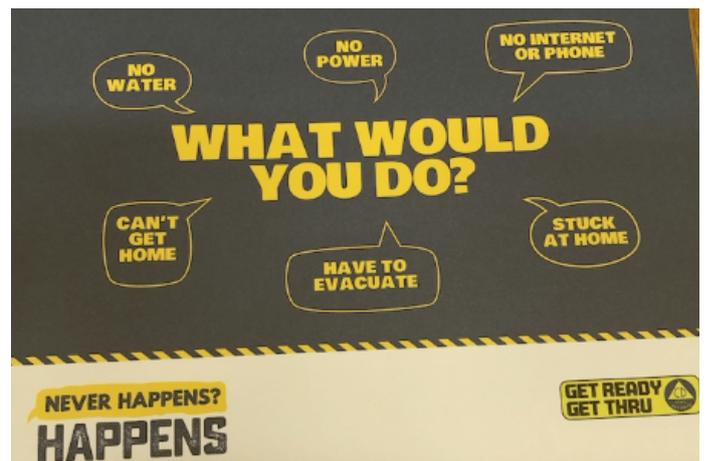


Figure 8: Photo showing a pamphlet suggesting which action to take when disasters occur
Source: Own photo

Hypothesis 2: “Education and instruction about the hazards are given to the locals to prepare them.”

The second hypothesis was explored by the questions asking, “Have you had any education at school/work about what to do during an earthquake?” and “Do you have an evacuation plan or meeting point with your family?” from the survey to prove their preparation.

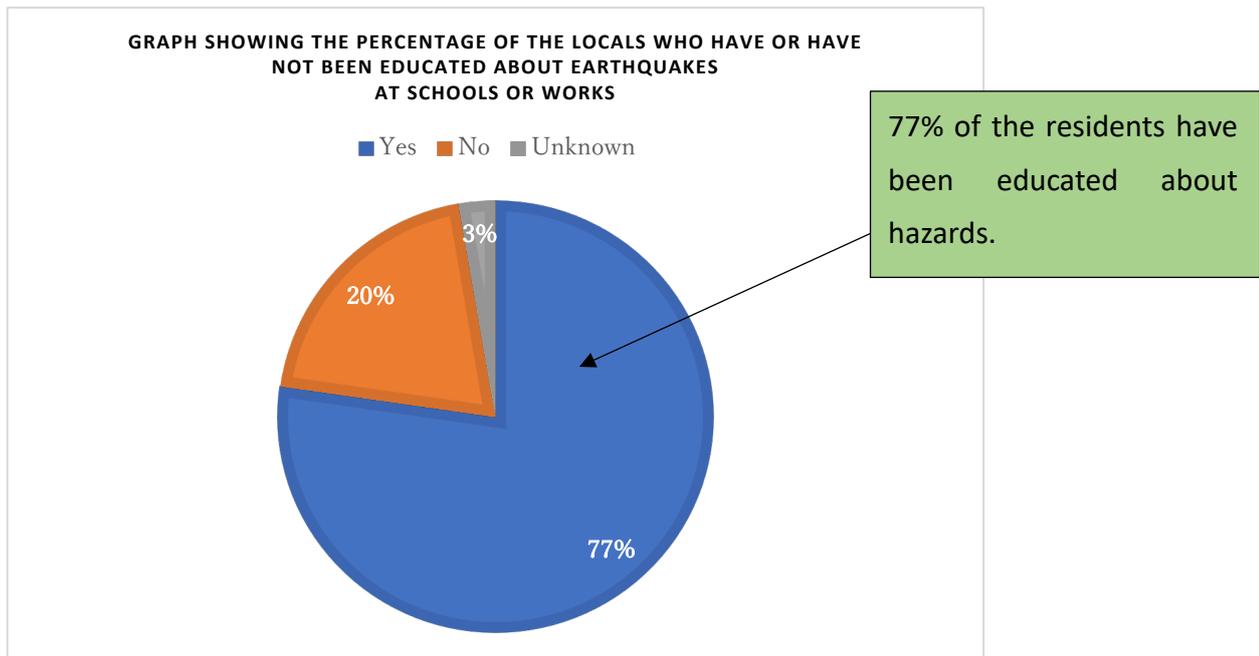


Figure 10: Graph showing the percentage of the locals who have or have not been educated about earthquakes

Figure 10 clearly shows that the majority of the locals (77%) have been educated about earthquakes.

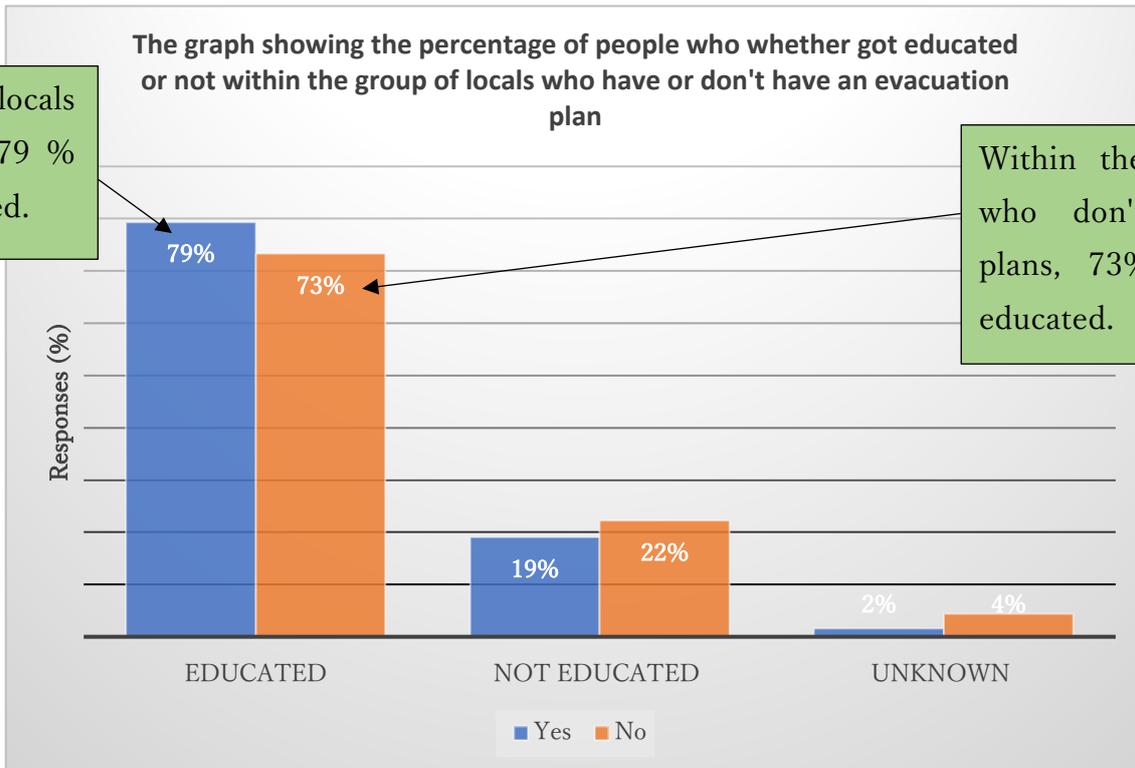


Figure 11: Graph comparing the percentage of locals who have or don't have evacuation plan within the group of people who have either answered they have been educated or not educated, or neither of them

Looking at Figure 11, both groups with and without plan, more than 70% were educated with a slightly higher percentage in the group with evacuation plans, which tells that education about earthquakes will to some degree, it determines whether the locals are going to prepare their evacuation plan. The level of awareness of hazards may be increased by educating them, which can lead them to prepare an evacuation plan, thus, less vulnerable. This proves that the second hypothesis is correct. However, in negative way, education may only have a slight determination on whether they are going to have evacuation plans. This was unexpected result since it was thought that education will have major impact on people's preparedness therefore, expected that the percentage of people without evacuation plan would be much lower.

In order to verify the relationship between having education about hazards and making an evacuation plan/meeting point or not, Chi squared test was performed. The following calculation was carried out (see appendix 4), which shows that the null hypothesis was accepted. Therefore, it is 95% confirmed that there is no significant difference between residents who have an evaluation plan within the group that are educated and not educated, which proves that education has no effect on one's preparedness of evacuation plan. This may be because, if earthquakes don't occur, people would less experience so that they may underestimate its dangerousness so less actions taken.

However, education may have a positive impact on one's confidence during a small and large earthquake. This is investigated by two questions: "I would know what to do during an earthquake" and "I would know what to do after an earthquake".

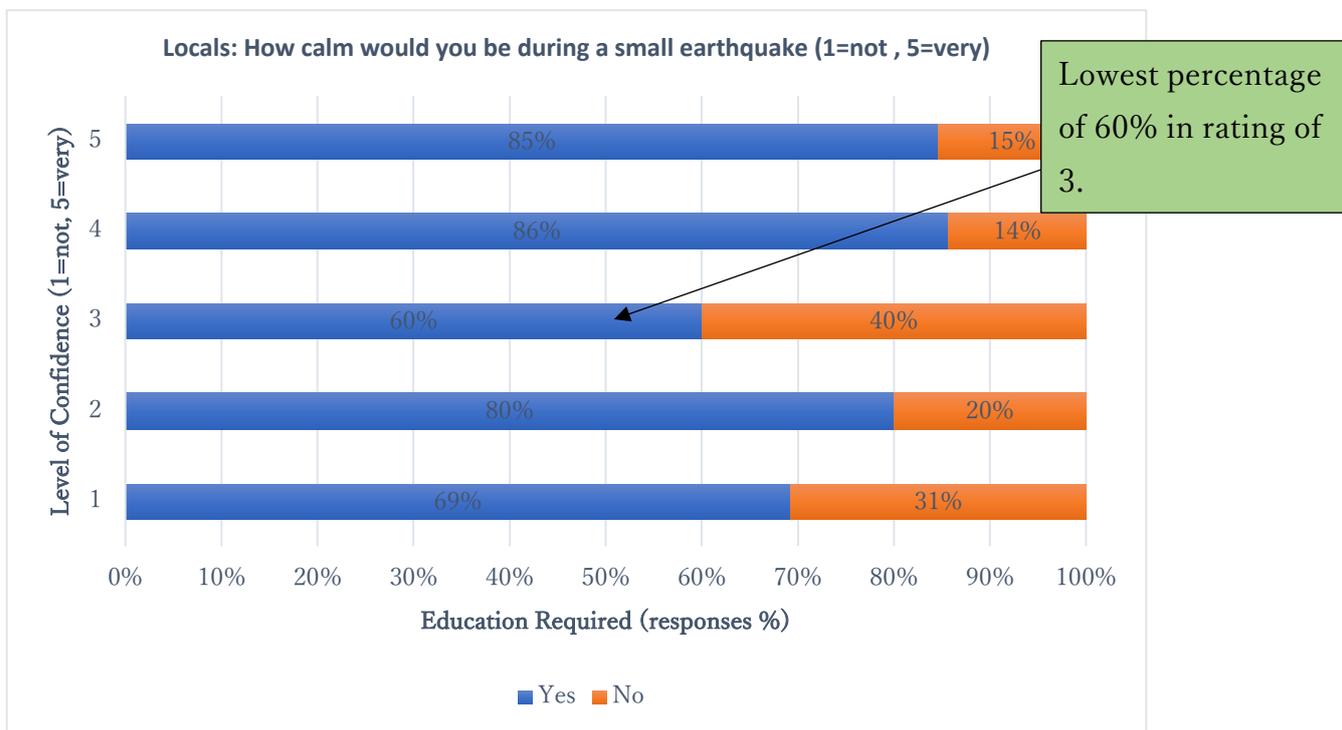


Figure 12: Graph showing if locals are educated about earthquakes and their different levels of confidence during a small earthquake

According to Figure 12, there is a positive correlation between education about earthquakes and estimated confidence during small earthquake (from 69% to 85%). However, an anomaly here is that people who gave a confidence rating of 3 had the

lowest level of 60% and high percentage of rating of 2 (80%). This may be because the survey had the potential to the respondents to acknowledge the risks and realize that they are not prepared by answering the questions.

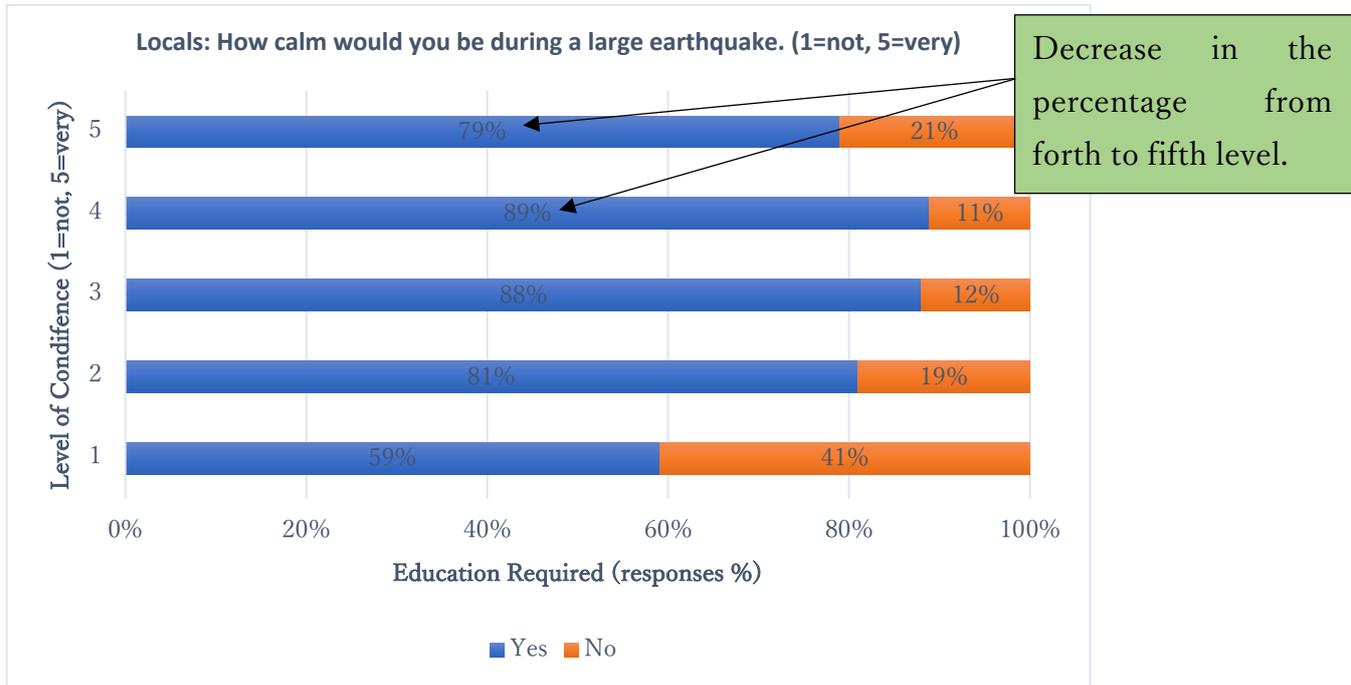


Figure 13: Graph showing if locals are educated about earthquakes and their different levels of confidence during a large earthquake

Same as large earthquakes (Figure 13), there is an overall trend that increase education level leads to an increase in the confidence (from 59% to 79%), with the anomaly of the highest percentage of 89% in the fourth level, but not the fifth level. This might be because, “5” indicates high confidence, but people may think that they are not perfectly but relatively confident which lead “4” to have the highest percentage.

Although education may increase one’s emotional preparedness, from Chi squared test and Figure 11 proved that education may not significantly affect one’s action for earthquakes, preparation of evacuation plans.

Hypothesis 3: “The local government takes a leading role in preparing people for tectonic hazards.”

This hypothesis was investigated using the questions in the survey asking both the tourists and locals to rate 1 (disagree) to 5 (agree) for “This community will keep me safe

during an earthquake or volcanic eruption” and the interview conducted in Skyline Rotorua.

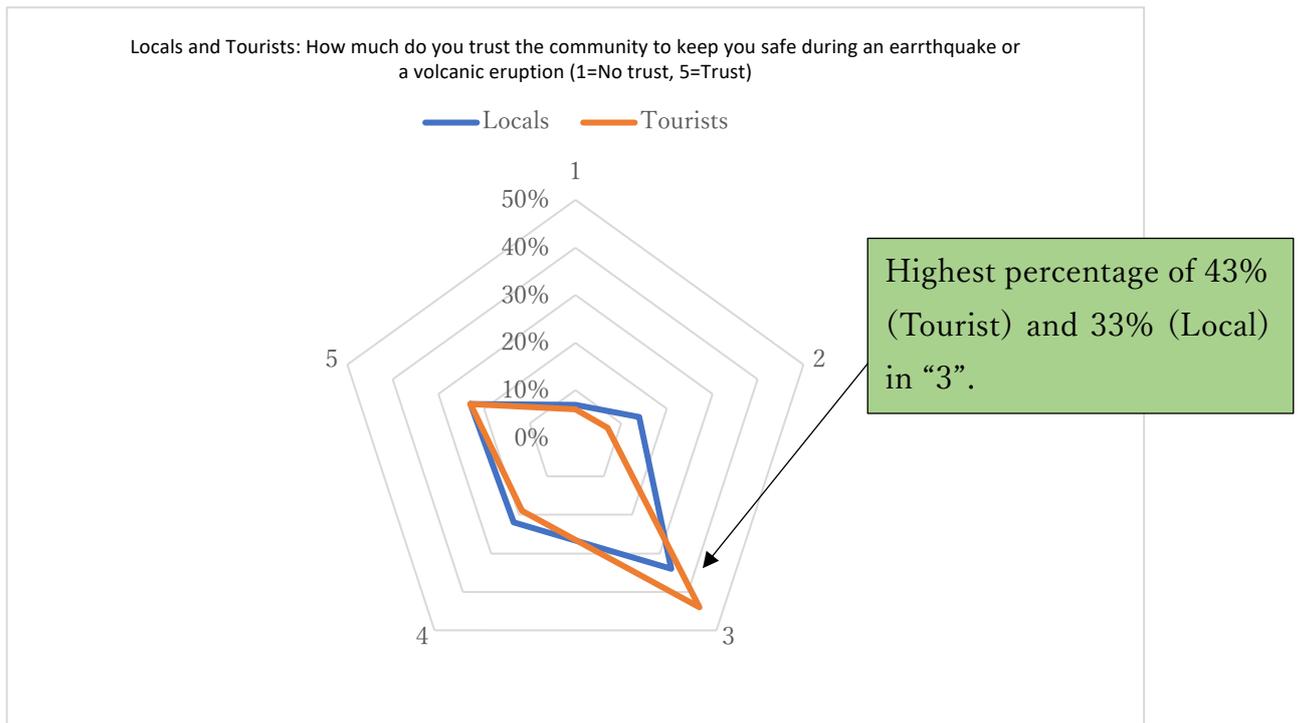


Figure 14: Graph comparing the locals and tourists’ trust in their community when an earthquake occurs

Figure 14 shows that although similar numbers of locals and tourists would trust the community (rating of 5) and more tourists selected the moderate value of 3 (44%) than locals (34%). This would be because they sit on the fence that they may have no opinion since they have only spent few days that they don't know much about the local community. Although the percentage of people who rated “5” is the same, locals relatively gave higher rating than locals when comparing the percentage of people who rated “4”. This may be because the locals know more about the community so that they trust more.

Figure 14 demonstrates that locals and tourists relatively trust the community. Behind this positive result, there were several actions taken to increase their trustworthiness.

Andrew Aitlen, the marketing manager in Skyline Rotorua, showed their “Incident Management Plan” (Figure 15) which contains not just an emergency and evacuation plan when an earthquake occurs, but also strong winds, fires, landslides and other

possible natural and humanitarian phenomenon. For each situation, it has a detailed plan of what the staff needs to do to keep the customers safe.

Moreover, since there are many international visitors who cannot speak English, the staff carries evacuation notices to the visitors in English, Chinese, Korean, Japanese, Hindi and Spanish (Figure 16). This would be a helpful tool to communicate with foreign visitors when emergency happens and need them to evacuate.

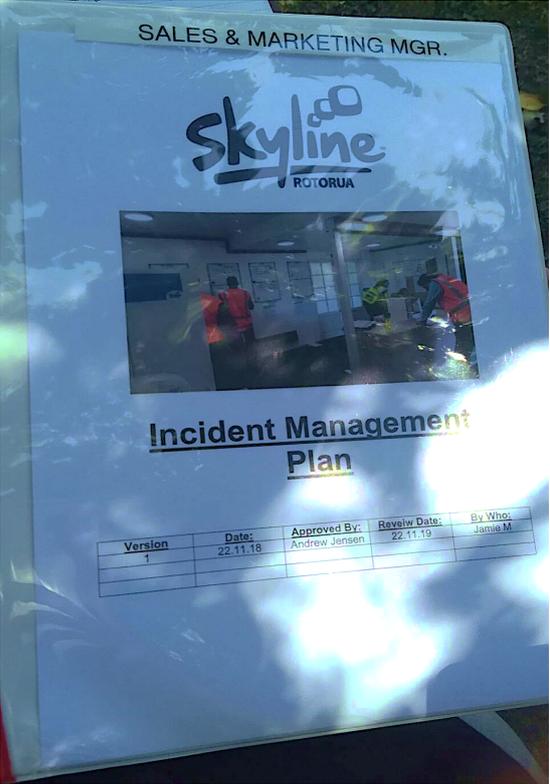


Figure 15: Picture of Incident Management Plan from Skyline Rotorua
Source: Taken by Vicky Yan Min Guan



Figure 16: Picture of Evacuation notices in different languages from Skyline Rotorua
Source: Taken by Vicky Yan Min Guan



Figure 17: Picture of action procedure notes from Skyline Rotorua

Source: Vicky Yan Min Guan

In addition, he mentioned that there is stimulated evacuations once a month, and real evacuations with New Zealand's fire service and St Johns ambulance service annually. They also have their action procedure notes ready so that they could keep their customers calm and give them instructions easily (Figure 17).

These preparations are made under Coordinated Incident Management System (CIMS), the system to manage the response to an incident (Civil Defence , 2019). Other tourist operators should also be prepared for hazards, as CIMS is mandated from the government to the emergency response agencies (LandSAR NZ , 2019).

Furthermore, the pamphlets (Figures 8 and 9) which include the instructions of actions to take when hazards occur are published, by the Civil Defense to make the locals and the tourists less vulnerable. Also, the fact that 77% of the residents in Rotorua answered that they were educated about the hazards at schools or at work establishes that the local government is attempting to make the community able to withstand disasters.

Therefore, it is true that the local government takes a leading role with a preparation, advertises the risks and gives instructions when disasters occur.

Conclusion

Is Rotorua, New Zealand, prepared for a major tectonic hazard?

Hypothesis 1:

Tourists will be unfamiliar with the risks of the area and so less prepared.

It is distinctly observed from Figure 5 that the tourists are familiar with the Rotorua's risks (82%), however, Figure 6 and 7 demonstrates that the even though the tourists are aware of the risks, they haven't taken into action to prepare themselves for the hazards or given any instructions, which proves that they are less prepared.

Overall, it can be concluded that the hypothesis is **only partially proven correct**, with the answer that many of the tourists ignore the risk and chose not to be prepared.

Hypothesis 2:

Education and instruction about the hazards are given to the locals to prepare them.

As Figure 10 reveals, 77% of the locals got educated about the risks which proves the hypothesis correct. Moreover, the education increases ones confident level during a small earthquake from 69% to 85% (Figure 12) and a large earthquake from 59% to 79% (Figure 13). However, Figure 11 shows that the education may not significantly determines on one's action on preparing evacuation plans which was also proven from chi squared test.

Therefore, it can be stated that the hypothesis is **to some extent it is rejected** and concluded that the education about the hazards are given to the locals to increase their preparedness and confidence level (as Figure 8 and 9 shows). Nevertheless, education hasn't given any impacts on one's preparedness, thus, their vulnerability hasn't changed.

Hypothesis 3:

The local government takes a leading role in preparing people for tectonic hazards.

The interview proved that they have well planned evacuation plans for several situations according to CIMS mandated by the government . Moreover, in some places such as Skyline Rotorua has conducted several stimulation test annually which makes them less vulnerable when hazards occur. Figure 9 also demonstrates that the government are trying to increase the locals through education. These actions, as a result, lead the community to relatively rely on them (Figure 14).

Therefore, the hypothesis is proven **correct** that the local government has a leading role in preparing people for tectonic hazards.

Overall, Rotorua is to some extent prepared by higher authorities, but there may be factors that limit the locals and the tourists' preparedness. Thus, Rotorua is relatively unprepared for a major tectonic hazard.

Evaluation

The survey was successfully that was carried in Rotorua collecting a large amount of responses which made the data reliable. However, there might have been significant influence on the respondents' answers. When asking their awareness and preparedness to the hazards, the questions may have affected their awareness to increase, therefore this may have influenced figure 12 especially. In addition, although stratified and opportunistic sampling were used, it biased the respondents that the large proportion of the survey responders were tourists while there were only few locals, which makes the data less reliable for the locals. This might be because the survey was carried out mainly in places where tourists' visits such as museums. This could've been improved by collecting more data from the locals where places, for instance, local supermarkets.

Additionally, there could have been improvements in the questions. For "Do you have an emergency kit?" and "Do you have emergency food and water?", it didn't specifically ask the tourists where they have those emergency goods. It might be in their home town or the tourists may carry with them as they travel around. Because this essay is assessing the vulnerability in Rotorua, thus, the result will not be reliable if the tourists ticked "Yes" when they have it in their home country. Therefore, the question should have asked more specifically, for example "Do you have an emergency kit in Rotorua?" to ensure that they are prepared in Rotorua.

Moreover, the phrasing in hypothesis can be changed for hypothesis 3. From the interview, not just the local government but the tourist operators in tourist attractions have adequately prepared for any possible hazards. Hence, this hypothesis can be rephrased as "The local government and tourist operators take a leading role in preparing the locals and tourists for tectonic hazards."

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Appendix

1. Survey Questionnaire (respondents: Locals)

2019 Survey for Rotorua – Local Residents

We are students from Auckland International College conducting a survey about hazards in Rotorua.

1. **Age (years) and Gender:**
 0-18 19-30 31-45 46-64 65+
 Male Female Other
2. **Ethnicity:**
 NZ European Maori Pacific Islander Asian Other: _____
3. **How long have you lived in Rotorua?** Less than 2 years More than 2 years
4. **Do you work in the tourism industry in any way?** Yes Indirectly No
5. **What kinds of dangers do you think happen here in Rotorua? (tick as many as you wish)**
 Earthquakes Hurricanes Tsunamis Volcanoes Tornadoes Crime
6. **Have you ever experienced an earthquake or volcanic eruption?** Earthquake Volcanic eruption
7. **How frequently do you experience earthquakes (small or large) in Rotorua?**
 Once a day Once a week Once a month Once a year
8. **Is your house earthquake proof?** Yes No I don't know
9. **Do you think the buildings in Rotorua are earthquake proof?** None Some Most All
10. **Have you had any education at school/work about what to do during an earthquake?** Yes No
11. **Have you seen elsewhere (eg on TV) what to do during an earthquake?** Yes No
12. Please tick:

Do you have the following things?	Yes	No	I don't know
Evacuation plan or meeting point with your family			
Emergency kit (including a torch, radio, batteries etc.)			
Emergency food and water			
A vehicle for emergency use/evacuation			
A place to stay if your accommodation becomes damaged			
13. Please tick how you feel about the following: **1 = disagree strongly 5 = agree strongly**

	1	2	3	4	5
I would be calm during a small earthquake					
I would be calm during a large earthquake					
I would know what to do during an earthquake					
I would know what to do after an earthquake occurs					
A large earthquake is likely to actually happen					
This community will keep me safe during an earthquake or volcanic eruption					
This community will help me to stay safe after an earthquake or volcanic eruption					

Thank you very much for your participation and patience!

2. Survey Questionnaire (respondents: Tourists)

2019 Survey for Rotorua - Tourists

We are students from Auckland International College conducting a survey about hazards in Rotorua.

1. **Age (years) and Gender:**
 0-18 19-30 31-45 46-64 65+
 Male Female Other
2. **Are you from New Zealand?** Yes No
3. **Ethnicity (NZ) or country (other):**
 NZ European Maori Pacific Islander Asian Other: _____
4. **What is the duration of your stay in Rotorua?** Less than a week More than a week
5. **Is this your first visit to Rotorua?** Yes No
6. **Why did you choose to come to Rotorua?** _____
7. **What kinds of dangers do you think happen here in Rotorua? (tick as many as you wish)**
 Earthquakes Hurricanes Tsunamis Volcanoes Tornadoes Crime
8. **Have you ever experienced an earthquake or volcanic eruption?** Earthquake Volcanic eruption
9. **Have you been told what to do during an earthquake and/or volcanic eruption in Rotorua?**
 Yes No
10. **Has the government in your home country provided earthquake education to you?** Yes No
11. **Do you think the buildings in Rotorua are earthquake proof?** None Some Most All

12. Please tick:

Do you have the following things?	Yes	No	I don't know
Evacuation plan or meeting point with your family			
Emergency kit (including a torch, radio, batteries etc.)			
Emergency food and water			
A vehicle for emergency use/evacuation			
A place to stay if your accommodation becomes damaged			

13. Please tick how you feel about the following: **1 = disagree strongly** **5 = agree strongly**

	1	2	3	4	5
I would be calm during a small earthquake					
I would be calm during a large earthquake					
I would know what to do during an earthquake					
I would know what to do after an earthquake occurs					
A large earthquake is likely to actually happen					
This community will keep me safe during an earthquake or volcanic eruption					
This community will help me to stay safe after an earthquake or volcanic eruption					

Thank you very much for your participation and patience!

3. Calculations:

- Chi Squared test

The table showing the number of locals with or without evacuation plan within the locals who got or who didn't get educated about the earthquakes

Evacuation Plan	Educated	Not Educated
Yes	50	12
No	33	10
Unknown	2	0

Chi-squared = 0.764068

Degrees of freedom = (2-1) x (3-1) = 1 x 2 = 2

Check whether the chi value is less than the value shown in table below

0.764068 < 5.99, therefore, null hypothesis is 95% accepted.

Chi-square Distribution Table

d.f.	.995	.99	.975	.95	.9	.1	.05	.025	.01
1	0.00	0.00	0.00	0.00	0.02	2.71	3.84	5.02	6.63
2	0.01	0.02	0.05	0.10	0.21	4.61	5.99	7.38	9.21
3	0.07	0.11	0.22	0.35	0.58	6.25	7.81	9.35	11.34
4	0.21	0.30	0.48	0.71	1.06	7.78	9.49	11.14	13.28
5	0.41	0.55	0.83	1.15	1.61	9.24	11.07	12.83	15.09

95% confidence = 0.05

If P value is less than 0.05, then null hypothesis is rejected

P = 0.682472 > 0.05, therefore, it is accepted.

- Percentage (calculated by excel)

Used in figures 5, 6, 7, 10, 11, 12, 13, 14, 15 and 16