Volcanic Hazards Simulation – Instructor Manual

This document is written to introduce and assist instructors in running a Volcanic Hazards Simulation in their curricula.

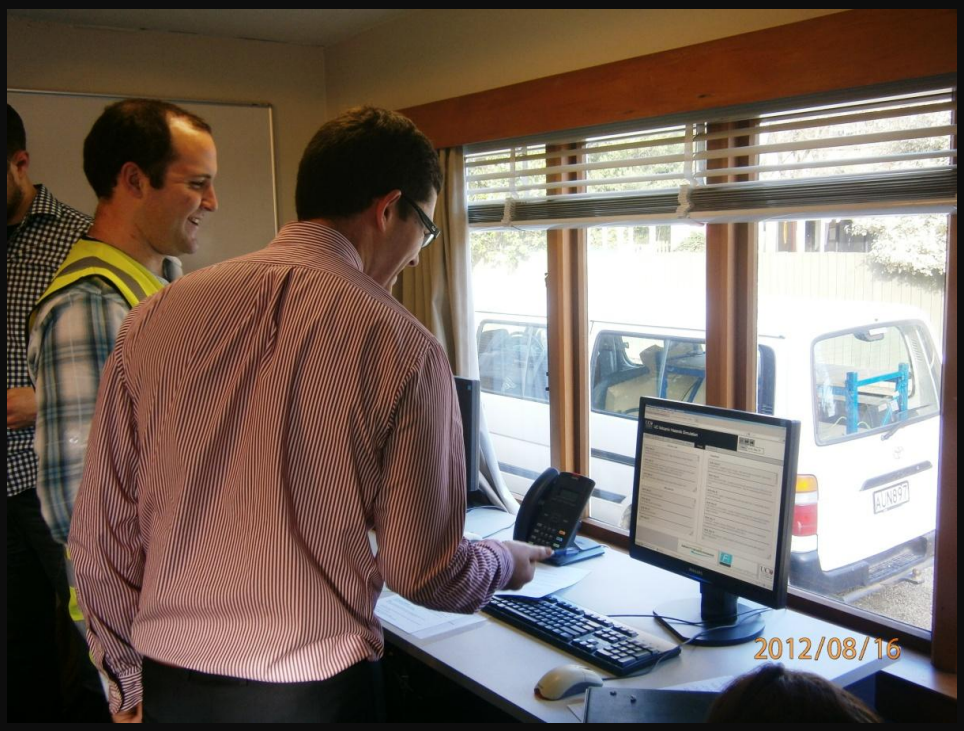


Table 1: Instruction Steps

[1]These steps are mandatory for new instructors, and can be skipped by instructors who have run the Simulation before.

Step 1	Pick a Geologic Scenario[1] **1.1 Tongariro Volcanic Centre (TONG) –** Plinian-style Eruption Sequence; Regional environment (Appendix T Materials) **1.2 Auckland Volcanic Field (AVF) –** Strombolian Eruption Sequence, Urban environment (Appendix A Materials) **1.3 Make your own –** Use the simulations available, to make your own version. Will need to contact us to do so.	Things to Consider - Setting matters for context at your University and in your community. - Local versus Regional impacts. - If running a NZ-based exercise, you must familiarize yourself and your students with NZ places and locations. Timeline Months prior
Step 2	Get familiar with the Simulation[1] **2.1 Read this document** and **review** the Instructions given to Students (Appendix T1 and A1). **2.2 Review the Eruption Sequence** (Appendix T2 and A2) **2.3 Review geologic concepts and skills** your students will need (i.e., Table 2, Learning Goals) **2.4 Download all the files needed** All files and Data Stream (Appendix T9 and A9)	Things to Consider - The simulation is best used as a "capstone" activity (i.e., allowing students to apply what they've learned in your class). - If this is not what you are aiming to do, then other teaching activities could be used; See Step 5. Timeline Months prior
Step 3	Confirm dates, times, location, help **3.1 Book location & space & equipment –** Large space with computers and projector. **3.2 Book date & time –** Running time is 4-5 hours **3.3 Book Staff –** Usually 2-4 other staff to help. (See Table 3, Instructor Roles)	Things to Consider - The simulation runs on an offline PC computer (does not require the internet, but it is nice for Google Earth) - Need to schedule in pre-lab and lecture(s) into your curricular plan as well. Timeline 4 weeks prior

Step 4	Assign Students to Roles **4.1 Hand out** and collect the **Role Questionnaire** (Appendix C1) **4.2 Assign Roles -** Review the roles and team responsibilities (Bibliography; Appendix T3 and A3) and assign students to the right roles. Pay attention to leadership qualities. **4.3 Post** the students **roles** and teams **online** (or in person) **4.4 Post** the **Instructions** to students (Appendix T1 and A1), and **Bibliography** online (or in person) for students to read prior to the Simulation.	Things to Consider - The quality of the simulation is dependent on how prepared students are, and how much they relate to their role. - Assigning students to the right roles can be difficult; it is easier if you know the personalities of the students. - Mix genders and abilities. - Decide on how much the Simulation will be worth (typically 5-15% of a course grade) Timeline 2-3 weeks prior
Step 5	Give preparation exercises and lecture(s) **5.1 Set Simulation Assessment Worth –** This will motivate students to prepare and participate. *Suggested Exercises:* **5.2 Hazards Map Exercise** (i.e., Lab, Homework or Interactive Lecture) (Appendix T4 and A4) **5.3 Volcanic Monitoring Lecture**(s) – Overview of the science of monitoring volcanoes **5.4 Science Communication Lecture** (Appendix C2) – Overview of the best practices of science communication	Things to Consider - The quality of the simulation is dependent on how prepared students are. - If you course doesn't cover the topics needed, the students will struggle to perform well in the Sim. Timeline 2-3 weeks prior

Step 6	Preparing for the day of Simulation: **6.1 Print out all the reports** & paperwork needed (Appendix T5 and A5 for list of paperwork) **6.2 Unpack** the data stream package on your computer and open with Mozilla Firefox. (Appendix C7 for step-by-step instructions). **6.3 Organise beverages and food** - Remind students to bring their own lunch or provide food for them.	Things to Consider - The amount of paperwork that is needed to be printed will depend on the numbers of students you have. - You may assign some assessment to the pre-readings (e.g., have them write a one-page summary of their role and responsibilities prior to the Sim). - Run through the simulation yourself and with staff if time-available. - We like to complete the exercise with a BBQ. Timeline 1 week prior
Step 7	Day of the Simulation: **7.1 Installing the Data Stream** (Appendix C7) **7.2 Review the Instructions with the Students** (Appendix T1 and T2) and introduce all the students and all the experts to one another. **7.3 Have a staff person responsible for time-keeping -** Pauses, handing out Challenge Questions, etc. **7.4 Begin Simulation** **7.5 Give Guidance When Needed**	Things to Consider - Copying files can take up to 30 minutes - Pauses and Challenge Questions are very important. Review these ahead of time. - Students may become quite fatigued. Be sure to pause if all students are becoming tired.
Step 8	After the Simulation: **8.1 Grading of the Simulation** - Hand-out the Overall Performance Rubrics to the students after it is over (Appendix C3) **8.2 Collate Grades, and Collect Feedback**	Things to Consider - Any feedback you receive will help with the following year. - Send us feedback that you think will improve the Sim

Step 1. Pick a Geologic Scenario

Select the geologic setting and eruption sequence (i.e. Scenario) that best suits your curricula and learning goals. We have developed two scenarios within the New Zealand context: phreatic to Plinian volcanism from the ***Tongariro Volcanic Centre*** in the National Park; and a series of Strombolian and Hawaiian style volcanism within the ***Auckland Volcanic Field***.

1.1 Tongariro Volcanic Centre

This scenario requires your students to monitor the Tongariro Volcanic Centre. The event follows a Pinatubo-style eruption sequence (Appendix T2; the eruption sequence should be only shown to instructors). The impacts from the event range from proximal (within the National Park) to regional/national impacts with the progressively larger eruptions.

1.2 Auckland Volcanic Field

This scenario requires your students to monitor the Auckland Volcanic Centre. The event follows an eruption sequence modelled after Mt Wellington and uses several modern analogues (Appendix A2; the eruption sequence should be only shown to instructors). Monitoring is focused within the Mangere Bridge area of Auckland, and spreads to the city-wide once a vent is established.

1.3 Make your own

Adapting the current materials would require: developing an eruption sequence, collating literature to match the geologic history and emergency management topics within the new setting, adapting/modifying the data stream (i.e., the information the students "monitor") to match your scenario. Contact us (Dr. Jacqueline Dohaney, jdohaney@gmail.com or Dr. Ben Kennedy, ben.kennedy@canterbury.ac.nz) if this is the way you want to go.

Step 2. Get familiar with the Simulation

If you are running this simulation for the first time, there is a lot of literature and background information to get familiar with. The more prepared that you (the instructor) are, the more your students will benefit from this learning experience.

2.1 Review Instructions

This document and the Instructions for Students document (Appendix T1 and A1) are both excellent for understanding the 'rules' of the simulation, and the preparation documents and activities that need to be carried out prior to the simulation day.

2.2 Review the Eruption Sequence

The eruption sequence is essentially the answers to the simulation timeline. (Appendix T2 and A2). This information should be given to all the instructors or helpers. It includes all the major volcanic precursors, eruptions, and simulation pauses. These are important for time keeping, and for knowing what t0 expect (and therefore being helpful in guiding your students).

2.3 Review the geologic concepts, skills and learning goals

The simulation is a challenging learning experience. Students require specific skills and knowledge prior to the simulation (Table 2A). Be sure that your students will have been exposed to these concepts prior to the exercise.

After the simulation activity, students should have achieved several higher-level learning goals (Table 2B). It is common that instructors misinterpret the main objectives of the exercise. The objective is not to have the simulation run perfectly, or for your students to behave exactly as the professionals would - It is for your students to learn about the ways that a volcanic disaster is monitored and mitigated.

2.4 Download all the files

Within this document, the instructions, and the bibliography, there are many digital files that should be downloaded, organised and printed. A large (>150 Mb) zip file of all the most up to date (check date stamp) files can be found here:

Digital files

Tongariro Simulation files

Auckland Simulation files

If the files you have do not work, or are not updated. Please email the designer (Dr. Jacqueline Dohaney; jdohaney@gmail.com).

Table 2: Learning Goals of the Simulation

A. Prior to the simulation, students should be familiar with….
1. The variety of volcanic hazards associated with different types of volcanism. 2. Reading and understanding geological and topographical maps. 3. Volcanic monitoring data types and interpretation of these data in case studies and in "real-time". 4. How different monitoring data go together to form a working model of what's happening in the volcano. 5. Knowledge of New Zealand Alert levels 6. A general idea of what the GeoNet and Emergency Management professionals do during a crisis.
B. After the simulation, students should be able to…
1. **Observe** volcanic monitoring data and social media in "real-time"; **record** observations and **communicate** these observations to a team (orally and in writing). 2. **Collaborate** within a team, by using multiple streams of data in "real-time" to **develop** a working-model (inclusive of scientific and social-economic data) together in order to: a.) **assess** the current state of volcanic activity; b.) **identify** major changes in volcanic activity; c.) **judge** if changing conditions threaten the human population; d.) use a-c to **assign** appropriate GNS alert levels; e.) **respond** to community concerns. 3. **Estimate** and **illustrate** the distribution of volcanic products (e.g. volcanic ash) based on the volume and style of activity in order to create volcanic hazard maps using geological and socio-political map data (i.e. geology map, geological history, and contoured topographic map). 4. **Estimate** the impact to social and political sectors based on the distribution and style of volcanic activity, given the alert level of the volcano in question. **Respond** to crises (in a timely manner) in order to mitigate the impact before/during/and after a volcanic disaster. 5. **Communicate** effectively (orally and written) within your team and to the other teams and to the public (newsfeed) in order to effectively handle any possible volcanic threat. These are assessed by: a.) Press Conferences (Questions and Responses) b.) Effective group discussions b.) Media Releases c.) Volcanic Impact Reports d.) Effective Inter-agency (between GeoNet and EM) conversations & meetings 6**. Have an awareness** of a.) scientists and emergency managers responsibilities, agendas, and expertise; b.) team structures. hierarchy and protocols; c.) external agencies that assist Emergency Managers, and d.) the public's concerns; during a simulated volcanic crisis.

Step 3. Confirm Dates, Times, Location & Staff

3.1 Book Location & Space & Equipment

The space that the students work in is important for running a successful simulation. The preferred setting is: a large (lab space, or open room), with desktop room (for writing, and making maps) and PC or Mac computers. You may ask your students to bring their own laptops as well.

Photo of Tongariro Simulation run at GNS Wairakei in 2011.

3.2 Book Date & Time

The simulation is made up of periods of data monitoring, and periods of pause (where students perform more complex tasks). The entire simulations run for ~4-5 hours but they can run longer if the students need more time to do the necessary tasks. Typically, an hour preparation is also good to schedule in (to make sure that the computers run the program properly, and the paperwork and space is organised).

3.3 Book Staff

The simulation runs best when several postgraduates and staff members help out. Instructors have the expertise necessary to think through the complex tasks smoothly, and provide students with assistance. At a minimum having three staff (total) allows one person to work with the Emergency Management team, one with the GeoNet team, and one who plays the

"Volcano". Other roles are great for creating a more authentic experience (See Table 3) and if necessary some roles can be doubled up.

Table 3: Instructor Roles

Role	Responsibilities
The "Volcano"	Follows the eruption sequence, improvises and responds to the GeoNet field team requests. Anticipates the behaviour of the volcano. Should use a model that aligns with the volcanic events (which are pre-determined).
Emergency Management Specialist	Oversees, assists, and challenges the Emergency Management team. Should review local and national protocols which are specific to volcanic crises.
Volcanology Specialist	Oversees assists and challenges the GeoNet team. Should provide help with interpreting volcanic precursors, and developing a model of the ongoing volcanic activity.
Local Mayor	Responds to concerns of social and economic welfare of the community. Helps weight in on issues around infrastructure and costs of evacuations, etc.
Prime Minister	Responds to concerns of social and economic welfare of New Zealand. Helps weight in on issues around long term impacts of a volcanic crisis.
Public Information Director	Gives assistance on providing accurate and useful written and oral communications. Critiques format, content and tone of communications.
Rogue Volcanologists	Inquires on science decisions. Can have extreme or appropriate reactions to science information (to challenge and to throw students off)
Time Keeper & Challenge Card Dispenser	Hands out challenge questions, and helps keep time and the simulation running smoothly. See Appendix T7 and A7 for list of Challenge Questions.

Step 4. Assign Students to Roles

4.1 Hand-out and Collect the Role Questionnaire

In order for students to be assigned to the right roles, we have them fill out a Role Questionnaire (Appendix C1). Distribute the questionnaires, and collect them.

4.2 Assign Roles

There are several important roles that can make, or break the success of the simulation: The team leaders (Group Controller, Section Manager, and Duty Manager), the Public Information Officers, and the Ash Specialist. Refer to the role descriptions within the Bibliography (Appendix T3 and A3) and match the skills and attributes (self-reported in the Role Questionnaire) to the students.

The Role Questionnaire asks the students a series of questions. Section 1 is demographic information. Things to consider include: geology background (i.e., year of study), age, and gender. Students at higher levels of study will theoretically have more geologic expertise. These students can be placed in important roles. Students who are older may have more life experience, which can make for better leadership and teamwork qualities. To keep the teams balanced, it is good to have a mix of female and male members.

Section 2 asks students about their behaviour and abilities. Students who are generally more confident in their teamwork and communication skills will have mostly "agree" statements. These students should be matched to leader roles. The GeoNet team requires students to be more quantitative, so Section 2 question 8 is more important for those roles. Section 3 asks students about their favourite and least favourite geology topics. For motivational reasons, it is good to match students likes (e.g., a student who enjoys geochemistry, should be placed in the geochemist role).

4.3 Post the Roles Online

Once all the students have been assigned to roles and team, post these online so that students can begin preparing for the simulation.

4.4 Post the Instructions and Bibliography Online

To get students prepared for the simulation, post the literature (i.e., Interactive Bibliography; Appendix T3 and A3) and the instructions (Appendix T1 and A1) online. Give students adequate time to read the materials (more than 9 days).

Step 5. Give preparation exercises and lecture(s)

5.1 Set the Simulation Assessment Amount

In order to get students prepared for the simulation you should assign grades so that you can motivate students to participate and be accountable. Typically, instructors assign 10-15% (with 5% going towards the Hazards Map Exercise or reading summaries). Set the simulation assessment worth in the course outline.

5.2 Hazards Map Activity

So that students might familiarise themselves with the geology and infrastructure of the local area we recommend setting your students to do a hazards mapping learning exercise (Appendix T4 and A4). This activity was originally designed for a full day field trip and can be adapted to a full day of learning.

5.3 Volcanic Monitoring Lecture

The GeoNet team is tasked with monitoring the activity of a volcano. Providing the science and practical aspects of volcanic monitoring in a lecture is ideal for introducing these concepts to them.

5.4 Science Communication Lecture

Communication is key to success of the simulation. To provide communication best practices, you can deliver a lecture which covers the basics of communicating in a volcanic crisis (See Appendix C2).

Step 6. Preparing for the day of Simulation:

6.1 Review and Print out all the Paperwork

There are reports and other paperwork that needs to be printed for the simulation. A list of all the paperwork that needs to be printed is in Appendix T5 and A5.

Team Structures (i.e., Flow of Information) (Appendix T6 and A6) – These large diagrams (A3) are used for illustrating how communication should work during the simulation. They also illustrate the hierarchy within the teams.

Challenge Questions (Appendix T7 and A7) – Prompts that are given to the students throughout the simulation (only for the instructor to see). The instructor(s) may choose to omit some of the challenge questions, if the simulation is running long, or is becoming too difficult for the students.

Overall Performance Rubric (Appendix C3) – This document is used to grade the students performance. Typically we have the student's grade themselves, and then grade a partner's performance.

Data Logs (Appendix C4) – This document is used for students to record their thinking during the simulation (their thoughts, drawings, graphs, etc.).

Media Release (Appendix C5) – This document is used to communicate the science and hazards information to the public.

Reports (Appendix C6) – Used to communicate information to the Public. GeoNet team has two reports: the **Alert Level Report** (which is used when a Volcanic Alert Level is changed) and a **Field Work Risk Assessment Report** (which is used to gain permission to go onto the volcano). The Emergency Management team has **Volcanic Impact Report** (which is used to communicate risks and recommendations to the public during a volcanic event).

Maps (Appendix T8 and A8) **-** Students use these to draw ash dispersal and emergency management actions (e.g. evacuation zones, or no-fly zones). Print on A3 paper size.

6.2 Unpack the Data Stream & Experiment

The monitoring and social media information that the students monitor is delivered on an offline website package (Appendix T9 and A9). The website package runs on Mozilla Firefox. Practice unpacking the data stream on your work computer. Refer to Appendix C7 for step-by-step instructions on how to unpack and run the data. Once it is up and running, press play, pause, fast forward, etc. to see the events unfold and to practice using the interface.

6.3 Organise Food and Beverages

As the simulation runs for a half day, it is best to advise students to eat prior to the simulation, and provide snacks or a BBQ during or at the end.

Step 7. Day of the Simulation

7.1 Unpack the Data Steam and Install Firefox

The monitoring and social media information that the students monitor is delivered on an offline website package. The website package runs on Mozilla Firefox. Practice unpacking the data stream on your work computer. Refer to Appendix C7 for step-by-step instructions on how to unpack and run the data.

7.2 Review the Instructions with the Students

It is good to begin the simulation by introducing the staff, the teams and the general "rules". Refer to Appendix T1 and A1 page 1 for the general rules.

7.3 Have a Time Keeper

One staff member should be selected to watch the time, call the pauses, and to hand out the Challenge Questions. This helps the simulation move forward, and helps participants to stay on task. The simulation website is not synced; therefore one person counts down and tells all the participants to press pause on their screens. The pauses are in the Eruption Sequence (Appendix T2 and A2). This staff member could also be one of the other roles, if necessary.

7.4 Begin Simulation

Count down, and have all students press play at the same time.

7.5 Give Guidance to Students When Needed

The students may or may not have all the knowledge and skills that are needed to carry out the tasks. Instructors are asked to guide the teamwork, critical thinking, decision-making and communication tasks. We did not set up the simulation to "fail", so it is advised that you follow along and step in to provide helpful assistance when needed.

Step 8. After the Simulation

8.1 Grading the Students Performance

Hand out the overall performance in the simulation rubric (Appendix C3) to the students. Have them grade their own skills, and another student. Use these grades to assess their participation and behaviour during the simulation.

8.2 Collate grades and Collect Feedback

Collate the grades and send out an email or a short questionnaire that assesses how well the simulation went, and where students think you can improve. Some suggested questions include: What were your favourite aspects of today's simulation? What was your least favourite? What aspects of the stimulation would you keep? What would you change?

Appendix T – Tongariro Volcanic Centre

The following is a series of curricula that has been designed specifically for the Tongariro Volcanic Centre Scenario. All materials are presented here in this document, but original digital files exist and can be accessed through the digital package (See Step 2).

Appendix T1. Instructions to Students, Tongariro
Appendix T2. Tongariro Eruption Sequence
Appendix T3. Tongariro Interactive Bibliography
Appendix T4. Tongariro Hazards Map Activity
Appendix T5. List of Paperwork to be printed
Appendix T6. Team Structure (i.e., Flow of Communication) Diagrams
Appendix T7. Tongariro Challenge Questions
Appendix T8. Tongariro Maps

Appendix T1. Instructions to Students, Tongariro

Volcanic Hazards Simulation: Instructions to Students

Before we start:

1. Do your reading!: Based on your **role** and responsibilities, read or skim over the relevant **literature** from the Interactive Bibliography.

2. Respect the **group organization**, and your roles. The Section Manager and Controller is 'in charge' but your group must work democratically to achieve the best solutions. Refer to **Flow of Information** (GeoNet team; Emergency Management Team) documents at the end of this packet.

During the Simulation:

3. You should **record** all of your observations on your **data log**. Include interpretations, sketches or whatever is helpful to you. Put your name, date and role on **EVERYTHING** that you record during the simulation (Be accountable ☺)

4. **Communication** and **teamwork** are essential tools used by REAL GeoNet scientists and Emergency Managers in order mitigate disasters! Be sure to use these best that you can!

5. **Ask questions** to the 'Experts' whenever you think you need help or are stuck.

6. **Fill out** the relevant **paperwork** or **maps**, at the appropriate times!

GeoNet:	**Emergency Managers:**
Alert Level Change Reports; Ash Dispersal Map (Isopach) Flow Dispersal Maps. Media Releases Fieldwork Risk Assessment	Volcanic Impacts Reports; Evacuation Routes or Road Closure Maps; Media Releases

7. There are **engineered PAUSES** into the simulation, to allow you more time to think and do the tasks that are given to you.

After the Simulation:

8. You will be graded by yourself (a self-assessment) and someone seated next to you using a Rubric (Overall performance in the Simulation; See the end of this document).

Learning Goals for Volcanic Hazards Simulation

Prior to the simulation, students should be familiar with….

1. The variety of volcanic hazards associated with different types of volcanism.
2. Reading and understanding geological and topographical maps.
3. Volcanic monitoring data types and interpretation of these data in case studies and in "real-time".
4. How different monitoring data go together to form a working model of what's happening in the volcano.
5. Knowledge of New Zealand Alert levels
6. A general idea of what the GeoNet and Emergency Management professionals do during a crisis.

After the simulation, students should be able to…

1. **Observe** volcanic monitoring data and social media in "real-time"; **record** observations and **communicate** these observations to a team (orally and in writing).

2. **Collaborate** within a team, by using multiple streams of data in "real-time" to **develop** a working-model (inclusive of scientific and social-economic data) together in order to:
a.) **assess** the current state of volcanic activity;
b.) **identify** major changes in volcanic activity;
c.) **judge** if changing conditions threaten the human population;
d.) use a-c to **assign** appropriate GNS alert levels;
e.) **respond** to community concerns.

3. **Estimate** and **illustrate** the distribution of volcanic products (e.g. volcanic ash) based on the volume and style of activity in order to create volcanic hazard maps using geological and socio-political map data (i.e. geology map, geological history, and contoured topographic map).

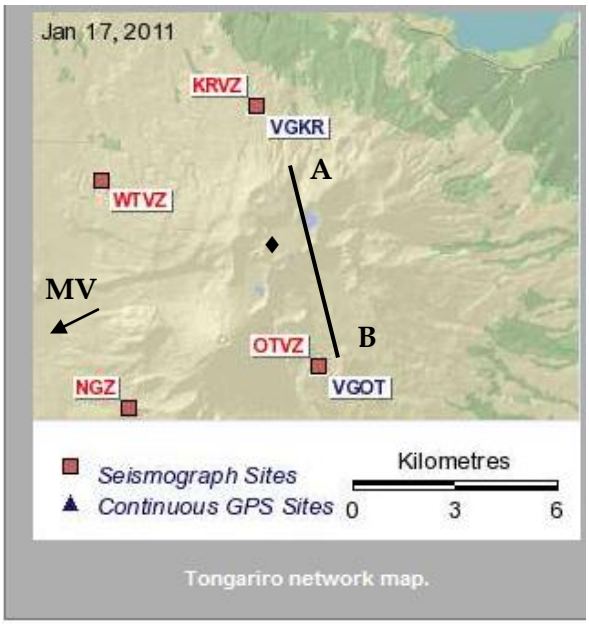
4. **Estimate** the impact to social and political sectors based on the distribution and style of volcanic activity, given the alert level of the volcano in question. **Respond** to crises (in a timely manner) in order to mitigate the impact before/during/and after a volcanic disaster.

5. **Communicate** effectively (orally and written) within your team and to the other teams and to the public (newsfeed) in order to effectively handle any possible volcanic threat. These are assessed by:

   a.) Press Conferences (Questions and Responses)
   b.) Effective group discussions
   b.) Media Releases
   c.) Volcanic Impact Reports
   d.) Effective Inter-agency (between GeoNet and EM) conversations & meetings

6**. Have an awareness** of
a.) scientists and emergency managers responsibilities, agendas, and expertise;
b.) team structures. hierarchy and protocols;
c.) external agencies that assist Emergency Managers, and
d.) the public's concerns; during a simulated volcanic crisis.

GeoNet Team: Tongariro Monitoring Network and Measurements



A –B	Cross section, along which Deformation is calculated
♦	Volcano Cam, and Microphone Station
MV	Mangatepopo Valley Weather Station

Seismicity: 4 seismometers (KRVZ, WTVZ, OTVZ, and NGZ) report activity around the volcano. The reports given to you represent information about earthquake activity:
a. the **number** of quakes that occurred;
b. the maximum **magnitude** (~Richter scale, New Zealand Modified);
c. average **depth** (km); and
d. the **type** of quakes. The type of quakes reported include: **HF** (high frequency), **LF** (low frequency), **EX** (explosion signals) and **T** (tremor).

Gas Readings: CO_2 and SO_2 are both reported as weekly to daily measurements from the Volcano Cam site (diamond). Airborne surveys report an emission rate (tonnes/day) for SO_2 and CO_2.

Weather: Wind Direction (e.g., N – Winds coming from the North), Wind speed (Maximum reported km/hour), and Precipitation (mm). These data are remotely reported from a weather station located in Mangatepopo Valley (**MV**). Reported by New Zealand's MetService.

Deformation: (meters) **Deformation** is measured by calculating the present distance between two GPS located stations (VGOT and VGJR) (Line A-B, above), and assessing any changes from the last reading. A positive value indicates that the stations have moved away from one another, and a negative indicates that they have moved closer to one another. Most volcanoes do not inflate or deflate by more than a couple meters per year.

Tilt: (μR) Microradians is the measure of extremely small angular distance. A increase in slope of the volcano is indicated by increasing values, while a decrease in values represents a decrease in the slope. Tilt is measured from the **VGOT** station and has a precision of 5-10 μR.

Visual Data: Webcam located near Red Crater which streams the visual information back to GeoNet. A microphone is also part of the same station. Views of Ngauruhoe are also possible from this location. In the event of an eruption, MetService reports the **Maximum Plume height** (in meters) recorded by satellites.

Ash Thickness Estimates + Isopach Maps – The ash volcanologist, can use an Ash Plume Model (excel file) to help estimate ash thicknesses immediately after an eruption to make predicted thicknesses. See Ash Plume Model excel sheet for more assistance.

New Zealand Volcanic Alert Level System

	Volcanic Alert Level	Volcanic Activity	Most Likely Hazards
Eruption	5	Major volcanic eruption	Eruption hazards on and beyond volcano*
Eruption	4	Moderate volcanic eruption	Eruption hazards on and near volcano*
Eruption	3	Minor volcanic eruption	Eruption hazards near vent*
Unrest	2	Moderate to heightened volcanic unrest	Volcanic unrest hazards, potential for eruption hazards
Unrest	1	Minor volcanic unrest	Volcanic unrest hazards
	0	No volcanic unrest	Volcanic environment hazards

An eruption may occur at any level, and levels may not move in sequence as activity can change rapidly.

Eruption hazards depend on the volcano and eruption style, and may include explosions, ballistics (flying rocks), pyroclastic density currents (fast moving hot ash clouds), lava flows, lava domes, landslides, ash, volcanic gases, lightning, lahars (mudflows), tsunami, and/or earthquakes.

Volcanic unrest hazards occur on and near the volcano, and may include steam eruptions, volcanic gases, earthquakes, landslides, uplift, subsidence, changes to hot springs, and/or lahars (mudflows).

Volcanic environment hazards may include hydrothermal activity, earthquakes, landslides, volcanic gases, and/or lahars (mudflows).

***Ash, lava flow, and lahar (mudflow) hazards may impact areas distant from the volcano.**

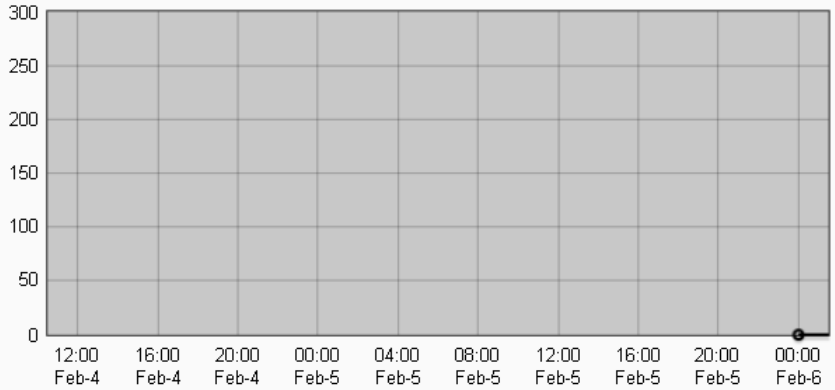
This system applies to all of New Zealand's volcanoes. The Volcanic Alert Level is set by GNS Science, based on the level of volcanic activity. For more information, see geonet.org.nz/volcano for alert levels and current volcanic activity, gns.cri.nz/volcano for volcanic hazards, and getthru.govt.nz for what to do before, during and after volcanic activity. Version 3.0, 2014.

UC Volcanic Hazards Simulation

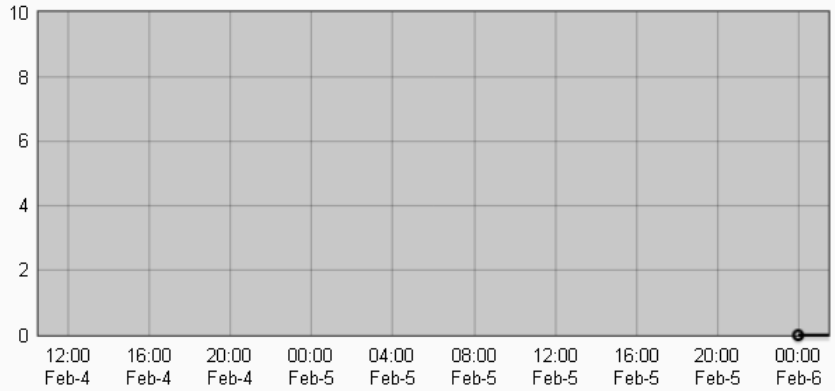
Time 00:00, Feb 6

Seismic 1 | Seismic 2 | Gas | Deformation | Weather | Visuals | Ash Reports

No. of Quakes



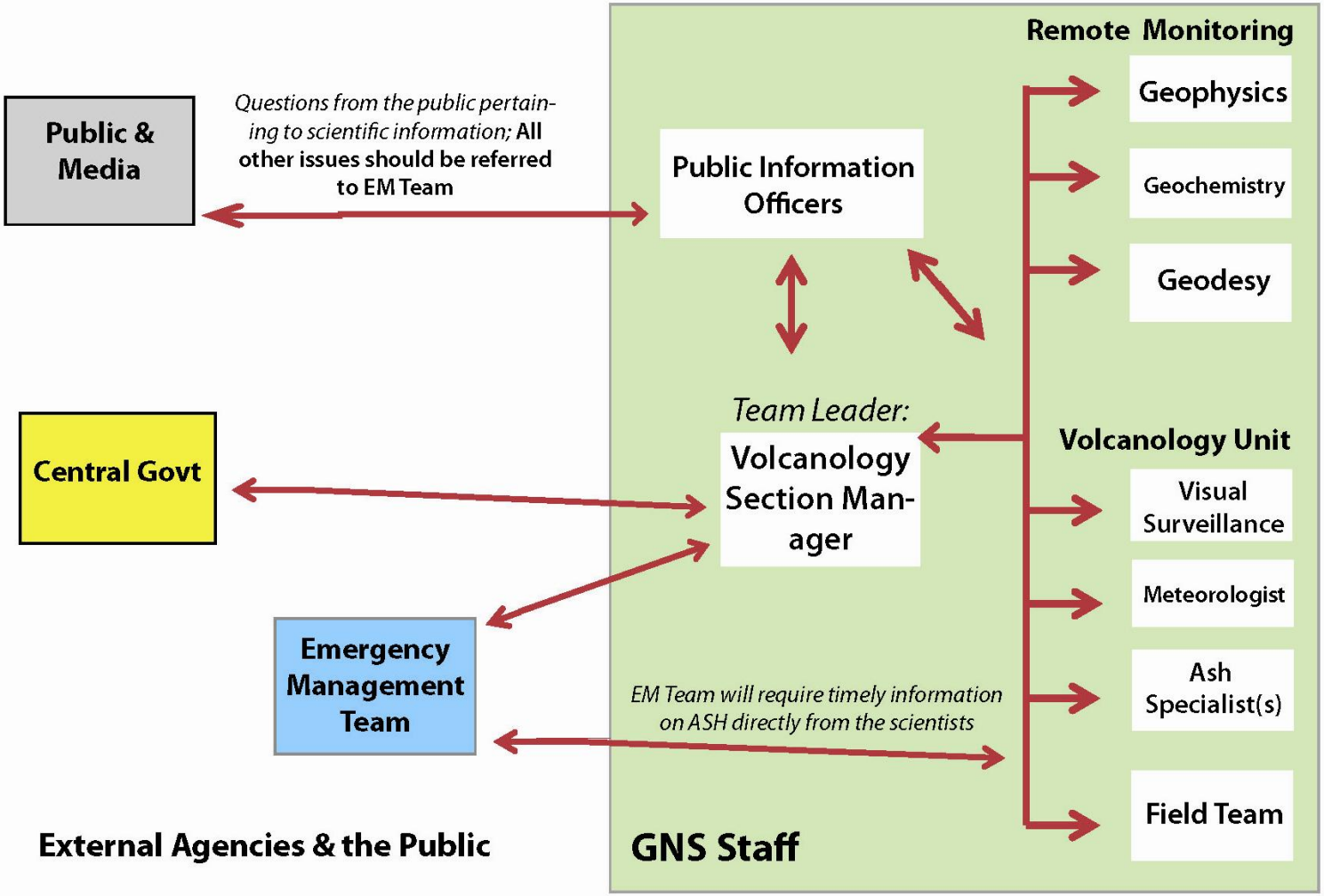
No. of Quakes {clipped to 10}



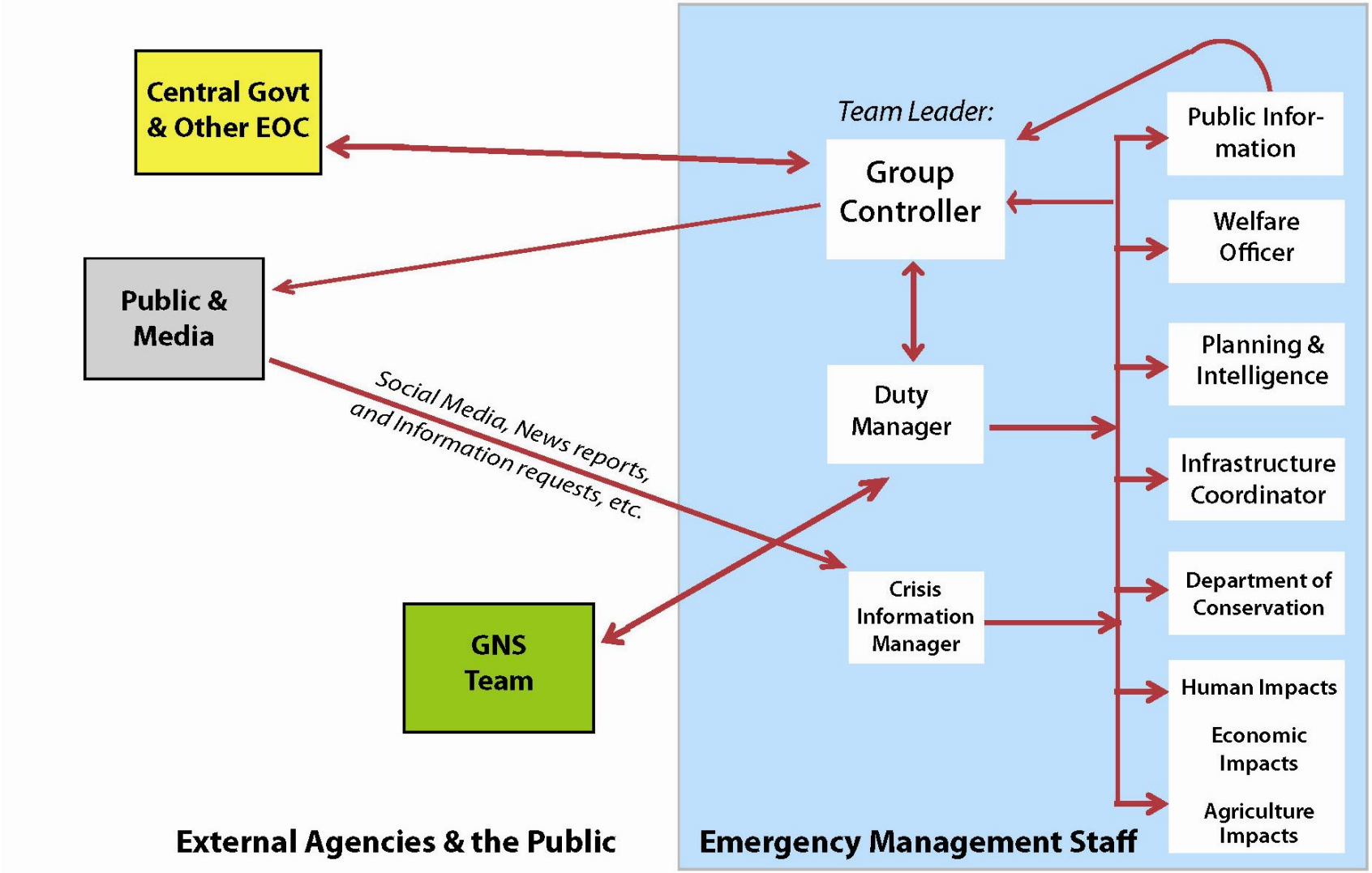
Newsfeed

Flow of Information for the GNS Team

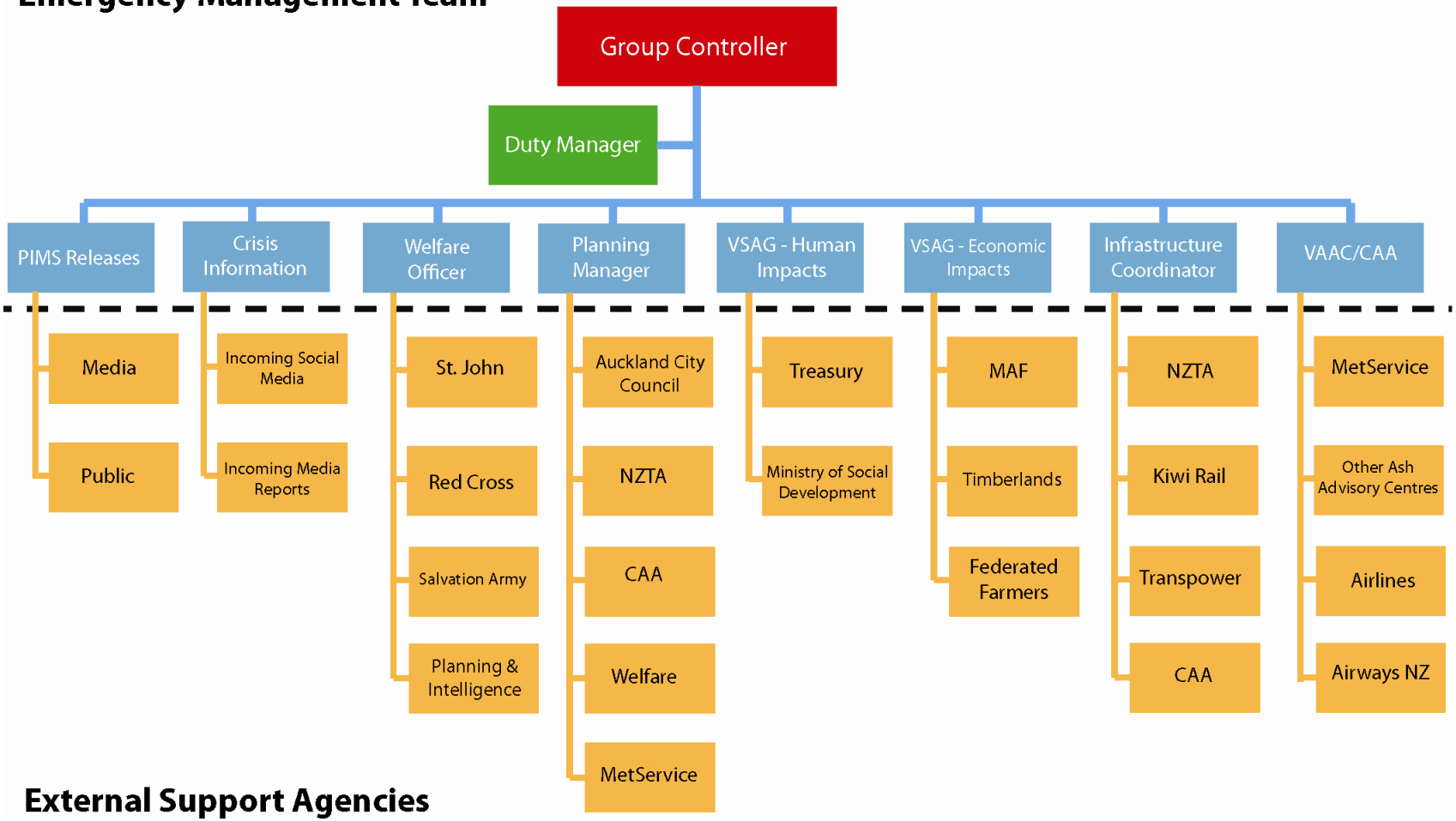
Note: The direction of arrows represents the flow of information, from one party to another.



Flow of Information for the EM Team



Emergency Management Team



External Support Agencies

Overall Performance in the Volcanic Simulation Rubric

Student Name_____

The following standards describe your performance in this simulation. This is used to give you feedback about your performance and to help you improve in the future! *Instructor notes: Should check (with an x) the box for each category and tally up, for a final score out of 10. Half marks can be used.*

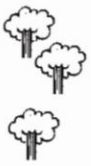
Standards	Exemplary (2 Marks)	Satisfactory (1 Mark)	Needs Major Improvement (0 Marks)	Your Score	Final Comments from Instructor:
Critical Thinking Skills	Student illustrated excellent use of critical thinking skills: utilizing: objectivity, thoughtful interpretations, and weighing all the options	Student illustrated good critical thinking skills with some minor mistakes in one of the categories (left)	Student did not illustrate good use of critical thinking skills and made errors such as being subjective, false interpretations, and/or failing to weigh all the options before making conclusions		
Written communication* *(Reports, Data logs)*	Written material made by the student are complete, accurate, and well written	Written materials are for the majority – complete, accurate, and well-written with some minor errors	Written materials are not complete, contains obvious errors, may not be easy to read or understand		
Oral communication* *(Press conferences and team discussions)*	Student communicates very well with the 'public' (avoids jargon) and within their team with efficiency, accuracy and professionalism.	Student communicates with 'public' and within their team efficiently, with minor errors, and a mostly professional attitude	Student communicates with 'public' and within their team poorly. Illustrating some inaccuracies, or displaying unprofessional attitudes or demeanors		
Collaborative Skills	Student illustrates excellent use of collaborative skills: brainstorming, sharing, debating and diplomacy	Student illustrates satisfactory use of collaborative skills with some minor problems	Student does not use collaborative skills well and had difficulty working in a team-setting		
Enthusiastic Participation	Student illustrated strong efforts to participate and enact their role during the simulation	Student illustrated a moderate level of participation and enacted their role mostly well during the simulation	Student illustrated a poor level of participation and did not make an effort to 'get into' their role.		

Reviewer_____ Grand Total _____/ 10

Appendix T2. Tongariro Eruption Sequence

Tongariro Eruption Sequence

TIMELINE

	Precursors	Event	PAUSES
1-Mar	No precursory activity, building up of a baseline of background activity		None
15-Mar	Short HF swarms, and shallowing of earthquakes in general		None
1-Apr	Presence of LF eq's and increasingly closer swarms of HF could indicate unrest, CO2 elevated from April 2 onward, phreatic events could indicate unrest	 3 phreatic events	April 2nd at 20:00 for 30 minutes (15 minute to work on questions, and 15 for press conference
15-Apr	Increasing seismicity in general (more HF, more LF), earthquake shallowing continues, SO2 elevated dramatically, and CO2 continutes to rise	 3 phreatic events, with column < 1km to 1.2 km	April 22nd at 8:00 (20 min pause, 10 min prep and 10 min Interview with GeoNet Section Manager)
1-May	Seismicity is getting shallower, of higher magnitude, and more freq LF; CO2 and SO2 increasing steadily, until May 9th - mega increase in SO2	 5 phreatic events, with small column heights < 1 km. 1st magmatic event (May 12th), 5km column (Vulcanian), winds are from the S	May 12 at 20:00 (10 minutes to prepare, and 20 minute press conference)
15-May	Seismic network down on May 12 till 18th, Higher magnitude, deep eQ occur, steady increase in gas, Mid May - slight increase in tilt and def, and then Late May - sudden increase in the tilt and deformation data. Phreatic eruptions continue	 3 phreatic events, 1-1.5 km column heights. Earthquakes are causing distress in Turangi.	No Pauses, have themwork through this
1-Jun	Deformation and tilt, more dramatic and Visible; Further seismic unrest, phreatic eruptions continue, and magmatic eruptions are scaling up.	 May 31 - Cracks in Red Crater; 2nd (June 3rd) and 3rd (June 10) magmatic event, (2 and 5 km columns), not windy, rainy. Lava dome visible growth in red crater. 4th magmatic event (June 12th), 45 minute eruption, 9km column, no winds	June 1, at 16:00 (10 minute pause to produce Media Releases)
15-Jun	June 13 +14 - major changes to SO2 and CO2. LF and Tremor EQ's prior to June 15th	 5th and final HUGE 19 km eruption; Wind from the South. Lava dome growth in red crater after explosion	June 11 at 8:00 (10 min prep, and 15 min joint CDEM-GeoNet Meeting to discuss) AND June 15 at 08:00 (5-min PAUSE - Everyone told to watch the remaining media, 15 min prep for a 20 minute wrap-up press conference)

Appendix T3. Tongariro Interactive Bibliography

Instructions:
1. Go to your assigned role.
2. Review your specific responsibilities.
3. Read and summarize the necessary literature to prepare for the simulation.
4. Read the instructions (separate document).

Note: The more prepared you are for the simulation, the better overall you and your team can respond to the volcanic event.

Click the links (in the readings row) to download the papers from my Dropbox. If you have trouble downloading any of the papers, please email **Jackie** asap (jdohaney@gmail.com).

Emergency Management Team

Role:	**Group Controller**
Responsibilities:	Team Leader; to lead, direct and coordinate the emergency response. Primary decision-maker. **CHALLENGE** questions may be posed to you and your teams. Respond accordingly and communicate this information as instructed. Be sure to read the cards with the people noted, so that everyone is informed.
Important Readings:	Volcanic Alert Levels (GNS); Advice to Emergency Management Team Leaders (Australian Govt)
Additional Readings:	Advice to the Public during an Eruption (MCDEM); Tongariro Alpine Crossing Fact Sheet (DOC) Impacts of ash from Tongariro (Hitchcock and Cole)

Role:	**Duty Manager**
Responsibilities:	Coordinates and organises the EM Team, assists Group Controller to carry out tasks. Receives incoming information from GeoNet and delegates tasks. When an eruption occurs, your team must fill out Volcanic Impact Reports. It is your responsibility to make sure your team members fill these out.
Important Readings:	Volcanic Alert Levels (GNS); Advice to Emergency Management Team Leaders (Australian Govt)
Additional Readings:	Tongariro Alpine Crossing Fact Sheet (DOC) Impacts of ash from Tongariro (Hitchcock and Cole)

Role:	**Crisis Information Manager**
Responsibilities:	Records all incoming information from the **Newsfeed** (i.e., social media) tab, and distributes this information to the team. Keeps the team up to date with the public's wants and needs. Vets information carefully. If an event occurs, you will work with the Public Information Officers to fill out Media Releases.
Important Readings:	Advice to the Public during an Eruption (MCDEM) Tongariro Alpine Crossing Fact Sheet (DOC)
Additional Readings:	Media Release to the Public after a small eruption on Ruapehu (MCDEM);

	Media Release to the Public after the Canterbury Earthquake (MCDEM); Media coverage after Ruapehu eruptions 1995 (Reuters); Example of news article after Ruapehu activity, and misquoting of scientist (Smellie)

Role:	**Public Information Officer**
Responsibilities:	Writes media releases to the public concerning event advice (what to do, what to be prepared for...). Liaises with GeoNet Team, and gathers incoming information. Media Releases should be timely, concise and considered.
Important Readings:	Tongariro Alpine Crossing Fact Sheet (DOC) Media Release to the Public after a small eruption on Ruapehu (MCDEM); Media Release to the Public after the Canterbury Earthquake (MCDEM); Media coverage after Ruapehu eruptions 1995 (Reuters); Example of news article after Ruapehu activity, and misquoting of scientist (Smellie)
Additional Readings:	VEI: Volcanic Explosivity Index (Newhall & Self); Advice to the Public during an Eruption (MCDEM)

Role:	**Planning Manager**
Responsibilities:	Primarily concerned with infrastructure and evacuation efforts. Focus on status of major road networks (works with Infrastructure Coordinator on this effort). Evacuations are planned with Welfare Officer.
Important Readings:	Tongariro Alpine Crossing Fact Sheet (DOC) Volcanic ash impacts on critical infrastructure (Wilson);
Additional Readings:	Aviation hazards from Volcanoes (Prata & Tupper); Advice for Airports during an Eruption (Wilson & Stewart); Advice for use of Generators during an Eruption (Hill et al); Advice for Power Plant Operators during an Eruption (Wilson et al); Impacts of ash from Tongariro (Hitchcock and Cole) Aviation Alert Level Codes (GNS);

Role:	**Infrastructure Coordinator**
Responsibilities:	Primarily in charge of the status (open, closure) of roads, water (waste and drinking), shipping, rail, and airports. Works with Planning Manager on roads. Works with Welfare Officer on evacuation routes.
Important Readings:	Volcanic ash impacts on critical infrastructure (Wilson); Advice for use of Generators during an Eruption (Hill et al); Advice for Roading Managers during an Eruption (Wilson et al); Advice for Building Managers during an Eruption (Wilson et al); Advice for Power Plant Operators during an Eruption (Wilson et al); Advice for Power Transmission Operators during an Eruption (Wilson et al); Advice for Wastewater Managers during an Eruption (Wilson et al); Advice for Water Supply Managers during an Eruption (Stewart and Wilson);
Additional Readings:	Tongariro Alpine Crossing Fact Sheet (DOC);

	Ash leachates (Stewart et al) Impacts to Agriculture from Eruptions (Wilson and Cole) Impacts of ash from Tongariro (Hitchcock and Cole)

Role:	**Welfare Officer**
Responsibilities:	Organising and planning the essentials of life for people affected by an event – Primarily concerned with evacuation centres, Salvation Army, and Housing New Zealand. Works with Planning Manager on evacuation routes and centre locations. Works with VSAG Human Impacts on how volcanic eruptions may affect citizens.
Important Readings:	Volcanic ash impacts on critical infrastructure (Wilson); Advice for Building Managers during an Eruption (Wilson et al); Organisational Response to Ruapehu Eruption (Paton et al) Human Impacts from Volcanoes (Doocy et al)
Additional Readings:	Tongariro Alpine Crossing Fact Sheet (DOC) Impacts of ash from Tongariro (Hitchcock and Cole)

Role:	**Human Impacts (Volcanic Scientific Advisory Group)**
Responsibilities:	Specialises on how ash and volcanic eruptions impact humans (health, sociological, and infrastructure related). Liases with other members of the EM Team to assess impacts to human health. Should request information from GeoNet as needed (e.g., ash composition, size, eruption styles, etc.)
Important Readings:	Ash leachates (Stewart et al) Contamination of water supplies due to volcanic ash (Stewart et al); Tongariro Alpine Crossing Fact Sheet (DOC); Human Impacts from Volcanoes (Doocy et al) Impacts of ash from Tongariro (Hitchcock and Cole)
Additional Readings:	Volcanic ash impacts on critical infrastructure (Wilson); Advice for Water Supply Managers during an Eruption (Stewart and Wilson); Advice for Building Managers during an Eruption (Wilson et al);

Role:	**Agriculture & Forestry Impacts (Volcanic Scientific Advisory Group)**
Responsibilities:	Provides EM Team with advice on how eruptive activity and decision-making will impact the agriculture and forestry sectors. Should focus on short term and long term impacts to these sectors. Specifically immediate impacts and relocation of livestock; and long term impacts to soils and trees.
Important Readings:	Tongariro Alpine Crossing Fact Sheet (DOC) Impacts to Agriculture from Eruptions (Wilson and Cole) Impacts to Agriculture and Forestry (Neild et al)
Additional Readings:	Volcanic ash impacts on critical infrastructure (Wilson); Impacts of ash from Tongariro (Hitchcock and Cole)

Role:	**Department of Conservation (DOC)**
Responsibilities:	Makes final call on whether to close, open, and events occurring within the National Park boundaries. Should liaise with GeoNet and their Field Team to coordinate any efforts to go into the National Parks. When the National Park is closed, you must file a DOC Closure of Park Report. Read more about the Department of Conservation.
Important Readings:	Tongariro Alpine Crossing Fact Sheet (DOC) Aviation Alert Level Codes (GNS);
Additional Readings:	Volcanic and Structural Evolution of the TVZ (Wilson et al); History of Activity at Tongariro Volcanic Centre (Hobden et al) Impacts of ash from Tongariro (Hitchcock and Cole)

GNS GeoNet Team

Role:	**Volcanic Section Manager**
Responsibilities:	Team Leader; To lead, direct and coordinate monitoring of volcanoes in NZ. Makes final decision to raise or lower alert levels. When/if an Alert Level must be raised or lowered, you need to fill out an Alert Level Change form. **CHALLENGE** questions may be posed to you and your teams. Respond accordingly and communicate this information as instructed. Be sure to read the cards with the people noted, so that everyone is informed.
Important Readings:	Volcanic Alert Levels (GNS); Volcanic Eruption Meeting Agenda (Jolly); VEI: Volcanic Explosivity Index (Newhall & Self); Advice to Emergency Management Team Leaders (Australian Govt); Volcanic and Structural Evolution of the TVZ (Wilson et al); History of Activity at Tongariro Volcanic Centre (Hobden et al) Modelling geophysical (a.k.a., seismic) precursors at Mt Tarawera (Sherburn and Nairn)
Additional Readings:	Basics on monitoring Gas, Seismic and Deformation (IRIS); Working on Volcanoes (GNS) Tongariro Alpine Crossing Fact Sheet (DOC)

Role:	**Public Information Officer**
Responsibilities:	Writes media releases to the public concerning the SCIENCE of an event. Liases with EM Team, and provides timely information as the event unfolds. Media Releases should be timely, concise and considered.
Important Readings:	Volcanic Alert Levels (GNS); VEI: Volcanic Explosivity Index (Newhall & Self); Media Release to the Public after a small eruption on Ruapehu (MCDEM); Media coverage after Ruapehu eruptions 1995 (Reuters); Example of news article after Ruapehu activity, and misquoting of scientist (Smellie)
Additional Readings:	Volcanic and Structural Evolution of the TVZ (Wilson et al); History of Activity at Tongariro Volcanic Centre (Hobden et al)

Role:	**Geophysics (Remote Monitoring)**
Responsibilities:	Monitors **seismic** data tabs. Records, analyses this data and provides updates to GeoNet Team. **Additional datasets** may show up in the Newsfeed data tab.
Important Readings:	Volcanic Alert Levels (GNS); Modelling geophysical (a.k.a., seismic) precursors at Mt Tarawera (Sherburn and Nairn); Basics on monitoring Gas, Seismic and Deformation (IRIS)
Additional Readings:	Volcanic and Structural Evolution of the TVZ (Wilson et al); VEI: Volcanic Explosivity Index (Newhall & Self)

Role:	**Geochemistry (Remote Monitoring)**
Responsibilities:	Monitors **geochemistry** data tab. Records, analyses this data and provides updates to GeoNet Team.
Important Readings:	Volcanic Alert Levels (GNS); COSPEC at Active Volcanoes (Stix et al); Basics on monitoring Gas, Seismic and Deformation (IRIS)
Additional Readings:	Volcanic and Structural Evolution of the TVZ (Wilson et al); VEI: Volcanic Explosivity Index (Newhall & Self); Ash leachates (Stewart et al); Health Effects of VOG (Office of the Governor)

Role:	**Geodesy (Remote Monitoring)**
Responsibilities:	Monitors **ground deformation** data tab. Records, analyses this data and provides updates to GeoNet Team.
Important Readings:	Volcanic Alert Levels (GNS); Modelling geophysical (a.k.a., seismic) precursors at Mt Tarawera (Sherburn and Nairn); Basics on monitoring Gas, Seismic and Deformation (IRIS)
Additional Readings:	Volcanic and Structural Evolution of the TVZ (Wilson et al); VEI: Volcanic Explosivity Index (Newhall & Self)

Role:	**Visual Surveillance (Volcanology Unit)**
Responsibilities:	Monitors **Visuals (webcam)** data tab. Records, analyses this data and provides ongoing updates to GeoNet Team. Be aware of extra data sets that may show up in the **Newsfeed** tab.
Important Readings:	Volcanic Alert Levels (GNS); VEI: Volcanic Explosivity Index (Newhall & Self); Volcanic and Structural Evolution of the TVZ (Wilson et al); History of Activity at Tongariro Volcanic Centre (Hobden et al)
Additional Readings:	COSPEC at Active Volcanoes (Stix et al); Basics on monitoring Gas, Seismic and Deformation (IRIS);

Role:	**MetService Meteorologist (Volcanology Unit)**

Responsibilities:	Monitors **Weather** data tab. Records this data and provides ongoing updates to the Ash and Flow scientists (they need this information to make tephra dispersal maps). Be aware that **Weather Forecasts** will show up in the **Newsfeed** tab.
Important Readings:	Volcanic Alert Levels (GNS); Basics on monitoring Gas, Seismic and Deformation (IRIS); Quantitative Modelling of Ash Plumes (Carey and Sparks)
Additional Readings:	Volcanic and Structural Evolution of the TVZ (Wilson et al); VEI: Volcanic Explosivity Index (Newhall & Self)

Role:	**Ash Specialist (Volcanology Unit)**
Responsibilities:	Monitors **Ash Reports** data tab. Records data, and creates ash dispersal maps based on each eruption. Ash dispersal maps can be made using this **Ash Plume Model** excel sheet: Ash Plume Dispersal Model Excel Sheet (Hill and Edwards) If you have questions on how to use this excel sheet, please ask. You will need weather information to help calculate ash thicknesses. ***This information must be sent to the EM team as soon as possible.***
Important Readings:	Volcanic Alert Levels (GNS); Ruapehu Ash Isopach Example (Wilson); Quantitative fall out models of ash; Used to determine ash cloud distributions (Carey and Sparks)
Additional Readings:	Volcanic and Structural Evolution of the TVZ (Wilson et al); VEI: Volcanic Explosivity Index (Newhall & Self); Basics on monitoring Gas, Seismic and Deformation (IRIS); Advice for Airports during an Eruption (Wilson & Stewart)

Role:	**Field Team (Volcanology Unit)**
Responsibilities:	To organise, plan field excursions to check for visually observed and measured data that cannot be assessed remotely. Must ask permission from **Section Manager** when going out into the field by filling out Fieldwork Risk Assessment forms. Check with other GeoNet team members if additional datasets are needed. When "going to the field" – visit the "**Volcano**" to get your information.
Important Readings:	Working on Volcanoes (GNS); Volcanic Alert Levels (GNS); Volcanic and Structural Evolution of the TVZ (Wilson et al); History of Activity at Tongariro Volcanic Centre (Hobden et al) VEI: Volcanic Explosivity Index (Newhall & Self); Basics on monitoring Gas, Seismic and Deformation (IRIS) Pyroclastic flow assessments from Merapi 2010 eruptions (Jenkins et al);
Additional Readings:	COSPEC at Active Volcanoes (Stix et al); Modelling geophysical (a.k.a., seismic) precursors at Mt Tarawera (Sherburn and Nairn);

Appendix T4. Tongariro Hazards Map Activity

Pre-Simulation Lab: Science Communication & Volcanic Hazards Team Exercises

Lab Part 1: Volcanic Hazards Specialists

Instructions: You will be split up into **4 groups** that have been formed to become specialists about a particular important geologic and emergency management topic that is crucial for understanding volcanic hazards and the history of Tongariro.

Group 1: Historic Geology Group

Group 2: Volcanic Products Group

Group 3: Hazards Focus – Distal Impacts

Group 4: Hazards Focus – Proximal Impacts

Materials Needed: A0 Tongariro Park Map (6 copies, preferably colour), Blank A3 (20-30 pages) and A4 paper for drawings, print-outs of Literature (hyperlinks below), or access to the internet so that students can access the literature. Some students should bring laptops (to view literature) and to create ash isopachs (using the Ash isopach excel sheet) and use Google Earth, and Wikipedia to look at local and regional population centres.

Note: You may want your students to read the literature prior to the lab, if you have time to do this.

Group 1: Historical Geology Group

Responsibility: Your group is responsible for doing background geological history research on the Tongariro Volcano Centre (i.e. the historic vents, **excluding** Mt. Ruapehu).

Instructions:

1. Get the literature (see below) and maps needed.
2. Work together to create a **volcanic history map**, and **summary statement** which describes and illustrates the historic volcanic activity of the Tongariro Volcanic Massif:
    a. Identify (draw a **map**) of all Recent (last 30,000 years BP) eruptive vents, and briefly describe these in your own words. On a blank piece of A3 paper to draw a **legend** for your map.
    b. Draw a "**Time-slice" diagram** that illustrates the change in volcanism on A3 paper (i.e., location of vents, type of volcanism, and composition of volcanism) voer the last 30k years BP.
    c. Write a **summary** of the magmatic processes that are likely occurring beneath Tongariro in the future, which has led to its present form and distribution. Statement should be written for geologists (1 page A4).

Literature: Hobden, et al (1999). Cole, J. W. (1978); Wilson et al (1995), Basics of NZ

Group 2: Volcanic Products Group

Responsibilities: Your group is responsible for doing research on **types**, **distribution**, and **scale** of volcanism that can occur at the Tongariro Volcano Centre (i.e. the vents that you cover on the Tongariro Crossing, excluding Mt. Ruapehu).

Instructions:

1. Have a group discussion to discover (use the literature provided to help).
    a. The **composition** and **magma genesis** of the source beneath Tongariro.
    b. The typical **scale** of volcanism that has occurred at Tongariro in the past 30,000 year BP.
    c. Compare the scale of volcanism that occurs at Tongariro to the volcanism that occurs at Okataina Caldera complex.
    d. Draw a helpful **diagram** to help explain these. Be sure to include extent of erupted material, and the time scale of eruptive activity.

2. Create a **statement** that summarizes the topics discussed above. Write the statement in language suitable for geologists. 1 page, A4.

Literature: Cole, J. W. (1978); Wilson et al (1995); Nairn, I., & Self, S. (1978). Newhall and Self (1982), Basics of NZ

Group 3: Hazards Focus – Distal Impacts

Responsibilities: Your group is responsible for cataloguing and understanding the distal (or Regional) impacts of volcanism. Your setting is the Tongariro Volcano Centre (i.e. the vents that you cover on the Tongariro Crossing, excluding Mt. Ruapehu), focus your efforts of areas outside of the National Park (see Figure 1 below, dashed lines).

Instructions:

1. As a group, list and describe all of the **Distal** volcanic products that can be expelled from a stratovolcano (or composite volcano) during a large eruption.
2. Identify the location of Napier (relative to Tongariro National Park). List the population, main industry, "life lines" (i.e., road networks, electricity network, etc.) for Napier. Use Wikipedia and Google Earth to research Napier.
3. Provide a description of the overall short term **impacts** on human life and property in the town of Napier if a large (i.e., Vulcanian-Plinian) eruption was to occur.
4. Provide a description of the overall long term **impacts** on human life and property in the town of Napier if a large (i.e., Vulcanian-Plinian) eruption was to occur.
5. Create a **statement** that summarizes the topics discussed above. Write the statement in language suitable for the public. 1 page, A4.

Maps: Tongariro Local Map; Map of the North Island of New Zealand;

Literature: Hitchcock and Cole (2007); Newhall and Self (1982); MCDEM Advice to the Public (2011); Wilson et al, critical infrastructure paper (2011), Basics of NZ

Group 4: Hazards Focus – Proximal Impacts

Responsibilities: Your group is responsible for cataloguing and understanding the proximal (or Local) impacts of volcanism. Your setting is the Tongariro Volcano Centre (i.e. the vents that you cover on the Tongariro Crossing, excluding Mt. Ruapehu). Limit your area of **impact** to within the National Park boundaries (see Figure 1 Below, dashed lines).

Instructions:

1. List and describe all of the near-vent volcanic products that can be omitted from a stratovolcano (or composite volcano).
2. Provide a description of the overall short term impacts on human life and property in the town of **Turangi** if a Vulcanian eruption was to occur from Tongariro.
3. Provide a description of the overall long term impacts on human life and property in the town of **Turangi** if a Vulcanian eruption was to occur from Tongariro.
4. Create a **statement** that summarizes the topics discussed above. Write the statement in language suitable for the public. 1 page, A4.

Literature: Hitchcock and Cole (2007); Newhall and Self (1982); MCDEM Advice to the Public (2011); Wilson et al, critical infrastructure paper (2011), Basics of NZ

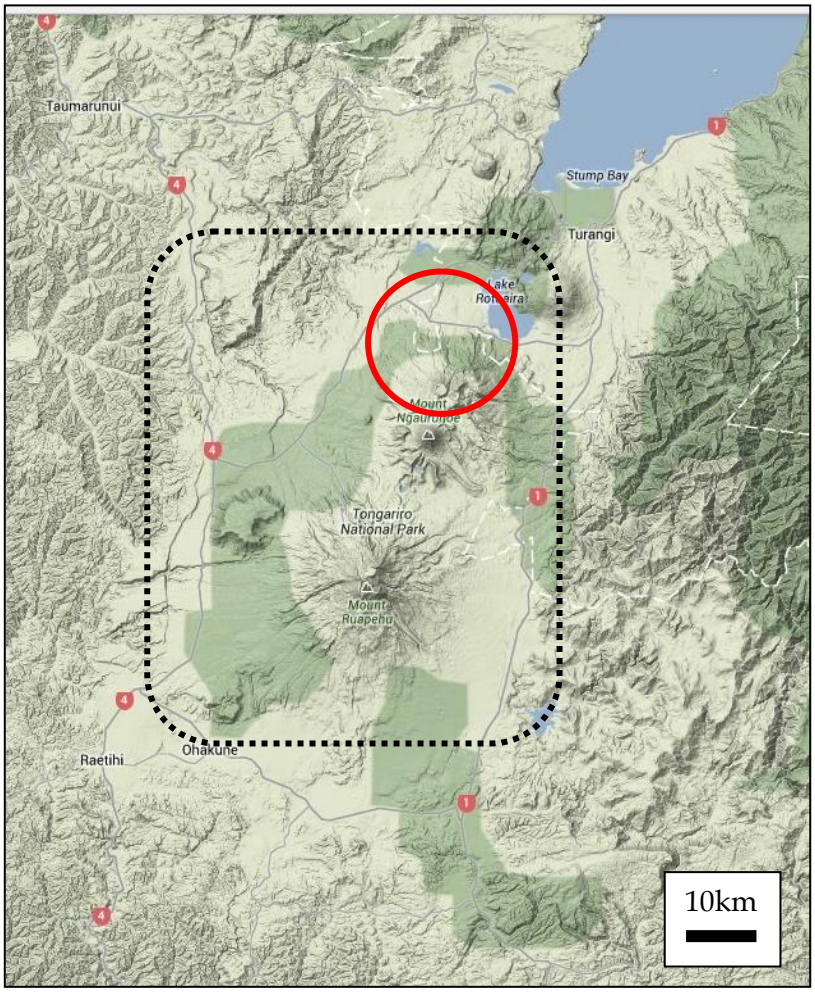


Figure 1: Tongariro National Park
Dashed lines – outline of the Tongariro National Park
Red circle – general outline of the Tongariro Volcanic Complex

Part 2: Inter-Agency Team Work

Instructions: Mix your groups - New groups will now be formed with at least one member from each previous group. The purpose of Part 2 is to share the knowledge you have gained and make it useful for the other specialties *(i.e. a geologist is focused on the scientific knowledge; While an emergency manager is focused on the impacts of the volcanic eruptions)*

1. Each member of the new groups have 3-minutes to present their findings from their specialty. Focus on how the knowledge that you have will be of use to the other members. Each member can take 5 minutes to prepare for this.
2. As a new group, create a plan and a map that illustrates a sound monitoring network for Tongariro Volcano based your research.
   a. **Brainstorm** all of the monitoring methods (or data) that is used to monitor active volcanoes.

      Questions to Consider:
      What factors impact the **location** of the monitoring stations?
      How **many** monitoring stations do you think you need?
      How might monitoring costs and policy impact data monitoring in different countries?

3. Make an ash isopach map of a large eruption. Use the Carey and Sparks paper, to estimate the **extent** and **distribution** of a Use the ash isopach excel sheet (provided) to make calculations and plot onto a regional ash isopach map. Plot your ash distribution onto an ash map of the North Island.

   Eruption parameters: 40km (column height) eruption emitted from the Tama Lakes vent (with uniform 10 km/hr northeasterly winds (wind that is coming from the Northeast) that lasts for 2 hours (in duration).

Part 3: Hazards Map – All students

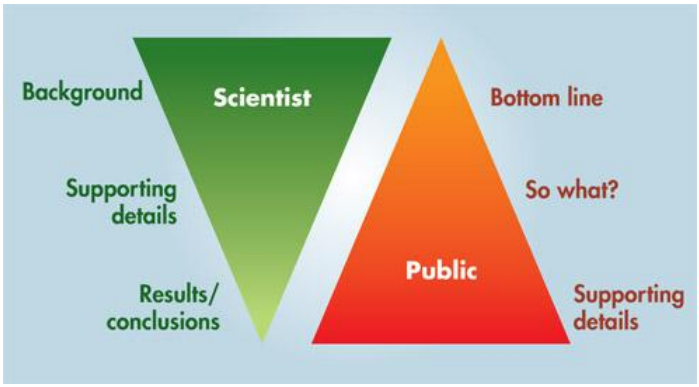
Instructions: All students will now work together to make a class hazards map of the Tongariro Volcanic Centre. Your goal is to make a hazard map that communicates the important geological and hazards knowledge to the Public.

Steps: Using the Tongariro Park Map provided, **create** a geologic hazard map for the general public and emergency response services **locally**. Make a **legend**, with **symbols** and descriptions. Be sure to include:

a. **Identify** the Recent (10,000 Na) eruptive vents, and briefly **describe** these in the legend.
b. **Identify** local population centers around the volcano. (Rural communities, adacent to Tongariro: National Park, Turangi, Ohakune, Waioru)
c. **Identify** and **illustrate** critical lifelines and infrastructure for the region (and nation, if it is relevant).
d. **Define** the various hazard zones and their volcanic products in the legend.
e. **Create** and **illustrate** the different **hazard** zones. **Justify** your decisions.

Finale: Present and justify your Tongariro Hazards Map to your instructor. Think about your language, and imagine that you are speaking to the Public (refer to Appendix 1)

Appendix 1: Science Communication Best Practices:



Who is your audience? This is the first, and most important question a writer and communicator should ask. Your words, style, and behavior should all be adapted to the specific needs of your audience. A good example is to picture the difference between trying to explain to a child versus a university student - why the Moon revolves around the Earth. What background in science does your audience have? Are there common misconceptions they may hold? Is there an aspect of your science that is sensitive, or controversial to them? Will they respect your opinion/practices? What words should you use?

Providing Context for the audience: Explaining to the audience the **IMPORTANCE** of your work is one of the most powerful (and often missed) points that a communicator should address. If you start to explain a complicated process, and do not provide the 'who cares' & 'how does that effect me' statements, your audience will not be motivated to listen to you. A very useful tip, is to state the WHY at the very beginning of your talk, or prose. This engages the reader right away, and makes them feel that it is useful to them to listen.

Jargon-appropriate communication: Jargon is a word or phrase that is specialized. Science jargon is only appropriate when describing something to a colleague within your discipline. As a science student, you are asked by your professors to learn new words (jargon) that are used to explain/describe exactly what you mean. This is important for colleague-communication, but is rarely appropriate in any other situation.

Using gestures, props, and drawings: Depending on what you are trying to communicate, a drawing or gesture may explain your concept much better than words. Studies of expert, successful field geologists show that the more expert they become, the more gesturing they use. Using your hands, and getting others to do the same, can be an effective method of explaining a scientific principle. However, be sure that the audience understands what each element (prop, hand, direction) is meant to represent, be explicit, and repetitive with gestures and props.

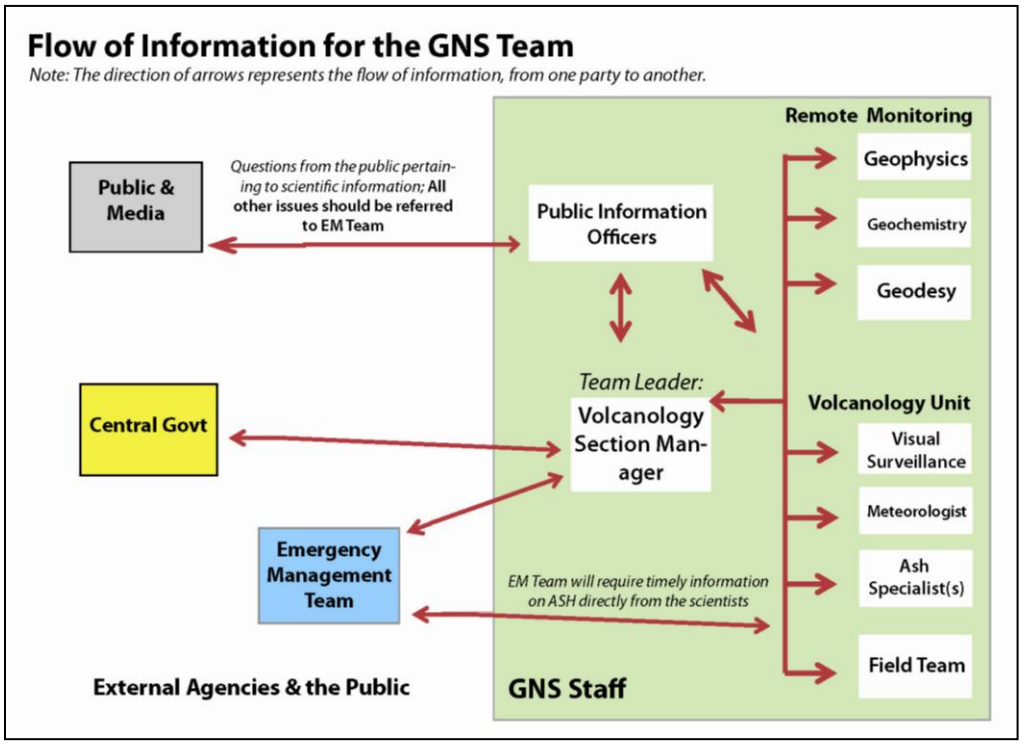
Socratic Questioning & Engaging the audience: Depending on the formality of the setting, asking the audience to answer a question, and asking them to help you write a list, or shout out ideas – is one of the simplest ways to engage an audience. Asking them for feedback, and probing their ideas on a subject, is a relatable, respectful method of keeping the audience on track and engaged. This builds rapport (mutual respect), and can be the best way to illustrate your ideas, and understand if they '**get it'.**

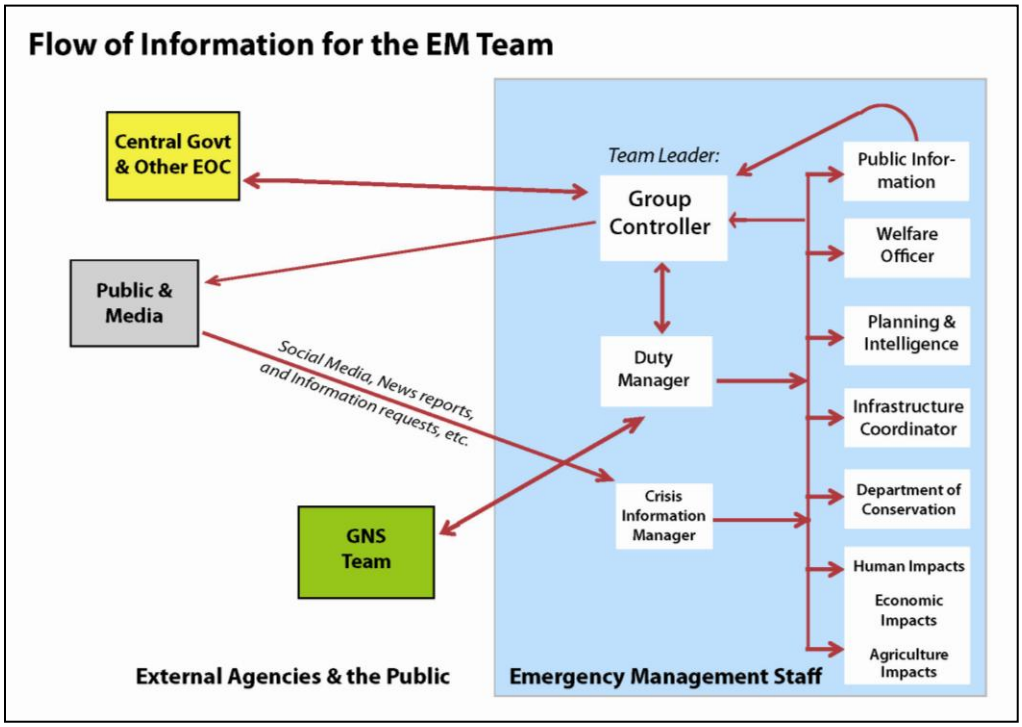
Appendix T5. List of Paperwork

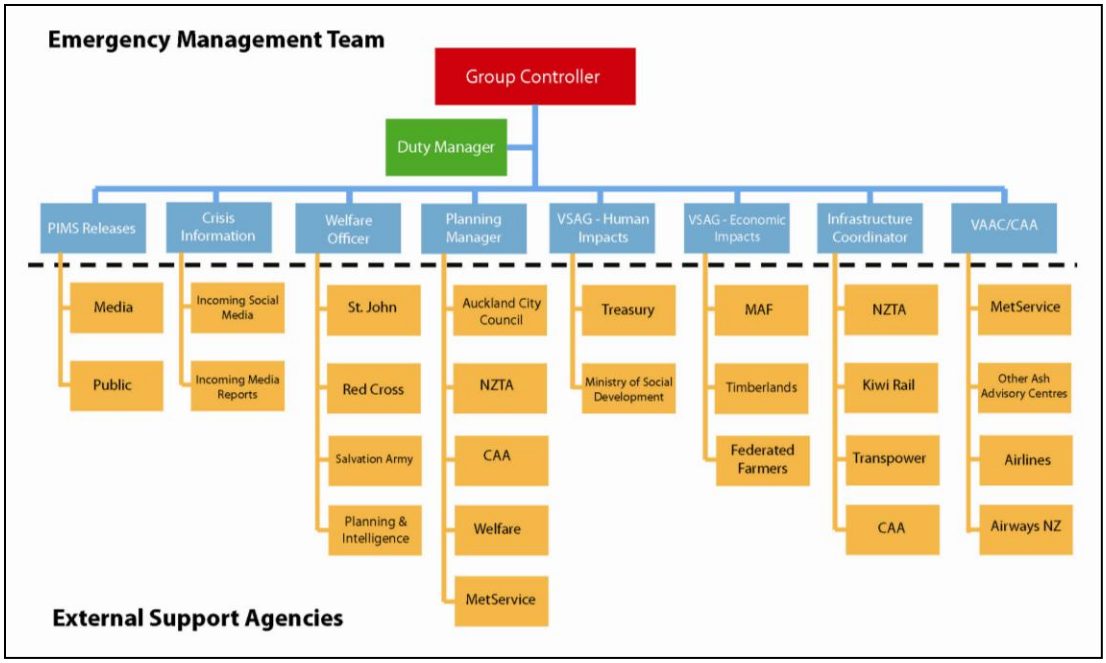
Print-outs for Tongariro Volc Sim

Maps:	**Size**	**Copies**
Map of the North Island of New Zealand	A3 B&W	20-30
Local Tongariro Map	A3 colour	20-30
Instructions:	**Size**	**Copies**
Table 1 from Instructor Manual (send electronically too)	A4	n of instructors
Eruption Sequence (send electronically too)	A4	n of instructors
Instructions for Students (send electronically too)	A4	n of students
	Size	**Copies**
Challenge Questions	A4 single	1
(print, and then cut up into individual pieces)	sided colour	
Challenge Questions (for instructors)	A4 B&W, dbl s	n of instructors
Roles & Teams	**Size**	**Copies**
Interactive Bibliography	A4 colour	1
Instructor Roles	A3 colour	2
Flow of Information GeoNet	A3 colour	2
Flow of Information EM	A3 colour	2
External Agencies	A3 colour	2
Reports & Data Logs	**Size**	**Copies**
Data Logs	A4, B&W	n of students x3
Alert Level Report	A4, B&W	10
Fieldwork Risk Assessment	A4, B&W	15
Media Release	A4, B&W	80
Volcanic Impacts Report	A4, B&W	40
Grading Rubric	**Size**	**Copies**
Overall Performance in the Simulation	A4, B&W	n of students x2

Appendix T6. Team Structure (i.e., Flow of Information) Diagrams






Emergency Management Team
Group Controller
Duty Manager
PIMS Releases
Crisis Information
Welfare Officer
Planning Manager
VSAG - Human Impacts
VSAG - Economic Impacts
Infrastructure Coordinator
VAAC/CAA
Media
Public
Incoming Social Media
Incoming Media Reports
St. John
Red Cross
Salvation Army
Planning & Intelligence
Auckland City Council
NZTA
CAA
Welfare
MetService
Treasury
Ministry of Social Development
MAF
Timberlands
Federated Farmers
NZTA
Kiwi Rail
Transpower
CAA
MetService
Other Ash Advisory Centres
Airlines
Airways NZ
External Support Agencies

Appendix T7. Tongariro Challenge Questions

1-Mar	4:00	EM	**EM1.** Welcome to the simulation! An Emergency Management (EM) team works together to mitigate crises. As there is no reported volcanic unrest, at this time, you can consider yourselves in 'planning and preparation' mode - The tasks that you must complete together: 1. Introduce each member's role and responsibilities. Each member should talk about their specific strategies and considerations that you have for your individual sector 2. The Controller and Duty Manager should explain the protocols for the **flow of communication** within the EM, and to the GeoNet Team. 3. **All team members** should think about how they will contribute to decision making. And record your thoughts and observations on your Data logs. **You have 20-30 minutes.**
1-Mar	4:00	GeoNet	**GeoNet1**. Welcome to the simulation! Your job is to assess background levels at the volcano. 1. **The Section Manager** is advised to visit all of the monitoring stations and briefly (**5 mins**) introduce yourself, and your role. **2. The Section Manager should explain the protocols for the flow of communication within the EM, and to the GeoNet Team. 3. All team members should think about how they will contribute to decision making. All team members** should record your thoughts and observations on background levels at the volcano in your Data logs.
1-Mar	4:00	EM	**EM2.** Following EM team meeting, the **Duty Manager** is requested to touch base with the Geonet public information officer and clarify the flow and modes of communication between the GeoNet team, and the EM team. The crisis information manager should be observing the "Newsfeed" at all times. **~ 10-20 minutes**
1-Mar	4:00	GeoNet	**GeoNet2**. **The GeoNet Field Team** is advised to list and describe all of the methods for monitoring volcanoes in the field. Separate out these data types into - Proximal and Distal categories. Check with the Field Volcanologist Specialist if all of these are possible at Tongariro. Implement a two-week plan of fieldwork that should help to collect more data for the volcano. Fill out the necessary paperwork. You should spend **~ 20-30 minutes doing this.**
20-Mar	0:00	GeoNet	**GeoNet3.** The **volcano geophysicist(s**) are asked to describe the difference between high frequency and low frequency earthquakes. Write down these observations on your Geological Data log (Spend ~ **5 minutes** doing this). Inform the **Geonet Field team** needs to look for other changes in the state of the volcano, based on changes in seismicity.
2-Apr	20:00	EM	**EM3.** There has been activity at Tongariro, and so **your whole team** is meeting to discuss how this may play out in the media. The **PIMS Releases Manager** is asked to explain to the group how they think media should be handled. **Each person in the team** should consider if there are any impacts to your sector. Discuss, and release a Volcanic Impacts Report (that goes to the National CDEM group), a written Media Release (to the public). **You have 20 minutes**. A brief (10 minute) Press Conference will be held by the GeoNet team. All team members should record your thoughts on your Emergency Management Data logs during the conference
2-Apr	20:00	GeoNet	**GeoNet4**. There has been activity at Tongariro. The **whole GeoNet team** must prepare a **8 minute** (2 minutes for questions), Press Conference to address several questions: a. A brief overview of Tongariro Volcanic Complex (in lay speak) and where the eruption has occurred from (Red Crater); b. Define what a phreatic eruption is (in lay speak), c. Status of Tongariro's Volcanic Alert Level, and d. Confer with EM team on general advisory to the public. Section Manager should work democratically with all GeoNet members, and the Public Information Officers should assist in format, phrases, wording and tone of the message to the public. **You have 20 minutes to prepare**. **All team members should participate** in this discussion (see **GeoNet Volcanic Eruption Meeting Agenda**) record your thoughts on your Geological Data log

2-Apr	20:00	EM	**EM4.** Ash has fallen on the Tongariro National Park. The **Department of Conservation is advised to write a Volcanic Impacts Report** describing the impacts that ash could have on the safety of the trampers in the Park (should it remain open?). Discuss longterm plans and shortterm plans with other EM members.
2-Apr	20:00	GeoNet	**GeoNet5. Field team** is advised to discuss nature and type of field work needed to collect time-sensitive ash data. Fill out the necessary paperwork and depart for fieldwork in the next good weather day.
5-Apr	12:00	GeoNet	**GeoNet6**. Several days after the phreatic activity, discuss among the entire GeoNet team what phreatic activity means. What is happening inside the volcano? Utilize other supporting datasets to help answer this question. **All GeoNet members** should record your thoughts on your Geological Data log and ask the **Analytical Geologist** to assess the quality of your observations. (Spend about 10 minutes doing this).
5-Apr	12:00	EM	**EM5a. PIMS Releases Manager** should work Group Contoller critique the press conference. Ask the Public Information Director to fill out a Rubric. How did it go? What went well? What did not go well? Language.. (Spend a maximum of 10 minutes on this).
5-Apr	12:00	EM	**EM5b.** The Government wishes to know what makes a good location for an evacuation center. The **Welfare Manager** and the **Planning and Intelligence Manager** should prepare a short report describing the attributes they look for in an evacuation center. The report should address issues such as location, supplies and transportation. Consider what external agencies might be able to assist at the center. (You have 15min to complete this report and hand to the Group Controller).
22-Apr	8:00	GeoNet	**GeoNet7**. Have a brief discussion among the GeoNet team to inform the Section Manager the status of each type of monitoring data. **The public information officers** should assist **the Section Manager** in preparing for an unscripted Media Interview. **Preparation - 10 minutes, Interview 10 minutes.** During the interview, **the Field team** should be planning there next field missions by consulting with the rest of the GeoNet team: Thinking about plans for monitoring ash thicknesses, deformation/eruption visuals? ash dispersal? geochemistry? Preparing risk assessment forms for future field missions. (Field team has 10 minutes to do this).
22-Apr	8:00	EM	**EM6. Each member of the EM team gets to submit a question** that will be used in a 10-min interview of the GeoNet Section Manager. Pretend that you are a member of the public, with little to no understanding of volcanoes. Vote as a team, and select 4 questions to go to the interview stage. Elect one member of the EM team to pretend to be a famous New Zealand Journalist. **You have 10 minutes to prepare.** Observe the interview, and critique the Section's Managers responses in your Data logs**.**
1-May	0:00	GeoNet	**GeoNet8.** Information requested by the Prime Minister. **The Section Manager** and the **Public information officers** write a brief (~100 words) scientific summary, that can be understood by the Prime Minister's scientific advisor. **Deadline: May 8th.** One of the public information officers should discuss these findings with the Prime Minister and report back.
1-May	0:00	EM	**EM7.** Local forestry companies are concerned that a larger eruption may cover industrial forested land. **The VSAG Agricultural Impacts Manager** should consult literature and experts to write a Volcanic Impacts Report on the impacts that ash can have on this important New Zealand industry. **Submit report to the Duty Manager**, and briefly discuss your findings. (You have **8 minutes** to write this).
12-May	20:00	GeoNet	**GeoNet9.** What kind of eruption is this? Where did it occur? Prepare (10 minutes) for a **15 minute press conference** to explain to the public what has happened at the volcano. As a group, elect your representative from your team to give this presentation. Both teams (EM and GeoNet) will present the most important information (5 minutes each) with 5 minutes of questions from the Public.

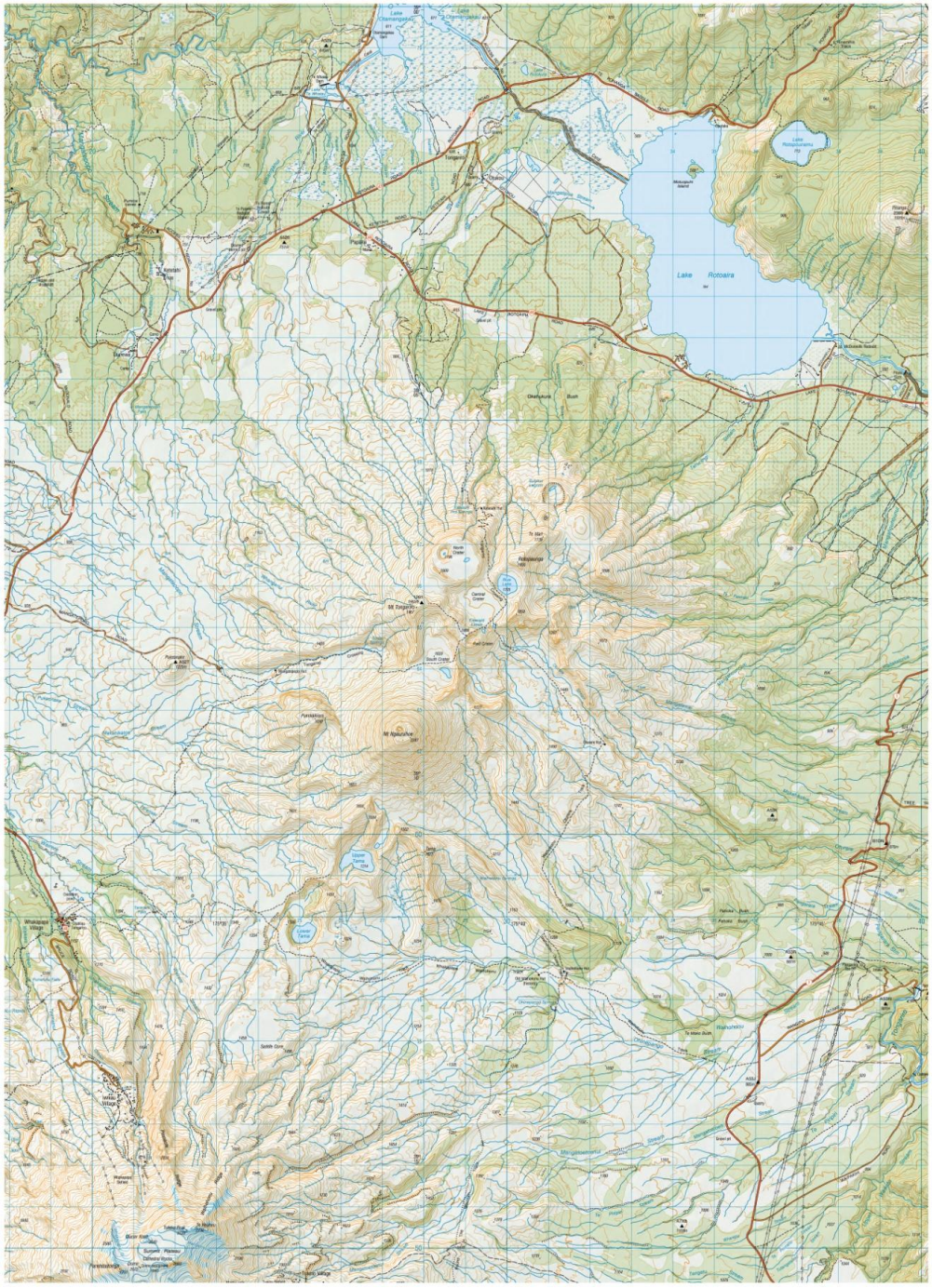
12-May	20:00	GeoNet	**GeoNet10.** IMPORTANT: GeoNet and the EM team need a **detailed ash dispersal map**. The **Ash specialist** is asked to produce a **cumulative** isopach map based on the data available. Ask the **field team** more the most up to date ash thicknesses. The Analytical Geologist and Field Volcanology Expert(s) should be helpful for this.
12-May	20:00	EM	**EM8.** An eruption has occurred. The **Duty Manager** should lias with the Geonet team to get the necessary geological information. The **EM team** should write a list with: a. The impacted areas, b. Basic advice to citizens in impacted areas, c. The worst-case scenario for each sector (agriculture, roads.. etc). Elect one representative from your team to give this list during the press conference. Both teams (EM and GeoNet) will present the most important information (5 minutes each) with 5 minutes of questions from the Public.
12-May	20:00	EM	**EM9.** The **Infrastructure Manager** is advised to prepare a short Volcanic Impacts Report, on how the road network and road conditions may be affected by the most recent eruption. (You have 5 minutes to write this).
14-May	12:00	GeoNet	**GeoNet11.** As a team, discuss expectations (scale, type of volcanism), and what your group thinks could happen. What are the data telling you? Write down observations in your Data Log. **(10 minute scientific discussion).**
14-May	12:00	GeoNet	**GeoNet12. Equipment has malfunctioned**. The **Field Team should** weigh the risk of going into the field to fix this. Which seismic station has malfunctioned? Which seismic stations are safe to repair? Are there areas that are more at risk than others in the Park? **Discuss your decision-making with Field Volcanology Experts**, and fill out the necessary paperwork. Also, what are some time sensitive data that we should collect after the most recent eruption? Should you inquire for volunteers (grad students) to help? Who plans field collection? Who owns this data?
16-May	16:00	EM	**EM10a.** Ministry of Education requests a Media Release for Teachers in New Zealand from the **PIMS Releases Manager**. They have many school children who are afraid and excited about volcanoes, but do not fully understand how they work. Hand in and discuss this Media Release with the **Group Controller**. (**You have 5 minutes to do this**).
16-May	16:00	EM	**EM10b. Welfare Manager** and the **Planning and Intelligence Manager** should work together to practice planning for a large eruption. Use the following information to help plan your response. The eruption is from a vent on Mt. Tongariro and has a 5km high column. There is a strong south west wind. The flowing locations are receiving ash. Turangi – 50mm, Taupo – 30mm, Mangakino – 20mm, Tokoroa & Rotorua – 10mm, Cambridge and Te Puke – 7.5mm, Tauranga, Waihi, Edgecumbe & Kawarau – 5mm. (You have 20min to complete this task).
16-May	16:00	EM	**EM11:** Tourism New Zealand requests information from the **VDAG team** and the **Head of Department of Conservation** on significant concerns of long term impact to the tourism industry if the volcano continues to erupt. Write a Volcanic Impacts Report, you have 5 minutes to do this.
22-May	8:00	EM	**EM12:** Some stronger earthquakes have causes local families to consider self-evacuating to another city or perhaps another country. **PIMS Releases Manager** needs to get information from relevant members of the team (particularly the about evacuations) in order to provide realistic scientific advice, and welfare advice on evacuation and impacts related to this.
22-May	8:00	GeoNet	**GeoNet13:** The **Meteorologist** should discuss with the Ash Scientist the impacts that weather can have on volcanic products. What would happen if a large eruption occurred during a weather storm? What would this do to the ash distribution and the nature of the ash? Does it alter the impact that ash has on other sectors? Write notes and share with the GeoNet team.

1-Jun	16:00	GeoNet	**GeoNet14:** The Prime Minister would like to be reassured via a personal, scientific statement from the **Volcanology Section Manager** on that status of the volcano. You have 10 minutes.
1-Jun	16:00	EM	**EM13:** National CDEM Managers are asking local CDEM groups to release a Media Release summarizing what to do in the event of a major (Plinian) eruption. Use the literature provided. The **Group Controller** needs to get the necessary info from the **EM team** and the Geonet team **(via the Duty Manager)** so the **PIMS Releases Manager** can write the report. You have 10 minutes.
1-Jun	16:00	EM	**EM14:** The Mayor of Turangi would like GeoNet and EM to provide scientific and social-political information for or against the evacuation of Turangi, and other local communities near the volcano. The **Welfare Manager** should lead this investigation in consultations with the **VSAG team, Planning and Intelligence Manager and the Infrastructure Coordinator**. You have 10 minutes.
1-Jun	16:00	GeoNet	**GeoNet15.** The **Field Team** is advised to liase with the Head of **Department of Conservation** to plan/weigh the risks of rescuing lost backpackers in Tongariro National Park. You have 10 minutes.
4-Jun	16:00	EM	**EM15:** The **Infrastructure Coordinator and VSAG - Human Impacts Manager** is advised to respond to concerns from Airways New Zealand on the status of the aviation codes in New Zealand. You have **5 minutes** to justify the aviation code in a Volcanic Impacts Report.
4-Jun	16:00	GeoNet	**GeoNet16:** Brief Media Release from **the Public Information Officers** to address worrying misconceptions in the Media. You have **5 minutes** to do this.
4-Jun	16:00	EM	**EM16**: Federated Farmers at Ohakune and Taupo want information on likely impacts of ashfall and want to know what they should be doing. Brief **Volcanic Impacts Report from the VSAG - Agricultural Manager. You have** 5 minutes **to do this.**
11-Jun	8:00	EM	**EM17:** You are going to have a 15 minute Joint Meeting between the GeoNet Team and the EM Team. Ash impacts the water quality in the area. Major public health concerns for air quality and for water quality where ashfall has occurred. **VSAG - Human Impacts Manager** should write brief Volcanic Ash Report to address these issues. You have **10 minutes** to write it, and provide this information at the meeting.
11-Jun	8:00	GeoNet	**GeoNet17:** You are going to have a 15 minute Joint Meeting between the GeoNet Team and the EM Team. This is to discuss the status of the volcano, volcanic activity, and draft a Media Release to be given out on general advisement to the Public. Topics to cover include: a. eruption type, b. what can we expect?, c. will the activity continue, will it subside?, d. what does your data tell you, what does it prove? You have **10 minutes** to prepare.
11-Jun	8:00	EM	**EM18:** You are going to have a 15 minute Joint Meeting between the GeoNet Team and the EM Team. This is to discuss the status of the volcano, volcanic activity, and draft a Media Release to be given out on general advisement to the Public. Topics to cover include: a. Impacts of ash on health, electricity, roads, buildings, agriculture. b. How much ash before an evacuation is called? c. Which issue do you tackle first? What is priority? You have **10** minutes to prepare.
12-Jun	20:00	EM	**EM19:** Based on the meeting between groups, the **Group Controller** is asked: When does he/she expect the National CDEM group take over? Who makes this decision? Ask Emergency Management Specialist who can help advise here.

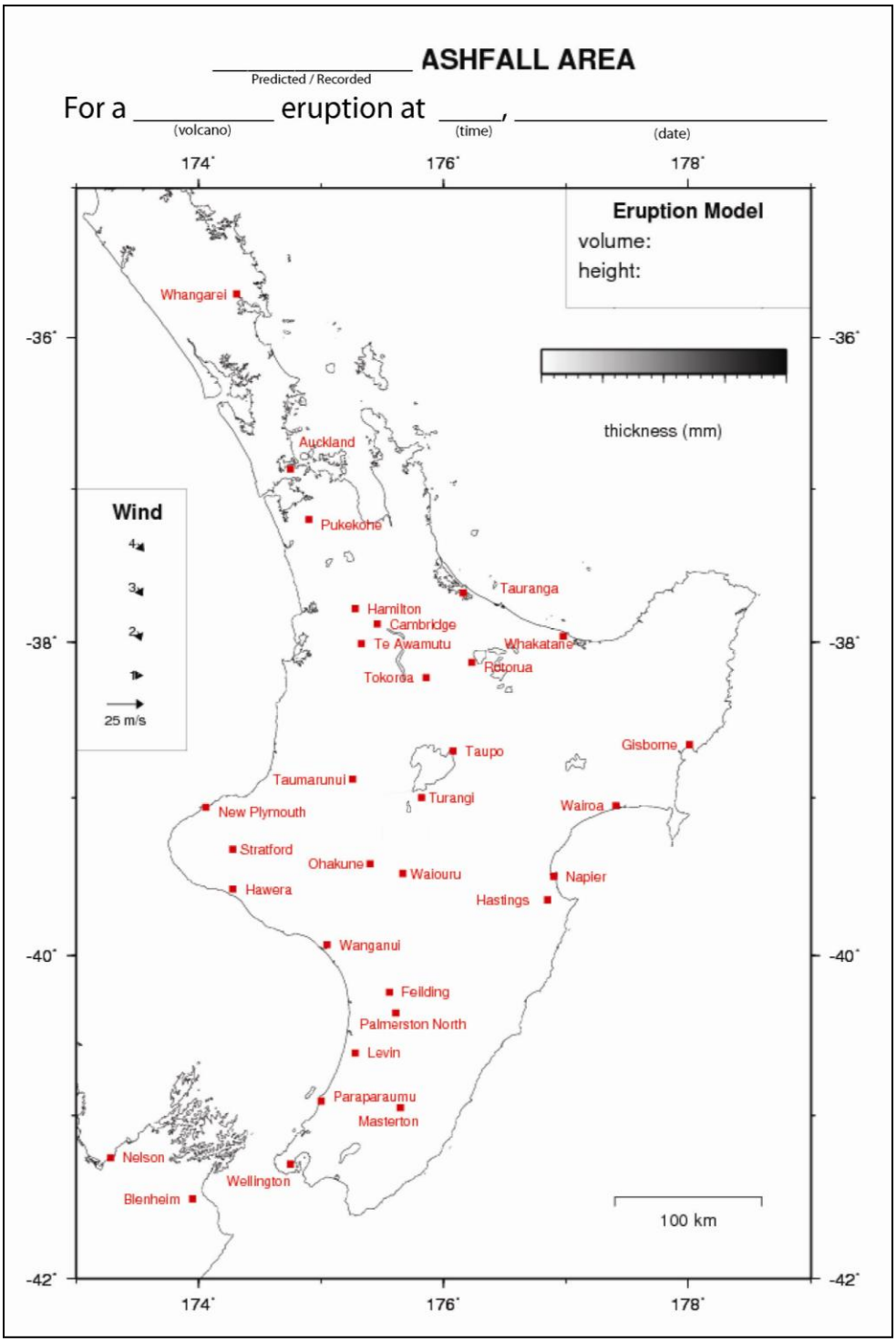
12-Jun	20:00	EM	**EM20:** Domestic electricity fails north of Tongariro National Park. This includes ALL major city centers north including Auckland, Taupo, Rotorua, Hamilton, etc. **VSAG - Human Impacts Manager and Infrastructure Coordinator** is advised to write a brief Volcanic Impacts Report on suggestions to the public. You have **5 minutes** to write this.
12-Jun	20:00	GeoNet	**GeoNet18: The Field Team** is asked to collect water samples to assess water quality. Request information from the **Duty Manager (EM team)** regarding impacts to forestry, water quality, planning, how many samples you need, how long it will take, mark on the map the sample localities. You have **5 minutes**.
12-Jun	20:00	GeoNet	**GeoNet19:** Within your teams, decide if some personnel are allowed to return home to their families. How many people should remain? What are the criteria for these decisions?
15-Jun	8:00	EM	**EM21: 5-min PAUSE -** Both teams are advised to STOP and watch the remaining Media and Community Response info for the remainder of the simulation (should take a couple of minutes)
15-Jun	8:00	GeoNet	**GeoNet20: 5-min PAUSE** - Both teams are advised to STOP and watch the remaining Media and Community Response info for the remainder of the simulation (should take a couple of minutes).
19-Jun	20:00	GeoNet	**GeoNet21:** A 15 minute press conference will be used to summarize the most recent events. Section Manager should report on: a. Scale of eruption, b. Whether the team believes further eruptions will occur, c. Ash Dispersal, and liaise with EM team on list of affected regions, d. equipment conditions, and plan to repair. Remember to speak in plain speak - this is for the public, not volcanologists. You may invite team members to speak about their specialties. You have **15 minutes** to prepare
19-Jun	20:00	GeoNet	**EM22: You are reincarnated as the National CDEM group,** A 15 minute press conference will be used to summarize the most recent events. Group should report on: a. List of effected regions (and populations), b. requests for international or national assistance?, c. long term recommendations to farmers, d. recommendations for home-owners, e. evacuated zones and evacuation routes (which roads are closed?), and recommendations on how long evacuations will take place. f. Communications are down in some areas, what do you recommend? Remember to speak in plain speak - this is for the public, not scientists. You may invited the members of your team to speak about their specialties. **You have 15 minutes to prepare**
19-Jun	20:00	GeoNet	**GeoNet22:** IMPORTANT: GeoNet and the EM team need a detailed ash dispersal map of this recent eruption, and a cumulative ash map should be produce for all of the magmatic eruptions. The Ash specialist is asked to produce an isopach map based on the data available. Ask the field team to ground check locations and ash thickness. The Analytical Geologist and Field Volcanology Expert(s) should be helpful for this. **You have 10 minutes to prepare and give this info to both teams.**

Appendix T8. Tongariro Maps

Local Tongariro Map



North Island of New Zealand Ash Isopach Map



Appendix T9. Tongariro Data Stream

The data that the students monitor throughout the simulation is built into an offline website package. This data file (.zip file) should be downloaded, extracted (using WinRar or other extraction software), and the file folder should be copied and pasted onto the computers you are using. See Appendix C7 for detailed instructions on the "unpacking process".

Tongariro Data Stream Files (see digital version).

Appendix A – Auckland Volcanic Field

The following is a series of curricula that has been designed specifically for the Auckland Volcanic Field Scenario. All materials are presented here in this document, but original digital files exist and can be accessed through the digital package (See Step 2).

Appendix A1. Instructions to Students, Auckland
Appendix A2. Auckland Eruption Sequence
Appendix A3. Auckland Interactive Bibliography
Appendix A4. Auckland Hazards Map Activity
Appendix A5. List of Paperwork to be printed
Appendix A6. Team Structure (i.e., Flow of Information) Diagrams
Appendix A7. Auckland Challenge Questions
Appendix A8. Auckland Maps

Appendix A1. Instructions to Students, Auckland

Before we start:

1. Do your reading!: Based on your **role** and responsibilities, read or skim over the relevant **literature** from the Interactive Bibliography.

2. Respect the **group organization**, and your roles. The Section Manager and Controller is 'in charge' but your group must work democratically to achieve the best solutions. Refer to **Flow of Information** (GeoNet team; Emergency Management Team) documents at the end of this packet.

During the Simulation:

3. You should **record** all of your observations on your **data log**. Include interpretations, sketches or whatever is helpful to you. Put your name, date and role on **EVERYTHING** that you record during the simulation (Be accountable ☺)

4. **Communication** and **teamwork** are essential tools used by REAL GeoNet scientists and Emergency Managers in order mitigate disasters! Be sure to use these best that you can!

5. **Ask questions** to the 'Experts' whenever you think you need help or are stuck.

6. **Fill out** the relevant **paperwork** or **maps**, at the appropriate times!

GeoNet:	**Emergency Managers:**
Alert Level Change Reports; Ash Dispersal Map (Isopach) Flow Dispersal Maps. Media Releases Fieldwork Risk Assessment	Volcanic Impacts Reports; Evacuation Routes or Road Closure Maps; Media Releases

7. There are **engineered PAUSES** into the simulation, to allow you more time to think and do the tasks that are given to you.

After the Simulation:

You will be graded by yourself (a self-assessment) and someone seated next to you using a Rubric (Overall performance in the Simulation; See the end of this document).

Learning Goals for Volcanic Hazards Simulation

Prior to the simulation, students should be familiar with….

1. The variety of volcanic hazards associated with different types of volcanism
2. Reading and understanding geological and topographical maps
3. Volcanic monitoring data types and interpretation of these data in case studies and in "real-time"
4. How different monitoring data go together to form a working model of what's happening in the volcano
5. Knowledge of New Zealand Alert levels (two levels; when to raise them)
6. A general idea of what the GeoNet and Emergency Management teams do during a crisis.

After the simulation, students should be able to…

1. Observe volcanic monitoring data and social media in "real-time", record observations and **communicate** these observations to a team (orally and in writing).

2. Collaborate within a team, by using multiple streams of data in "real-time" to develop a working-model (inclusive of scientific and social-economic data) together in order to:

a.) assess the current state of volcanic activity;
b.) identify major changes in volcanic activity,
c.) judge if changing conditions threaten the human population.
d.) use a-c to assign appropriate GNS alert levels
e.) respond to community concerns

3. Estimate and **illustrate** the distribution of volcanic products (e.g. volcanic ash) based on the volume and style of activity in order to **create** volcanic hazard maps using geological and socio-political map data (i.e. geology map, geological history, and contoured topographic map).

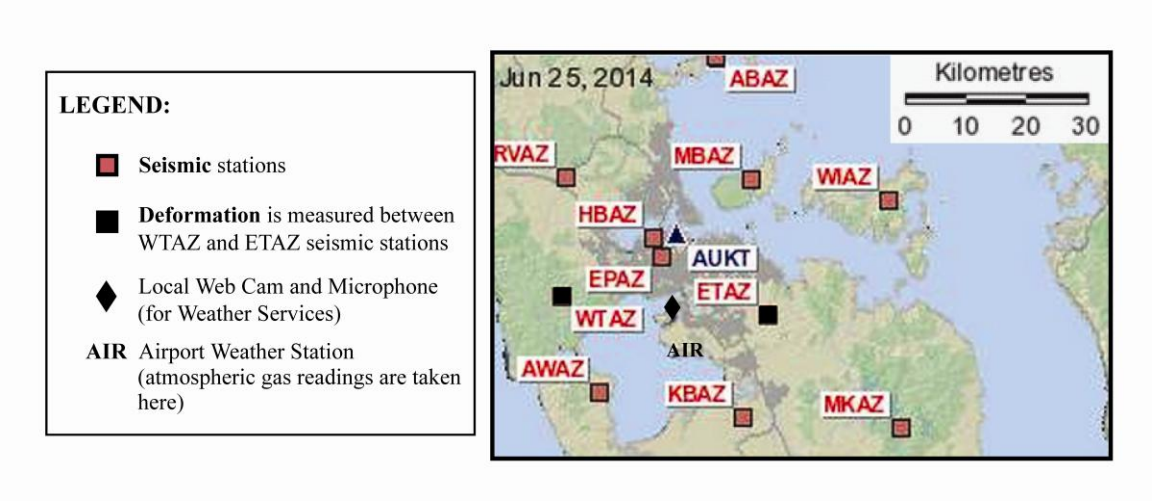
4. Estimate the impact to social and political sectors based on the distribution and style of volcanic activity, given the alert level of the volcano in question. **Respond** to crises (in a timely manner) in order to mitigate the impact before/during/and after a volcanic disaster.

5. Communicate effectively (orally and written) within your team and to the other teams and to the public (newsfeed) in order to effectively handle any possible volcanic threat. These are assessed by:

a.) Press Conferences (Questions and Responses)
b.) Effective group discussions
b.) Media Releases
c.) Volcanic Impact Reports
d.) Effective Inter-agency (between GeoNet and EM) conversations & meetings

6. Have an awareness of a.) scientists and emergency managers responsibilities, agendas, and expertise; b.) team structures. hierarchy and protocols; c. external agencies that assist Emergency Managers, and c.) the public's concerns; during a simulated volcanic crisis.

GeoNet Team: Auckland Volcanic Field Monitoring Network and Measurements



Seismicity: 11 seismographs (refer to map above) report activity around the volcano. The reports given to you represent information about the earthquake activity:
a. the **number** of quakes that occurred;
b. the maximum **magnitude** (~Richter scale, New Zealand Modified);
c. average **depth** (km); and
d. the **type** of quakes. The type of quakes reported include: **HF** (high frequency), **LF** (low frequency), **EX** (explosion signals) and **T** (tremor).

Gas Readings: **CO_2** and **SO_2** gas are both reported as daily measurements taken from the **AIR** weather station. These measurements are taken to observe anthropogenic gas levels.

Weather: Wind Direction (e.g. N – Winds coming from the North), Wind speed (Maximum reported km/hour), and Precipitation (mm). This data is remotely reported from the **AIR** airport weather station. Reported by New Zealand's MetService. **IMPORTANT**: ***Additional Weather forecasts will show up in the NewsFeed.***

Deformation: (meters) **Deformation** is measured by calculating the present distance between two GPS located stations (**WTAZ to ETAZ**), and assessing any changes from ongoing readings. A positive value indicates that the stations have moved away from one another, and a negative indicates that the have moved closer to one another. Most volcanoes do not inflate or deflate by more than a couple meters per year. **Tilt** data is not available at these GPS sites.

Visual Data includes: Webcams all over the city which streams the visual information back to GeoNet (see **images**, and the descriptive **text**). A **microphone** is also part of the each station. If an eruption were to occur, the webcam **closest to the activity** will be activated. In the event of an eruption, MetService will also report the **Maximum Plume height** (in meters) recorded by satellites and the **local ash thickness** – these data are found in the **Ash Reports** tab.

Ash Thickness Estimates + Isopach Maps – The ash volcanologist, can use an Ash Plume Model (excel file) to help estimate ash thicknesses immediately after an eruption to make predicted thicknesses. See Ash Plume Model excel sheet for more assistance.

New Zealand Volcanic Alert Level System

	Volcanic Alert Level	Volcanic Activity	Most Likely Hazards
Eruption	5	Major volcanic eruption	Eruption hazards on and beyond volcano*
Eruption	4	Moderate volcanic eruption	Eruption hazards on and near volcano*
Eruption	3	Minor volcanic eruption	Eruption hazards near vent*
Unrest	2	Moderate to heightened volcanic unrest	Volcanic unrest hazards, potential for eruption hazards
Unrest	1	Minor volcanic unrest	Volcanic unrest hazards
	0	No volcanic unrest	Volcanic environment hazards

An eruption may occur at any level, and levels may not move in sequence as activity can change rapidly.

Eruption hazards depend on the volcano and eruption style, and may include explosions, ballistics (flying rocks), pyroclastic density currents (fast moving hot ash clouds), lava flows, lava domes, landslides, ash, volcanic gases, lightning, lahars (mudflows), tsunami, and/or earthquakes.

Volcanic unrest hazards occur on and near the volcano, and may include steam eruptions, volcanic gases, earthquakes, landslides, uplift, subsidence, changes to hot springs, and/or lahars (mudflows).

Volcanic environment hazards may include hydrothermal activity, earthquakes, landslides, volcanic gases, and/or lahars (mudflows).

***Ash, lava flow, and lahar (mudflow) hazards may impact areas distant from the volcano.**

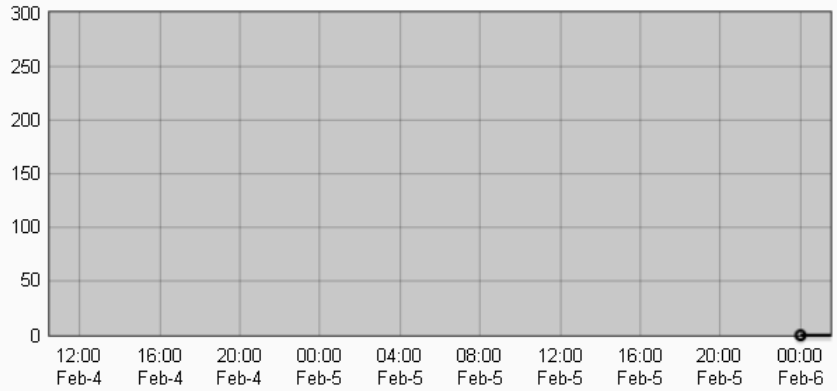
This system applies to all of New Zealand's volcanoes. The Volcanic Alert Level is set by GNS Science, based on the level of volcanic activity. For more information, see geonet.org.nz/volcano for alert levels and current volcanic activity, gns.cri.nz/volcano for volcanic hazards, and getthru.govt.nz for what to do before, during and after volcanic activity. Version 3.0, 2014.

UC Volcanic Hazards Simulation

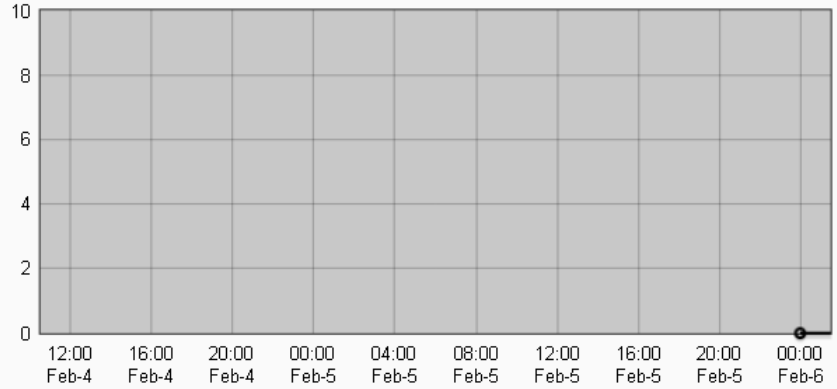
Time | 00:00, Feb 6

Seismic 1 | Seismic 2 | Gas | Deformation | Weather | Visuals | Ash Reports

No. of Quakes



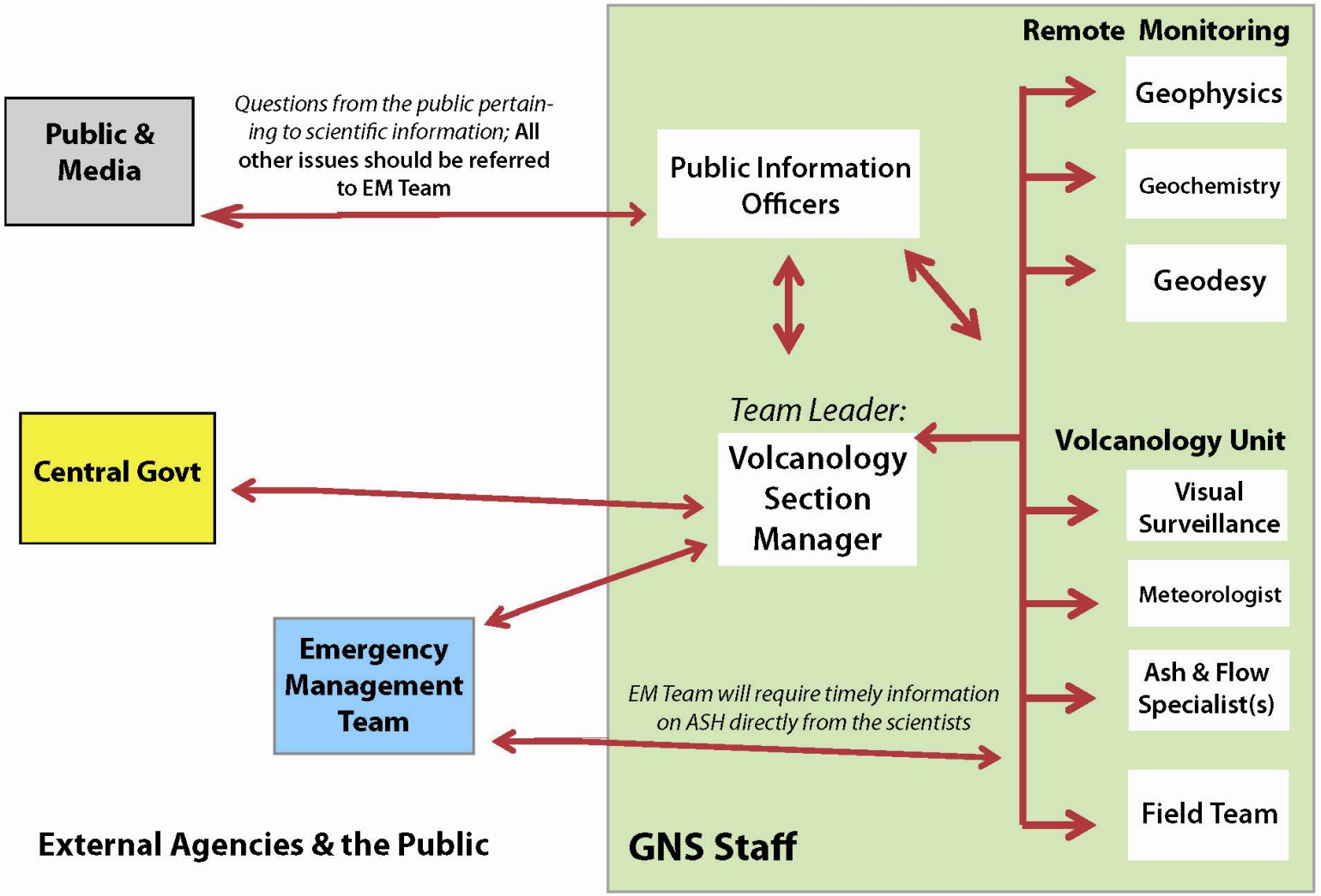
No. of Quakes {clipped to 10}



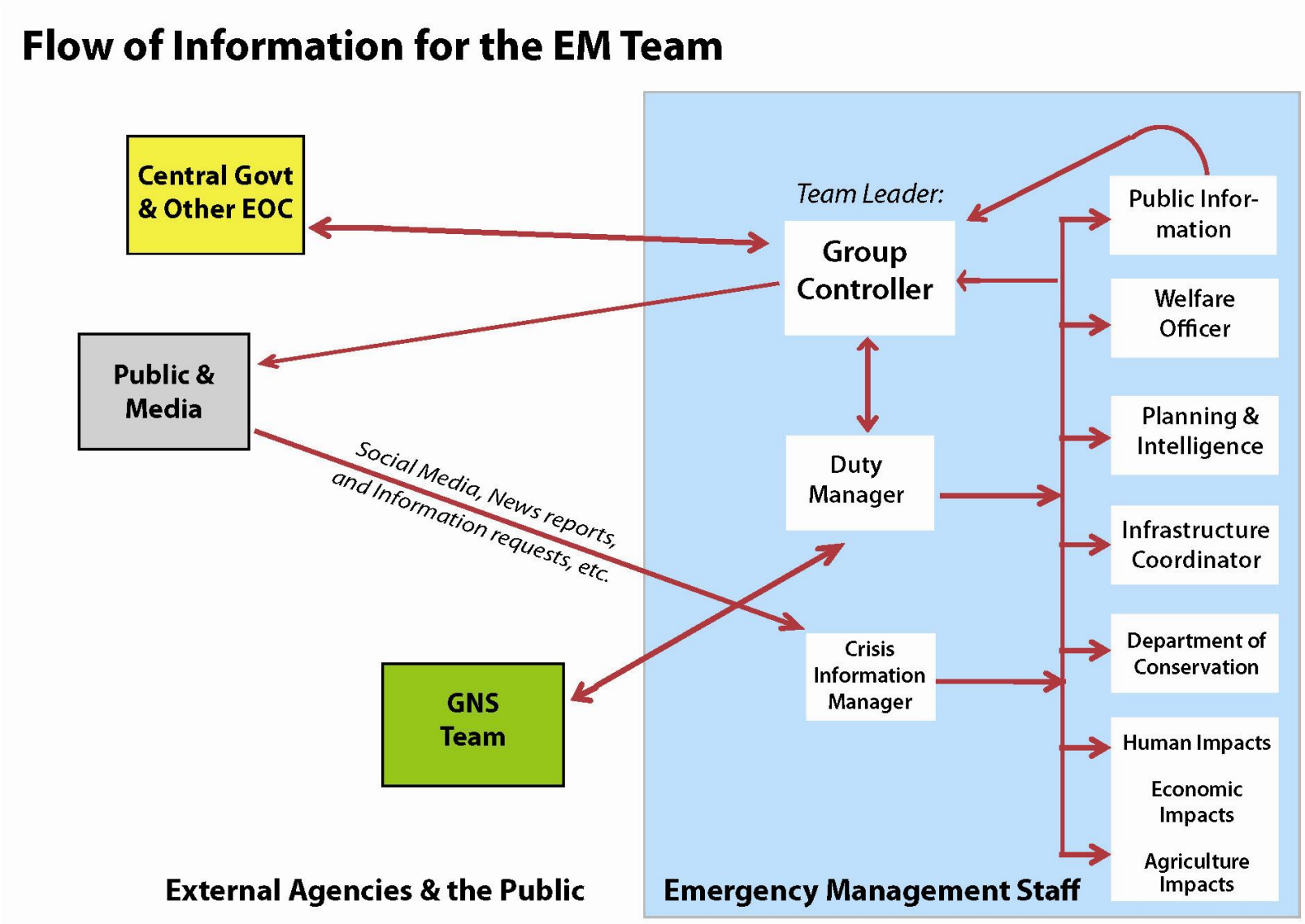
Newsfeed

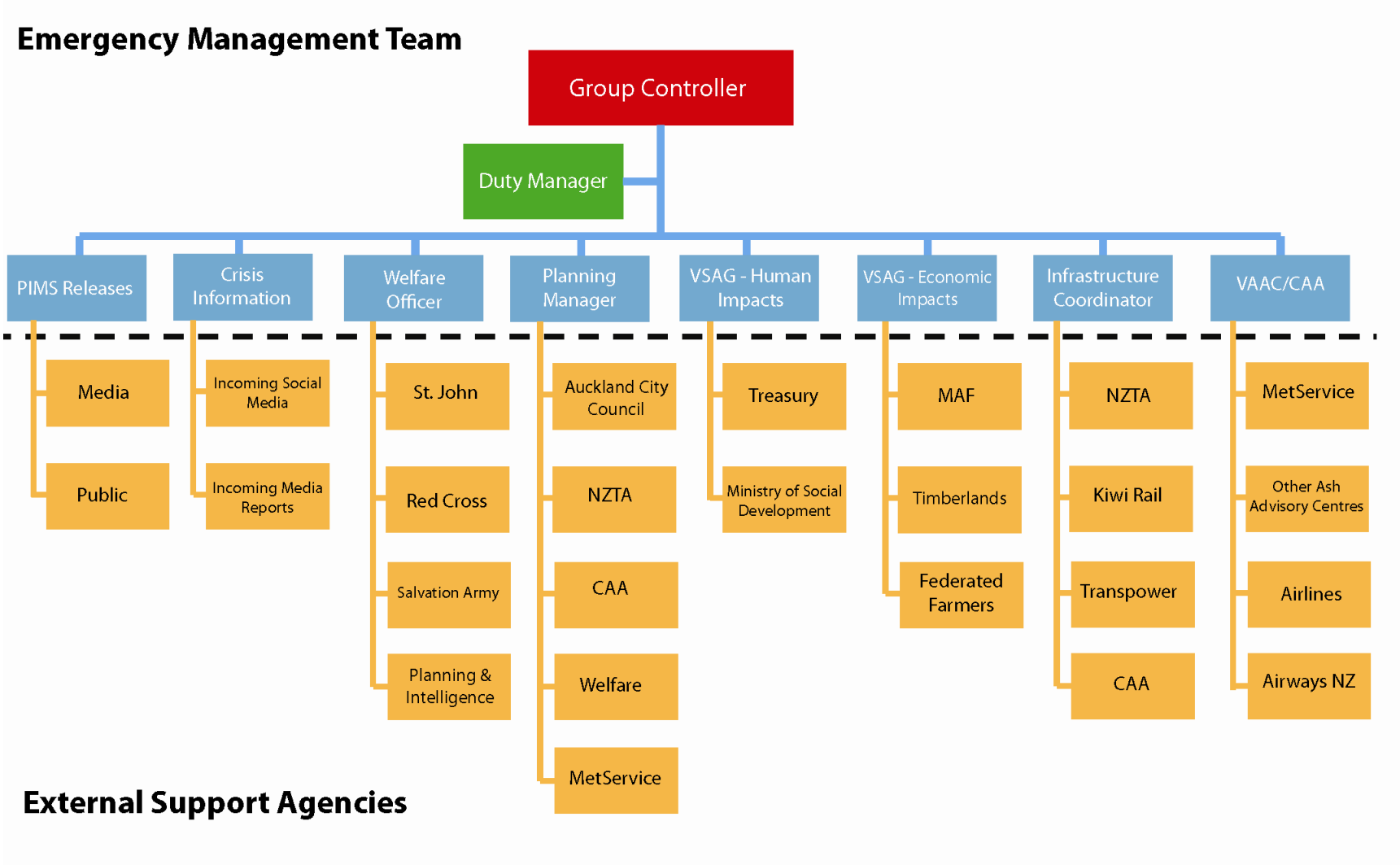
Flow of Information for the GNS Team

Note: The direction of arrows represents the flow of information, from one party to another.



Flow of Information for the EM Team




Emergency Management Team
Group Controller
Duty Manager
PIMS Releases
Crisis Information
Welfare Officer
Planning Manager
VSAG - Human Impacts
VSAG - Economic Impacts
Infrastructure Coordinator
VAAC/CAA
Media
Public
Incoming Social Media
Incoming Media Reports
St. John
Red Cross
Salvation Army
Planning & Intelligence
Auckland City Council
NZTA
CAA
Welfare
MetService
Treasury
Ministry of Social Development
MAF
Timberlands
Federated Farmers
NZTA
Kiwi Rail
Transpower
CAA
MetService
Other Ash Advisory Centres
Airlines
Airways NZ
External Support Agencies

Overall Performance in the Volcanic Simulation Rubric

Student Name_____

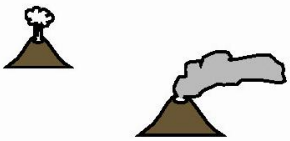
The following standards describe your performance in this simulation. This is used to give you feedback about your performance and to help you improve in the future! *Instructor notes: Should check (with an x) the box for each category and tally up, for a final score out of 10. Half marks can be used.*

Standards	Exemplary (2 Marks)	Satisfactory (1 Mark)	Needs Major Improvement (0 Marks)	Your Score	Final Comments from Instructor:
Critical Thinking Skills	Student illustrated excellent use of critical thinking skills: utilizing: objectivity, thoughtful interpretations, and weighing all the options	Student illustrated good critical thinking skills with some minor mistakes in one of the categories (left)	Student did not illustrate good use of critical thinking skills and made errors such as being subjective, false interpretations, and/or failing to weigh all the options before making conclusions		
Written communication* *(Reports, Data logs)*	Written material made by the student are complete, accurate, and well written	Written materials are for the majority – complete, accurate, and well-written with some minor errors	Written materials are not complete, contains obvious errors, may not be easy to read or understand		
Oral communication* *(Press conferences and team discussions)*	Student communicates very well with the 'public' (avoids jargon) and within their team with efficiency, accuracy and professionalism.	Student communicates with 'public' and within their team efficiently, with minor errors, and a mostly professional attitude	Student communicates with 'public' and within their team poorly. Illustrating some inaccuracies, or displaying unprofessional attitudes or demeanors		
Collaborative Skills	Student illustrates excellent use of collaborative skills: brainstorming, sharing, debating and diplomacy	Student illustrates satisfactory use of collaborative skills with some minor problems	Student does not use collaborative skills well and had difficulty working in a team-setting		
Enthusiastic Participation	Student illustrated strong efforts to participate and enact their role during the simulation	Student illustrated a moderate level of participation and enacted their role mostly well during the simulation	Student illustrated a poor level of participation and did not make an effort to 'get into' their role.		

Reviewer_____ Grand Total _____/ 10

Appendix A2. Auckland Eruption Sequence

Auckland Eruption Sequence

		Precursors	Event	PAUSES
TIMELINE	6-Feb	Background, no changes		
	15-Feb	Background; Feb 19 - small HF earthquakes representing background seismicity		Feb 23rd 0:00 - PAUSE - 20 minutes to prepare for a 10 min Press Conference
	1-Mar	Mar 6: LF quakes at depth, and shallowing. Mar 8: Magma reaches the brittle crust; Mar 8-13: Some HF quakes, with an increase in magnitude, and continuing to shallow. Swarms present now with up to 300 quakes per day.		March 8th 16:00 - PAUSE - 15 mins prepare for a 10 minute Interview between the Section Manager and a member of the EM team
	10-Mar	Some HF quakes, swarms. Deformation data no longer background. March 12 - beginning of gas changes. March 14- Tremor quakes present now, with accelerating deformation data and visual observations of cracking near Mangere. Gas levels increase, with deflation of ground surface. March 15-20 sudden decrease in gas levels. March 18 - tuff ring visible below waters surface.	 March 14th AM first phreatic eruption (Mangere). March 14 PM phreatomagmatic eruption (3 km plume); March 18 - Tuff ring visible underwater.	March 14th @ 16:00 PAUSE, 10 min to prepare for a 15 min Joint GNS-EM Team Meeting to discuss the status of the Event
	20-Mar	March 20 - inflation (deformation) measureable now. March 21 - huge spike gas content (by huge magnitudes). Steady decrease in gas content after this. Prior to most magmatic eruptions, inflation events occur, with deflation occuring afterwards.	 Mar 21 - Phreatomagmatic eruption (2.5 km plume) which continues sporadically over ~48 hours. March 22nd - 3rd phreatomagmatic eruption (1.5km), March 23rd - Tuff ring visible above water level. March 25 AM - Phreato to Magmatic eruption with fire-fountaining (500 m plume); March 25 PM - fire fountaining continues, ballistics are thrown 350 m high, continues for 8 hours; March 26th - Strombolian eruption (1 hr of fire fountaining; plume height of 300 m); March 29th - Magmatic eruption (max height of 500 m plume), intermitant eruptions over 2 days	March 25th - 4:00 PAUSE 5 minute break :)
	April 1 to April 14	Tremor continues over the entire eruptive period. Gas levels fall off as the activity becomes more effusive. Levels stabilize around April 4th. Height of deformation around April 2nd. Deflation continues as activity becomes more effusive	 Small cinder cone is now visible. April 3rd - surface lava flows are visible. Flows go south to Kiwi esplanade. April 5th - flows on the western part of the cone. Flows go west, and reach the water - forming littoral explosions. A plume is present at lava-water contact (mostly steam, gas, and some ash) - that is present from April 5-13th. Lava bench collapse on April 14th (height of plume ranges from 40 -100 m)	April 3rd PAUSE 10 minutes to prepare for a 15 minute press conference

Appendix A3. Auckland Interactive Bibliography

Instructions:
1. Go to your assigned role.
2. Review your specific responsibilities.
3. Read and summarize the necessary literature to prepare for the simulation.
4. Read the instructions (separate document).

Note: The more prepared you are for the simulation, the better overall you and your team can respond to the volcanic event.
Click the links (in the readings row) to download the papers from my Dropbox. If you have trouble downloading any of the papers, please email Jackie asap (jdohaney@gmail.com).

Emergency Management Team

Role:	**Group Controller**
Responsibilities:	Team Leader; to lead, direct and coordinate the emergency response. Primary decision-maker. **CHALLENGE** questions may be posed to you and your teams. Respond accordingly and communicate this information as instructed. Be sure to read the cards with the people noted, so that everyone is informed.
Important Readings:	Volcanic Alert Levels (GNS); Advice to Emergency Management Team Leaders (Australian Govt)
Additional Readings:	Hazard Assessment of the Auckland Volcanic Field (Jan Lindsay) Advice to the Public during an Eruption (MCDEM); Volcano Fact Sheet: Rangitoto Volcano (GNS)

Role:	**Duty Manager**
Responsibilities:	Coordinates and organises the EM Team, assists Group Controller to carry out tasks. Receives incoming information from GeoNet and delegates tasks. When an eruption occurs, your team must fill out Volcanic Impact Reports. It is your responsibility to make sure your team members fill these out.
Important Readings:	Volcanic Alert Levels (GNS); Advice to Emergency Management Team Leaders (Australian Govt) Auckland Volcanic Field Contingency Plan (CDEM) Infrastructure of Auckland
Additional Readings:	Proximal tephra hazards: Recent eruption studies applied to volcanic risk in the Auckland volcanic field, New Zealand (Houghton et al)

Role:	**Crisis Information Manager**
Responsibilities:	Records all incoming information from the **Newsfeed** (i.e., social media) tab, and distributes this information to the team. Keeps the team up to date with the public's wants and needs. Vets information carefully. If an event occurs, you will work with the Public Information Officers to fill out Media Releases.
Important Readings:	Advice to the Public during an Eruption (MCDEM) Infrastructure of Auckland
Additional Readings:	Media Release to the Public after a small eruption on Ruapehu (MCDEM); Media Release to the Public after the Canterbury Earthquake (MCDEM); Media coverage after Ruapehu eruptions 1995 (Reuters);

	Example of news article after Ruapehu activity, and misquoting of scientist (Smellie)

Role:	**Public Information Officer**
Responsibilities:	Writes media releases to the public concerning event advice (what to do, what to be prepared for...). Liaises with GeoNet Team, and gathers incoming information. Media Releases should be timely, concise and considered.
Important Readings:	Media Release to the Public after a small eruption on Ruapehu (MCDEM); Media Release to the Public after the Canterbury Earthquake (MCDEM); Media coverage after Ruapehu eruptions 1995 (Reuters); Example of news article after Ruapehu activity, and misquoting of scientist (Smellie)
Additional Readings:	VEI: Volcanic Explosivity Index (Newhall & Self); Advice to the Public during an Eruption (MCDEM)

Role:	**Planning Manager**
Responsibilities:	Primarily concerned with infrastructure and evacuation efforts. Focus on status of major road networks (works with Infrastructure Coordinator on this effort). Evacuations are planned with Welfare Officer.
Important Readings:	Auckland Volcanic Field Contingency Plan (CDEM) Volcanic ash impacts on critical infrastructure (Wilson); Infrastructure of Auckland
Additional Readings:	Aviation hazards from Volcanoes (Prata & Tupper); Advice for Airports during an Eruption (Wilson & Stewart); Advice for use of Generators during an Eruption (Hill et al); Advice for Power Plant Operators during an Eruption (Wilson et al); Advice for Urban Clean-up following an Eruption (Wilson et al); Aviation Alert Level Codes (GNS); Auckland's water supply system, and Demand Report in 2011 (WaterCare)

Role:	**Infrastructure Coordinator**
Responsibilities:	Primarily in charge of the status of roads, water (waste and drinking), shipping, rail, and airports. Works with VAAC/CAA on air. Works with Planning Manager on roads. Works with Welfare Officer on evacuation routes.
Important Readings:	Volcano Fact Sheet: Rangitoto Volcano (GNS); Volcanic ash impacts on critical infrastructure (Wilson); Advice for use of Generators during an Eruption (Hill et al); Advice for Roading Managers during an Eruption (Wilson et al); Advice for Building Managers during an Eruption (Wilson et al); Advice for Power Plant Operators during an Eruption (Wilson et al); Advice for Power Transmission Operators during an Eruption (Wilson et al); Advice for Wastewater Managers during an Eruption (Wilson et al); Advice for Water Supply Managers during an Eruption (Stewart and Wilson); Advice for Urban Clean-up following an Eruption (Wilson et al) Infrastructure of Auckland
Additional Readings:	Proximal tephra hazards: Recent eruption studies applied to volcanic risk in the Auckland volcanic field, New Zealand (Houghton et al); Ash leachates (Stewart et al)

Role:	**Welfare Officer**
Responsibilities:	Organising and planning the essentials of life for people affected by an event – Primarily concerned with evacuation centres, Salvation Army, and Housing New Zealand. Works with Planning Manager on evacuation routes and centre locations. Works with VSAG Human Impacts on how volcanic eruptions may affect citizens.
Important Readings:	Volcano Fact Sheet: Rangitoto Volcano (GNS); Volcanic ash impacts on critical infrastructure (Wilson); Advice for Building Managers during an Eruption (Wilson et al); Organisational Response to Ruapehu Eruption (Paton et al) Human Impacts from Volcanoes (Doocy et al) Infrastructure of Auckland
Additional Readings:	Proximal tephra hazards: Recent eruption studies applied to volcanic risk in the Auckland volcanic field, New Zealand (Houghton et al)

Role:	**Human Impacts (Volcanic Scientific Advisory Group)**
Responsibilities:	Specialises on how ash and volcanic eruptions impact humans (health, sociological, and infrastructure related). Liases with other members of the EM Team to assess impacts to human health. Should request information from GeoNet as needed (e.g., ash composition, size, eruption styles, etc.)
Important Readings:	Ash leachates (Stewart et al) Contamination of water supplies due to volcanic ash (Stewart et al); Proximal tephra hazards: Recent eruption studies applied to volcanic risk in the Auckland volcanic field, New Zealand (Houghton et al) Human Impacts from Volcanoes (Doocy et al)
Additional Readings:	Volcanic ash impacts on critical infrastructure (Wilson); Auckland's water supply system, and Demand Report in 2011 (WaterCare); Health Effects of VOG (Office of the Governor); Advice for Water Supply Managers during an Eruption (Stewart and Wilson); Advice for Urban Clean-up following an Eruption (Wilson et al) Advice for Building Managers during an Eruption (Wilson et al);

Role:	**Economic Impacts (Volcanic Scientific Advisory Group)**
Responsibilities:	Provides EM Team with advice on how eruptive activity and decision=making will impact the local and national economy. All decisions made by the Team should be considered (cost, short term and long term) economic impacts. Long term impacts – relocation of people, insurance, tourism, etc. Should be considered.
Important Readings:	Proximal tephra hazards: Recent eruption studies applied to volcanic risk in the Auckland volcanic field, New Zealand (Houghton et al); Aviation hazards from Volcanoes (Prata & Tupper); Exercise Ruaumoko - Report of the Economic Workgroup: Assessment of the Impacts of a Volcanic Eruption on the Auckland Economy (Shearer) Infrastructure of Auckland
Additional Readings:	Volcano Fact Sheet: Rangitoto Volcano (GNS); Volcanic ash impacts on critical infrastructure (Wilson); Advice for Urban Clean-up following an Eruption (Wilson et al) Auckland's water supply system, and Demand Report in 2011 (WaterCare); Advice for Power Plant Operators during an Eruption (Wilson et al)

Role:	**VAAC (**Volcanic Ash Advisory Centre**)/** **CAA (**Civil Aviation Authority of New Zealand)
Responsibilities:	Makes final call on whether to close or open air space over NZ. Should liaise with MetService (in GeoNet) on status of weather and with Ash Specialist (in GeoNet) on location of ash dispersal events. Liaise with Economic Impacts to consider costs of closing airports.
Important Readings:	Aviation Alert Level Codes (GNS); Volcano Fact Sheet: Rangitoto Volcano (GNS); Aviation hazards from Volcanoes (Prata & Tupper); Advice for Airports during an Eruption (Wilson & Stewart)
Additional Readings:	Proximal tephra hazards: Recent eruption studies applied to volcanic risk in the Auckland volcanic field, New Zealand (Houghton et al)

GNS GeoNet Team

Role:	**Volcanic Section Manager**
Responsibilities:	Team Leader; To lead, direct and coordinate monitoring of volcanoes in NZ. Makes final decision to raise or lower alert levels. When/if an Alert Level must be raised or lowered, you need to fill out an Alert Level Change form. **CHALLENGE** questions may be posed to you and your teams. Respond accordingly and communicate this information as instructed. Be sure to read the cards with the people noted, so that everyone is informed.
Important Readings:	Volcanic Alert Levels (GNS); Volcanic Eruption Meeting Agenda (Jolly); Proximal tephra hazards: Recent eruption studies applied to volcanic risk in the Auckland volcanic field, New Zealand (Houghton et al) VEI: Volcanic Explosivity Index (Newhall & Self); Advice to Emergency Management Team Leaders (Australian Govt); Monitoring seismic precursors to an eruption from the Auckland Volcanic Field, New Zealand (Sherburn et al);
Additional Readings:	Basics on monitoring Gas, Seismic and Deformation (IRIS); Volcanic styles of the Auckland Volcanic Field (Smith & Allen); Working on Volcanoes (GNS)

Role:	**Public Information Officer**
Responsibilities:	Writes media releases to the public concerning the SCIENCE of an event. Liases with EM Team, and provides timely information as the event unfolds. Media Releases should be timely, concise and considered.
Important Readings:	Volcanic Alert Levels (GNS); VEI: Volcanic Explosivity Index (Newhall & Self); Media Release to the Public after a small eruption on Ruapehu (MCDEM); Media coverage after Ruapehu eruptions 1995 (Reuters); Example of news article after Ruapehu activity, and misquoting of scientist (Smellie)
Additional Readings:	Proximal tephra hazards: Recent eruption studies applied to volcanic risk in the Auckland volcanic field, New Zealand (Houghton et al)

Role:	**Geophysics (Remote Monitoring)**
Responsibilities:	Monitors **seismic** data tabs. Records, analyses this data and provides updates to GeoNet Team. **Additional datasets** may show up in the Newsfeed data tab.
Important Readings:	Volcanic Alert Levels (GNS); Monitoring seismic precursors to an eruption from the Auckland Volcanic Field, New Zealand (Sherburn et al); Basics on monitoring Gas, Seismic and Deformation (IRIS)
Additional Readings:	VEI: Volcanic Explosivity Index (Newhall & Self)

Role:	**Geochemistry (Remote Monitoring)**
Responsibilities:	Monitors **geochemistry** data tab. Records, analyses this data and provides updates to GeoNet Team.
Important Readings:	Volcanic Alert Levels (GNS); COSPEC at Active Volcanoes (Stix et al); Basics on monitoring Gas, Seismic and Deformation (IRIS)
Additional Readings:	Proximal tephra hazards: Recent eruption studies applied to volcanic risk in the Auckland volcanic field, New Zealand (Houghton et al); VEI: Volcanic Explosivity Index (Newhall & Self); Ash leachates (Stewart et al); Health Effects of VOG (Office of the Governor)

Role:	**Geodesy (Remote Monitoring)**
Responsibilities:	Monitors **ground deformation** data tab. Records, analyses this data and provides updates to GeoNet Team.
Important Readings:	Volcanic Alert Levels (GNS); Monitoring seismic precursors to an eruption from the Auckland Volcanic Field, New Zealand (Sherburn et al); Basics on monitoring Gas, Seismic and Deformation (IRIS)
Additional Readings:	Proximal tephra hazards: Recent eruption studies applied to volcanic risk in the Auckland volcanic field, New Zealand (Houghton et al); VEI: Volcanic Explosivity Index (Newhall & Self)

Role:	**Visual Surveillance (Volcanology Unit)**
Responsibilities:	Monitors **Visuals (webcam)** data tab. Records, analyses this data and provides ongoing updates to GeoNet Team. Be aware of extra data sets that may show up in the **Newsfeed** tab.
Important Readings:	Volcanic Alert Levels (GNS); Proximal tephra hazards: Recent eruption studies applied to volcanic risk in the Auckland volcanic field, New Zealand (Houghton et al); VEI: Volcanic Explosivity Index (Newhall & Self); Proximal tephra hazards: Recent eruption studies applied to volcanic risk in the Auckland volcanic field, New Zealand (Houghton et al)
Additional Readings:	COSPEC at Active Volcanoes (Stix et al); Basics on monitoring Gas, Seismic and Deformation (IRIS); Littoral Hydrovolcanic Explosions: a case study of lava – seawater interaction at Kilauea Volcano (Mattox & Mangan)

Role:	**MetService Meteorologist (Volcanology Unit)**
Responsibilities:	Monitors **Weather** data tab. Records this data and provides ongoing updates to the Ash and Flow scientists (they need this information to make tephra dispersal maps). Be aware that **Weather Forecasts** will show up in the **Newsfeed** tab.
Important Readings:	Volcanic Alert Levels (GNS); Basics on monitoring Gas, Seismic and Deformation (IRIS); Quantitative Modelling of Ash Plumes (Carey and Sparks)
Additional Readings:	Proximal tephra hazards: Recent eruption studies applied to volcanic risk in the Auckland volcanic field, New Zealand (Houghton et al); VEI: Volcanic Explosivity Index (Newhall & Self)

Role:	**Ash Specialist (Volcanology Unit)**
Responsibilities:	Monitors **Ash Reports** data tab. Records data, and creates ash dispersal maps based on each eruption. Ash dispersal maps can be made using this **Ash Plume Model** excel sheet: Ash Plume Dispersal Model Excel Sheet (Hill and Edwards) If you have questions on how to use this excel sheet, please ask. You will need weather information to help calculate ash thicknesses. ***This information must be sent to the EM team as soon as possible.***
Important Readings:	Volcanic Alert Levels (GNS); Ruapehu Ash Isopach Example (Wilson); Quantitative fall out models of ash; Used to determine ash cloud distributions (Carey and Sparks) Ash dispersal estimates from the AVF (Bebbington and Cronin)
Additional Readings:	Proximal tephra hazards: Recent eruption studies applied to volcanic risk in the Auckland volcanic field, New Zealand (Houghton et al); VEI: Volcanic Explosivity Index (Newhall & Self); Basics on monitoring Gas, Seismic and Deformation (IRIS); Advice for Airports during an Eruption (Wilson & Stewart)

Role:	**Flow Specialist (Volcanology Unit)**
Responsibilities:	Monitors Visual tabs with Surveillance expert to assess what possible flows (ash, pyroclastic and lava) can happen when an eruption occurs. Map estimated run-out, confirm with LIDAR data (Additional datasets will show up in **Newsfeed** tab) and help determine an appropriate "exclusion zone" based on proximal hazards. Liaise with Section Manager and Planning Manager (EM Team) to discuss proximal hazards and run-out.
Important Readings:	Volcanic Alert Levels (GNS); Ruapehu Ash Isopach Example (Wilson); Pyroclastic flow assessments from Merapi 2010 eruptions (Jenkins et al); Volcanic styles of the Auckland Volcanic Field (Smith & Allen)
Additional Readings:	Proximal tephra hazards: Recent eruption studies applied to volcanic risk in the Auckland volcanic field, New Zealand (Houghton et al); Quantitative fall out models of ash; Used to determine ash cloud distributions (Carey and Sparks) VEI: Volcanic Explosivity Index (Newhall & Self); Basics on monitoring Gas, Seismic and Deformation (IRIS)

Role:	**Field Team (Volcanology Unit)**
Responsibilities:	To organise, plan field excursions to check for visually observed and measured data that cannot be assessed remotely. Must ask permission from **Section Manager** when going out into the field by filling out Fieldwork Risk Assessment forms. Check with other GeoNet team members if additional datasets are needed. When "going to the field" – visit the "**Volcano**" to get your information.
Important Readings:	Working on Volcanoes (GNS); Volcanic Alert Levels (GNS); Proximal tephra hazards: Recent eruption studies applied to volcanic risk in the Auckland volcanic field, New Zealand (Houghton et al); VEI: Volcanic Explosivity Index (Newhall & Self); Basics on monitoring Gas, Seismic and Deformation (IRIS) Pyroclastic flow assessments from Merapi 2010 eruptions (Jenkins et al);
Additional Readings:	COSPEC at Active Volcanoes (Stix et al); Monitoring seismic precursors to an eruption from the Auckland Volcanic Field, New Zealand (Sherburn et al); Littoral Hydrovolcanic Explosions: a case study of lava – seawater interaction at Kilauea Volcano (Mattox & Mangan)

Appendix A4. Auckland Hazards Map Activity

Pre-Simulation Lab: Science Communication & Volcanic Hazards Team Exercises

Lab Part 1: Volcanic Hazards Specialists

Instructions: You will be split up into **4 groups** that have been formed to become specialists about a particular important geologic and emergency management topic that is crucial for understanding volcanic hazards and the history of the Auckland Volcanic Field.

Group 1: Historic Geology Group

Group 2: Volcanic Products Group

Group 3: Hazards Focus – Distal Impacts

Group 4: Hazards Focus – Proximal Impacts

Materials Needed: A0 Map of the Auckland Regional Area (6-10 copies, preferably colour), Blank A3 (20-30 pages) and A4 paper for drawings, print-outs of Literature (hyperlinks below), or access to the internet so that students can access the literature. Some students should bring laptops (to view literature) and to create ash isopachs (using the Ash isopach excel sheet) and use Google Earth, and Wikipedia to look at local and regional population centres.

Note: You may want your students to read the literature prior to the lab, if you have time to do this.

Group 1: Historical Geology Group

Responsibility: Your group is responsible for doing background geological history research on the Auckland Volcanic Field (i.e. the historic vents).

Instructions:

3. Get the literature (see below) and maps needed.
4. Work together to create a **volcanic history map**, and **summary statement** which describes and illustrates the historic volcanic activity of the Auckland Volcanic Field:
    d. Identify (draw a **map**) of all Recent (last 80,000 years BP) eruptive vents, and briefly describe these in your own words. On a blank piece of A3 paper to draw a **legend** for your map.
    e. Draw a "**Time-slice" diagram** that illustrates the change in volcanism on A3 paper (i.e., location of vents, type of volcanism, and composition of volcanism) over the last 80k years BP.
    f. Write a **summary** of the magmatic processes that are likely occurring beneath Auckland in the future, which has led to its present form and distribution. Statement should be written for geologists (1 page A4).

Literature: Houghton et al (2006); Smith & Allen (1994); Molloy et al (2009);

Group 2: Volcanic Products Group

Responsibilities: Your group is responsible for doing research on **types**, **distribution**, and **scale** of volcanism that can occur at the Auckland Volcanic Field (i.e. the historic vents).

Instructions:

3. Have a group discussion to discover (use the literature provided to help).
    e. The **composition** and **magma genesis** of the source of the Auckland Volcanic Field.
    f. The typical **scale** of volcanism that has occurred in the AVF in the past 80,000 year BP.
    g. Compare the scale of volcanism that occurs in the AVF to the volcanism that occurs in the Taupo Volcanic Zone.
    h. Draw a helpful **diagram** to help explain these. Be sure to include extent of erupted material, and the time scale of eruptive activity.

4. Create a **statement** that summarizes the topics discussed above. Write the statement in language suitable for geologists. 1 page, A4.

Literature: Houghton et al (2006); Smith & Allen (1994); Molloy et al (2009); Wilson et al (1995);

Group 3: Hazards Focus – Distal Impacts

Responsibilities: Your group is responsible for cataloguing and understanding the **distal** (or Regional) impacts of volcanism from the Auckland Volcanic Field (i.e. the historic vents).

Instructions:

1. As a group, list and describe all of the **Distal** volcanic products that can be expelled from a shield (or maar) volcano during a Strombolian eruption. Focus your efforts on impacts to the area outside of Auckland (and impacts to the country as a whole).
2. Look at the map of Auckland an Identify the suburb of Point England. A Strombolian eruption occurs within the Morrin Reserve. The eruptions which follow dispel ash in a south easterly direction over several weeks.
    a. List the population, main industry, "life lines" (i.e., road networks, electricity network, etc.) in this area. Use Wikipedia and Google Earth to research.
    b. Provide a description of the overall short term **impacts** on human life and property in New Zealand if a volcanic event were to occur here.
    c. Provide a description of the overall long term **impacts** on human life and property in New Zealand if a volcanic event were to occur here.
3. Create a **statement** that summarizes the topics discussed above. Write the statement in language suitable for the public. 1 page, A4.

Maps: Map of Auckland Area; Map of the North Island of NZ

Literature: Houghton et al (2006); Smith & Allen (1994); Newhall and Self (1982); MCDEM Advice to the Public (2011); Wilson et al, critical infrastructure paper (2011)

Group 4: Hazards Focus – Proximal Impacts

Responsibilities: Your group is responsible for cataloguing and understanding the proximal (or Local) impacts of volcanism. Your setting is the Auckland Volcanic Field (i.e. the historic vents). Limit your area of **impact** to within the National Park boundaries (see Figure 1 Below, dashed lines).

Instructions:

1. As a group, list and describe all of the **Proximal** volcanic products that can be expelled from a shield (or maar) volcano during a Strombolian eruption. Focus your efforts on impacts to the area within Auckland City.
2. Look at the map of Auckland an Identify the suburb of Point England. A Strombolian eruption occurs within the Morrin Reserve. The eruptions which follow dispel ash in a south easterly direction over several weeks.
    a. List the population, main industry, "life lines" (i.e., road networks, electricity network, etc.) in this area. Use Wikipedia and Google Earth to research.
    b. Provide a description of the overall short term **impacts** on human life and property in this suburb if a volcanic event were to occur here.
    c. Provide a description of the overall long term **impacts** on human life and property in this suburb if a volcanic event were to occur here.
3. Create a **statement** that summarizes the topics discussed above. Write the statement in language suitable for the public. 1 page, A4.

Maps: Map of Auckland Area; Infrastructure of Auckland

Literature: Houghton et al (2006); Smith & Allen (1994); Newhall and Self (1982); MCDEM Advice to the Public (2011); Wilson et al, critical infrastructure paper (2011)

Part 2: Inter-Agency Team Work

Instructions: Mix your groups - New groups will now be formed with at least one member from each previous group. The purpose of Part 2 is to share the knowledge you have gained and make it useful for the other specialties *(i.e. a geologist is focused on the scientific knowledge; While an emergency manager is focused on the impacts of the volcanic eruptions)*

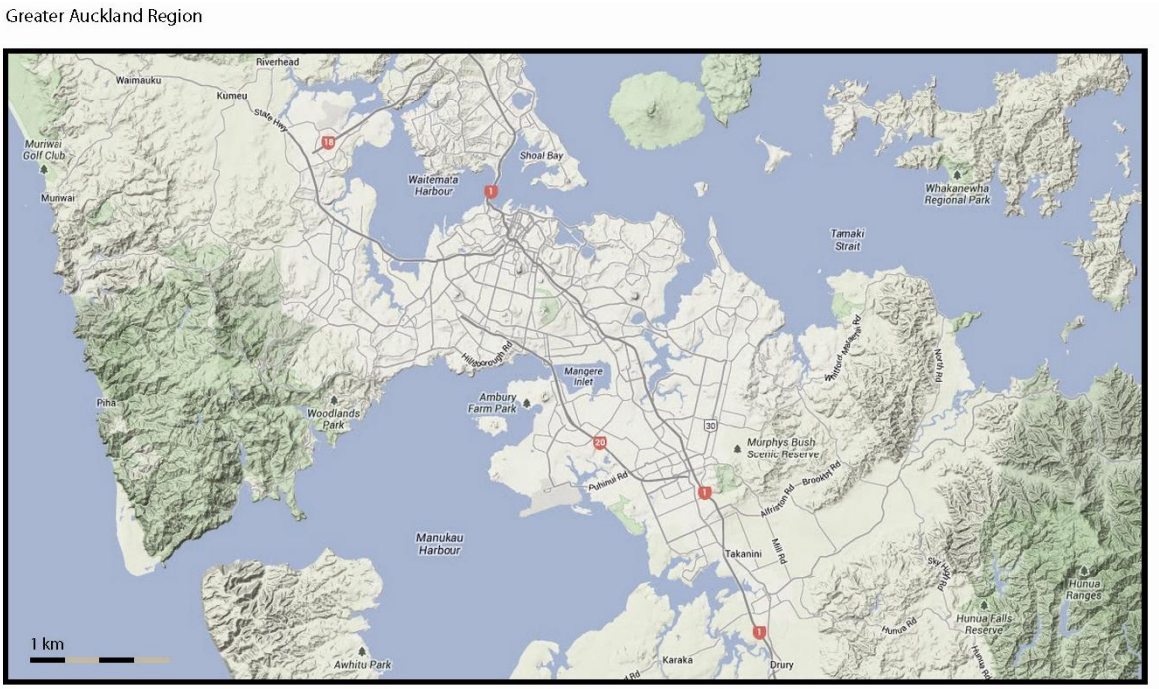
4. Each member of the new groups have 3-minutes to present their findings from their specialty. Focus on how the knowledge that you have will be of use to the other members. Each member can take 5 minutes to prepare for this.
5. As a new group, create a plan and a map that illustrates a sound monitoring network for the Auckland Volcanic Field based your research.
    b. **Brainstorm** all of the monitoring methods (or data) that is used to monitor volcanoes.

Questions to Consider:
What factors impact the **location** of the monitoring stations?
Where do you put your monitoring stations?
How **many** monitoring stations do you think you need?
How might monitoring costs and policy impact data monitoring in different countries?

6. Make an ash isopach map of a large Strombolian eruption from Point England. Use the Carey and Sparks paper, to estimate the **extent** and **distribution** of a Use the ash isopach excel sheet (provided) to make calculations and plot onto a local ash isopach map. Plot your ash distribution onto a map of Auckland (A3).

   Eruption parameters: 3km (column height) eruption emitted from the Point England vent (with uniform 10 km/hr northwesterly winds (wind that is coming from the Northwest) that lasts for 2 hours (in duration).

Figure 1: Auckland Region



Part 3: Hazards Map – All students

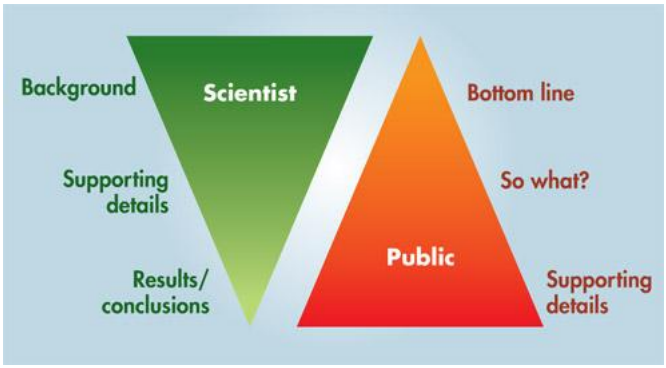
Instructions: All students will now work together to make a class hazards map of the Auckland Volcanic Field (Point England Vent). Your goal is to make a hazard map that communicates the important geological and hazards knowledge to the Public.

Steps: Using a large map of Auckland, **create** a geologic hazard map for the general public and emergency response services **locally** after an eruption from Point England. Make a **legend**, with **symbols** and descriptions. Be sure to include:

f. **Identify** the eruptive vent, and briefly **describe** the deposits in the legend.
g. **Identify** local population centers around the volcano.
h. **Identify** and **illustrate** critical lifelines and infrastructure for the suburb and City (and nation, if it is relevant).
i. **Draw** and **define** the various hazard (or exclusion) zones on the map and in the legend.
j. **Justify** your decisions.

Finale: Present and justify your Auckland Hazards Map to your instructor. Think about your language, and imagine that you are speaking to the Public (See Appendix 1)

Appendix 1: Science Communication Best Practices:



Who is your audience? This is the first, and most important question a writer and communicator should ask. Your words, style, and behavior should all be adapted to the specific needs of your audience. A good example is to picture the difference between trying to explain to a child versus a university student - why the Moon revolves around the Earth. What background in science does your audience have? Are there common misconceptions they may hold? Is there an aspect of your science that is sensitive, or controversial to them? Will they respect your opinion/practices? What words should you use?

Providing Context for the audience: Explaining to the audience the **IMPORTANCE** of your work is one of the most powerful (and often missed) points that a communicator should address. If you start to explain a complicated process, and do not provide the 'who cares' & 'how does that effect me' statements, your audience will not be motivated to listen to you. A very useful tip, is to state the WHY at the very beginning of your talk, or prose. This engages the reader right away, and makes them feel that it is useful to them to listen.

Jargon-appropriate communication: Jargon is a word or phrase that is specialized. Science jargon is only appropriate when describing something to a colleague within your discipline. As a science student, you are asked by your professors to learn new words (jargon) that are used to explain/describe exactly what you mean. This is important for colleague-communication, but is rarely appropriate in any other situation.

Using gestures, props, and drawings: Depending on what you are trying to communicate, a drawing or gesture may explain your concept much better than words. Studies of expert, successful field geologists show that the more expert they become, the more gesturing they use. Using your hands, and getting others to do the same, can be an effective method of explaining a scientific principle. However, be sure that the audience understands what each element (prop, hand, direction) is meant to represent, be explicit, and repetitive with gestures and props.

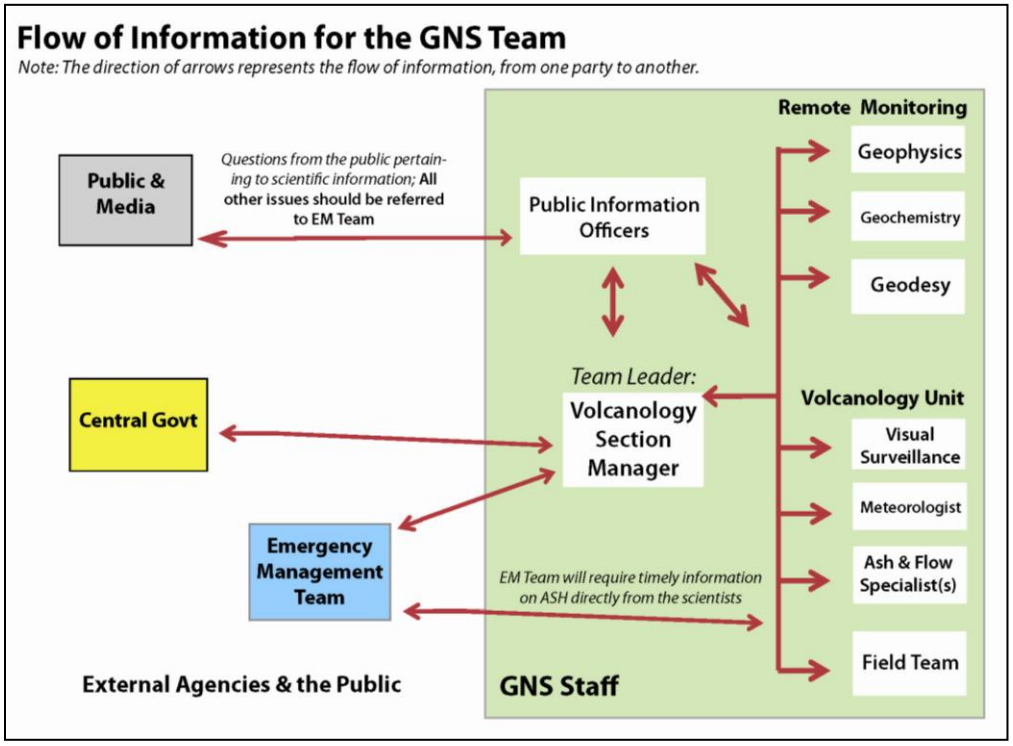
Socratic Questioning & Engaging the audience: Depending on the formality of the setting, asking the audience to answer a question, and asking them to help you write a list, or shout out ideas – is one of the simplest ways to engage an audience. Asking them for feedback, and probing their ideas on a subject, is a relatable, respectful method of keeping the audience on track and engaged. This builds rapport (mutual respect), and can be the best way to illustrate your ideas, and understand if they '**get it'.**

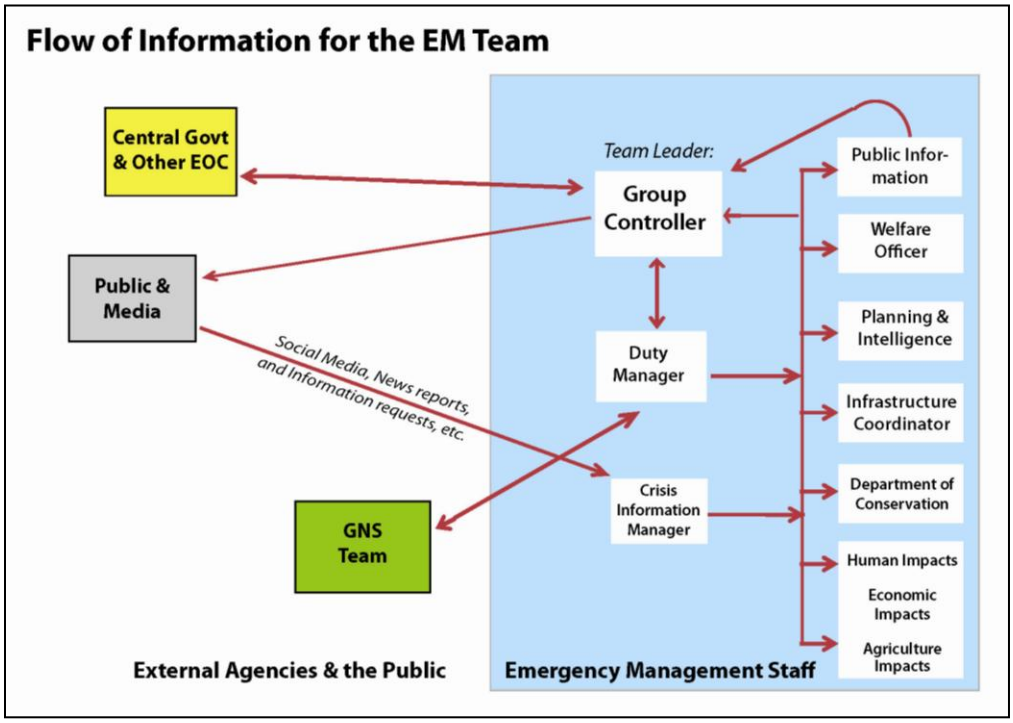
Appendix A5. List of Paperwork

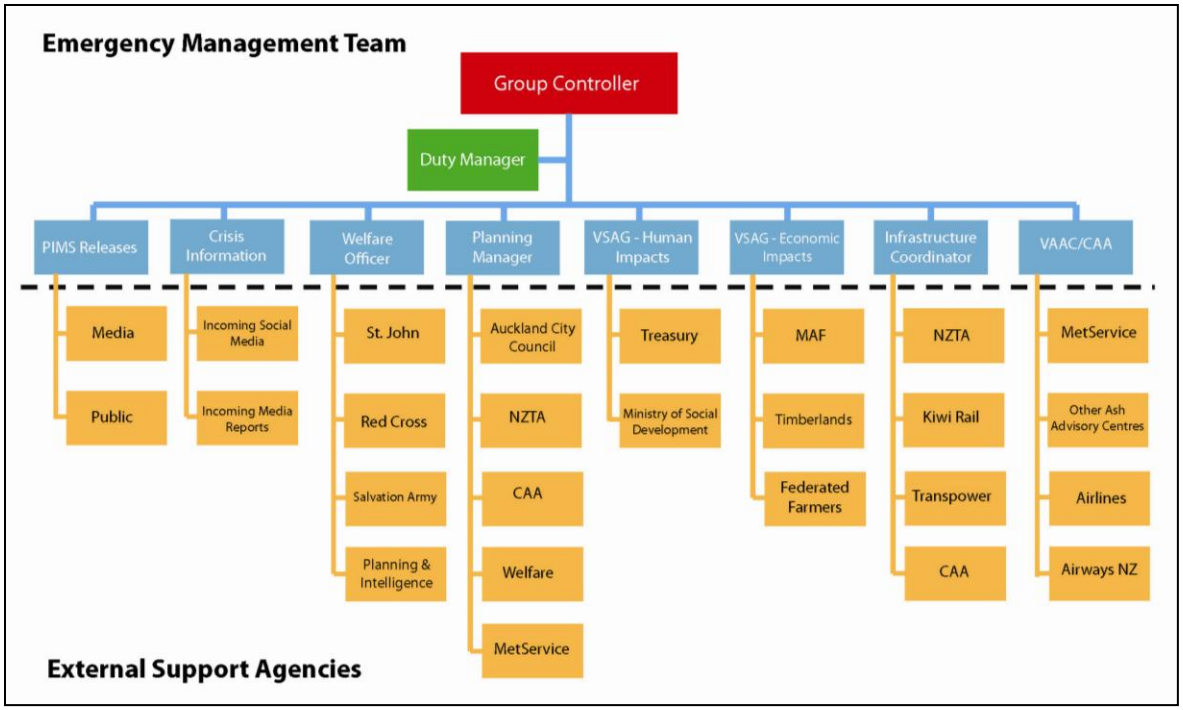
Maps:	**Size**	**Copies**
Auckland City Map	A3 colour	20-30
Auckland City Infrastructure Map	A3 colour	10-20
Mangere Bridge Local Map	A3 B&W	20-30
Instructions:	**Size**	**Copies**
Table 1 from Instructor Manual (send electronically too)	A4	n of instructors
Eruption Sequence (send electronically too)	A4	n of instructors
Instructions for Students (send electronically too)	A4	n of students
	Size	**Copies**
Challenge Questions	A4 single	1
(print, and then cut up into individual pieces)	sided colour	
Challenge Questions (for instructors)	A4 B&W, dbl s	n of instructors
Roles & Teams	**Size**	**Copies**
Interactive Bibliography	A4 colour	1
Instructor Roles	A3 colour	2
Flow of Information GeoNet	A3 colour	2
Flow of Information EM	A3 colour	2
External Agencies	A3 colour	2
Reports & Data Logs	**Size**	**Copies**
Data Logs	A4, B&W	n of students x3
Alert Level Report	A4, B&W	10
Fieldwork Risk Assessment	A4, B&W	15
Media Release	A4, B&W	80
Volcanic Impacts Report	A4, B&W	40
Grading Rubric	**Size**	**Copies**
Overall Performance in the Simulation	A4, B&W	n of students x2

Appendix A6. Team Structure (i.e., Flow of Communication) Diagrams

This appendix includes the ideal flow of communication pathways which illustrate how the students should behave in the simulation. Digital files of these figures can be changed for your specific needs.






Emergency Management Team
Group Controller
Duty Manager
PIMS Releases
Crisis Information
Welfare Officer
Planning Manager
VSAG - Human Impacts
VSAG - Economic Impacts
Infrastructure Coordinator
VAAC/CAA
Media
Public
Incoming Social Media
Incoming Media Reports
St. John
Red Cross
Salvation Army
Planning & Intelligence
Auckland City Council
NZTA
CAA
Welfare
MetService
Treasury
Ministry of Social Development
MAF
Timberlands
Federated Farmers
NZTA
Kiwi Rail
Transpower
CAA
MetService
Other Ash Advisory Centres
Airlines
Airways NZ
External Support Agencies

Appendix A7. Auckland Challenge Questions

6-Feb	0:00	**EM1.** Welcome to the simulation! An Emergency Management (EM) team works together to mitigate crises. As there is no reported volcanic unrest in Auckland, at this time, you can consider yourselves in 'planning and preparation' mode - The tasks that you must complete together: 1. Introduce each member's role and responsibilities. Each member should talk about their specific strategies and considerations that you have for your individual sector 2. The Controller and Duty Manager should explain the protocols for the **flow of communication** within the EM, and to the GeoNet Team. 3. **All team members** should think about how they will contribute to decision making. And record your thoughts and observations on your Data logs. **You have 10-15 minutes**
6-Feb	0:00	**GeoNet1**. Welcome to the simulation! Your job is to assess background levels in and around the Auckland Volcanic Field. 1. **The Section Manager** is advised to visit all of the monitoring stations and briefly introduce yourself, and your role. **2. The Section Manager should explain the protocols for the flow of communication within the EM, and to the GeoNet Team. 3. All team members should think about how they will contribute to decision making. All team members** should record your thoughts and observations on background levels at the volcano in your Data logs. **Discussions should take ~ 10-15 mins**
6-Feb	0:00	**EM2.** Following EM team meeting, the **Duty Manager** is requested to touch base with the Geonet public information officer and clarify the flow and modes of communication between the GeoNet team, and the EM team. The crisis information manager should be observing the "Newsfeed" at all times. **This should take ~ 10-15 minutes**
6-Feb	0:00	**GeoNet2**. **The GeoNet Field Team** is advised to list and describe all of the methods for monitoring volcanoes in the field. Separate out these data types into - Proximal and Distal categories. Check with the Field Volcanologist Specialist if all of these are possible in the Auckland Volcanic Field (AVF). Assess whether 'traditional' monitoring methods are applicable in Auckland. List the most important barriers to active monitoring in and around a city center. Implement a two-week plan of fieldwork that should help to collect background activity for the volcanic field. Fill out, and get the necessary 'Field Work Risk Assessment' forms signed by your superior. You should spend **~ 10-15 minutes doing this.**
23-Feb	0:00	**GeoNet3**. There has been seismic activity in Auckland. The **whole GeoNet team** must prepare a **8 minute** (2 minutes for questions), Press Conference to address several questions: a. A brief overview of Auckland Volcanic Field (in lay speak) and Geophysicists should explain/hypothesize why the earthquakes have occurred; b. The volcano geophysicist(s) are asked to describe and explain the fundamental difference (geological processes, and monitoring) between high frequency and low frequency earthquakes; c. Status of Auckland's Volcanic Alert Level, and d. Confer with EM team on general advisory to the public. Section Manager should work democratically with all GeoNet members, and the Public Information Officers should assist in format, phrases, wording and tone of the message to the public. **You have 20 minutes to prepare**. **All team members should participate** in this discussion (see **GeoNet Volcanic Eruption Meeting Agenda**) record your thoughts on your Data log.
23-Feb	0:00	**EM3.** There has been seismic activity in Auckland, and so **your whole team** is meeting to discuss how this may play out in the media. The **Public Information Releases Manager** is asked to explain to the group how they think media should be handled. **Each person in the team** should consider if there are any impacts to your sector. Discuss, and release a Volcanic Impacts Report (that goes to the National CDEM group), a written Media Release (to the public). **You have 20 minutes**. A brief (10 minute) Press Conference will be held by the GeoNet team. All team members should record your thoughts on your Emergency Management Data logs during the conference.
23-Feb	0:00	**EM4. Following the Press Conference, the Public Information Releases Manager** should work with the **Group Controller** to critique the press conference. Ask the **Public Information Director** to fill out a Rubric and communicate the results with both teams. How did it go? What went well? What did not go well? Language.. (**Spend a maximum of 10 minutes on this**)

25-Feb	8:00	**EM5.** The Government wishes to know what makes a good location for an evacuation center. The **Welfare Manager** and the **Planning and Intelligence Manager** should prepare a short report describing the attributes they look for in an evacuation center to be sent to the government (Prime Minister). The report should address issues such as choice of locations, supplies and transportation. Consider what external agencies might be able to assist at the center. (You have **5-10min** to complete this report signed of by the Group Controller, handed to the Prime MInister, ask them to critique it and hand it back when done)
8-Mar	16:00	**EM6. Each member of the EM team gets to submit a question** that will be used in a 10-min interview of the GeoNet Section Manager. Pretend that you are a member of the public, with little to no understanding of volcanoes. Vote as a team, and select 4 questions to go to the interview stage. Elect one member of the EM team to pretend to be a famous New Zealand Journalist. **You have 10 minutes to prepare.** Observe the interview, and critique the Section's Managers responses in your Data logs**. Use this information to construct a group policy around communication with the public.**
8-Mar	16:00	**GeoNet4**. Have a brief discussion among the GeoNet team to inform the Section Manager the status of each type of monitoring data. **The public information officers** should then assist **the Section Manager** in preparing for an unscripted Media Interview about the status of volcanism in Auckland. During the interview planning, the **Field team** should be planning future fieldwork, and consulting with the rest of the GeoNet monitoring team when needed. Read, and Prepare 'Field Work Risk Assessment' forms for future field missions. (Field team has 10-15 minutes to do this) **Preparation - 10 minutes, Interview 10 minutes.**
8-Mar	20:00	**EM7. The EM team** should work together to practice planning for a fake eruption scenario. Use the following information to help plan your response: A Vulcanian eruption sourced from a vent in Manukau Harbour ~2km offshore of Titirangi (directly south) and has an effected area of ~2.5 km radius from the vent. a. Design and justify, and map possible 'Exclusion Zones'. Write a Volcanic Impacts Report providing the Mayor of Auckland scientific and socio-political information for or against the evacuation of Auckland (or specific areas). Ask them to critique your decision-making and the wording of the report. The **Welfare Manager** should lead this investigation in consultation with the **VSAG team, Planning and Intelligence Manager and the Infrastructure Coordinator**. **The Controller** should sign off on all decisions and reports. You have 10-15 minutes to practice, and write the report
8-Mar	20:00	**GeoNet5: FORECAST:** The **GeoNet team has been requested by the Prime Minister** to work together to narrow down a location for a possible eruption vent using the available datasets. The Section Manager must make the final decision. This forecast should be written in a report and sent to the EM Team, and to the Prime Minister. Be sure to include probabilities and uncertainties that are part of your decision-making. You have 10 minutes to do this.
10-Mar	8:00	**EM8: The Crisis Information Manager** should quickly verbally update the group on the status of public media (social media, and reported media). Brief the EM team, and make suggestions on what information is of value, and what is not - establishing a team strategy on the media.
14-Mar	16:00	**EM9:** You are going to have a 15 minute Joint Meeting between the GeoNet Team and the EM Team. This is to discuss the volcanic activity, and draft a Media Release to be given out on general advisement to the Public. Get a working map from the GeoNet team on where tephra has fallen. Topics to cover include: a. Impacts of volcanism on health, electricity, roads, buildings, agriculture. b. What is the status of evacuation(s)? c. Which issue do you tackle first? What is priority? **VSAG - Human Impacts Manager** can take the lead on writing a brief Volcanic Ash Report to address these issues. You have **10 minutes** to write it, and provide this information at the meeting.
14-Mar	16:00	**GeoNet6:** You are going to have a 15 minute Joint Meeting between the GeoNet Team and the EM Team. This is to discuss the status of the volcano, volcanic activity, and draft a Scientific Media Release to be given out on general advisement to the Public. Topics to cover include: a. Eruption type, b. What can we expect to happen?, c. Will the activity continue, Will it subside?, d. What does your monitoring data tell you, what does it prove? What is the uncertainty? Be sure to include rough probabilities. You have **10 minutes** to prepare, and a 15-min meeting to share.

15-Mar	8:00	**EM10.** The **Infrastructure Co-ordinator** is advised to prepare a short Volcanic Impacts Report, on how the road network and road conditions may be affected by the most recent eruption. (You have **5 minutes** to write this). Then the **VAAC** and **VSAG - Human Impacts Manager** is advised to respond to concerns from Airways New Zealand on the status of the aviation codes in New Zealand. You have **5 minutes** to justify the aviation code in a Volcanic Impacts Report.
15-Mar	8:00	**EM11:** Ministry of Economic Development requests information from the **VSAG -Economic Impacts** on significant concerns of long term impact to the city's economy if the volcano continues to erupt. Be sure to include general estimates of financial impact based on probable longevities. Write a Volcanic Impacts Report, you have 5 minutes to do this.
15-Mar	8:00	**EM12: The GeoNet Field Team** should be asked to help collect water samples from the water supply network to assess the city's water quality. The VSAG-Human Impacts and the Infrastructure Coordinator should communicate with the GeoNet field team regarding the affected locations that require sampling, how many samples you need, and how long it will take. You have **5 minutes**.
15-Mar	8:00	**GeoNet7.** As a team, discuss expectations (scale, type of volcanism), and what your group thinks could happen. What are the data telling you? Write down observations in your Data Log. **(10 minute informal scientific discussion)**
15-Mar	8:00	**GeoNet8: The Field Team** is asked to collect ash and tephra samples and make measurements of the total tephra thickness to produce isopach maps. Liaise with the Ash Specialist, and the MetService Unit to help sort out where samples should be collected from. Remember to consider how long it will take, access to the sites, and mark on the map the sample localities. Be sure to fill out the necessary paperwork and see **the Volcano** for the results.
21-Mar	8:00	**GeoNet 9:** For every subsequent eruption (if one occurs), the **volcanologists,** with help from the **field team** are asked to compile: 1) a cumulative isopach map; 2) projected lava flows and base surges from eruptions. Use the topography and eruption parameters to help you. You can also use observations and samples obtained by the field team.
3-Apr	0:00	**EM13.** A change in eruption has occurred. The **Duty Manager** should lias with the Geonet team to get the necessary geological information. The **EM team** should write a list with: a. The areas most likely to be impacted, b. Basic advice to citizens in these areas, c. The worst-case scenario for each sector (water, roads.. etc). Elect one representative from your team to give this list during the press conference. Both teams (EM and GeoNet) will present the most important information (5 minutes each) with 5 minutes of questions from the Public.
3-Apr	0:00	**GeoNet10.** What kind of eruption is this? Where did it occur? Prepare (10 minutes) for a **15 minute press conference** to explain to the public what has happened at the volcano. As a group, elect your representative from your team to give this presentation. Both teams (EM and GeoNet) will present the most important information (5 minutes each) with 5 minutes of questions from the Public.
3-Apr	4:00	**EM14:** Auckland City Council wishes to know of any mitigation strategies they could use to slow/stop further destruction from lava flows. The **whole team** should list strategies and cases of where they have been used and whether they would work at this volcano. You have **5 minutes**
3-Apr	4:00	**EM15: VSAG Human and environmental Impacts** is asked to write a brief volcanic impacts report on the effects of exposure to high levels of CO2 and SO2 both health wise and effects to the environment. You have **5 minutes**
3-Apr	4:00	**EM16 :** The **Planning and Intelligence Manager,** the **Infrastructure Coordinator** and the **Welfare Manager** are asked to create a volcanic hazards map of the Auckland volcano, utilising scientific information from the GeoNet team. Be sure to include all types of eruptions and their impacts that have occurred.You have **10 minutes**

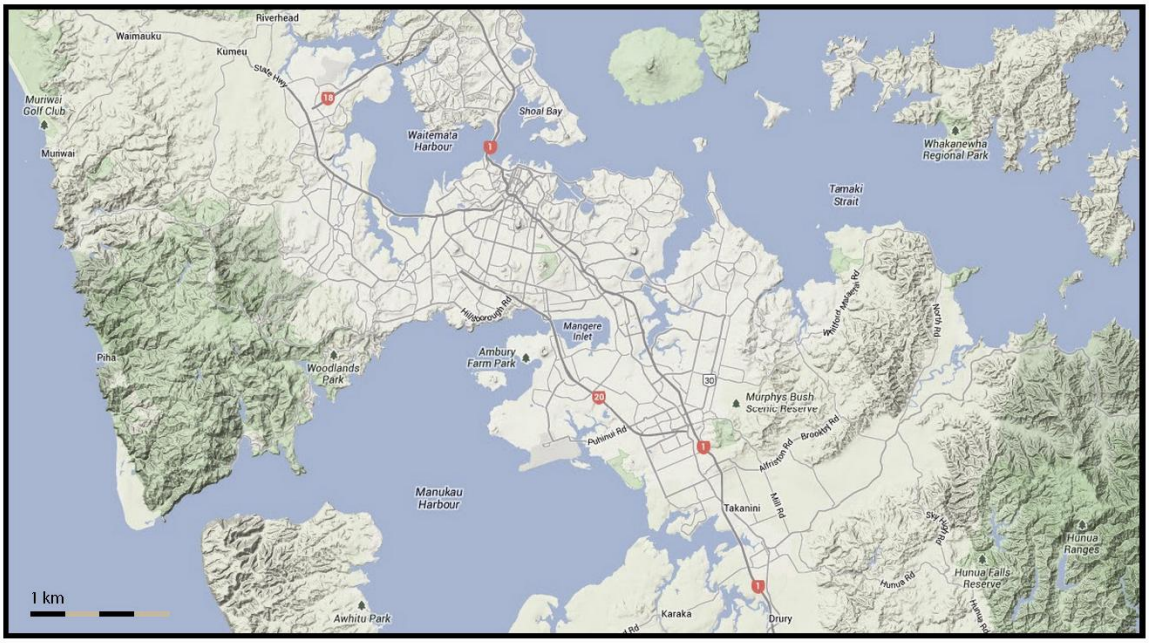
13-Apr	4:00	**EM17:** Both teams are advised to STOP and watch the remaining Media and Community Response info for the remainder of the simulation (should take a couple of minutes)
13-Apr	4:00	**GeoNet11:** Both teams are advised to STOP and watch the remaining Media and Community Response info for the remainder of the simulation (should take a couple of minutes)
14-Apr	20:00	**GeoNet12:** A 15 minute press conference will be used to summarize the most recent events. Section Manager should report on: a. Scale of eruption, b. Whether the team believes further eruptions will occur, c. Ash and flow dispersal, and liase with EM team on list of affected regions, d. equipment conditions, and plan to repair. Remember to speak in plain speak - this is for the public, not volcanologists. You may invite team members to speak about their specialities. You have **15 minutes** to prepare
14-Apr	20:00	**EM18:** A 15 minute press conference will be used to summarize the most recent events. Group should report on: a. List of effected regions (and populations), b. reccomendations for home-owners, c. status of the exclusion zone, and d. recommendations on how long evacuations will take place. e. Communications are down in some areas, what do you reccommend? Remember to speak in plain speak - this is for the public, not scientists. You may invited the members of your team to speak about their specialties. **You have 15 minutes to prepare**

Appendix A8. Auckland Maps

Below are the maps that students use to plot tephra distribution and illustrate evacuation routes and other impacts to infrastructure. These should be printed at A3 size.

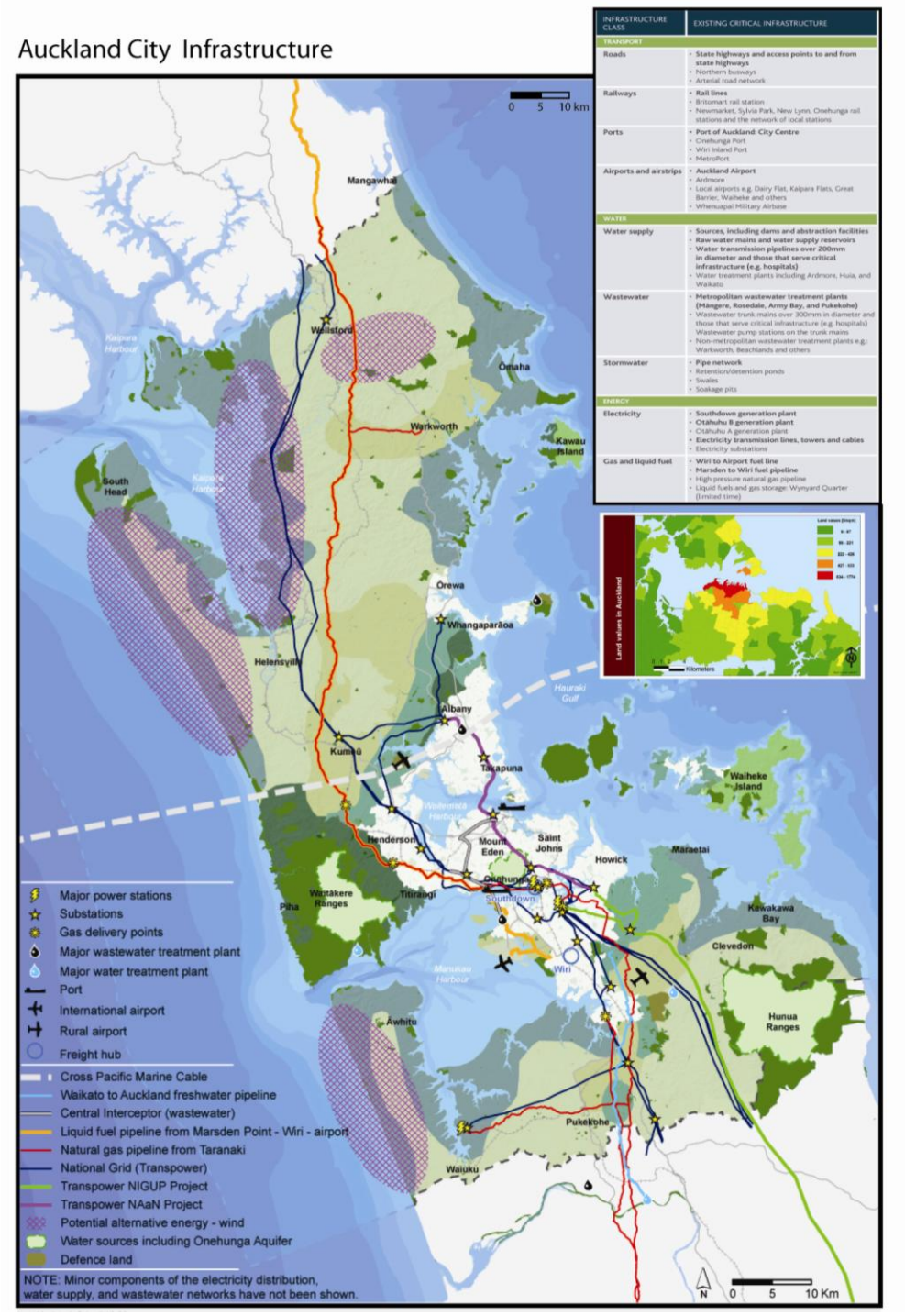
Auckland City

Greater Auckland Region



Mangere Bridge (only to be shown to students once the vent is revealed)

Auckland Infrastructure



Appendix A9. Auckland Data Stream

The data that the students monitor throughout the simulation is built into an offline website package. This data file (.zip file) should be downloaded, extracted (using WinRar or other extraction software), and the file folder should be copied and pasted onto the computers you are using. See Appendix C7 for detailed instructions on the "unpacking process".

Auckland Data Stream Files (see digital version).

Appendix C – Additional Curricular Material

Appendix C1. Role Questionnaire

Instructions: This questionnaire is used to assign you to a role for the simulation. This is confidential and will not be shared with other class members or instructors. Fill in, or "bold" the responses, and return to the researcher. Thanks!

Section 1 Basics:

Name:

Gender:

Age:

Nationality (What country do you reside in normally?):

Current University 'Year' in 2013? 200-level, 300-level, 400-level, or Masters

Section 2 Statements:

Select if you "Agree", "Are neutral", or "Disagree" with the following statements about **yourself.**

1. People that know me would say that I am extroverted.

   Agree Neutral Disagree

2. I am very comfortable presenting information in front of the class and my peers.

   Agree Neutral Disagree

3. I have strong leadership skills.

   Agree Neutral Disagree

4. I enjoy working under pressure.

   Agree Neutral Disagree

5. I am very good at multi-tasking and task-prioritizing.

   Agree Neutral Disagree

6. I am a team player, and I like working with other people.

   Agree Neutral Disagree

7. I am very good at writing, and written communications.

   Agree Neutral Disagree

8. I am a Maths-Quantitative person.

   Agree Neutral Disagree

Section 3 Other Comments:

1. List your three favourite geology-related topics:

2. Are there any geology-related topics that you really dislike? List these.

3. List three other non-geology topics that really interests you.

Appendix C2. Science Communication Lecture

10/16/2013

Science & Hazards Communication:
"Best Practices"

Jackie Dohaney
University of Canterbury

UC UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Why teach Communication Skills?

Consistently mentioned as a top skill needed for graduates

"**Social skills are really important in the job.** You've got to be able to communicate with people. And that's not just like at a professional level, it's at a social level too. You've got to be able to sit down and have a drink with someone, and talk to them about not just what's been going on at work, but what's going on with them, personally as well. And form relationships with people. It's important."

Different Forms of Communication

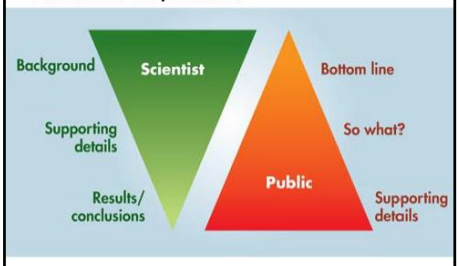
Media Release
Bulletin

Press Conferences
Meetings Discussions
Townhall

Blog
Twitter, Facebook

What variables contribute to communication?

Different Perspectives:



TED ideas worth spreading Teaser

1. Watch talk
2. While watching, write down what you consider to be the "takeaway messages".

http://www.ted.com/talks/gregory_petsko_on_the_coming_neurological_epidemic.html

Communicating with Colleagues

1. **Specialized** audience! Can use jargon where appropriate.
2. Be **terse** (get to the point!)
3. Be **explicit** (use exact terms, be very precise with your descriptions)
4. Be **transparent** about the **limitations** of your findings! (Is your work preliminary?)

1. Who is your Audience?

Your **words**, communication **style**, and **behaviour** need to be adapted.

What background in science does your audience have?

Are there any aspects which may be sensitive or controversial to them?

1. Who is your Audience?

Experts have a different mental structure about concepts and the links between them than **novices**

- Faster access to knowledge
- Faster recognition of important aspects
- Faster pattern recognition
- Better transfer of knowledge

You may think your argument or graph is easy to follow, but does the audience think so too?

Context – Why does it matter to them?

In some cases, this is obvious

In others you will need to point out WHY your science matters

Words that are Specialized; Unknown to non-specialists

Be **Jargon**-appropriate!!

If you need to use a term (to be specific) be sure to '**modify**' it or use an **analogy**

" Some types of eruptions can involve water, and are otherwise known as ***phreatomagmatic eruptions***. These can be dangerous because… "

2. Using props, diagrams or gestures when communicating

- These will help you **SHOW** your audience what you are talking about
- Be sure to **be explicit** with these (can leave the audience more confused)
- Diagrams should **avoid complicated units**, or derivations. Should be straightforward.

Science Communication Best Practices

3. Engaging the audience

- **Avoid passive,** 'lecture-style' communication (unchanging, 'closed', clinical)
- **Ask the audience questions**: "What do you think? Shout out some ideas, Ask me some questions"
- This allows to you **build rapport** with the audience, and also they may ask questions you had not thought to bring up, etc.

Science Communication Best Practices

Engaging: Being Emotional

Conveying **emotional** aspects of your science (when appropriate) will help you connect with the public.

If your findings have **impact** on human beings, then showing emotions is healthy, and people respond to this.

Science Communication Best Practices

4. Avoid appearing arrogant

Avoid phrases like "**obviously**", and "**of course** you will know this".

Your audience **DOES NOT LACK INTELLIGENCE** – they simply lack expertise in your area

They may hold **Misconceptions** as well (things that they think to be true, but is not).

Be patient, and open

Science Communication Best Practices

5. The great 'Uncertainty'

- It is important to be clear about **how 'certain'** you are about your findings.
- Also to convey that 'this method'; or 'this type of science' may have certain caveats…

The public may WANT you to have a firm answer – when in reality this is NOT realistic.

7 C's of Science Communication

Comprehensible – simple, clear, jargon-free
Contextualized – diversity, cultures, differences
Captivating – engaging, relevant
Credible – open, frank, acknowledges uncertainty
Consistent – backed by evidence, confirmable
Courteous – compassionate, empathetic, respectful
(Addresses) **Concerns** – empowers action/response

Vivienne Bryner, doctoral research (Otago)
http://www.youtube.com/watch?v=grhrLT8tfjg

Standards	Exemplary (2 Marks)	Satisfactory (1 Mark)	Needs Major Improvement (0 Marks)
Organization	Has a clear opening statement that catches audience's interest; maintains focus throughout; summarizes main points	Has opening statement relevant to topic and is mostly organized; provides adequate "road map" for the listener	Has no opening statement or has an irrelevant statement; gives listener no focus or outline of the presentation
Delivery & Attitude towards audience	Has natural delivery; is articulate; projects enthusiasm, interest, and confidence; Expresses themselves respectfully to the needs and wants of the public	Has appropriate pace; is easily understood; But demonstrates out-of-role behaviour. Has neutral expression towards public	Is often hard to understand; has voice that is too soft or too loud; has a pace that is too quick or too slow. And may not take the press conference seriously. May show disrespect (superiority) to public audience.
Use and Quality of Supporting Media	Uses media (Maps, graphs or documents) to enhance presentation; Provides easily understood and accurate information	Relies on media to support facts, but provides misleading or confusing information.	Relies too heavily on use of supporting media, or does not use supporting media at all. Public would be confused to see media.
Response to Questions	Demonstrates full knowledge of topic; explains and elaborates on all questions appropriately	Shows ease in answering questions but does not elaborate. Has difficulty responding to some questions	Demonstrates little grasp of information, has undeveloped, unclear, or incorrect answers to questions.
Use of Jargon	Uses easily understood terminology, uses analogies or anecdotes to help people understand what they are talking about.	Mostly clear use of terms and avoids jargon, but does use several phrases/concepts which would be difficult to understand.	Over-use of jargon, has difficulty expressing science to all the relevant audiences.

Quigley: http://tvnz.co.nz/national-news/severity-quake-stuns-experts-video-4038556

Who was his audience?

Who would be listening to this broadcast?

What parties are interested, and therefore keen to listen to what he says?

What words does Mark use when referred to how quakes will effect the lives of the people in ChCh?

Grade Quigley's Performance:

Attribute: Delivery & Attitude

- ☐ **(2 marks)** Has very natural delivery; is articulate; projects enthusiasm, interest, and confidence. Expresses themselves respectfully to the audience.
- ☐ **(1-1.5 marks)** Has appropriate pace; is easily understood; But demonstrates some minor ineffective behaviours (e.g. lacks confidence). Has a neutral expression towards the public.
- ☐ **(0-0.5 marks)** Is often hard to understand; has voice that is too soft or too loud; has a pace that is too quick or too slow. And may not take the press conference seriously. May show disrespect (superiority) towards the public.

Delivery + Attitude Text Analysis:

Reporter states Mark has **"... dedicated his life to studying earthquakes**".

What is this meant to convey to the Public listening?

- Showed confidence.
- Sincere, and down-to-earth
- **Some less-polished things** slipped through: "Things like that", etc. Um's and Ah's.

Jargon - text analysis

In general, he did very well avoiding jargon.

Some jargon may have been used + the ChCh + NZ public may be used to hearing it

Jargon -

"stress field, stress states, epicentre location, fault location"

"(fault) Loading up structures"

"Crust"

Summary – Tips!

Be concise. Answer the question in full, but avoid drawing out your answer, complicating it, or going off on tangents.

Stick to what you know. If you are asked something you don't know the answer to, it's ok to say you don't know. Avoid talking about things you don't have adequate knowledge, information, or authority to disclose.

Use clear, simple language. Technical scientific jargon can be confusing, intimidating, or discouraging to an audience. Aim to keep things informative, but accessible.

Give advice. Simple short reminders of where to find information, or what the public should be doing to prepare are a good idea.

Summary – Tips!

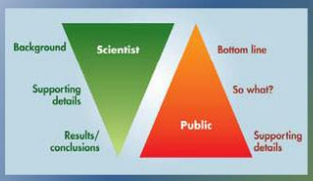
Avoid mutually exclusive language. Avoid using phrases such as "it will," or "it won't." DO try to use phrases such as "it's unlikely" or it's "very likely," which will include the uncertainty in the hazard information, and also reduce your chance of liability or misleading the audience.

Be professional. Joking, laughing, or being distracted during an interview about a potentially dangerous event could compromise your credibility. You want to instil the public's confidence in your team's ability to manage and respond.

Alert, don't alarm. Alert people of important information about the hazard or risk and make sure it is taken seriously, but avoid scaring and alarming people with dramatic language or descriptions. You want people to respond, not to panic.

Interview etiquette. Follow the cameraman's instructions about where to look, stand, etc. Stay relaxed and keep eye contact with the interviewer, avoid looking directly into the camera.

Questions about Science Communication?



Appendix C3. Overall Performance Rubric
This Rubric is used to assess the student's performance during the simulation.

Overall Performance in the Volcanic Simulation Rubric

Student Name_____

The following standards describe your performance in this simulation. This is used to give you feedback about your performance and to help you improve in the future! *Give scores, tally up, for a final score out of 10. Half marks can be used.*

Standards	Exemplary (2 Marks)	Satisfactory (1 Mark)	Needs Major Improvement (0 Marks)	Score	Comments
Critical Thinking Skills	Student illustrated excellent use of critical thinking skills: objectivity, thoughtful interpretations, and weighing all the options.	Student illustrated good critical thinking skills with some minor mistakes in one of the categories (left)	Student did not illustrate good use of critical thinking skills and made errors such as being subjective, false interpretations, and failing to weigh all the options.		
Written communication *(Reports, Data logs)*	Written material made by the student are complete, accurate, and well-written.	Written materials are for the majority – complete, accurate, and well-written with some minor errors.	Written materials are not complete, contains obvious errors, may not be easy to read or understand		
Oral communication *(Press conferences and team discussions)*	Student communicates very well with the 'public' (avoids jargon) and within their team with efficiency, accuracy and professionalism.	Student communicates with 'public' and within their team efficiently, with minor errors, and a mostly professional attitude.	Student communicates with 'public' and within their team poorly. Illustrating some inaccuracies, or displaying unprofessional attitudes or demeanors.		
Collaborative Skills	Student illustrates excellent use of collaborative skills: brainstorming, sharing, debating and diplomacy.	Student illustrates satisfactory use of collaborative skills with some minor problems.	Student does not use collaborative skills well and had difficulty working in a team-setting.		
Enthusiastic Participation	Student illustrated strong efforts to participate and enact their role during the simulation.	Student illustrated a moderate level of participation and enacted their role mostly well during the simulation.	Student illustrated a poor level of participation and did not make an effort to 'get into' their role.		

Name of Reviewer _____ Total _____ / 10

Appendix C4. Data Logs

Data log		
Name:	Position:	
Date + Time	Observations:	Alert Level
Sketchs or Graphs:		

Appendix C5. Media Release

Media Release **Date/time:**

Volcano Name:

Volcanic Alert Level (Circle one)

0 1 2 3 4 5

Status:
□ Dormant □ Unrest □ Eruptive

Keywords:

Headline:

Summary of data and information (plain speak; bullet points):

Author **Name:** **Position:**

Signature:

Team Leader **Name:**

Signature:

Appendix C6. Reports

Alert Level Report Used by GeoNet Team

GeoNet: Alert Level Change Report

Volcano Name:

Volcanic Alert Level (Circle one)

0 1 2 3 4 5

Status:
□ Dormant □ Unrest □ Eruptive

Summary of Volcanic Activity:

Justification of Alert Level Change:

Recommendations to the Emergency Management Team:

GNS Scientist Position:

Name: **Signature:**

Fieldwork Risk Assessment Used by GeoNet Team

Field Work Risk Assessment: Is it safe to work on the Volcano?

Volcano Name:

Volcanic Alert Level (Circle one)
0 1 2 3 4 5
Status:

☐ Dormant/Quiescent ☐ Unrest ☐ Eruptive

Number of staff: ☐ **Emergency** Equipment Malfunction?
Time needed on Volcano:

Location of work:

☐ Near vent (within 1km) ☐ Proximal (within 1-3 km of vent)

☐ Distal (outside of 3km)

Brief Description and Purpose of Proposed Field Excursion:

Checklist:

☐ Staff is aware of hazards on volcanoes, and the recommended actions to avoid injury and death

☐ Staff has read the associated section on risks based on volcanic activity (eruptive versus non-eruptive)

☐ Staff is aware of the possibility of 'Blue-sky' eruptions, and major risks within 3 km of the vent.

Probability of an Eruption occurring which staff are on the volcano?
Low
Medium
High

☐ **I acknowledge that working on volcanoes is dangerous, and that all health and safety regulations have been considered.**

Field Manager Name: **Signature:**

☐ **I approve this field excursion** **Date:**

Section Manager Name: **Signature:**

Volcano is Quiescent, Risk of 'Blue-Sky' Event:

Table 1. Return periods for potentially life threatening eruptions with no recognised precursory activity at New Zealand's frequently active volcanoes. Note: these numbers are the best available at the time of writing. With more detailed research, the risk will be better defined.

	Number of years	Maximum and minimum number of life-threatening eruptions with no precursory activity[1]	Maximum and minimum number of life –threatening eruptions **per year** with no precursory activity
White Island	50	2-3	0.04-0.06
Ngauruhoe	50	0	0
Ruapehu	50	3-7	0.06-0.14
Tongariro	153	0	0
Raoul Island	200	0-1	0.005

[1] The definition of unrest will be different for each volcano.
[1] Ngauruhoe appears to mostly have precursory activity before eruptions, usually vigorous steaming from the crater and fumaroles. The record of eruptions at Tongariro is not good enough to make a judgment on whether there was precursory activity. Given that the time since the last eruption is long, one would probably expect there to be significant unrest before an eruption.

Volcano is Showing 'Unrest', or is 'Eruptive' → Risk of Future Event:

Using global statistics (Newhall and Hoblitt, 2002), once a period of significant unrest is initiated, the likelihood of an eruption within one year is between 10 and 50%. If there is any doubt, then fieldwork within 3 km of the vent should be suspended for at least 24 hours. Following an initial eruption, the probability of further eruptions could be higher or lower, depending on the volcano, the style of the eruption and the magnitude of the eruption.

Things to consider:

Make the risk assessment on the day of your fieldwork. Consider –where you are going, how long you need to be there, and what parts of the volcano are 'safer' than others. **If there has been an eruption (phreatic and/or magmatic) realistically no vent-work will be allowed for weeks.** If this is the case, look at Distal field work or airborne fieldwork. If equipment needs mending, a fly-by-pick-up is recommended.

(Russell and Newcombe, 2000)

LEVEL OF RISK			TYPE OF ACTIVITY/EXPOSURE				
SDU	Numerical	Categorical	Drug use	Leisure activity	Disease/illness	Accident/injury	Other exposures
0	1 in 1	*Maximum*					Intensive care
1	1 in 10	*Extremely high*		Russian roulette*			Brain surgery
2	1 in 100	*Very high*	Tobacco	BASE jumping	Heart disease		Surgical operation
			Methadone	Serious climbing ~	Cancer		Space travel
			Injecting	Grand Prix racing	Respiratory disease		Deep sea fishing
3	1 in 1,000	*Quite high*	Heroin	Hang gliding	Hypothermia etc.	Violence	Hospitals- babies
			Morphine	Parachuting	Mental disorders	Pollution	White asbestos
			Barbiturates	Motorbike racing	Strokes	Sudden infant death	Offshore oil work
			Alcohol	Recreat. climbing~	Prostate c. (men)	Shaking of babies	Mining
4	1 in 10,000	*Medium*	Solvents	Motor sports	Diabetes	Suicide; Falls	Construction work
			Benzodiazepines	Water sports ***	Leukaemia	Road travel/use	Farming/agriculture.
			Dextropropoxy.	Mountain hking ~	Influenza	Giving birth	Police custody
			Dihydrocodeine	Canoeing	Skin cancer	Helicopter travel	GA-dentist; liposuct.
5	1 in 100,000	*Quite low*	Ecstasy/MDMA	Dance partes	Asthma	Air & rail travel	Factory/machine work
			Amphetamine	Fighting sports	HIV/AIDS	Homicide;	C.A.Refusal of int.care
			Cocaine; GHB	Snow sports	Meningitis	Stairs (falling)	Manufacturing (cars etc) &
			Prescribed drugs	Soccer & rugby	Sudden death syn.	Eating (choking)	Passive smoking
			Analgesics	DIY (home)	Food poisoning	Electrocution; Guns	X-rays; Machines
			Contracep. pill	Sport spectator	Cervical cancer	Drowning; Fire	Work (general)
6	1 in 1 million	*Very low*	LSD (*acid*)	Fairground rides	Legionnaire's	Beds (falling out)	Clerical/office work
			Hal.mushrooms	Running/jogging	Food allergies	Clothing fires; Toys	Vaccination; Abortion
			Antibiotics	Swimming	Malaria; Syphilis	Boilers/heaters !	Police cars; Storms
			Viagra (men)	Riding sports	Appendicitis	Pedest. crossings	War/terrorism
7	1 in 10 million	*Extremely low*	Herbal cannabis	Indoor sports	CJD/BSE; Measles	Insect stings	Nuclear radiation
			Cannabis resin	Playgrounds	Toxic shock synd.	Dogs; Copulation	Police shootings
			Alkyl nitrites	Gymnasiums	Peanut allergy	Starvation; Thirst	Lightening
8	1 in 100million	*Minimum (negligible)*	Caffeine; Khat	Table games	Bubonic plague	Snakes; Birds; Cats	State executions
			Nitrous oxide	Computer games	Smallpox	Sharks;Telephones	Meteorites;Volcanoes
			Ketamine; DMT	Masturbation	Leprosy	UFOs/aliens	Earthquakes;sp.comb.

Volcanic Impacts Report Used by Emergency Management Team

Volcanic Impacts Report – Risk and Damages

Volcano Name:

Volcanic Alert Level (Circle one)
0 1 2 3 4 5

Status:
□ Dormant □ Unrest □ Eruptive

Brief Summary of Volcanic Activity:

Communities Affected:

Sector (e.g. Agriculture)	Actions

Emergency Management Position:

Name: **Signature:**

Appendix C7. Installing the Data Stream

Step 1: Installing Mozilla Firefox (Can skip this step, if already installed)

The computers need to have Firefox installed. The website package only runs properly on Firefox.

Go to: http://www.mozilla.org/en-US/firefox/new/ and download the browser.

or copy and paste the Firefox exe in the Appendix C files.

If possible have this installed prior to the day of the simulation (either on the student's computers or the laboratory computers).

Step 2: Extract files and Copy to Desktop

The data stream files are compressed into a zip file. Access these files in Appendix T9 (Tongariro files) or A9(Auckland files). Download this zip file to the desktop or laptop that you are running it on.

Extract the files by right-clicking on the fiel, or opening it with your extraction software of choice (e.g. , WinRAR http://www.rarlab.com/).

Because the file folder is made up of many many files (~5000 small files) it is best transported as a zip, and then extracted.

Be sure to copy, paste and run the files from the folder onto the desktop.

Note: If there are administrator rights on the computers, you should be sure to have the log in and password. Sometimes computers will not allow you to download or run new files without administrator permission.

Step 3: Navigate to Sim file

Open the main folder. Go to the **sim** folder.

Right-click on the **simulation.html** file, and "**Open with**" Firefox.

A new window in Firefox should open with the Front end of the Interface. Depending on the screen size, etc. Feel free to **zoom in** or zoom out to adjust the screen properly (e.g. ctrl – or ctrl +)

Step 4: Open additional software

We recommend students use **Google Earth**, or **Google Maps** (with Terrain feature) to view the local area. Students can also browse reference materials (from the Bibliography).

Appendix C8. Ash Plume Model Excel Sheet

Two students play the role of ash and flow volcanologists. These students are responsible for informing the other participants of both erupted and forecasted ash distribution. To fulfil this requirement they are provided with a simplified ash distribution model and the necessary input parameters to produce ash isopach maps. Input parameters include wind speed and direction (provided in the weather tab), plume height, and a VEI scale (Newhall and Self, 1982) in which to ascertain erupted volume using the supplied plume height and eruptive style.

Ash Plume Model Excel Sheet (link)

Screenshot of Ash Plume Model