VISG
VOLCANIC IMPACT STUDY GROUP

NEWSLETTER

ISSUE NO.7 MARCH 2017

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VISG CO-ORDINATOR'S NOTE

by Natalia Deligne

I hope you have had a lovely (non) summer.

I would like to draw your attention to three items in this newsletter.

First, this month's ***Research Spotlight*** by George Williams and Tom Wilson summarises results of ALG-funded work on the impact of volcanic ash on diesel-powered generators. In the next few months the VISG team will be updating the Building and GenSet ash impact poster (and website) with the findings of this research. We thank the ALG for their ongoing support for volcanic impacts research.

Second, in the December 2016 newsletter I provided a summary of the 2016 Cities on Volcanoes conference in Chile. I am pleased to write that in this newsletter, Emma Hunt from the Auckland Council CDEM group shares her perspective of the same conference – see ***Conference Report***. I hope this serves as an encouragement for members the CDEM and lifeline sectors to attend the Cities on Volcanoes conference in Italy in 2018!

And finally, after a year and a half of keeping us well informed of eruptions from around the world, Josh Hayes has passed the ***Global Eruption Roundup*** baton to Sophia Tsang, a PhD student at the University of Auckland. Thank you Josh for your contribution, and welcome Sophia!

NEWS

GeoNet is working on a new website! You can visit the beta-site at http://beta.geonet.org.nz/ and provide feedback at https://www.surveymonkey.com/r/BetaGeoNetwebsite. The beta is still lacking a lot of information and will continue to be updated regularly before it replaces the current site. **Your feedback will help ensure the new website meets your needs.**

The GeoNet team has successfully used **UAVs** to develop a detailed digital elevation model and photo-mosaic of the active crater White Island. UAVs were also used to map the fault displacements and landslides produced by the Kaikoura earthquake, and are an exciting new tool at GeoNet.

RESEARCH SPOTLIGHT

Volcanic ashfall impacts to diesel generators – results from the lab.

by George Williams and Tom Wilson (University of Canterbury)

Why is this important?

Volcanic ash is the most widely dispersed hazard during an explosive eruption. Volcanic ash can cause outages on both electrical distribution and transmission networks, therefore use of emergency power generation equipment (Generator Sets, also known as GenSets) may be necessary. Air intakes on GenSets (Figure 1) are vulnerable to blockage by airborne ash, causing suffocation of the GenSet engine and/or disruption of the cooling system, and so some mitigation strategies may be required. Air intakes on heating, ventilation and air-conditioning (HVAC) systems are similarly vulnerable. Potential disruption of GenSets during a volcanic ashfall could have serious implications for essential facilities which rely on them for emergency power, such as hospitals, water supply systems and telecommunication exchanges.

It's happened before...

In 2011, the eruption of Cordon-Caulle volcano in Chile created a large ash cloud which deposited ash over large areas in southern Chile and Argentina. The ash cloud travelled around the globe, causing disruption of aviation in New Zealand and Australia. A number of towns and cities were affected in Chile and Argentina. The largest was Bariloche, Argentina (pop. 135,000), 92 km southwest of Cordon-Caulle volcano. Bariloche received ashfalls of up to 45 mm in 24 hours, which led to disruption of electricity supply to the town for up to several weeks. Flash-overs on electrical transmission and distribution circuits caused by ash contamination cut supply from the Argentine national grid, and then high concentrations of falling ash blocked filters in five 1 MW diesel generators within the town, suffocating the engines. The shock of losing

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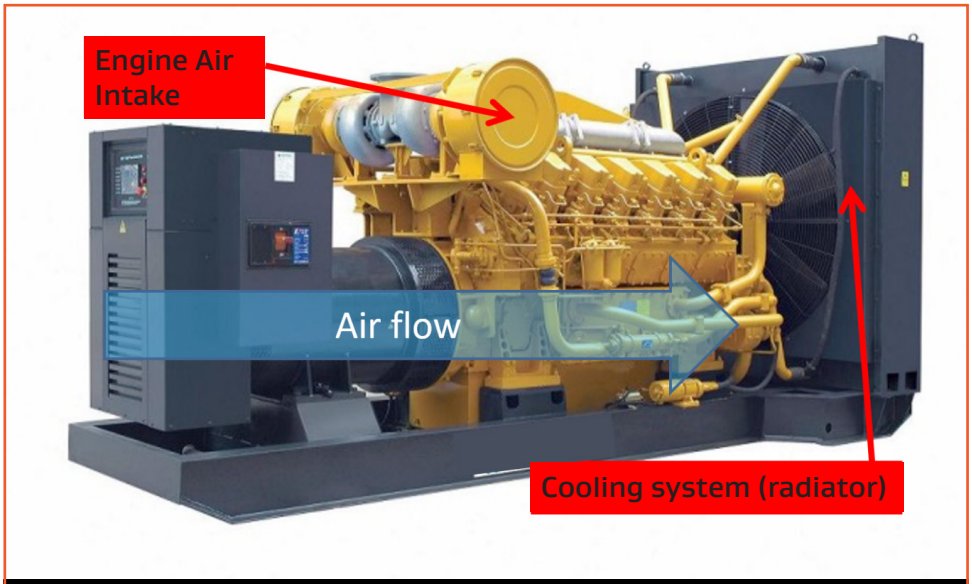

Figure 1: GenSet's such as the one pictured are normally housed within cases or buildings whose air intakes are fitted with an initial layer of air filtering.

Figure 2: The 20 MW generator farm to the south of Bariloche. The farm consists of 22 units, each capable of 1 MW (two extra units to allow full load during maintenance).

Figure 3: Deflection hood installed above the air intake of a 1 MW GenSet containers in Bariloche to reduce ingestion of ash.

electricity to this important tourist town led to the Argentine government constructing a GenSet farm providing 20 MW emergency supply for the city (Figure 2 and Figure 3). However, even these modern units suffered filtration problems due to on-going light ashfalls (1-2 mm/event) and remobilised ash blown in from strong westerly winds, requiring accelerated filter replacement when in operation during ashy conditions (Figures 5 and 6). For more information, please refer to Wilson et al. 2013[1].

Lessons from this and other overseas case-studies suggests that suffocation of engines due to clogging of air filters is the most common cause of GenSet disruption.

New Zealand's volcanoes are all capable of producing explosive eruptions, which could lead to ashfalls almost anywhere in the North Island. So understanding the likely impact of ashfalls on GenSets and identifying the most appropriate mitigation advice is important. Auckland Lifelines Group considered this a priority for VISG, following a presentation on lessons from the Cordon-Caulle eruption.

What did we do?

The Volcanic Ash Testing Lab based at the University of Canterbury and supported by GNS Science and Massey University. Researchers undertook a series of experiments to investigate the risk posed by ash ingress to GenSets and explore different filtration methods to mitigate ash ingress (Figure 4).

The critical issue informing this testing was to ensure that GenSet filtration systems do not clog with ash such that airflow through the GenSet is reduced to the point that either the engine is suffocated or the cooling system efficiency is compromised, leading to overheating. So in other words, the aim is to strike a balance between allowing sufficient airflow within the GenSet to allow for engine aspiration and cooling system operation, versus filtering as much ash as possible from

1 Wilson, TM., Stewart, C., Bickerton, H., Baxter, PJ., Outes, V., Villarosa, G. and Rovere, E. (2012) Impacts of the June 2011 Puyehue Cordon-Caulle volcanic complex eruption on urban infrastructure, agriculture and public health. GNS Science Report 2012/20. 88p. Available here: https://www.gns.cri.nz/static/pubs/2012/SR%202012-020%20Print%20Copy.pdf

the ingested air to reduce the likelihood of engine filter and cooling system clogging.

Secondly, we wanted to investigate the time required for different filter types to clog with ash and thus reduce airflow below operating limits, during different ashfall scenarios. This informs advice for GenSet operators to optimise filter replacement frequency during ashfalls.

The work focused on three key questions:

1. How much ash is likely to be ingested into GenSets without filtration under different ashfall scenarios (e.g. high and low airbourne ash concentrations)
2. How effective are standard and temporary GenSet filters at filtering ash during a range of ash fall scenarios
3. How often might GenSet filters require replacement under different ashfall scenarios

The tests used a range of ashfall scenarios, including different types of ash such as basaltic and rhyolitic, a range of ash grainsizes, and concentrations of ash in the air.

The experimental results demonstrated (Table 1):

- When no filters are used between ~80-90% of ash would be ingested into the GenSet primary filters, depending on ash type, ash concentration, and GenSet airflow rate. When a deflection hood was added, this was reduced to ~60-80%.
- Temporary filtration steps, such as high density 110PPI insulation foam, were highly effective at filtering ash (98% efficiency) however they rapidly clogged and impeded airflow.
- In contrast, 45PPI reticulated polyurethane foam filters and G2 classed synthetic fibre filters may be more suitable for operational use as they exhibited substantially less impedance of airflow.
- Filters were found to clog relatively quickly when exposed to likely ashfall scenarios, even when ashfall concentrations were low. For instance, ~1.5 grams per cubic metre of fine grained ash (~55µm) blocked all filter types tested within 1 hour of exposure.
- Standard GenSet filters filtered between 40-95% of ingested ash (see Table).

Table 1: Percentage of ash filtered. Percentages calculated by measuring the concentration of airborne ash immediately on either side of a filter during testing.

Filter type	Percentage of ash filtered
45 pores per inch polyurethane foam sheet	38 – 62
G2 class synthetic fibre filter (acc. to EN:779)	67 – 72
110 pores per inch insulation foam sheet	96 – 98

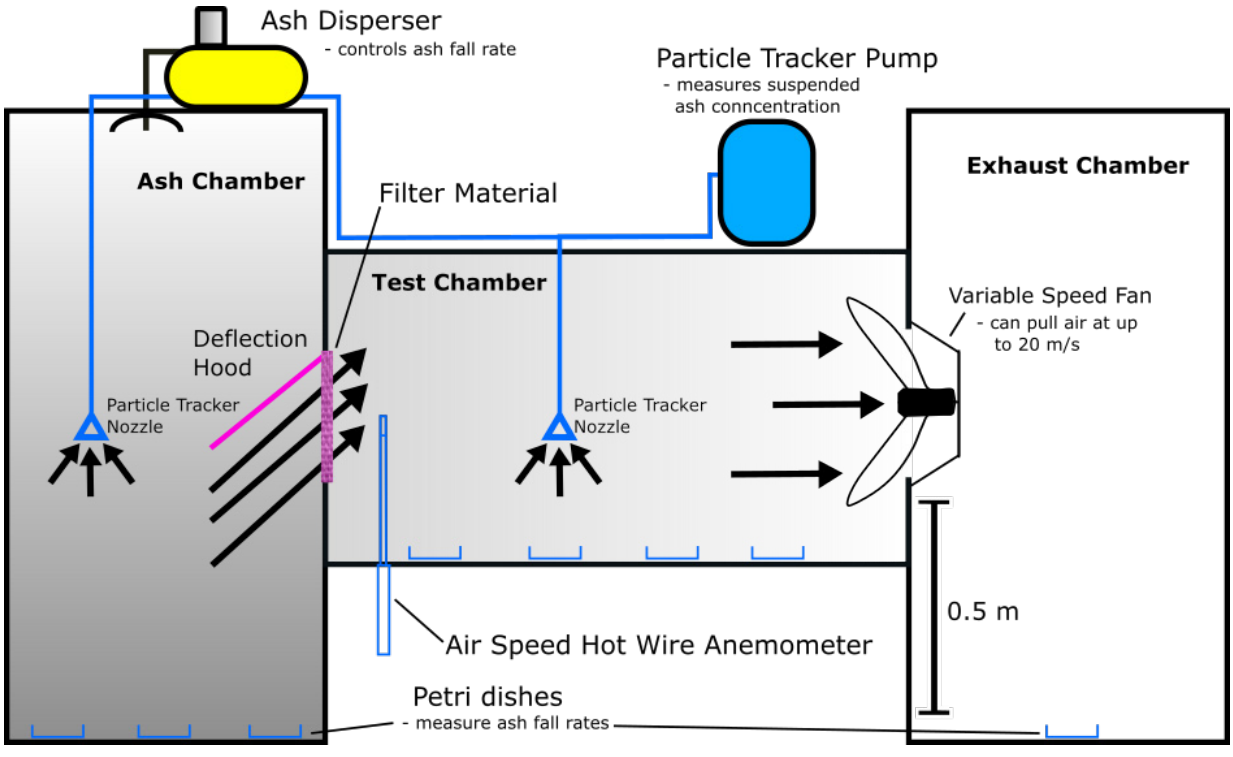

Figure 4: Schematic of set up used to test the performance of the primary air filters which are fitted over the air intake of a GenSet's casing. Primary filters are used to reduce the amount of ash in the air which a GenSet's engine filters (secondary filters) are exposed to.

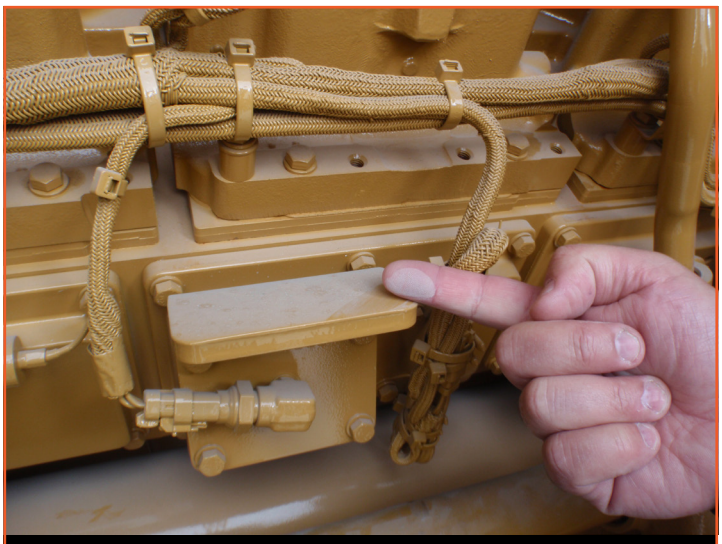

Figure 5: Ash deposited on the engine block of a generator within the new 20MW generator farm.

Figure 6: A large supply of high density insulation foam filters are stored at the generator farm to allow for a high frequency of filter changes during ash falls.

Take home messages

- The test results suggest GenSet operators should plan for replacing filters at much higher frequency during ashfalls. Even exposure to relatively low ash concentrations may require hourly filter replacement.
- Facilities which rely on GenSets for emergency power should have access to a large stock of filters, develop filter monitoring and replacement procedures, and ensure sufficient resources to effect the procedure are available (e.g. maintenance staff).

Updating Impact and Mitigation advice

This work will be used to update the relevant posters/web advice in the volcanic ash impact and mitigation resources developed with VISG and Auckland Lifelines Group over the past ten years, and the USGS/GNS Ash Impacts and Mitigation web encyclopedia (which is actively supported by VISG researchers). Check them out here:

- **http://www.aelg.org.nz/document-library/volcanic-ash-impacts/**
- **https://volcanoes.usgs.gov/volcanic_ash/**

International Interest

The work has received interest for a large European nuclear power plant operator who are interested in investigating possible ash impacts to air-handling systems following eruptions from distal volcanoes.

The work was presented at the 9th Cities on Volcanoes conference in Chile in November 2016. Here it gained interest from Mexican civil defence managers and the advice on rapid filter replacement was confirmed by volcanologists from the Icelandic Meteorological Office who use portable diesel generators to operate ash radar equipment following eruptions.

Funding

This research has been funded by the Auckland Lifelines Group and the Determining Volcanic Risk in Auckland (DEVORA) programme.

RESEARCH HIGHLIGHTS

Josh Hayes (University of Canterbury PhD candidate) published a paper in Journal of Applied Volcanology entitled ***A model to assess tephra clean-up requirements in urban environments.*** This paper presents a geospatial model for estimating clean-up duration and cost for volcanic ashfall. The model is applied to Auckland for both local and distal eruption sources.; the estimated clean-up costs are NZ13.4-25.6 million and NZ$0.6 – 1.1 million, respectively.

VISG researcher Carol Stewart is a co-author on the paper ***Leaching of lava and tephra from the Oldoinyo Lengai volcano (Tanzania): remobilisation of fluorine and other potentially toxic elements into surface waters of the Gregory Rift*** led by Bosshard-Stadlin and published in January 2017 in the Journal of Volcanology and Geothermal Research. This paper has important water supply implications for the communities in Tanzania around Oldoinyo Lengai volcano. The same chemical analyses, detailed in an International Volcanic Health Hazard Network (IVHHN) protocol, are done in New Zealand to ascertain the safety of our water supply following ashfall.

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CONFERENCE REPORT

Cities on Volcanoes 9: A CDEM perspective

by Emma Hunt, Auckland Council CDEM

On 22 April 2015 in Puerto Varas, Chile, the Calbuco volcano erupted with little warning and with significant effects to both neighbouring and distant communities. In November of last year, a large contingent from New Zealand, including myself, attended the 9th International Cities on Volcanoes conference ("COV9") in this city. I am a Hazards and Planning Advisor for Auckland Civil Defence and Emergency Management (CDEM) with a responsibility for understanding disaster impacts and how to manage these impacts and our vulnerabilities to build resilience. Given Auckland's location directly over a volcanic field, learning from international research and best-practice management for volcanoes is crucial for the CDEM sector and other agencies and organisations involved in emergency management.

The Calbuco eruption caused widespread evacuations and impacts to agriculture and infrastructure in both Chile and Argentina. Following the first eruption, a red alert was declared and a 20km radius around the volcano was evacuated. The eruption was a "surprise" and at the time Calbuco was not under any form of special observation. Pyroclastic flows were a major risk given that the volcano had such a high eruption column. Major impacts were caused by lahar flows down the slopes of the volcano and in river valleys, while ash fall disrupted air travel and other infrastructure, and had damaging effects to agriculture.

A field trip to a village at the southern foot of Calbuco showed the significant impact of the eruption and provided many insights into response and recovery. Evacuations had been largely self-directed and residents were unable to return to the village for up to six months due to lahar flow damages. Communities were primarily concerned about livestock health and restoring transport infrastructure to enable them to return home. Ash fall disrupted infrastructure and agriculture in particular, with major clean-up costs and land remediation. Once government officials and emergency managers better understood the needs and priorities of communities, the journey to recovery was significantly faster and more effective. The learnings from this response and recovery, as well as the multitude of other international examples throughout the conference were extremely beneficial for contingency and recovery planning for Auckland.

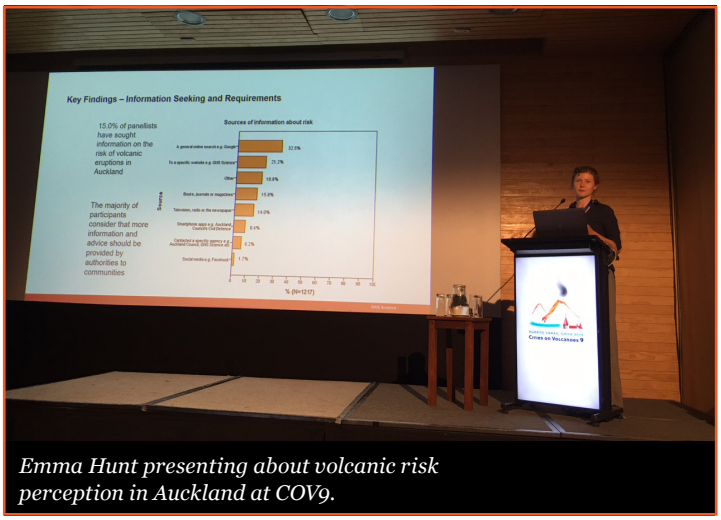
Throughout the conference, researchers discussed the numerous resources, from video games to disaster models, community resilience programs to connect neighbours and essential resources, and examples of training programmes for schools and stakeholders. I presented the results of a volcanic risk perception study undertaken with Auckland CDEM and GNS Science (link below). This paper described the high awareness and understanding Aucklanders have about volcanoes, and the intended behaviour of communities in the event of a volcanic eruption, such as which factors would affect someone's ability to evacuate. Presenting this research sparked many valuable conversations about research and initiatives around the world for CDEM. It is clear that there is a significant opportunity for scientists and emergency managers to collaborate more closely in this area and share learnings on a regular basis.

We would encourage others who can apply research and best-practice to attend conferences such as this. The learnings were very useful for us in CDEM, and the opportunity to make connections across the world with people who manage similar issues was invaluable. If you would like to discuss the findings from an emergency management perspective in more detail, or connect with the CDEM sector regarding your own work, please contact Auckland CDEM: **Civildefence.info@aucklandcouncil.govt.nz.**

Many thanks to DEVORA for making this opportunity possible.

http://www.aucklandcouncil.govt.nz/EN/AboutCouncil/HaveYourSay/Documents/devorariskperceptionvolcanichazards.pdf

Meeting with the community at the southern foot of Calbuco volcano.



Emma Hunt presenting about volcanic risk perception in Auckland at COV9.

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GLOBAL ERUPTION ROUNDUP

By Sophia Tsang

Most of the impacts reported near volcanoes in the past three months have been related to tephra. Impacts have included closed air space, evacuations, and more refugees needing to be relocated.

Sinabung – Indonesia

From 2 February to 7 February, Sinabung produced 8 to 12 ash events per day. These plumes were accompanied by pyroclastic density currents that travelled up to 2 km on the southern, south-eastern, and eastern sectors of the volcano. Although there have not been any reported fatalities from this current eruption episode (at least 16 people have died since the eruption started in 2013), there is an increased number of refugees requiring relocation.

Sabancaya - Peru

In the end of 2016, the number of explosions emanating from Sabancaya, in addition to gas flows and gas-and-ash and ash plumes, triggered a state of emergency in 17 local districts. Both livestock (~30 thousand animals including llamas and alpacas) and local inhabitants (~4 thousand people) were evacuated to at least 12 km from the volcano.

Bogoslof – Alaska, United States

Activity at Bogoslof began 20 December, resulting in numerous ash plumes among other volcanic phenomena. Citizens in Unalaska have reported dustings of ash so thin that they could not be measured. At first, pilots diverted from planned flight paths to avoid the plumes. As conditions worsened, PenAir cancelled 10 flights due to weather and volcanic conditions. The passengers were accommodated on later flights.

Eruption: A farmer continues to tend to his field on the Indonesian island of Sumatra as Mount Sinabung erupts violently in the background

MEDIA COVERAGE

The **New Zealand Herald** and **The Aucklander** covered a recently paper by Dr Gabor Kereszturi describing the areas most at **risk from base surge activity** in the AVF, if an eruption were to occur locally (**http://insights.nzherald.co.nz/article/auckland-volcano-map** and **http://www.nzherald.co.nz/aucklander/news/article.cfm?c_id=1503378&objectid=11444436).**

UPCOMING EVENTS

On **2 April 2017** DEVORA, Auckland Uni Geology Association, and QuakeCoRE will have a booth at the **Street Science Fair at MOTAT in Auckland.** They'll be doing hands-on demonstrations of volcanic and earthquake processes and hazards and teaching kids how to prepare for natural disasters

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