Report of Transnational Access Projects

(Note: the information here will be publicly disclosed in the Geo-INQUIRE website, do not include sensitive information)

Project ID: C1_TA2-541-1_1

Principal investigator: Paul Antony Jarvis, https://orcid.org/0000-0003-4959-1131

Project team (if applicable): Josh Hayes, Danielle Charlton, Victoria Miller, Yannik Behr [GNS Science (now ESNZ)]

Project title: Probabilistic tephra fall hazard assessment for New Zealand's most active onshore volcano

Project acronym: TEPHRANZ

Hosting installation: PVHA@INGV, TA2-541-1, INGV; PVHA@SCIS, TA2-541-2, CSIC, Galielo100, CINECA

Hosting team: Laura Sandri, Beatriz Martinez, Antonio Costa (INGV); Arnau Folch, Leonardo Mingari, Alejandra Guerrero, Eva Hernandez (CSIC); Piero Lanucara (CINECA)

Period of access: 26 May – 13 June 2025

Report of activities:

Previous months-long volcanic eruptions from Mt. Ruapehu in 1945 and 1995-1996 have led to ashfall across the North Island of New Zealand (NZ). During such sustained periods of activity, ashfall forecasts are essential for Civil Defence Emergency Management (CDEM) Groups, infrastructure managers and communities to facilitate decision making around mitigation activities. Currently, short-term (hours-days) forecasts of ashfall in NZ are deterministic, i.e., one or few representative eruptions are simulated. Whilst this enables rapid computation, it does not account for uncertainty in the model inputs, potentially providing decision makers with inaccurate information. In this project, we are exploring a probabilistic approach, whereby large numbers of ashfall simulations are performed for different model input parameters. Although such ensembles are much more computational intensive than a small number of deterministic simulations, recent years have seen significant improvements in both model and access to computing capabilities, potentially enabling probabilistic forecasting on a response timescale.

Taking the 2022 unrest episode of Ruapehu as a case study, we are investigating how daily probabilistic ashfall forecasts could have been produced during the event by integrating a) Ruapehu's

long-term eruption frequency-magnitude relationship, b) the short-term probability of eruption as determined from an existing Bayesian Network, and c) ensemble-based simulations of volcanic ashfall. For the third component, we are using the high-performance computing (HPC) facilities provided by the Geo-INQUIRE Transnational Access to perform large numbers of parallelised ashfall simulations using the Fall3D software. The outputs from our developed workflow are maps of probabilistic ashfall hazard on different days of the 2022 unrest period (Figure 1).

The second component of this project is a feasibility study for the operational use of this workflow in NZ. By exploring different possible implementation configurations, e.g., model resolution, ensemble size, grain size classes, we are assessing what can be achieved with different levels of computational resource. The results from this project will inform future decisions about operational ashfall forecasting capability in NZ.

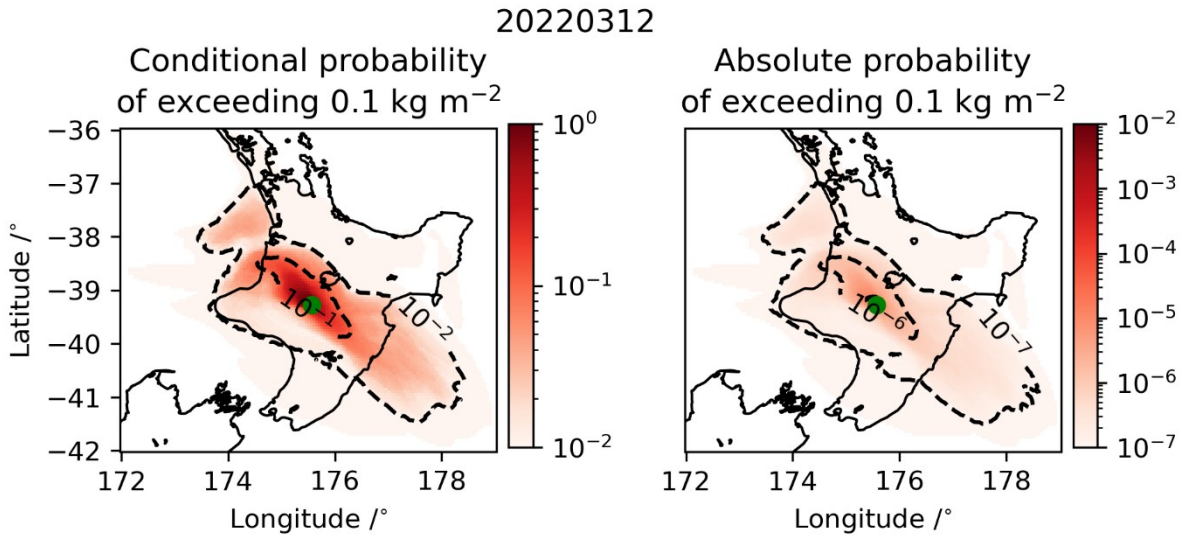

Figure 1 – Left: Map showing the probability of a location receiving more than 0.1 kg m^{-2} of ashfall if an eruption were to have occurred on 12/03/2022. Right: Map showing the absolute probability of a location receiving more than 0.1 kg m^{-2} of ashfall on 12/03/2022.

Project outcomes:

At the moment, still running simulations. By end of March 2026, they will be in the SDL and we will update with the correct DOI.

Note: Data, products, software and publications resulting from TA activities must be publicly accessible under a CC-BY 4.0, GPLv3 or equivalent open license. No embargos beyond June 2026 are allowed. They must cite Geo-INQUIRE as the source of funding. Minimal citation: "*Geo-INQUIRE is funded by the European Union (GA 101058518)*".