

Impacts on Society from Future Unrest and/or Eruptions from Caldera Volcanoes in New Zealand

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The Taupo Volcanic Zone (TVZ) in New Zealand is the most frequently active and productive rhyolitic system on Earth, with at least 8 overlapping caldera centres active during the Quaternary period. A major caldera-forming eruption from the TVZ would have a devastating impact on the health, social and economic infrastructure of New Zealand, probably Australasia, and possibly other parts of the world. Unrest at one of New Zealand's caldera volcanoes will pose hazards to society through 1) social and economic impacts from volcano unrest prior, or unrelated, to an eruption and 2) direct physical impacts from any consequent eruption. Eruptions at the young caldera volcanoes of Taupo and Okataina have varied in size over 5-6 orders of magnitude, from minor dome-building events (<0.01 km³) to catastrophic caldera-forming eruptions (>500 km³).

A caldera-forming eruption of the scale of the 26.5 ka Oruanui eruption from Taupo (530 km³ magma) would cover >104 km² of the North Island in ignimbrite, blanket much of the country in cm to metres of tephra and leave it uninhabitable for a significant period. The eruption would have deposited tephra as far away as Antarctica and possibly South America. It would produce substantial southern hemisphere atmospheric ash contamination at multiple levels, which would probably enter the northern hemisphere stratosphere. Volcanogenic atmospheric contaminants could lead to potential climatic effects. The 1.8 ka Taupo eruption (~35 km³ magma) devastated the central North Island and probably sent a large volume of ash into the stratosphere.

Particles would likely enhance nucleation of rain, and sulphur, chlorine and fluorine components could cause respiratory distress and also lead to acid rain well beyond New Zealand. Zielinski et al. (1994; Science 264, 948-952) have tentatively correlated this eruption with an acidity anomaly in ice core from Greenland. The social impacts of forecasting an impending eruption at one of New Zealand's caldera volcanoes are being addressed by intensive study of the relatively small (~4 km³ magma) AD1305 Kaharoa eruption from Okataina volcano. Multiple plinian eruptions distributed tephra over a substantial portion of the North Island occupied by 0.5 million people today. This particular eruption was triggered by repeated basaltic injections into the shallow rhyolite magma chamber. Such injections are likely to have been accompanied by long-period earthquakes in the lower crust. Based on petrological information, these may have occurred up to 5 years before the eruption, with increased surface geothermal activity, and associated shallow long-period earthquakes, occurring up to a year before eruption. If similar precursory-style activity were now detected below Taupo or Okataina and scientifically interpreted as possibly leading to an eruption, there would be a significant risk of over-reaction amongst New Zealand media. With a small but finite probability of an ensuing large, caldera-forming eruption, news of the potentially catastrophic effects would easily spread further. Likely scenarios are that property insurance in the central North Island may be cancelled, new investment would cease, land values would plummet and substantial population and capital flight ensue (with some precedents during and following the 1983-85 seismic crisis at Rabaul). A general decline in tourism (as seen on small scale at Long Valley in the summer of 1982) would affect all of New Zealand, and potentially other areas of the South Pacific. These events would also lead to negative mental and physical health effects on the New Zealand population. In the past, only a small proportion (roughly 5 %) of all eruptions at the young caldera centres have turned out to be caldera-forming eruptions up to two orders of magnitude larger than the most-common events. With no historic precedent worldwide, the impacts to society from a caldera-forming event are difficult to quantify but the effect on South Pacific health, insurance, land values, air travel, tourism and, ultimately, national economies would be enormous. Because such large eruptions at Taupo and Okataina occur on average only once every ~30,000 years (as opposed to one per ~700 years for all eruptions from the same centres), the potential physical damage from any indicated future eruption at these volcanoes may be far outweighed by social consequences, driven by perceptions of the largest, worst-case eruption scenarios.