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An experimental approach to quantify visibility in volcanic ashfall: impacts on surface transportation

Daniel M Blake [1], Thomas M Wilson [1], Carol Stewart [2]

[1] Department of Geological Sciences, University of Canterbury, Private Bag 4800, Christchurch, New Zealand

[2] Joint Centre for Disaster Research, Massey University/GNS Science, Massey University Wellington Campus, PO Box 756, Wellington 6140, New Zealand

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Atmospheric volcanic ash causes visibility degradation, which can disrupt all modes of surface transportation (road, rail and maritime, as well as ground movement at airports). There have been many cases of impacts due to low visibility following historical eruptions worldwide including recent examples near Kelud, Indonesia (2014) and Calbuco, Chile (2015). However, despite many qualitative reports, there have been few detailed studies that have attempted to quantify relationships between visibility conditions and observed impacts on network functionality and safety. Empirical datasets derived from laboratory investigations can help fill such gaps in knowledge. We use worldwide post-eruption data to estimate ash-settling rates and ash particle characteristics for Auckland City from eruptions in the Auckland Volcanic Field and elsewhere in the North Island of New Zealand. We then develop a new experimental set-up at the University of Canterbury's Volcanic Ash Testing Laboratory (VATLab), which incorporates a state-of-the-art transmissometer (Dynoptic DSL-460) and solid aerosol generator (TOPAS SAG-410) to reproduce ash-settling rates. Visual ranges in fine-grained (<320 ?m particle diameter) airborne volcanic ash are calculated. We find that visual ranges of just 1-2 m could occur for the largest ash-settling rates expected in Auckland (i.e. ~4,000 g m-2 h-1). Particle size is deemed the most important ash characteristic for visibility with finer ash causing shorter visual ranges. However, ash shape and colour are other influential properties. We consider potential implications for transportation disruption through comparisons with data obtained from atmospheric studies of fog, including anticipated vehicle speeds and accident rates. Various mitigation measures and opportunities for how our findings could be adopted in emergency and transportation management planning are subsequently suggested.