This Supplementary File accompanies the manuscript,

Craig, H., Wilson, T., Magill, C., Stewart, C. and Popovich, B. (2021) “Agriculture and forestry impact assessment for tephra fall hazard: fragility function development and New Zealand scenario application”, *Volcanica*, 4(2). pp. 345–367. doi: 10.30909/vol.04.02.345367.

Craig et al. (2021) should be cited if these data are used independently.

Supplementary Material 1: Descriptions, limitations, and examples of different vulnerability assessment methods, ranging from the simplest to the most complex.

|  | **Description** | **Limitations** | **Volcanic eruption application** | **Tephra fall and agriculture application** |
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| Qualitative exposure assessments | These exposure assessments are usually comprised of qualitative statements describing the likely impacts to assets due to the occurrence of a hazard. | Do not identify why different impacts will occur and often treat assets as homogenous in design. | Impacts to critical infrastructure based on previous case studies (Wilson et al., 2012). | Description of impacts to exposed agriculture have been qualitatively assessed after numerous previous events including: 1980 Mt. St. Helens (Cook et al., 1981); 2006 Merapi (Wilson et al., 2007); 2010 Pacaya (Wardman et al., 2012); and 2011 Cordón Caulle – Volcanic Complex (CC-VC) (Craig et al., 2016a).  |
| Qualitative vulnerability assessments | Factors which determine the vulnerability (or resilience) are identified and their relative influence qualitatively or quantitatively expressed. | Assigning the relative influence of different vulnerability characteristics can be subjective. | The identification of infrastructure vulnerability indicators on Vulcano Island, Italy (Galderisi et al., 2013). | Identification of aspects that increase agricultural vulnerability such as climate and access to irrigation after the 1991 Hudson eruption (Wilson et al., 2011a). |
| Damage/ impact states | Damage states categorise impacts to assets into several defined states, which each have a qualitative description of impacts and often a quantitative measure (such as percentage damage, repair cost). | Qualitative descriptors may not cover the full range of impacts. Some situations may not fit into a singular state. The division of impacts into damage states usually based on expert judgement. | Spence et al. (1996) proposed a damage state scale to classify building damage after the 1991 Pinatubo eruption. | Damage states for agricultural systems were proposed as part of the UN-ISDR Global Assessment Report on Disaster Risk Reduction (Jenkins et al., 2014b), tephra thickness ranges were also assigned to each state based on previous case studies. |
| Impact thresholds | As with damage states, the impacts are categorised into states. Additionally, hazard intensity thresholds are assigned to each state. This allows for damage states to be assigned in a predictive capacity when hazard intensities are forecasted. | Assumes that hazard intensity will affect all assets uniformly. Does not always consider the variety in asset design and function which will influence vulnerability. | A 'volcanic building damage scale' with qualitative descriptions and the associated dynamic pressures produced by pyroclastic flows was produced for Vesuvius (Spence et al., 2004). Wilson et al. 2014 proposed an impact state scale for infrastructure sectors with tephra thickness thresholds for each. |  |
| Vulnerability functions | These show the damage, damage ratio, loss of function, or economic losses, as a function of hazard intensity. | These functions require relatively large sets of data and are only as reliable as the data inputs. They also only use one hazard intensity measure, which may not be the best estimate of impacts in every scenario. | Studies used tephra thickness (Pomonis et al., 1999) and tephra loading (Spence et al., 2005) to create vulnerability functions showing the probability of roof collapse. | Wilson and Kaye (2007) proposed a set of vulnerability functions for New Zealand agricultural sectors. These correlated tephra thickness with a damage ratio. |
| Fragility functions | Fragility functions show the probability of a damage state being reached or exceeded when a hazard intensity occurs. | The amount of available information may not be sufficient to create reliable and representative fragility functions. | Zuccaro et al. (2008) created functions showing the probability of buildings being within a damage state given a particular tephra loading. | This study aims to create fragility functions showing the probability of different agricultural systems falling into a damage state with tephra thickness. |