Figures

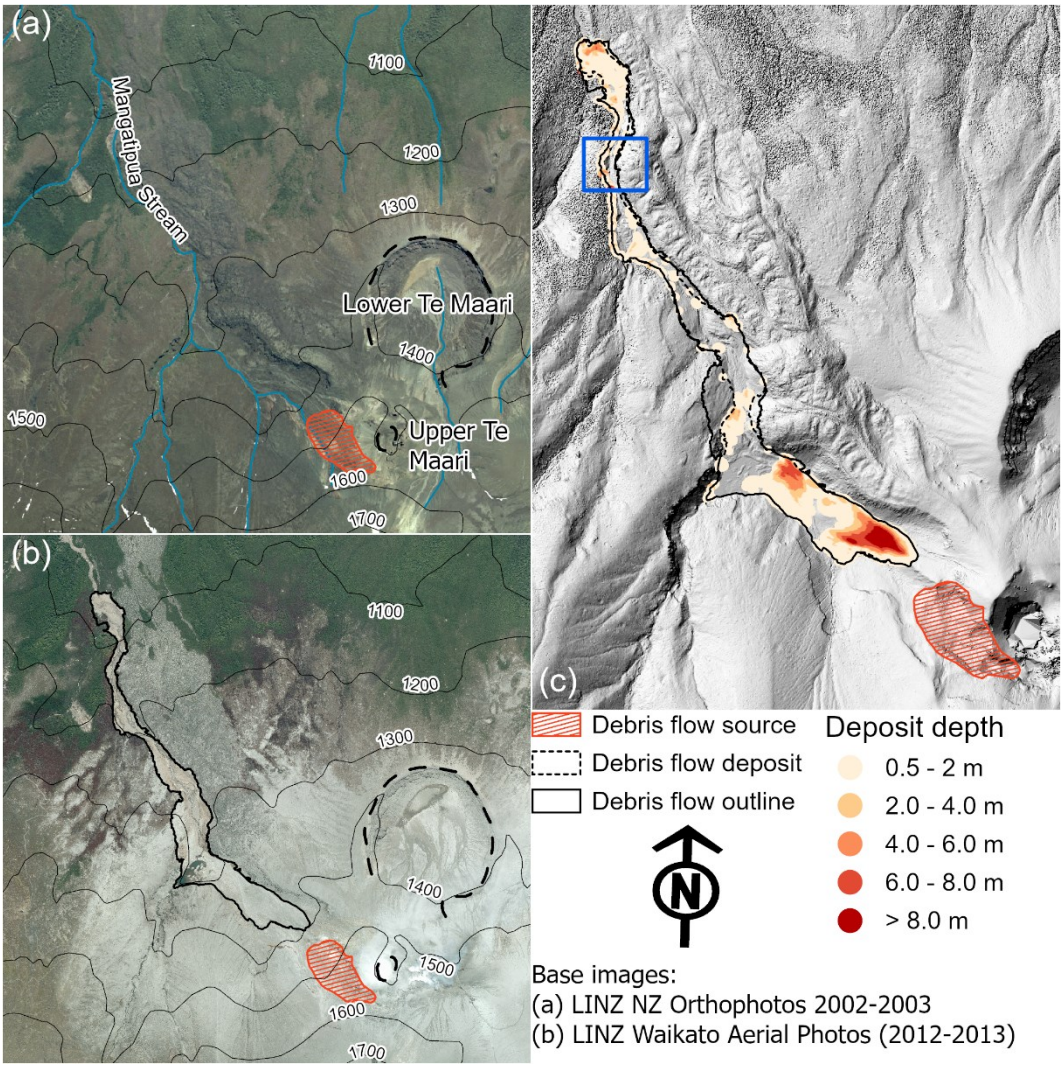

Figure 1. Te Maari debris avalanche case study region (a) pre-eruption, (b) post-eruption, and (c) debris avalanche deposit depth and outline. Blue rectangle in (c) shows area of spurious elevations from source Digital Terrain Model.

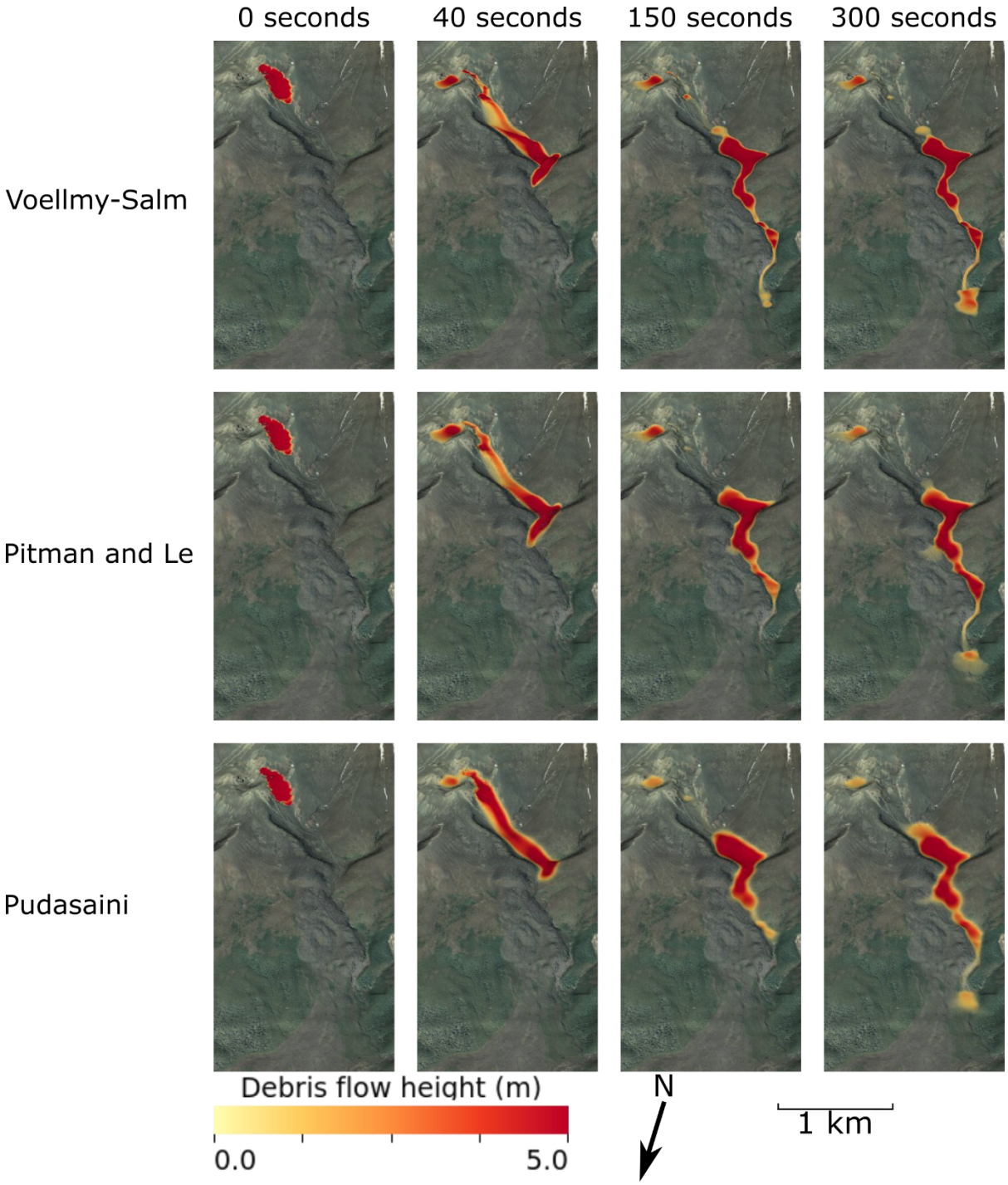

Figure 2. Snapshots of simulated debris flow height for each flow model at 0, 40, 150 and 300 seconds after initiation. Aerial basemap sourced from LINZ Waikato Aerial Photos (2012-2013).

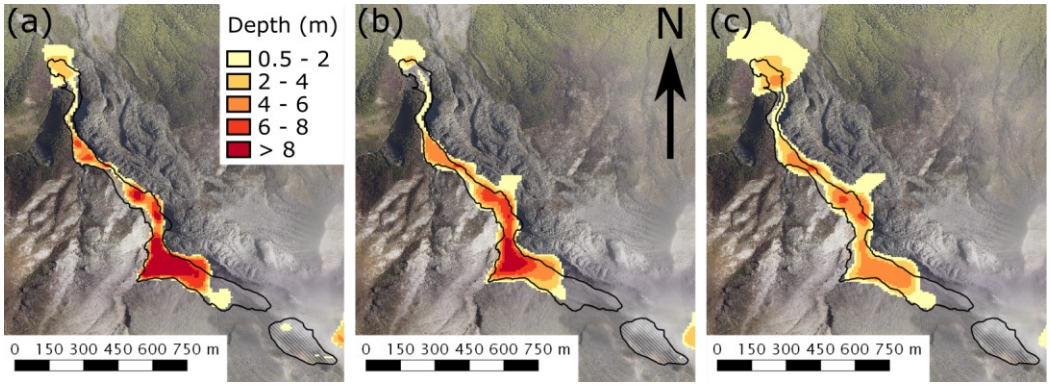

Figure 3. Simulated deposit depth for (a) Voellmy-Salm, (b) Pitman and Le (2005), and (c) Pudasaini (2012) models compared with the observed deposit and source outline (black). Aerial basemap sourced from LINZ Waikato Aerial Photos (2012-2013).

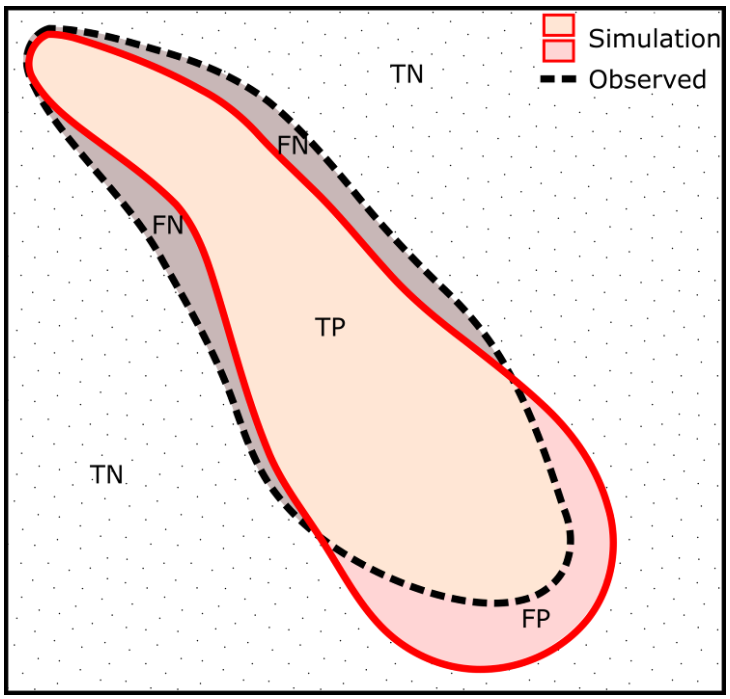

Figure 4. Illustration of confusion matrix classification for simulation performance assessment. Dashed black outline represents the observed flow outline; solid red outline represents the simulated flow outline. Areas outside of both simulated and observed flow outlines are classed as True Negatives (TN, dotted region); areas outside simulated outline but inside observed outline are classed as False Negatives (FN); areas inside both simulated and observed outline are classed as True Positives (TP); areas inside simulated outline but outside observed outline are classed as False Positives (FP).

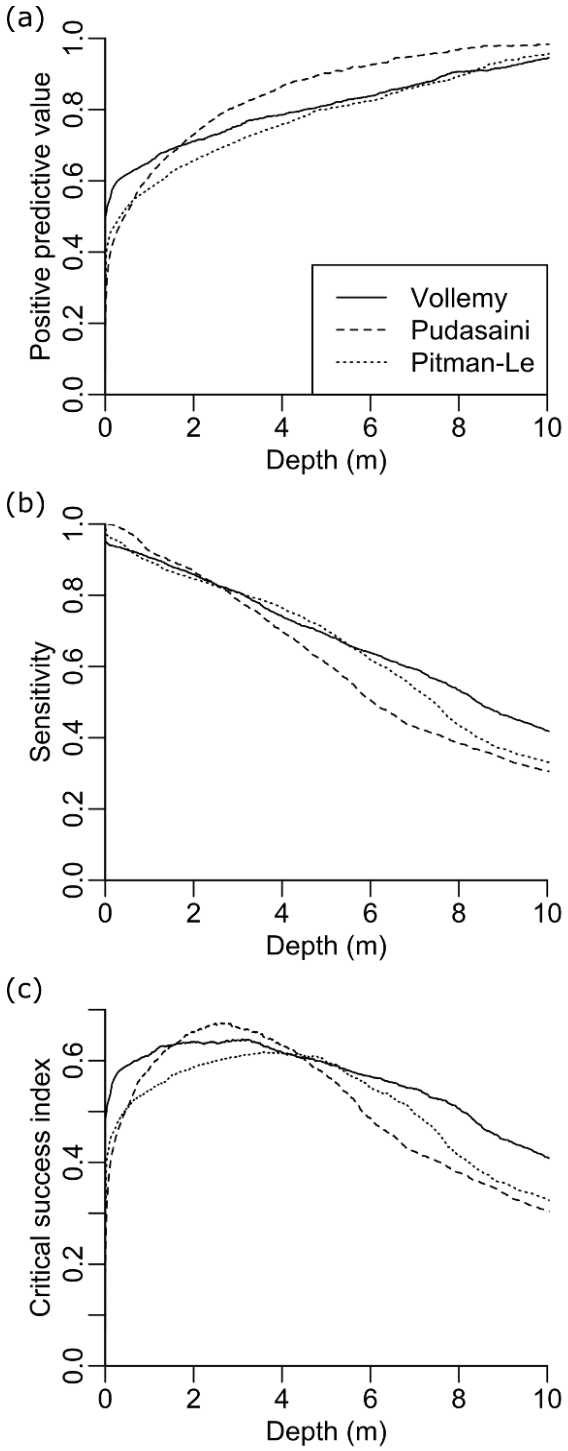

Figure 5. Flow outline performance with depth for Voellmy-Salm (solid line), Pudasaini (2012) (dashed line) and Pitman and Le (2005) (dotted line) flow models. Performance metrics are: (a) positive predictive value (PPV), (b) Sensitivity, and (c) Critical success index (CSI).

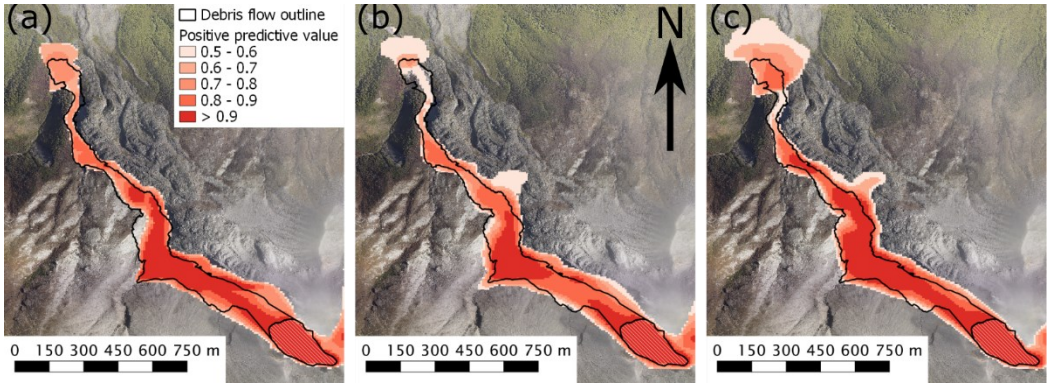

Figure 6. Positive predictive values for (a) Voellmy-Salm, (b) Pitman and Le (2005), and (c) Pudasaini (2012) simulations. The observed flow and source are outlined in black. Aerial basemap sourced from LINZ Waikato Aerial Photos (2012-2013).

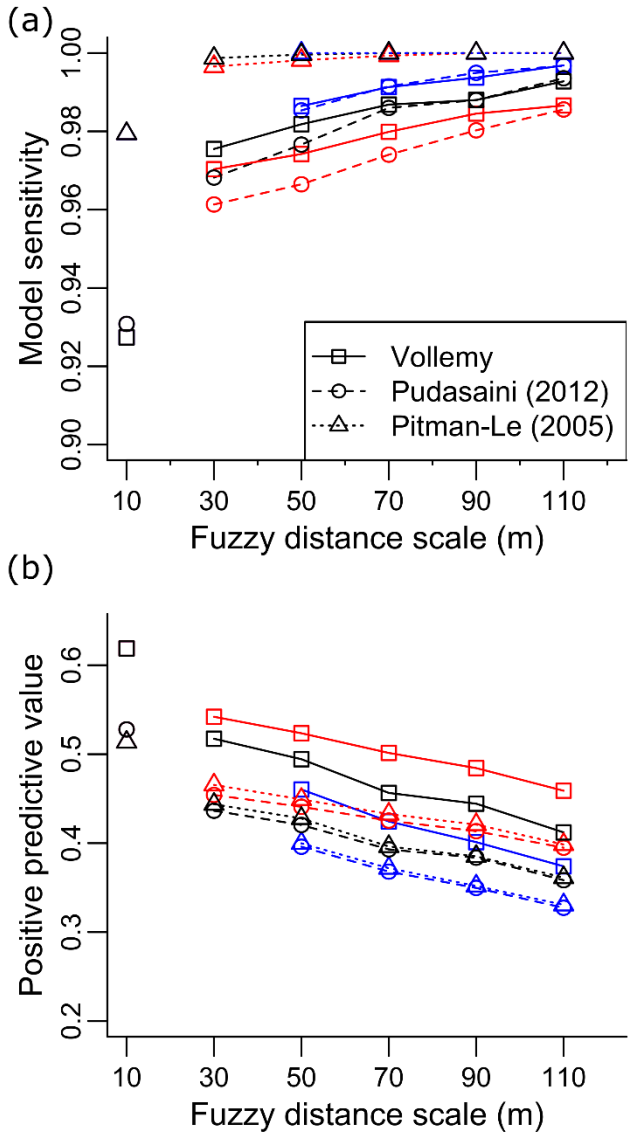

Figure 7. Fuzzy performance metrics at 3 cell (30 m), 5 cell (50 m), 7 cell (70 m), 9 cell (90 m) and 11 cell (110 m) length scales (λ) and fuzzy quantities of 0.1 (blue), 0.25 (black) and 0.5 (red) for (a) model sensitivity and (b) positive predictive value for Voellmy-Salm (solid line), Pudasaini (2012) (dashed line) and Pitman and Le (2005) (dotted line) flow models.

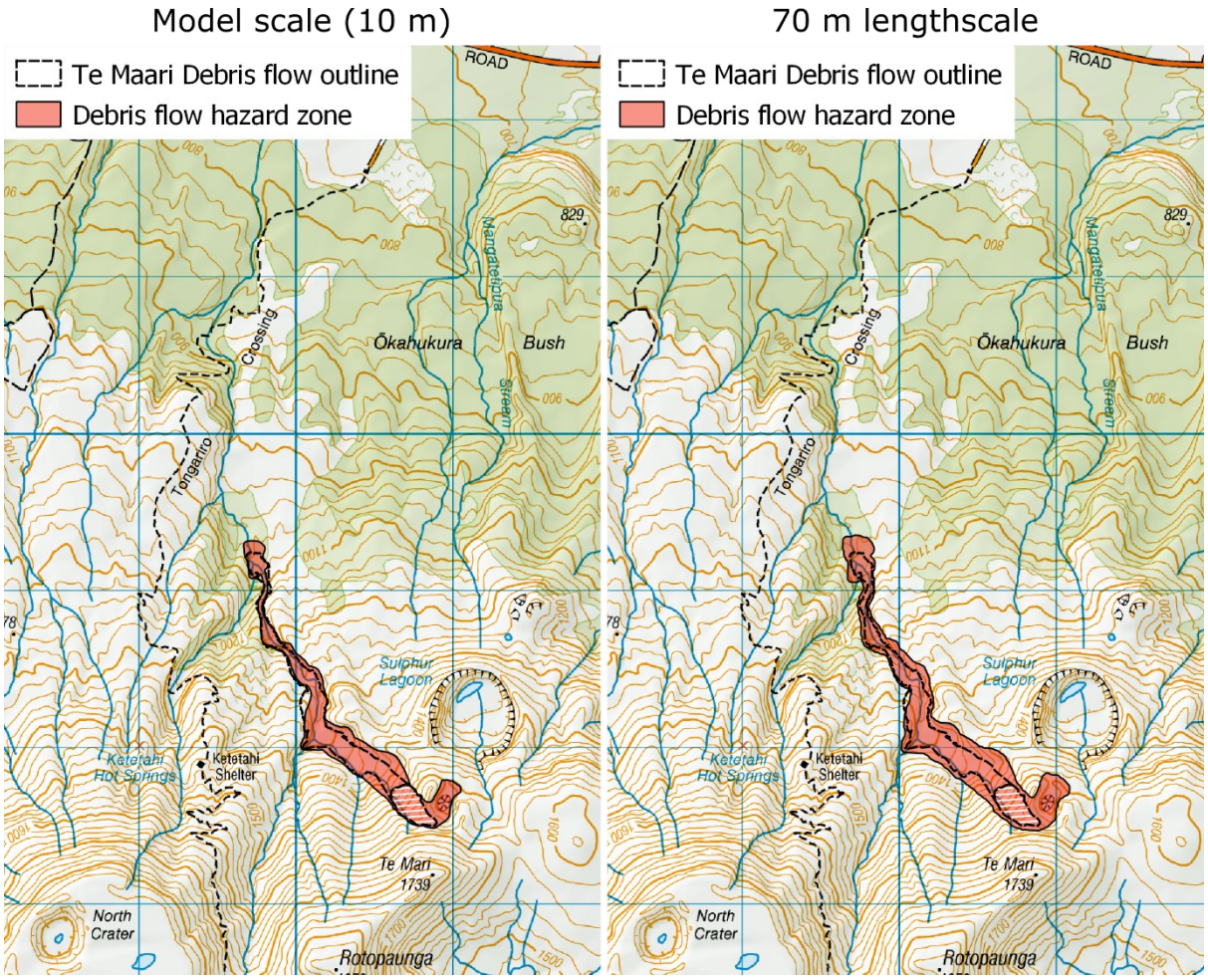

Figure 8. Hazard zones generated from simulations at (left) 10 m model scale, and (right) using fuzzy length scale of 70 m. Hazard outline for model scale is generated where flow heights exceed 0.5 m. Hazard outline for 70 m scale is generated where fuzzy quantity exceeds 0.25. Hazard zones are overlain on New Zealand Topo50 map from Land Information New Zealand (LINZ), blue gridlines are 1 km apart, oriented North-South and East-West.