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Sensitivity to volcanic field boundary

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Volcanic hazard analyses are desirable where there is potential for future volcanic activity to affect a proximal population. This is frequently the case for volcanic fields (regions of distributed volcanism) where low eruption rates, fertile soil, and attractive landscapes draw populations to live close by. Forecasting future activity in volcanic fields almost invariably uses spatial or spatio-temporal point processes with model selection and development based on exploratory analyses of previous eruption data. For identifiability reasons, spatio-temporal processes, and practically also spatial processes, the definition of a spatial region is required to which volcanism is confined. However, due to the complex and predominantly unknown sub-surface processes driving volcanic eruptions, definition of a region based solely on geological information is currently impossible. Thus, the current approach is to fit a shape to the known previous eruption sites. The class of boundary shape is an unavoidable subjective decision taken by the forecaster that is often overlooked during subsequent analysis of results.

This study shows the substantial effect that this choice may have on even the simplest exploratory methods for hazard forecasting, illustrated using four commonly used exploratory statistical methods and two very different regions: the Auckland Volcanic Field, New Zealand, and Harrat Rahat, Kingdom of Saudi Arabia. For Harrat Rahat, sensitivity of results to boundary definition is substantial. For the Auckland Volcanic Field, the range of options resulted in similar shapes, nevertheless, some of the statistical tests still showed substantial variation in results. This work highlights the fact that when carrying out any hazard analysis on volcanic fields, it is vital to specify how the volcanic field boundary has been defined, assess the sensitivity of boundary choice, and to carry these assumptions and related uncertainties through to estimates of future activity and hazard analyses.