

Volcanic ash present major challenges for communities, ecosystems, and economies owing to their convoluted and highly complex consequences. It can travel over vast distances by winds, causing harm to the environment, infrastructure, and socio-economic activity in distant regions through a multitude of direct and cascading effects. The growing concerns due to the potentially massive ash fallout from a large eruption highlights the critical need for comprehensive strategies for effectively respond to such a cataclysm. Adaptive measures are required to address the primary and secondary impacts associated with the complex nature of tephra dispersal processes at multiple spatial scales over time.

This doctoral study aims to address concerns pertaining to volcanic ash disasters by improving for their countermeasure strategies. Focusing on policy for overcoming the life-saving issue, this study offers a methodology to assess the risk of volcanic ash hazards, and introduces a practical mechanism to enhance the emergency response process. This research manufactured a volcanic ash hazard database to understand the extent of potential exposure areas, which can serve as a critical input to emergency decision making, particularly for developing evacuation strategy. From this database, this study realizes a risk analysis of the ashfall primary impacts on critical infrastructure, human safety, and socio-economic activities across various spatio-temporal scales by examining the behaviour of volcanic ash under diverse meteorological scenarios.

Extending the output of the hazard database on evacuation decision for residential areas, this study proposed a novel approach to manage hazard zones ahead of an expected eruption, through the development of a dynamic decision support system. As the decision to evacuate depends on multiple factors that are subject to change, it may be necessary to adjust the decision based on the latest information. The proposed framework allows for adaptive adjustments to volcanic ash prediction results to establish effective and efficient evacuation procedures, thereby decreasing the loss of life resulting from volcanic eruptions.

Insights gained from this doctoral study yield some findings. First, volcanic ash hazard database is a critical component that can aid in both risk and crisis management phase. Second, it suggested to regularly update the evacuation decision-making process to ensure that the most appropriate strategy is implemented. Third, dynamic adjustments on predicted hazard zones serve as an important step in supporting authorities to make better decisions. Lastly, despite the focus of the research is specific, the methodology and solutions developed in this thesis contribute to both risk reduction processes and dynamic countermeasure plans against massive ash fallout in general.