

Visualising Hazard and Vulnerability for Volcanic Risk Reduction

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1. Introduction

Identifying and visualising risk is critical to improving disaster risk reduction. To address this issue the UCL Hazard Centre at University College London has established a unique collaboration with the Catholic Agency for Overseas Development (CAFOD) and Aon Benfield to apply risk analysis and management tools for reducing the socio-economic impacts of natural hazards. The project has used ImpactOnDemand®, an online software platform developed by Aon Benfield, to assist humanitarian and development agencies anticipate and respond to disaster scenarios.

To visualise volcanic risk we have focussed on Mt Sinabung in North Sumatra, Indonesia. The previous and ongoing eruptions in 2010 and 2013, respectively, have resulted in 17 deaths and the evacuation of over 30,000 people. This is therefore an ideal example to investigate how different volcanic hazards affect local populations.

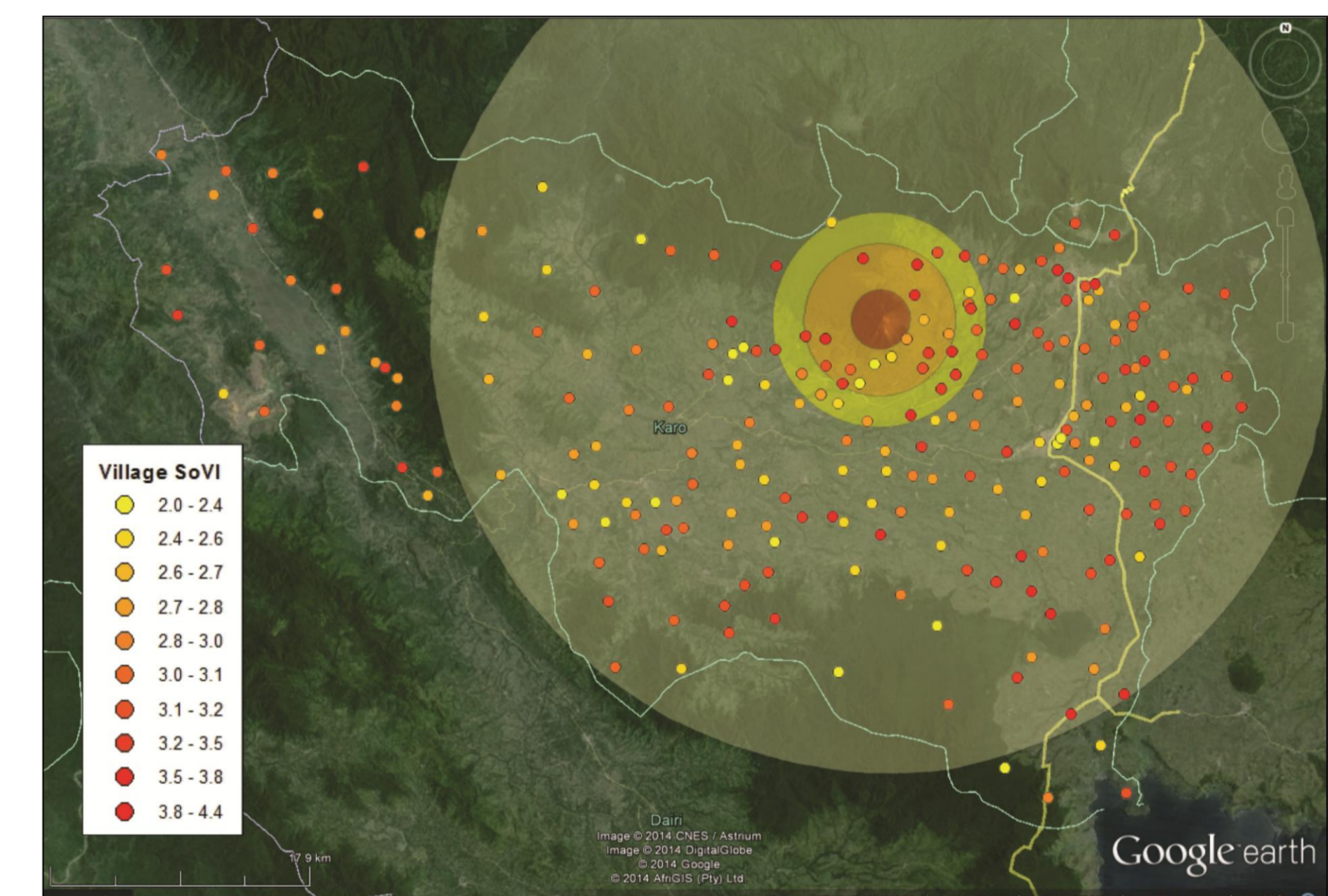
3. Representing vulnerability

The attributes within census data can be used to create a social vulnerability index (SoVI). This index gives values that represent the vulnerability of each village and it can be mapped to portray the spatial distribution of the community vulnerability. We have used participatory vulnerability and capacity assessments (PVCAs), collected by NGOs, to select the various attributes that communities themselves believe define vulnerability. Each attribute has been ranked by members of the village from low (1) to high (7) (Table 1) and combined to give an overall value of vulnerability. Using a synthetic dataset we have given each village in the Karo region a value for vulnerability (Figure 4).

Attribute	Elderly	Pregnant Women	Children	Physical Disability	Mental Health	Poor	Individuals not open to change
Score	4	1	7	1	-	1	1

Table 1. The attributes selected from PVCAs for villages on Mt Merapi, Indonesia. The scored value has been used to create the SoVI (Figure 4).

Figure 4. The vulnerability of each village in the trial dataset, determined using the SoVI. Concentric circles represent ash fall affecting a 2, 5, 7 and 30 km radius.



Data are plotted within GoogleEarth, where satellite images allow users to more quickly identify exposed regions.

2. Datasets and methodology

To visualise risk, ImpactOnDemand® requires a population dataset and a hazard footprint. We have made an assessment of the available datasets to determine which are the most appropriate for visualising risk.

1. Populations are represented by census data, available from Badan Pusat Statistik (Statistics Indonesia). These data have not yet been received and therefore we used geocoding software, within ImpactOnDemand®, to determine the locations of villages around Sinabung, in the Karo region (Figure 1). The attributes for each village are test data and do not reflect the true values of each village.

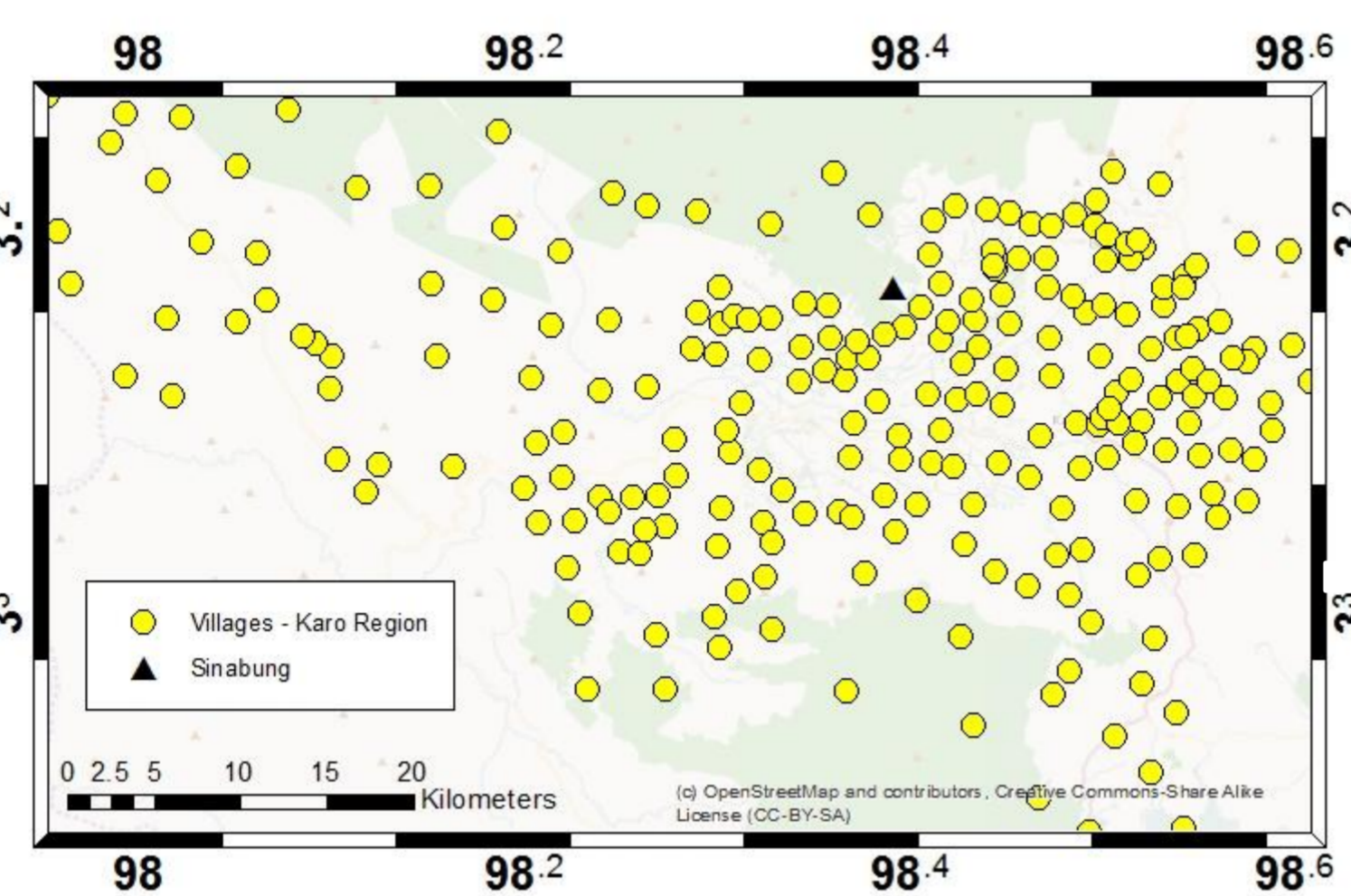


Figure 1. Locations of populations (yellow circles) using the geocoding software within ImpactOnDemand®. Mt Sinabung is identified by the black triangle.

2. Volcanic eruptions pose multiple hazards to surrounding communities. Hazard maps provided by the Centre for Volcanology and Geological Hazard Mitigation (CVGHM) contain valuable information on the extent of ash fall, pyroclastic flows and lahars (Figure 2), determined using previous eruption data.

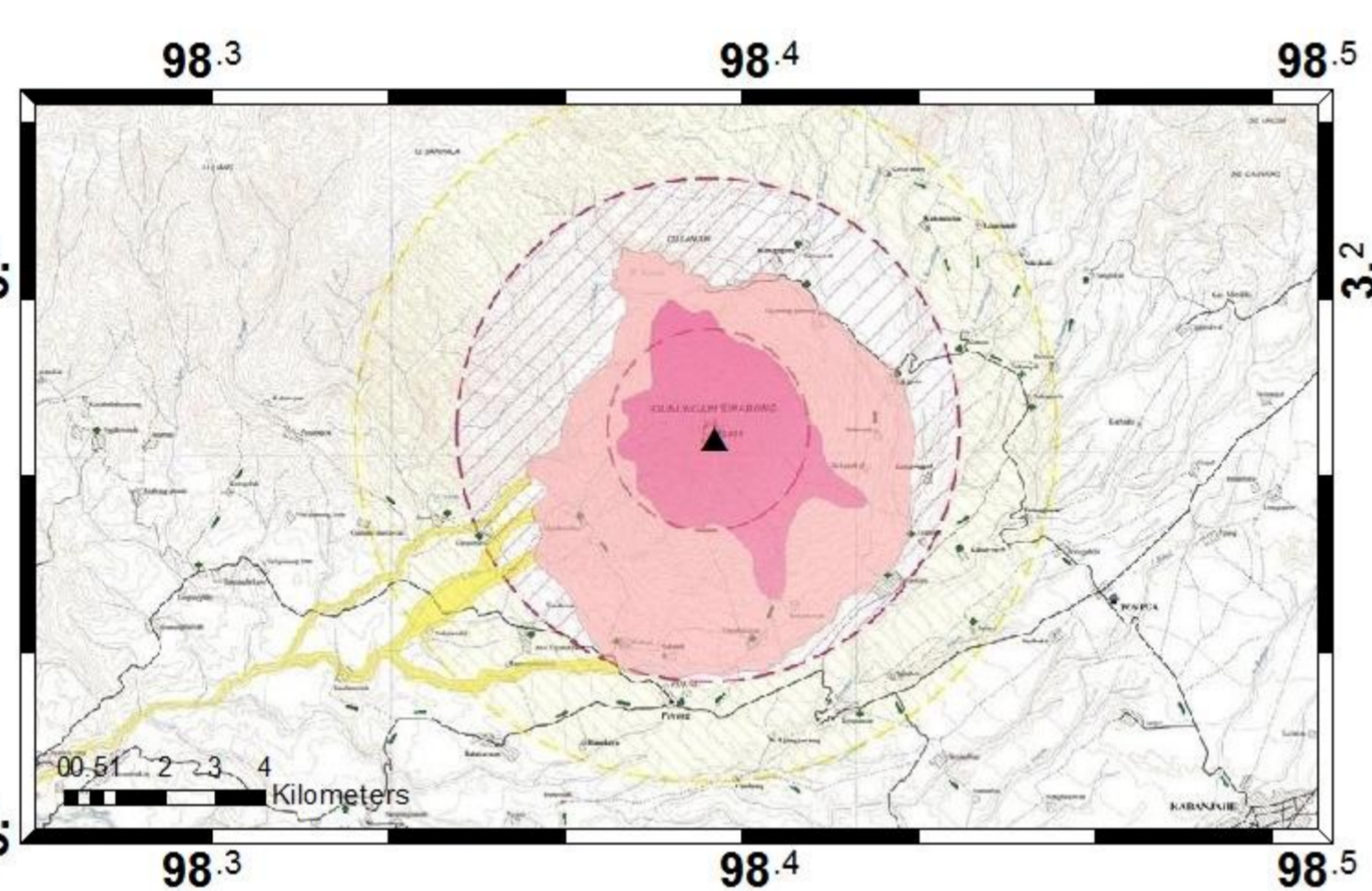


Figure 2. Hazard footprints for lahars, pyroclastic flows and ash fall, available from the CVGHM.

The exposure of villages to different hazards is determined by where they intersect the different hazards from the volcano. ImpactOnDemand® does this quickly and effectively (Figure 3), with the results portrayed on maps or exported as a spreadsheet. The results can be manipulated to show exposure for attributes above or below different thresholds. To make this technique available to a wide range of users we have adapted the methodology for use in both ArcGIS and freely available QuantumGIS.

4. Risk reduction and disaster relief

The juxtaposition of the community vulnerability data with the hazard footprints allows for: 1) the creation of disaster scenarios before a real eruption occurs, which enhances disaster mitigation planning and preparedness; and 2) the near real-time mapping of volcanic activity, which informs evacuations and relief efforts (Figure 5).

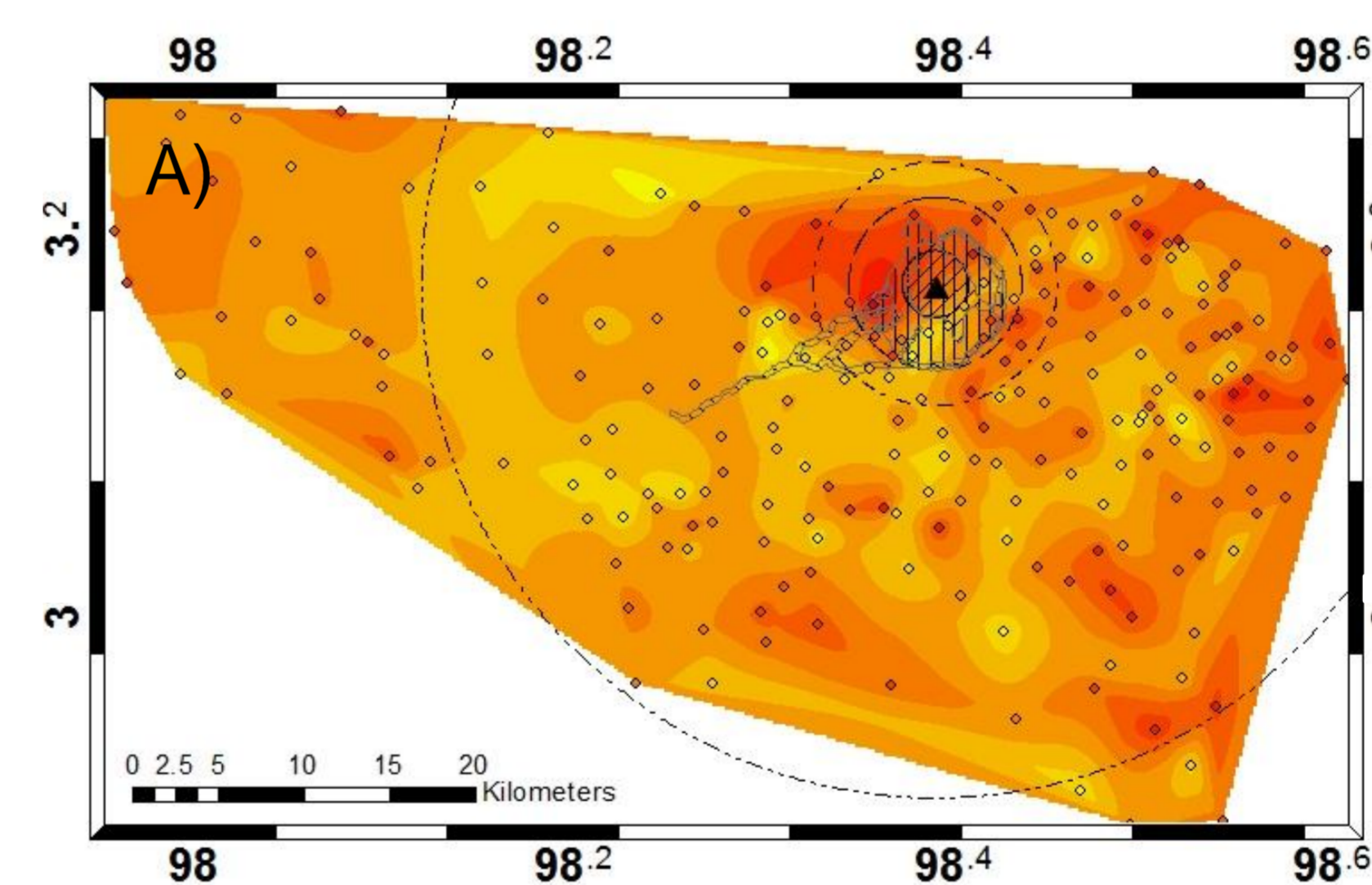
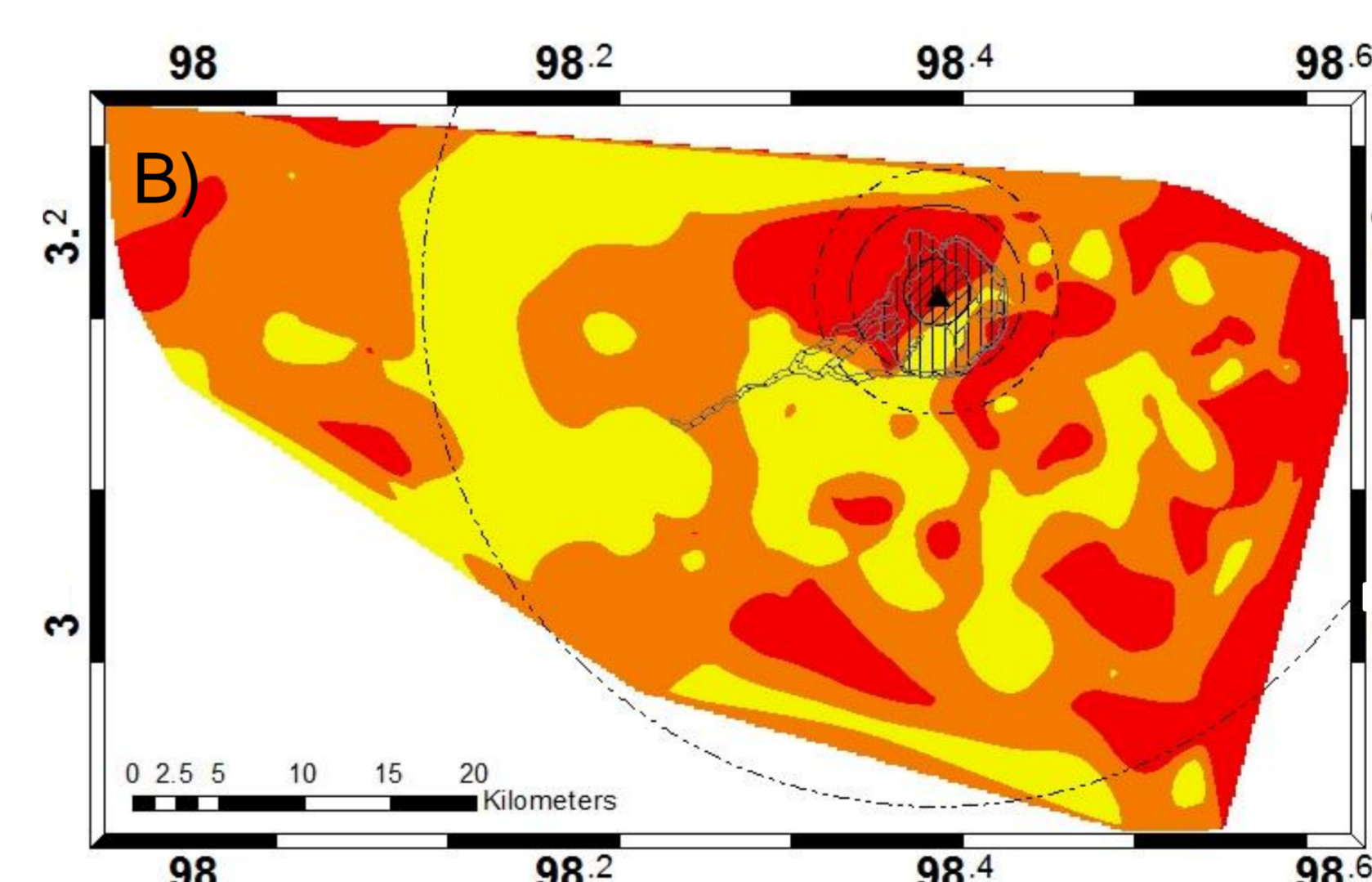


Figure 5. Vulnerability data overlaid by the hazard footprints from the Sinabung hazard map. A) is a more complex interpolation to retain the main features of data and B) is a simplified to enable quick identification of where vulnerable regions intersect hazards.



5. Conclusions

The project has demonstrated the benefit of academic-business-NGO partnerships for risk assessment and reduction, where each partner brings valuable expertise, tools and data to the project. The simple method developed here can be used to investigate, plan and respond to the impacts of volcanic activity on different vulnerabilities. The results can easily be modified to communicate results between a variety of stakeholders and have the potential to be integrated with other risk visualisation software such as Inasafe and RiskScape. The range of software that can be used, both commercial and non-commercial, to undertake the same analysis means that the method has wide application after basic training. Development of the SoVI also highlights the need for more comprehensive, open source post event surveys.

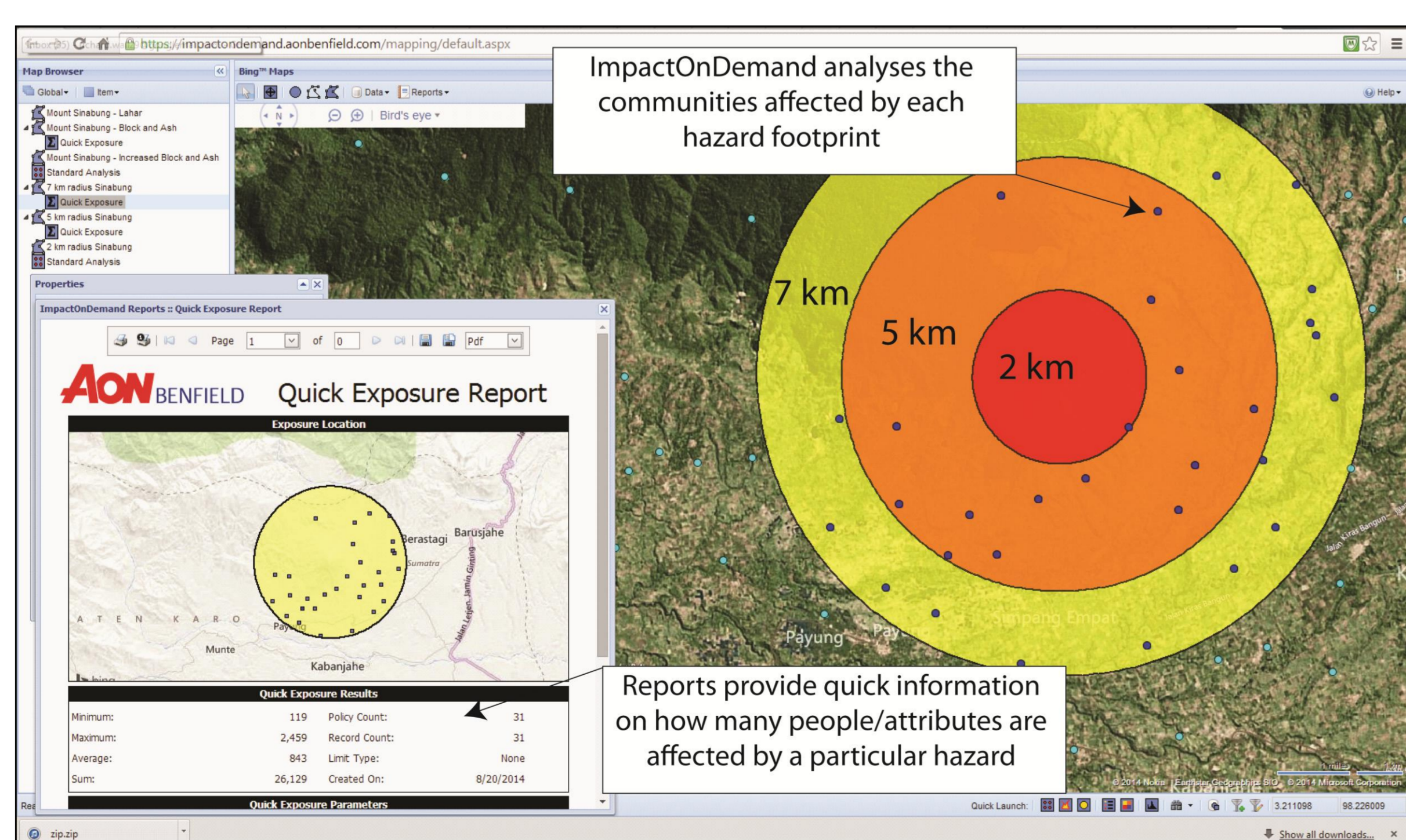


Figure 3. A screenshot from ImpactOnDemand® showing the villages in the Karo region of Indonesia that are exposed to ash fall within a 7km radius of Sinabung.