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The ELICIPY Expert Elicitation Tool Applied To Tsunami Hazard Assessment At Stromboli Volcano

Alessandro Tadini[a], Mattia de' Michieli Vitturi[a], Andrea Bevilacqua[a], Augusto Neri[a], Tomaso Esposti Ongaro[a], Matteo Cerminara[a], Emmie Bonilauri[b], Andrew Harris[b], Raphael Paris[b], Marco Pistolesi[c], Willy Aspinall[d]

[a]*Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Pisa, Pisa, Italy*
[b]*Université Clermont Auvergne, Laboratoire Magmas et Volcans, Aubière, France*
[c]*Università di Pisa, Dipartimento di Scienze della Terra, Pisa, Italy*
[d]*University of Bristol, School of Earth Sciences, Bristol, UK*

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Structured expert judgment is crucial when dealing with significant uncertainties, particularly in probabilistic hazard assessments, where decisions based on uncertain information are often critical. Organizing an expert elicitation session is a challenging task with respect to two equally important aspects. On one hand, it is necessary to carefully identify the problem under investigation (and therefore design an appropriate set of target questions), invite a balanced group of experts and, if performance-based expert elicitation is considered, to create clear and appropriate calibration questions. On the other hand, expert elicitation involves either in person, remote or hybrid meetings in which experts have to respond to multiple questions: this process and the subsequent collection of data and their entry into analysis software is a sensitive step, in which data entry and inconsistency checks in answers are often time-consuming for analysts. To address these application issues, we have developed ELICIPY (de' Michieli Vitturi et al., submitted; https://github.com/demichie/elicipy.git), a new open-source Python tool which allows expert elicitation sessions to be performed in a framework that deals with both the collection of experts' answers (Figure 1a) and their detailed analysis (Figure 1b); the latter process is partially based on the ANDURIL code (Leontaris and Morales-Napoles, 2018) and partially based on scripts that were developed in ca. 15 years of elicitation exercises at INGV Pisa (Neri et al., 2008; Bevilacqua et al., 2015; Tadini et al., 2017). The ELICIPY tool enables the automatic generation of online webforms (in multiple languages) for collecting experts' responses, automatic checking for consistency and, finally, analysis of these responses and processing them collectively into groupwise results using different weighting schemes (Classical Model - CM, Cooke 1991; Expected Relative Frequency - ERF, Flandoli et al. 2011; Equal Weight - EW). The tool automatically produces outputs in different formats (csv and graphical output) and collates them into a presentation file, produced just after the collection of individual expert responses is complete. Outputs generated are: 1) experts' weights under alternative weighting schemes; 2) itemwise graphs for seed and target questions; 3) percentiles of aggregated solutions for target items, expressed as a function of the different expert weighting schemes; 4) probability density functions, cumulative distribution functions, and histograms for target questions; 5) summary graphs where multiple target questions could be visualized along with their percentiles, including violin plots and pie charts. To illustrate an application of the ELICIPY tool, we present some preliminary results from the first session of an expert elicitation concerning Stromboli volcano, performed in December 2022. This elicitation was aimed at quantifying the uncertainties around landslide-generated tsunamis at Stromboli, with a focus on those generated by landslides > 1 Mm3 along the Sciara del Fuoco, a large mass-wasting failure feature on one flank of the volcano (Figure 1c).

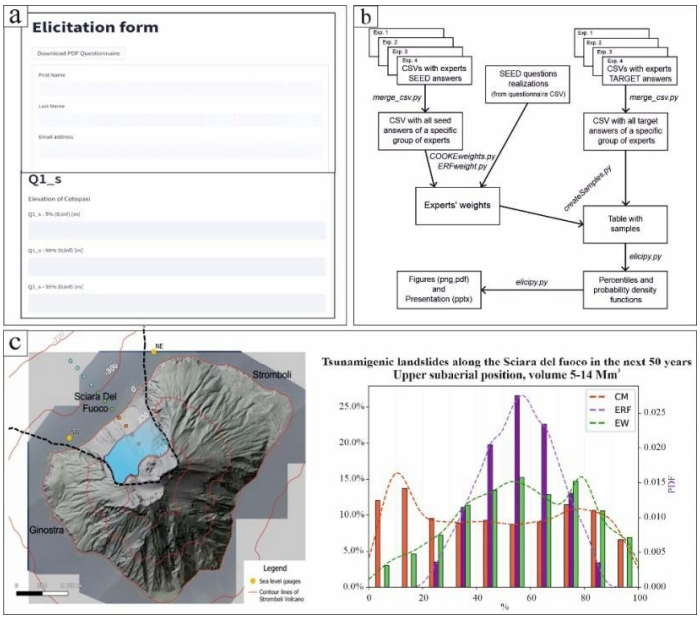

Fig. 1. (a) example of online form; (b) flowchart of the analysis tool; (c) Stromboli island with the Sciara del Fuoco highlighted (left) and an example of pdf/barplot for one target question using three different expert weighting schemes (right: *y*-axis is scenario probability of occurrence; *x*-axis is distribution of support for scenario probability at ten selected percentile levels under three alternative weightings).

A total of 21 experts from different countries provided judgments on parameter values for 35 target questions, characterizing value uncertainties with three defined statistical quantiles. Target items were divided into three sub-groups, focusing on different aspects of the hazard assessment problem (n° of tsunamigenic landslides in different time frames, triggering mechanism and probabilities of occurrence for tsunamigenic landslides with different volumes/initial positions – Figure 1c). The experts also provided uncertainty judgments for 16 calibration questions as the basis for computing target item aggregations using the different weighting schemes. Results of this elicitation will be used to create probabilistic inundation maps for different scenarios, derived from numerical modelling, to help civil protection in the wider hazard assessment of this volcanic island.

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