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Investigating the effects of methodological expertise and data randomness on the robustness of crowd-sourced SfM terrain models

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Structure-from-motion (SfM) techniques are now widely available to quickly and cheaply generate digital terrain models (DTMs) from optical imagery. Topography can change rapidly during disaster scenarios and change the nature of local hazards, making ground-based SfM a particularly useful tool in hazard studies due to its low cost, accessibility, and potential for immediate deployment. Our study is designed to serve as an analogue to potential real-world use of the SfM method if employed for disaster risk reduction purposes. Experiments at a volcanic crater in Santorini, Greece, used crowd-sourced data collection to demonstrate the impact of user expertise and randomization of SfM data on the resultant DTM. Three groups of participants representing variable expertise levels utilized 16 different camera models, including four camera phones, to collect 1001 total photos in one hour of data collection. Datasets collected by each group were processed using the free and open source software VisualSFM. The point densities and overall quality of the resultant SfM point clouds were compared against each other and also against a LiDAR dataset for reference to the industry standard. Our results show that the point clouds are resilient to changes in user expertise and collection method and are comparable or even preferable in data density to LiDAR. We find that 'crowd-sourced' data collected by a moderately informed general public yields topography results comparable to those produced with data collected by experts. This means that in a real-world scenario involving participants with a diverse range of expertise levels, topography models could be produced from crowd-sourced data quite rapidly and to a very high standard. This could be beneficial to disaster risk reduction as a relatively quick, simple, and low-cost method to attain a rapidly updated knowledge of terrain attributes, useful for the prediction and mitigation of many natural hazards.