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BOOK OF ABSTRACTS
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A successful experience of volunteer crowdsourcing via social media to enhance knowledge for seismic risk reduction

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Volunteer crowdsourcing information provides bottom-up knowledge that is potentially useful for disaster management in terms of monitoring and assessing the built environment. The crowdsourcing process begins with the collection of information from citizens, under the assumption that the collected information from many citizens will enhance professional knowledge (Bonney et al., 2016). Social media platforms such as Facebook and Twitter provide great potential for collecting and analyze information directly. However, social media platforms spread large amounts of false information and rumors. Although crowdsourcing is gaining popularity in the disaster reduction context, the compatibility of disaster preparedness and crowdsourcing by volunteers is an under-researched area (Kankanamge et al., 2019).

Several studies (e.g., Fallou et al., 2020) have already demonstrated that seismology is one of the research areas where citizen science projects successfully gather useful scientific information. When an earthquake affects a populated area, a need for information immediately arises in the population. The ubiquity of smartphones provides an opportunity to involve even more citizens than before, who voluntarily send and share information out of an emotional impulse. When people post comments on social media immediately after an earthquake, it is out of a need to share and receive information from others. This willingness, which occurs immediately after experiencing an earthquake, has been used to model the spatial distribution of macroseismic intensity assuming a known magnitude and hypocenter (De Rubeis et al., 1992; Atkinson and Wald, 2007; Sbarra et al., 2010; Sbarra et al., 2012). The acquisition of seismic intensity reports takes up to a few minutes and is analyzed to understand the potential impact of the earthquake on the population. The "Did You Feel It?" (Wald et al. 1999) was one of the first Internet-based scientific crowd-sourcing initiatives. Nowadays, smartphone apps allow users to send a report about an earthquake they experienced (e.g., Bossu et al., 2018), similar to macroseismic intensity questionnaires collected through websites (Atkinson and Wald, 2007; Tosi et al., 2015). This information is shared by citizens on a voluntary basis, but also by trained personnel, such as emergency response volunteers (Sandron et al., 2021).

On December 29, 2020, at 11:20 UTC, an earthquake of magnitude Mw 6.4 occurred near Petrinja, about 50 km from Zagreb in central Croatia (Markušic, et al., 2021). The earthquake was felt very clearly in northeastern Italy and in the city of Trieste. The social media of the OGS Seismological Research Centre, which monitors the seismicity of NE Italy (Bragato et al., 2021), recorded an unusual increase in traffic and posts by people from Trieste. People were frightened and ready to share their experiences with their fellow citizens. We immediately seized the opportunity to gather as much information as possible about the perception of the earthquake in the city of Trieste, in an organised way. For this purpose, through social media (Facebook, Twitter) we created a pool similar to "hai sentito il terremoto" (Sbarra et al., 2009, www.hsit.it) and asked the citizens of Trieste to fill it in and forward our request to all their contacts in the city. Whatsapp was also used to disseminate the questionnaire. Within a few hours, we collected 6582 questionnaires from Trieste and almost 3000 questionnaires from different places outside Trieste. For comparison, we refer to the results we obtained for the 2012, 20 May Emilia earthquake (Fig. 1) when we carried out a similar experiment and collected only 587 questionnaires. At that time we advertised the questionnaires through local newspapers and mailing lists. Social media was not yet as popular, and our Facebook and Twitter channel did not open until June 2013 (https://www.facebook.com/ogscrs). In addition to social media, the speed with which the questionnaire was distributed certainly had an impact on 2020.

The collected questionnaires were visually inspected and questionnaires of poor quality were rejected according to the criteria mentioned in Tosi et al. (2015): duplicate entries, contradictory answers, lack of information, and discrepancy between calculated and theoretical intensity. Correspondence between responses and intensity degrees (MCS and EMS scales) was determined using a scoring matrix according to the method of Tosi et al. (2015).

From the results collected (Fig. 2), it appears that 70% of the population of Trieste reported feeling the earthquake moderately strongly, and only 21% that they did not feel it. Most people who felt the earthquake were indoors, sitting or lying down, or at least not moving. Most people were between the first floor and the first 5 floors of the buildings. Of the people who were moving outside, most said they did not feel the quake, but some did. The theoretical intensity calculated for this earthquake was IV (Gómez Capera et al., 2017), which is in good agreement with the intensity estimated by the questionnaires.

After georeferencing each questionnaire and assigning an intensity value, we plotted a map of the intensities obtained for Trieste. The spatial data were imported into the environment GIS. A hexagonal grid with a size of 200 meters was used, and for each cell the average of the Mercalli-Cancani-Sieberg (Sieberg 1930, MCS) intensity residuals was calculated (the difference between the observed intensity and the theoretical intensity). We used a hexagonal grid because it provides better readability than a standard rectangular grid and improves the visual clarity of spatial distributions and homogeneity of cell neighborhoods, as the pattern is completely symmetric with respect to distance (Iurcev et al., 2021). Spatial data were then filtered in order to obtain a residual smoothed map, to be compared with geological maps (Fig. 3). To obtain this map, a GIS procedure was used to calculate the moving average of the data within a 500 m radius circle, starting from the centroid of each hexagonal cell.

The same approach was adopted for the analysis of the questionnaires collected for the May 20, 2012 earthquake in Emilia (Mw=6.1). For both the Petrinja and Emilia earthquakes, we superimposed the residual intensity maps on the geological map (Carulli et al. 2002). The residual intensity maps agree well with the ground amplifications that would be expected based on the local geology.

This study represents a positive case of citizen science being useful to increase knowledge and contribute to seismic risk reduction. The information provided by citizens was found to be reliable when properly analyzed and therefore can be used to provide a first approximation of reliable ground information when it is not available. Obviously, the more people involved, the better the resolution of the maps.

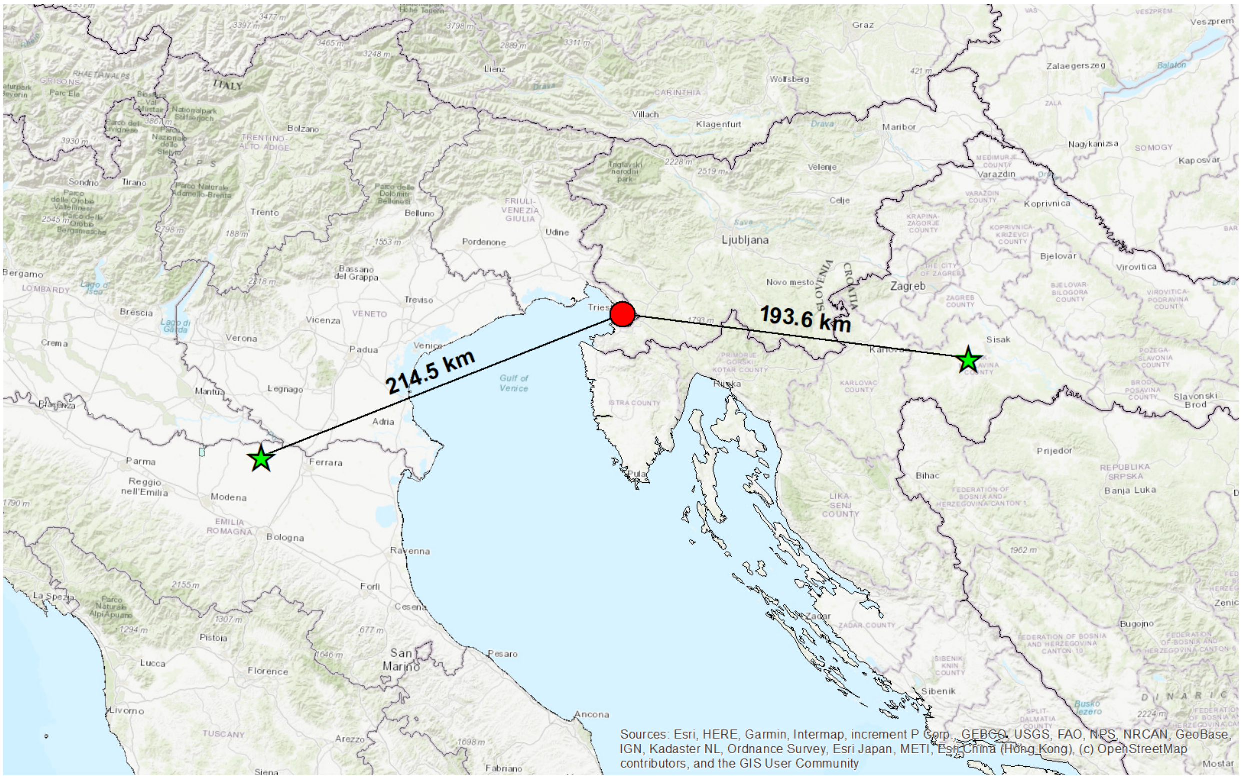
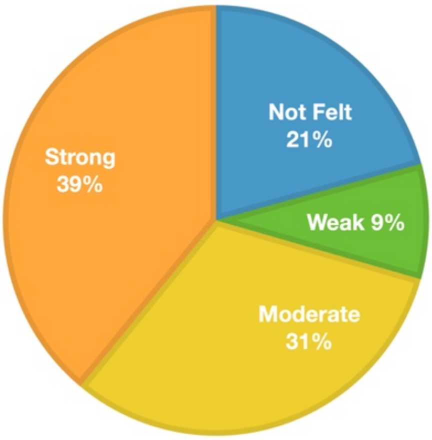
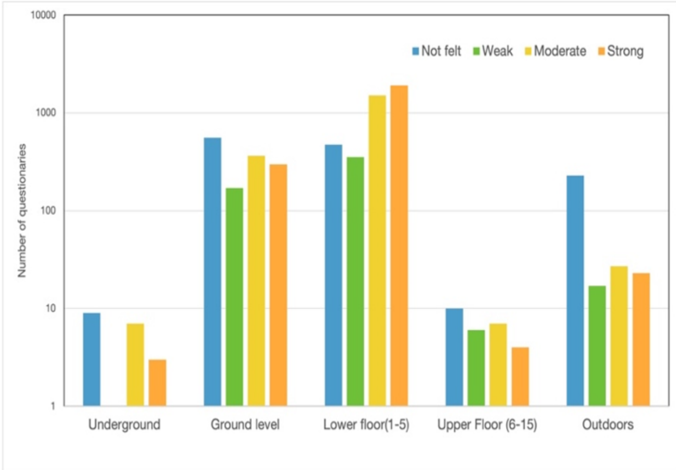
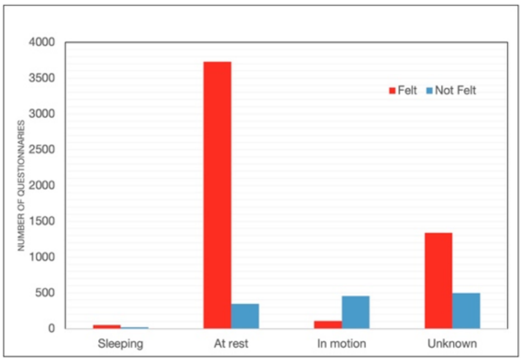


Fig. 1 - Map with the epicenters (stars) of the 2020 Petrinja earthquake (Mw 6.4) in Croatia, and the 2012 Emilia 20 May earthquake (Mw=6.1). The circle represents the city of Trieste where both the earthquakes were felt by the population. The distance form Trieste to the two epicenters is reported in the map.







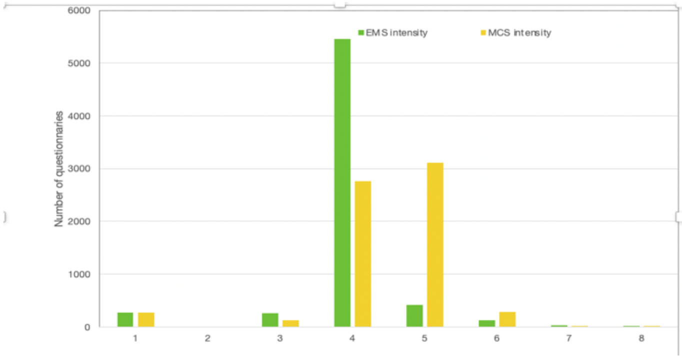


Fig. 2 - 2020 Petrinja earthquake: number of questionnaires collected from Trieste 6582.

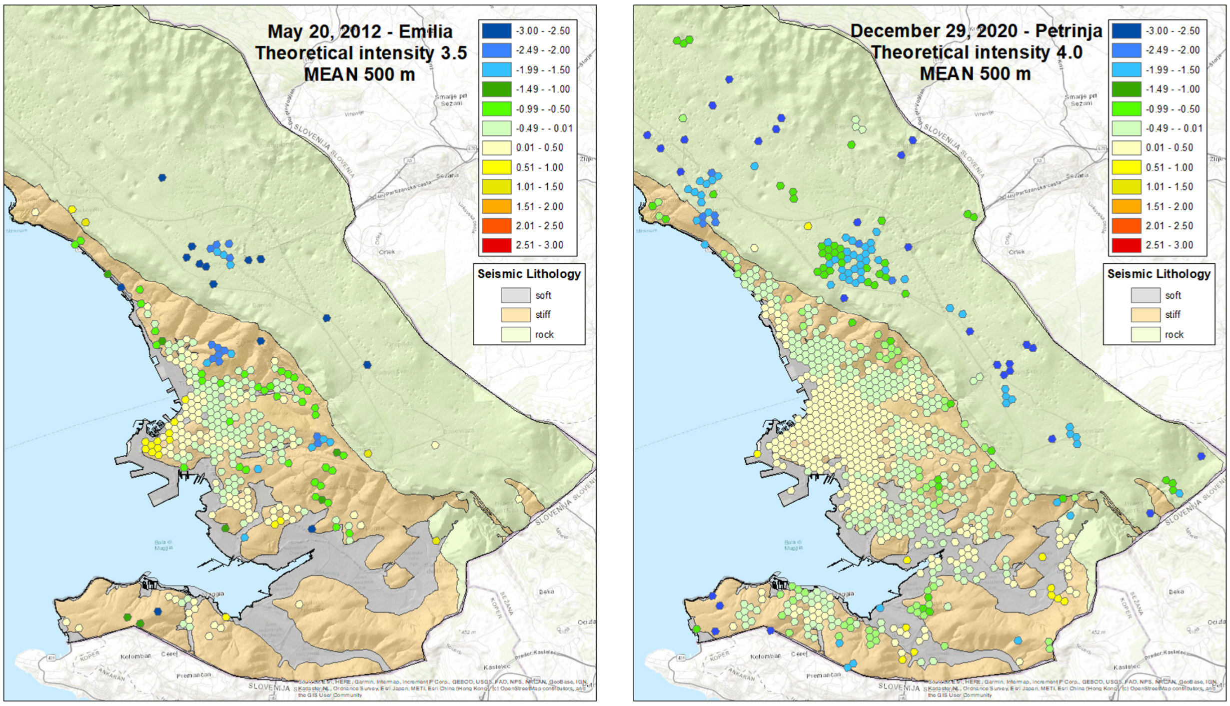


Fig. 3 - Residual smoothed maps for Emilia event on May 20, 2012 (left panel) and Petrinja December 29 2020 (right panel). The hexagonal cells represent intensity residuals plotted over the geological map of the city.

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