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## Gas emissions in volcanic islands: establishing an early warning network for gas hazard management

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The La Fossa volcano lies nearby the settled zone of the Island of Vulcano and its last eruption occurred in 1888-1890. Since then, the fumarolic-solfataric degassing accounted for both sulfur and carbon dioxide emissions at Vulcano Porto zone. Long exposure time to CO<sub>2</sub>-polluted air causes severe health injuries, including suffocation. Since volcanic emissions expose people at risk, several international agencies fixed safety threshold figures based on both the gas concentration and the time of exposure.

This study accounts for the results of the survey performed in the summer of 2020 inside some buildings in the settled zone of Vulcano Porto. The survey aimed at identifying four suitable sites for deployment of continuous surveying stations of both soil CO<sub>2</sub> flux and air CO<sub>2</sub> concentration. This investigation targeted the anomalous soil CO<sub>2</sub> emissions at the Faraglione zone. A comparison between our results and previous studies shows the anomalous degassing zones at Vulcano have not changed their current position substantially. Several significant changes (i.e. independent from changes in atmospheric pressure and temperature) occurred instead in the emissions levels because of the volcanic gas addition. The indoor measurements aimed to verify the conditions where air CO<sub>2</sub> concentration achieves values higher than the safety thresholds, as the results of soil CO<sub>2</sub> flux.

The investigation targeted several types of environments including both outdoor and indoor sites, either accessed or not by people. The outdoor sites allowed the comparison with air CO<sub>2</sub> levels of the indoor environments. An infrared spectrophotometer enabled the air CO<sub>2</sub> measurements in the range of 0 - 10% vol. At least four measurements were performed at each site with 2 minutes sampling frequency. The results enabled evaluating the CO<sub>2</sub> concentration patterns in a time window consistent with sporadic exposure in the selected sites.

The results show indoor air CO<sub>2</sub> concentration > 1000 ppm vol in several selected sites. In a few specific sites, the air CO<sub>2</sub> concentration achieved 6% vol after a few minutes of measurement, which is higher than the Immediately Dangerous to Life and Health exposure limit (IDLH = 4% vol). Both the soil CO<sub>2</sub> emissions and air exchange, either normal or artificially induced, caused these air CO<sub>2</sub> values.

This study shows that gas hazard mitigation includes several actions in the settled zones of

Vulcano Porto. The soil CO<sub>2</sub> flux and air CO<sub>2</sub> concentration surveying are both useful actions for risk decrease. However, it is unrealistic to design a network able to identify the risk level above a site-specific threshold and take timely mitigation actions. Comprehensive risk management includes the awareness of the gas hazard among people who live, work or arrive at the island of Vulcano. At the same time, people's training aims to promote self-reliance in hazard identification and address taking suitable actions against risk in specific cases.