Earthquake Precursor Measurements Employing a Network of Radon Sensors[1]

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Natural disasters like earthquakes haunt mankind in those regions that lie along the fault zones of tectonic plates. Being able to predict when, where and with which magnitude an earthquake will occur is not possible. At present, one can only speak about probabilities of an earthquake to occur in a given time window, that encompass many years. Measurements of changes of radon concentrations in groundwater have shown pronounced changes before imminent earthquakes, like e.g. prior to the Kobe earthquake [1]. Many groups have performed measurements in soil, where the results show larger variations, partly due to atmospheric influences (see the recent compilation of radon measurements in Greece [2]). The ArtEmis project will create new insight into the correlation between imminent earthquakes and changes in radon emission from the upper lithosphere. This will be achieved by a novel system design, anchored along three venues of development: 1) The ArtEmis sensor will measure changes of radon concentration in groundwater and springs along fault zones, selected by seismic and hydrological studies. In this fashion one expects a larger sensitivity to changes at deeper layers of the earth and at the same time a small and stable background, reducing atmospheric perturbations. The sensor is also measuring temperature, pressure and humidity. 2) The ArtEmis sensor combines high sensitivity with low cost, enabling the placement of around 100 sensors. The large number of sensors is a prerequisite to overcome the statistical uncertainty from previous measurements [3]. 3) The data will be analysed by means of advanced machine learning algorithms, that correlate the radon, temperature, pressure data to seismic data. Prototypes of the sensors have been placed in Italy, Greece and Switzerland. The sensor data is sent over the 3G/4G network to servers at KTH from which it is made available for further AI analysis at the Sorbonne. The next batch of improved sensors will be placed in the coming year. Once the final design is tested, the final number of sensors are to be placed in the regions of consideration: the Abruzzi region in Italy, the Ionian Islands in Greece and the Valais in Switzerland. The ArtEmis consortium is aiming at continuation and expansion of the project in the years to come. Data from the project is expected to give a final answer to the prospects of improved earthquake forecasting by means of advanced large scale sensor systems.

References

[1] G. Igarashi et al., Science. 269, 5220 (1995), doi: 10.1126/science.269.5220.60
[2] S. Stoulos, et. al. Journal of Radioanalytical and Nuclear Chemistry, (2024) https://doi.org/10.1007/s10967-024-09710-4
[3] N. Morales-Simfors, R. A. Wyss, and J. Bundschuh, Crit. Rev. Environ. Sci. Technol. 50 (2019) 979. DOI:10.1080/10643389.2019.1642833
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