Citizen-based radiation measurement in Europe:

Supporting informed decisions regarding radiation exposure for emergencies as well as in daily life.

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INTRODUCTION:

Lessons learned from the Fukushima Dai-ichi NPP crisis and its aftermath have confirmed that lack of knowledge and understanding during emergencies is extraordinarily stressful and will have negative psychological consequences, not only for people directly affected but also those witnessing it from a distance. For an individual, to understand the situation and to gain perspective transforms them from feeling like a helpless victim into an actor who has some degree of power over the situation. This is the main reason why some radioprotection bodies such as IRSN and SURO have developed strategies to not only inform people by providing them with basic useful knowledge for coping with such situations, but also by trying to empower citizens by encouraging them to measure radioactivity themselves and to share their data. One of the challenges a nuclear accident presents is to prepare for the post-accident phase, and to be adequately aware of the wider consequences that can derive from the accident. The population most affected by nuclear fallout may be obliged to evacuate or to live in contaminated areas with many constraints. Because citizens in this situation will likely need to carefully follow the recommendations of authorities in order to limit their individual doses, it becomes quite important for them to trust decision-makers. Taking their own measurements helps citizens become knowledgeable active participants in the safety dialogue.

Other local citizens as well as consumers worldwide who might be considered less directly affected by radioactive contamination nevertheless have a valid stake in accurate information. Lack of knowledge, mistrust of authorities, and receptivity to misinformation can lead many to erroneously consider a country which in fact has suffered a limited zone of hazardous contamination to be contaminated in its entirety. As has been seen after the Fukushima disaster, this can lead to product boycotts and lengthy embargoes, particularly for foodstuffs, but also against travel and tourism. The nuclear accident in Japan showed that all of these can have a significant economic impact and can lead to an entire country facing unexpected reputational challenges.

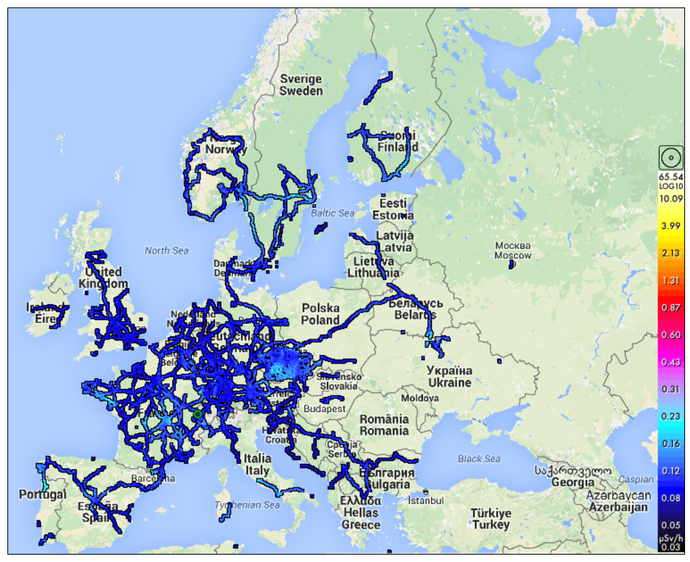
In the wake of the Fukushima Dai-ichi NPP disaster, citizen-science based radiation data collection efforts have proven very important in filling information gaps for the public. The technical abilities and organization of citizen groups has been increasingly recognized by governmental institutions, first responders, and international bodies, many of whom have expressed interest in integrating citizen efforts into disaster response plans, as was highlighted in the Eagle project.

The goal of this poster is to give examples of such developments and their results in Europe.

About Safecast:

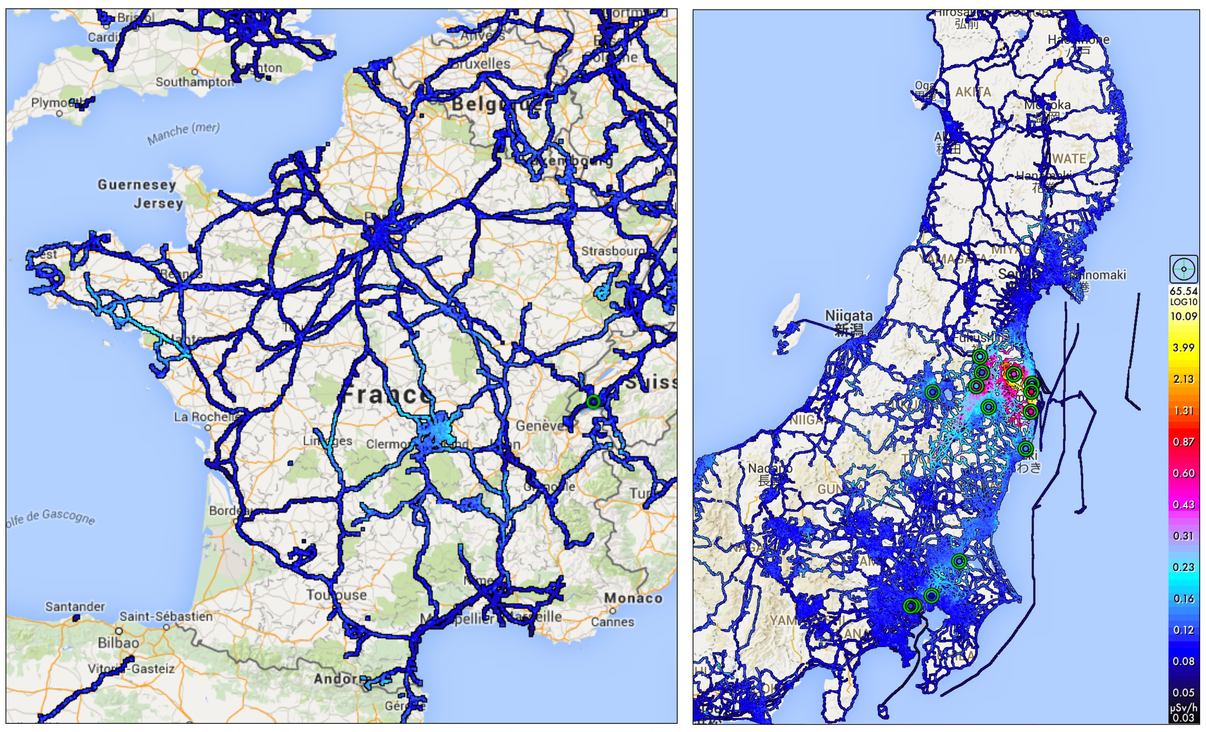
Safecast, is an international, volunteer-based organization devoted to monitoring and openly sharing information on environmental radiation and other pollutants. It was initiated on March 12, 2011, one day following the start of the Fukushima Dai-ichi NPP accident, in response to what several official reports on the disaster have criticized as the chaotic nature of TEPCO, inter-agency, and inter-governmental communication. Since 2011, Safecast has implemented participatory, open-source, citizen-science-centered radiation mapping solutions developed through a process of collaborative open innovation. Safecast develops sensors and a variety of other innovative hardware and software for visualizing environmental measurement data. The group seeks to provide people who are concerned about environmental and nuclear issues with tools they can use to build alternative open means of measurement and communication , which can be easily shared and built upon by others. Five years after the start of the Fukushima disaster, Safecast volunteers have built and deployed hundreds of radiation sensors worldwide and have amassed the largest open data set of radiation measurements to date. Many Safecast devices are in use in Europe and their data is shared on web-based and other Safecast maps.

The map to the right shows data in Europe accumulated by safecast volunteers as of May, 2016. Most of the measurements were done by car using the bGeigie Nano GPS-equipped detector, with data-logging capability.

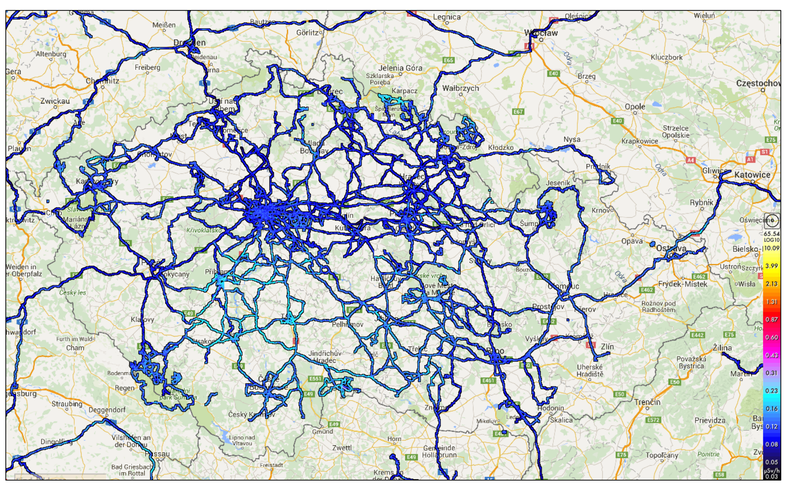


Safecast web map showing data from Europe as of May 2016

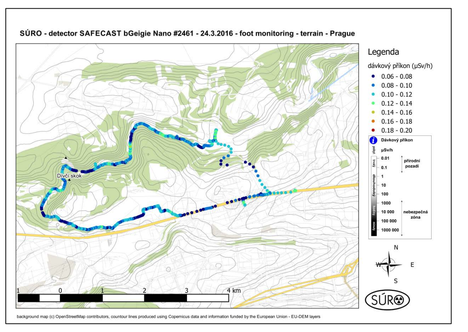
The devices were positioned at approximately 1m height. Each data point represents a sliding total of the previous 60-second count, advancing every 5 seconds. Location precision depends upon the quality of the GPS signal available. Over 60 Safecast bGeigie devices have been used in Europe to data, logging approximately 8 million datapoints (out of approximately 47 million in the entire Safecast database as of May 2016). In addition, the Safecast system has been adopted by educators in Japan, Europe, and the US.



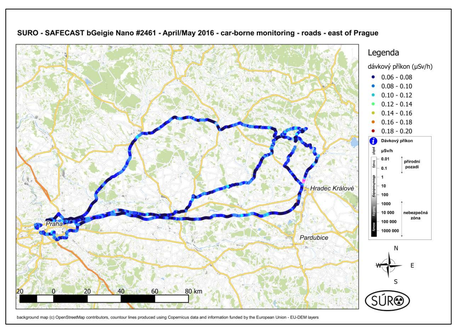
On this map, areas with naturally radioactive granitic soil are generally depicted in light blue, and occasionally in pink as in Rome. For comparison, the second map shows measurements in Fukushima prefecture in Japan. This visualization allows the viewer to grasp the extent of the contaminated areas, and helps Europeans understand that despite the widespread rumors, not all of Japan is contaminated. And the dark blue color shows him that radio activity is always present everywhere, presenting negligible risk.



Results of monitoring in CR on the Safecast web up to May 2016



Results of monitoring in CR prezented using QGIS project: On-foot and Car-borne monitoring



Results of monitoring in CR prezented using QGIS project: On-foot and Car-borne monitoring

Name	Price	Detector	Ready to use	Part of network	GPS	Data Logging
MightyOhm Geiger Counter	125 USD	Geiger-Müller, SBM-20	no, kit	no		
MyGeiger	105 USD	Geiger-Müller, SBM-20	no, kit	no		
Xwopen Geiger Counter	130 USD	Geiger-Müller, Gao Pingtan plateau counter	yes	no		
FTLab SmartGeiger	30 USD	semiconductor	yes[1]	no		
Polimaster PM1912 RadFlash II	~440 EUR	Geiger-Müller, unknown type	yes	yes, closed (proprietary)		
Radioactive@home	30 EUR	Geiger-Müller, SBM-20	yes	Yes, open (community)		
Libelkim Waspmote	~1500 EUR (inc. shipping)	Geiger-Müller, North Optic J305 (China)	no/yes[2]	no		
SAFECAST bGegie Nano	530 EUR (inc. shipping)	Geiger-Müller, „pancake" type LND 7317 (USA)	no	yes	yes	yes

FRANCE:

As part of its program of public empowerment, IRSN experts regularly give interactive lectures for high schools supported by a traveling exhibition consisting of 80 freestanding posters covering every anticipated question about radiation and nuclear risks. In addition, IRSN recommends that students learn to use a variety of tools for measuring radon (Corentium "Canary" Digital Electronic Radon Gas Monitor) or ambient radioactivity (Safecast bGeigie) in their home areas, and to become familiar with radioactivity measurement units (In Japan, after the NPP disaster the public was unfortunately forced to develop a working knowledge of previously unfamiliar units such as "Becquerel," "Sievert," and "Gray"). IRSN experts follow the studies carried out by students. For example, the blog http://radioactivite-auvergne.blogspot.fr/ presents the results of high school students' research.
In France, IRSN conducted a review of a number of different radiation measurement tools available for citizens and characterized their features and performance. Radiation applications for smartphone were gathered by web searches, analyzing those proposed for both iOS and Android. Most of the applications are available on both platforms. Applications available on both iOS and Android allow a larger number to total users to participate in data-gathering, while those available on only one platform supplement the quantity of data shared on radiation map websites. The web search utilized the keywords: "Geiger counter," "radioactivity measurement," and "dosimeter," in both French and in English. Japanese-language-only applications may not have been captured in this search, and so do not appear in this study. The applications which were identified are listed in the table of criteria below.
The applications intended for use by the general public generally fall into one of two categories, and appear to satisfy the needs of different kinds of users. Autonomous applications for smartphone are usually very inexpensive (€5-€6 maximum) and thus can reach a very wide public. Other applications require a separate sensor to be attached. These are often free, but require the purchase of the sensor, and would find a more limited but also more knowledgeable and motivated audience. The total number of downloads of the Android applications is published by Google Play, making it possible to identify the most downloaded ones, and thus, by implication, the ones which best met the expectations of the public.
Several smartphone applications on both Android and iOS are designed for use with external sensors, and include for example the Iterium radioactivity tester, Pocket Geiger, AOPA, Polismart, Smart Geiger, RadAngel, GS Ecotest, Depending the external sensor used, measurement times can range between 1 minute to 30 minutes. The sensitivity of the sensors varies a lot as well, with stated low thresholds ranging from 0.03 to 5 microsievert/h, with an expected tradeoff between sensitivity and reasonable measurement time. Prices for the external detector units range from about €40 to €320. Applications that don't require separate sensors include IRAD, Camera Geiger, and Radioactivity Counter. They less than €5, but the measurement times for low doses can be quite long. For example, the most frequently downloaded application, Radioactivity Counter, requires from 4 to10 minutes to generate a measurement in the range of 10 microsievert /h to 15 Sievert /h. IRSN is developing a website where citizens are given the opportunity to share their own measurements by uploading them on a map. The name of this future website is " Openradiation".

CZECH REPUBLIC:

In the Czech Republic, a program has been established which aims to improve public safety by introducing radiation monitoring systems at several levels, including institutions, schools, and citizens, in accordance with current international trends. Titled "Radiation Monitoring Network for Institutions and Schools to Assure Early Awareness and Enhancing Safety of Citizens (RAMESIS) - ID: 20152019028," this project is funded by the Czech Ministry of the Interior within the framework of security research.
Through this project, instrumentation, including central applications for receipt, storage, administration, and publication of radiation monitoring results will be analyzed, projected, developed, and procured. The system will be implemented at selected institutions and schools, including the provision of training and informational materials for improving overall understanding of radiation issues.
The project will run from 2015-2019, under the guidance of SURO in cooperation with the Institute of Technical and Experimental Physics of the Czech Technical University in Prague (detectors) and the NUVIA Corporation (applications for central database and for presentation system).
The radiation monitoring system proposal includes both a) fixed-stations and b) mobile monitoring:
a) The fixed-station component will cover the design, development, and production of a prototype simple cheap detector, based on Si-diodes, and a multi-purpose system based on pixel detectors, for installation at schools and other institutions, using continuous data-transfer and communication with the central workplace;
b) The mobile monitoring component will involve the evaluation and choice of a suitable detector for mobile monitoring, and the creation of appropriate methodologies both for measurement per se and for monitoring strategy.
Both components are supported by a central workplace ensuring data storage, procession, and presentation, and knowledge support including preparation and distribution of information materials for users, schools, and the public intended to improve overall understanding of radiation issues on the part of he public. An approach based on direct experience using appropriate devices and understanding of the measurement results obtained in this manner is considered the most effective and promising.
For component "B," mobile monitoring research was performed to show the current status of citizen-network-based monitoring, followed by practical testing of selected detectors at SURO – see table above.
Based on this test, the Safecast bGeigie Nano was chosen for mobile monitoring. SURO purchased approximately 30 units and deployed/distributed them to selected schools and institutions. SURO also prepared appropriate manuals and user guides for performing mobile monitoring and for sending the data to the central workplace. SURO also developed user-oriented, open-source based software modules to enable users to display their bGeigie Nano measurement results directly on on-line and off-line maps. SURO collects the results of field measurements from all the users participating in this project, and supervises submitting them to the safecast.org database for visualization.

CONCLUSION:

Citizen monitoring networks can make a valuable contribution to radiological monitoring in emergency situations, as well as providing useful input into databases of normal background radiation. The educational potential of participation in citizen radiation monitoring efforts has also been recognized in Europe and other parts of the world. The achievements of Safecast and similar groups following the Fukushima Daiichi NPP disaster represents the maturation of citizen science in general and has intensified the debate about quality control, training, and reliability of the data they produce. The independence of citizen-based environmental monitoring organizations is an important source of their credibility in the eyes of the public, and for this reason needs to be carefully guarded. Nevertheless groups like Safecast which promote the principles of openness and transparency should welcome close scrutiny and evaluation of their systems by outside experts and official radiological monitoring bodies. From the point of view of expert professionals, the technical limitations and tendencies of low-cost probes such as the bGeigie must be carefully characterized and taken into consideration when interpreting their data. This includes issues of calibration, linearity, energy dependence, appropriate gamma dose/dose-rate conversions, directionality, uncertainties in detector position and orientation, potential interference from vehicles or the human body. The experience of SURO and IRSN has shown that appropriate technical evaluation and support within an educational context can help foster interest in citizen-based radiation measurement, and provide the basis for good communication regarding risks and emergency response between citizen networks and experts.