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D9.134- Stakeholders feedback report on proposed tools and protocols

Lead Author: *Liudmila Liutsko[1-3], Adelaida Sarukhan[1] and Elisabeth Cardis[1-3]*

With contributions from: *Deborah Oughton[4], Paola Fattibene[5], Sara Della Monaca[5]; Aya Goto[6], Takashi Ohba[6], Koichi Tanigawa[6], Philippe Pirard[7], Yevgeniya Tomkiv[4], Sylvie Charron[8], Mélanie Maître[9], Pascal Croüail[9], Thierry Shneider[9]*

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Authors affiliations: 1) ISGlobal, Barcelona, Spain; 2) UPF, Barcelona, Spain; 3) CIBERESP, Madrid, Spain; 4) NMBU, Ås, Norway; 5) ISS, Rome, Italy; 6) FMU, Fukushima, Japan; 7) Santé Publique France, Saint-Maurice, France; 8) IRSN, Fontenay-aux-Roses, France; 9) CEPN, Fontenay-aux-Roses, France.

Abstract

The SHAMISEN SINGS task 1.2 aims to obtain feedback from stakeholders on proposals of mobile apps (input on the first proposals from WP2 and WP3).

A series of focus group meetings were held in the second half of the project's life to present and discuss WP2 and WP3 deliverables (requirements and specificities for dose measurement apps and devices, and for health and well-being monitoring) in order to determine if they correspond to the needs specified during task 1.1. An important issue to take into consideration is whether these apps or tools are suited for different age groups and cultures, or whether different approaches are needed for different populations. Advice is provided on this.

CONTENT

1 Overall aims of WP1

The overall aim of SHAMISEN-SINGS is to enhance citizen engagement in preparedness for and recovery from a radiation accident, through the use of mobile apps for measuring radiation doses and monitoring relevant health/well-being indicators (Liutsko, Sarukhan, Fattibene, Della Monaca, Charron, Barquinero, ... & Goto, 2018).

The objective of WP1 is to provide input and feedback from consultations with stakeholders (in particular representatives of local populations, teachers, medical personnel as well as local and national authorities) to identify their needs in the immediate and long-term phases of an accident and propose a tool (or framework for a tool) using new information technologies to optimize interactions between technical capacities offered by the applications, citizens and expert resources.

Building a strong relationship and timely information exchange with local stakeholders and affected populations is a key for managing and mitigating the early and long-term consequences of a radiation accident. By obtaining real time and on-place information, citizens would benefit from a reduction in anxiety related to radiation exposure and acquire a basic radiation protection culture (Liutsko & Cardis, 2018).

The need for information and the implication of different sectors of society after a disaster is an important issue to address, since different people have different information needs and degrees of scientific literacy. Exposed populations need to know where and when they can receive assistance or answers to their questions, the main one regarding whether they will be all right living where they are. On the other hand, decision makers can use this information when evaluating the needs of affected populations and the relevance of potential strategies to manage the consequences of the accident.

In the early phase of the response, there is an important but diverse need for information related to:

- Radiation contamination levels, areas of exposure, behaviours to decrease exposure risk, and health consequences of radiation exposure;
- Social issues, such as where to meet families, access medical care and social facilities;
- Actions taken and planned, such as evacuation zones and routes;
- Providing personalised information for census taking.

In the long term, there will be a need to exchange information on local contamination levels, food contamination, health monitoring results, and local decisions particularly in relation to lifting of evacuation orders and return of populations to their homes.

2 Methodology

The methodology used to obtain the stakeholders feedback consisted of group discussions during national (three) and international workshops (two - ERPW2018 and RICOMET2019).

The aim of these discussions with different stakeholder groups was to present the project, provide information on existing mobile apps and tools for dose measurements and health/well-being indicators relevant to nuclear accidents, and obtain the participants' opinion. In addition, guidelines and tutorials of a "recommended" app for dose measurements (input from WP2) and a prototype of health app (WP3) were presented at the SHAMISEN SINGS workshop on July 2, 2019 in Barcelona, during the RICOMET conference:

Tuesday, 2nd of July	
08:30	**SHAMISEN SINGS workshop** Marie-Curie conference room *Chairs: Liudmila Liutsko, Adelaida Sarukhan & Elisabeth Cardis, ISGlobal* open to congress participants / stakeholders, will present the project's key results and gather feedback on mobile APP proposals to enhance citizen participation in radiation measurements and health studies

Figure 1. SHAMISEN SINGS workshop in the RICOMET programme

3 Summary of stakeholders feedback on dose measurements and health/well-being indicators WP1

3.1 A brief summary of stakeholder feedback and discussions from national workshops (Spain)

A series of focus group discussions with stakeholders were performed in Madrid (Spain) during the year 2018 (June, 27, September, 21). During these meetings, assistants were briefly presented with the SHAMISEN SINGS project (5-10 minutes), after which they participated in a group discussion on mobile apps and tools that could be used by citizens (and for citizen science) in case of a nuclear accident.

The possibility of using mobile apps for dose measurements provoked diverse reactions among stakeholders – from surprise that such tools exist at all, doubts on quality and validity of data obtained, to willingness to use these apps in case of a nuclear emergency. Stakeholders working on environmental state monitoring in areas near nuclear power plants noted that measurements in times of "peace" (or normal time) could create confusion and generate mistrust towards authorities if official measurements differ from their own. To avoid this, additional information should be provided to populations in order to avoid data misinterpretation and / or inadequate measurements.

First responders saw these apps as a useful opportunity, since their teams are not equipped with enough dosimeters and therefore these additional resources could provide some indication of environmental contamination.

Almost all stakeholders agreed that, in the immediate aftermath of an accident, use of these apps will be very challenging and unhelpful unless citizens have prepared in advance and understand how they work. However, as observed in the case of Fukushima and Chernobyl, they can be very useful for the long-term recovery phases and help people control daily individual exposure and build a radiation protection culture.

3.2 Summary of stakeholders feedback and discussions from international workshops

3.2.1 *CONCERT* stakeholders –a group discussion of new projects (5th of October, 2018, Rovinj, Croatia // ERPW2018)

After a brief presentation of SHAMISEN-SINGS, we collected questions and comments from 20-25 CONCERT stakeholders attending the ERPW2018 and that agreed to participate in the workshop.

There were several questions and a wide discussion on the usefulness and appropriateness of mobile apps and external devices. However, the central concern was related to the quality of the data

collected with mobile phone cameras and/or with external devices to measure ionising radiation. One important issue raised was how to assess the quality of data and how to instruct people on the correct use of the tools. Main comments came from HERCA and from SEPA (Paul Dale.)

More specific questions that were raised:

1. How to assess the perception of radiation risk from people when using such apps (commercial apps may convey a negative perception of radiation). These apps could increase radiation fear, but also help control it.
2. What is the performance of these devices in measuring basal radiation in the environment?
3. Is the project going to analyse the use of these apps only after a nuclear emergency or also in different situations, especially in times of peace? Some people may also be interested in these tools in time of peace. Training under an emergency should be foreseen.
4. Who will be responsible for uploading and storing the information generated by these apps? Will these be public or private organisations?
5. How to merge official networks and citizens' data? Will these data be merged with governmental environment monitoring maps? There is a potential interest, but the data need to be correctly collected. Minimum quality of data should also be assessed. There are already projects in this field (Thierry Schneider suggested to include this point in the SRA).
6. Citizen measurements might help increase and integrate the volume of collected data in case of an emergency. In Europe (except Germany) the government networks are undersized.
7. In case of an accident, how can the mobile apps be used? Would these apps have enough capacity to store or transfer data?
8. Who is expected to use the mobile apps? The elder generations may have little practice with these tools… Can this be deduced from the questionnaire?
9. SCK-CEN performed a survey asking 1000 individuals if they wish to use mobile apps for radiation measurements, and asked if Shamisen-Sings has also asked this in the survey. The results of both Surveys can be compared later.

The report of this meeting is available on the SHAMISEN SINGS project web:

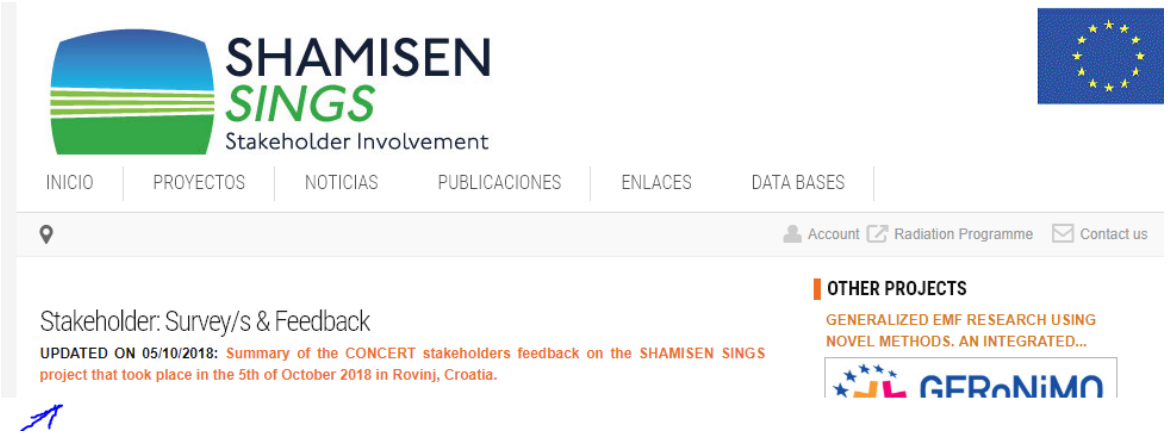

Figure 2. CONCERT stakeholders' feedback on mobile Apps for dose and health/well-being measurements (SHAMISEN SINGS project).

3.2.2 *Stakeholders feedback on the SHAMISEN SINGS proposal (WP2 & WP3) – an open* group discussion (2nd of July, 2019, Barcelona, Spain // RICOMET2019)

The second international SHAMISEN SINGS workshop for stakeholders was organised during the RICOMET conference in Barcelona, on July 2, and was open to all participants of the conference and ISGlobal colleagues. The participants' background was diverse: radiation protection, epidemiology, environmental effects on health, social sciences and humanities, technical disciplines, as well as representatives from associations and authorities.

Figure 3. Presenting SHAMISEN SINGS project (Dr. Cardis, ISGlobal, on the left) and apps for dose measurements after a nuclear accident (Dr. Fattibene, ISS, on the right)

A brief presentation SHAMISEN SINGS' main goals was followed by a presentation of recommended tools for measuring radiation doses and relevant indicators of health and well-being for affected populations by a nuclear accident, together with ethical issues related to their use and further exploitation of data. Workshop participants were free to give their opinions and suggestions, or provide any other feedback on these kinds of apps and tools.

4 Summary of Discussion of the SHAMISEN SINGS workshop (RICOMET)

Based on the results of reviews on mobile apps and tools on dose measurements (D9.133) and health/well-being (D9.132), and taking into account the stakeholder needs identified through the anonymous survey (D9.130), a series of guidelines for optimal mobile apps were developed and presented at the stakeholders workshop during RICOMET conference in Barcelona (2nd July 2019) for open discussion and feedback.

The apps on dose measurements created more discussion since these types of apps are relatively new and challenging. Many participants agree that, in case of a nuclear accident, citizens will search and use these apps and for this reason, we should prepare for this situation. SHAMISEN SINGS could provide potential users with something similar to **a "check list" with main parameters or criteria** to apply when choosing the app. This could prove beneficial for individual users and boost data sharing and use by authorised research organisations or other institutions.

Big data can smooth possible errors derived from individual measurements and partly resolve a problem of data quality.

Also, citizen measurements they would contribute to environmental monitoring by covering large territories, something for which local authorities do not have enough resources (**additional resources by citizens and citizen science**).

Recommendations should be **simple and short** so the users (mainly general public) may easily understand them.

Representatives of authorities from Germany and Austria do not confirm the doubts expressed by other participants from this and previous meetings as to whether this type of citizen engagement projects may be of the interest of authorities. Indeed, Germany, for example, is already developing its own projects on this issue.

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6 ANNEX: Related dissemination // communications at the conferences within SHAMISEN SINGS project and stakeholders engagement

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Ohba, T. et al. (July, 2019). Development of a mobile phone application for interactive supports of retuned residents in a nuclear accident. International conference RICOMET, Barcelona, Spain (poster)

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6.1 POSTERS

SHAMISEN-SINGS project: Review of mobile phone applications for citizen health and well-being assessment following the Fukushima accident

Takashi Ohba [1*], Yuliya Lyamzina [1], Aya Goto [1], Hiroki Nakano [1], Michio Murakami [1], Yujiro Kuroda [1], Makoto Miyazaki [1], Atsushi Kumagai [1], Tetsuya Ohira [1], Liudmila Liutsko [2], Adelaida Sarukhan [2], Koichi Tanigawa [1], and Elisabeth Cardis [2]

[1] Fukushima Medical University, Fukushima 960-1295, Japan, [2] ISGlobal (Instituto de Salud Global de Barcelona), Barcelona 08003, Spain

*Contact information: tohba@fmu.ac.jp

BACKGROUND

In recent years, the Fukushima accident has led to the identification of a number of key issues that need to be addressed in the aftermath of an accident. These include quality of life of residents (eating habits, stress, daily physical status) and need for improvement of radiation protection measures such as long-term evacuation after a nuclear accident and return to the evacuation area. Since the accident, advances in communication technology have progressed across the world, portable devices have become widely used, and applications (Apps) using mobile phone are becoming widespread. The principal aim of WP3 (Work Package 3) of **SHAMISEN-SINGS (Nuclear Emergency Situations: Improvement of Medical And Health Surveillance- Stakeholder INvolvement in Generating Science) project** was to review existing mobile phone Apps - and propose guidelines for novel tools if necessary – to promote health condition and well-being indicators in the aftermath of a nuclear accident.

METHODS

First of all, we tried to collect the information of residents' support activities after the Fukushima Daiichi nuclear power plant accident during 2011-2017. The information were included project's information (name, targeted subject, period, and support tool) and project's components (radiation, quality of life, diet, health in general, maternal and child health, and thyroid examination). Then, we picked up these information to build up components of novel tool for mobile phone Apps.

DISCUSSION

The following concepts are considered as a mobile application tool in the present study;

- Alert radiation exposure to citizens (radiation protection)
- Help reduce anxiety and concerns to health effect of radiation exposure
- Help improve their quality of life
- Share the information of radiation exposure and safety
- Inform on possible radiation effects, in advance
- Promote radiation culture
- Address health issues in general (to enable residents to make well balanced health-related decisions)
- Facilitate community participation in the face of a health crisis

Table 2. Basic concept and needs in mobile phone

Items	Details	Comments
Population level	~1,000, ~10,000, ~100,000	To modify App's contents (short questionnaires) on population level.
Age	Children/students, Adults/Mother, Elderly	To modify App's contents (short questionnaires) on ages.
Period (When feasible)	Preparedness, After a nuclear accident	It is desirable to enter participant's basic information, in advance.
Feedback	Health, Diet, Quality of life, Mental health	It is difficult to reply comments of mental health because citizens can't take countermeasures.
Data security	Personal information	Who connects and handles this questionnaire data?
Understanding needs	Citizen Advisory Board members in Fukushima	These needs can be reflected our questionnaire.

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RESULTS

Table 1. Residents' support activities after the Fukushima Daiichi nuclear power plant accident

No.	Project name	Subject and periods	Support tool	Radiation	Quality of life	Diet	Health in general	Maternal and child health	Thyroid examination
1	Fukushima Health Management Survey (FHMS)	Residents/evacuees From: June, 2011	Questionnaires	●	●		Physical and mental	●	●
2	Fukushima keeping health and mind project	Residents (mainly from Iitate village) From: February, 2016	App		●	●	●		
3	The Fukushima Ambassadors Program	Foreign students in Fukushima University From: 2014	Hands-on learning	●	●		Physical and mental		
4	The Fukushima Future Center for Regional Revitalization (FURE)	Evacuees (Fukushima evacuation area) and Fukushima University From: April, 2011	Discussion/action	●		●		●	
5	ICRP Dialogue initiative	Fukushima evacuees/ local residents From: December, 2011/2016	Dialogue including radiation measurement	●	●	●		●	
6	Fukushima Dialogue (continuing the dialogue in cooperation with ICRP)	Residents/evacuees/ local residents From: 2016/today	Dialogue including radiation measurement	●	●				
7	Nagatoro University/Kawamata Village Revitalization Promotion	Evacuees (Fukushima evacuation area) From: April, 2013	Radiation detector	●	●	●	●		
8	D-Shelle Project	High-school students June-July, 2014 in Japan November, 2014 in Europe	D-Shelle+ Personal behaviors	●					
9	Citizen-led RAMECART project in a Fukushima Geographical Information	Residents in the world including museum in Fukushima From: April, 2011	Radiation detector+ Google map	●	●				
10	Fukushima Wheel Project	Citizens From: 2013	RAMECART device Bike with radiation detector	●					
11	Fukushima Contamination and Citizen Science after Fukushima (Japanese)	Citizens From: 2016	RAMECART device for citizen science	●					
12	Fukushima center for Disaster mental health	Residents/evacuees From: 2013	-					●	
13	Program of International Medical Corps	Residents in the Great East Japan Earthquake From: 2011	Support to local NGO		●				
14	Association for Aid and Relief JAPAN (AAR)	Residents in the Great East Japan Earthquake April 2011- December 2014	Radiation detection were presented to Korea City	●	●	●			
15	Japan International Volunteer Center (JVC)	Residents in the Great East Japan Earthquake From: May, 2011	Supporting the Operation of Temporary Housing Bakers		●				
16	Fukushima Branch Committee Citizens' Initiative	Fukushima Branch Committee (NPO) From: 2013	Booklet						
17	Remediation of Fukushima	Evacuees (Fukushima evacuation area) From: October, 2011	Radiation detector for remediation	●	●		●		
18	Kinkoo-Disaster Relief Center Fukushima radiation measurement information site	Residents From: 2013	Radiation detector+ Measurement data with real time	●					
19	Fukushima 30 year project	Education for residents From: August, 2012	Radiation detector for local and WBC	●		●			
20	Life Agriculture Fukushima	Food measurement From: 2011	Radiation detector for local	●		●			
21	Mothers' Radiation Lab Fukushima	Residents From: 2011	Radiation detector for local and WBC	●		●		●	
22	Health Literacy Promotion Toolkit	Health professionals From: 2016	Booklet	Participating communication (including close communication index)					
23	Hints of Life in Hamakaze	Fukushima evacuees and other local professionals From: 2017	Booklet of tips of how to discuss about radiation	●	●	●	Physical and mental	●	X (Explicitly on)
24	Volunteered Geographical Information (VGI)	Volunteer citizens	Radiation detector Google map	VGI is sourced from social media platform, such as Twitter, Facebook, and Instagram to study a variety of subjects including natural hazards, demographics, and health.					
25	UK National Atmospheric Release Advisory Center (NARAC)	Scientific data to 2011	Simulation, Dose map	●					
26	Database for Radioactive Substance Monitoring Data	Scientific data From: 2011	Measurement data, Dose map	●					
27	Fukushima Prefectural Center for Environmental Creation in Miharu town	Scientific data & Communication and Educational Activities From: 2017	Measurement data	●					
28	Fukushima Global Communication Program	Public seminars April 2013-March 2018	Preparation for lessons learned						
29	The Citizen Dosimeter project	Citizens From: January, 2013	Environmental data	To investigate the relationship between technologies and practices of environmental sensing and citizen engagement					
30	Yamakiya Gakko	Local residents and outside expert From: 2012	Measurement, Dialogue	●					
31	Miho Project	Local residents and outside expert From: 2011	Measurement, Dialogue	●					
32	Team Kodamaru	Local residents From: August, 2011	Measurement, Dialogue	●					
33	Mori kaigi	Local residents From: 2013	Dialogue		●				

An Economic Analysis of citizens' engagement in ionizing radiation measurements

Sonia Brescianini, Paola Fattibene
Istituto Superiore di Sanità, Viale Regina Elena 299, Roma, I-00161, Italy

E-mail: sonia.brescianini@iss.it

PURPOSE

In the framework of the Shamisen-Sings project, an economic cost-benefit evaluation of the citizen engagement in the preparedness of an accident is being performed. This paper describes the model chosen for such an evaluation and the parameters identified for the costs.

METHODS

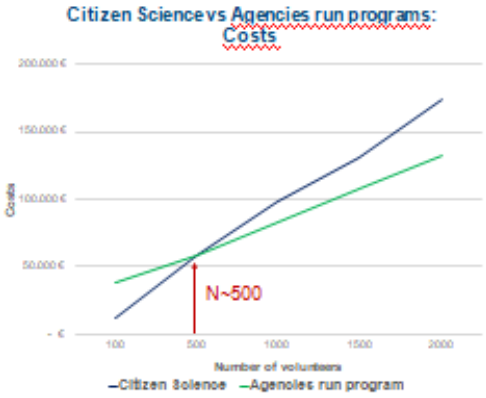
Main hypotheses:

1. The "case study" used figures form the Italian Piedmont region (29 radiation air monitoring stations).
2. The costs for the Agencies run program include:
   - monitoring stations
   - network implementation
   - personnel
3. The costs for the radiation measurements from Citizen Science (CS) include:
   - staff allocated to the CS project (researchers, administration, support)
   - advertising and recruitment (e.g. newsletters)
   - training (typically short for this kind of apps)
   - supplies and equipment (apps for radiation measurements are affordable – ca.5 euros)
   - data collection and validation (researcher).
4. Time frame is 1 year.
5. No benefit is considered at this point.

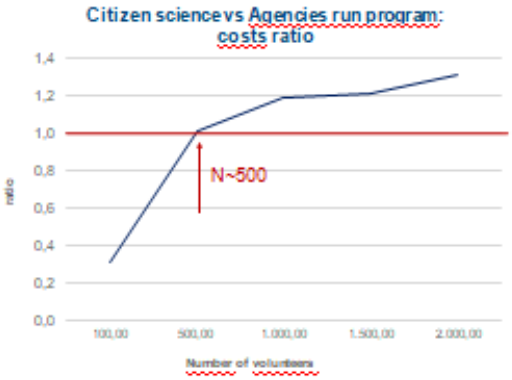
Map of Geiger station network in Piedmont Region.

RESULTS

A. The graph below shows the increase in costs as number of volunteer increases for CS and Agencies run programs



B. Below the ratio of the costs of the two strategies is shown. After a certain number of volunteers CS is not advantageous anymore.



CONCLUSIONS of the "case study"

1. To collect the same kind of information, citizen science is less costly up to 500 volunteers.
2. At the same cost (500 volunteers), the spatial distribution of detectors is more widespread but measurement uncertainties are higher in CS than in agencies run programs.
3. As for benefits, specific surveys have to be conducted in order to monetize them.

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Benefits of citizen participation in science in accident recovery programs (nuclear accidents)

Liudmila Liutsko[1-3] and Elisabeth Cardis[1-3]
[1]Barcelona Institute for Global Health (ISGlobal), Barcelona, Spain
[2]CIBERESP, Madrid, Spain
[3]UPF, Barcelona, Spain
* Correspondence to Liudmila.Liutsko@ISGlobal.org

Background

Citizen-science is scientific research conducted, in whole or in part, by amateur (or nonprofessional) scientists. Citizen science is sometimes described as "public participation in scientific research" (Wikipedia). Participants are volunteers involved in research for their own (education) or for the benefit of the research. The involvement of citizen in science has been successful in environmental monitoring, and is growing in epidemiology. The aim of the SHAMISEN SINGS project is to explore more benefits and practical uses for and of such volunteers in post-accidental period after nuclear disasters (web: http://radiation.isglobal.org/index.php/en/shamisen-sings-home).

Method

A review of peer-reviewed publications was performed on the topic citizen-science both in general and specifically related to radiation, nuclear disasters and dosimetry. It was complemented by the work conducted in reviewing lessons learnt from practical experiences on post-accidental recovery programs after the Chernobyl and Fukushima nuclear accidents (SHAMISEN project – Nuclear Emergency Situations: Improvement of dosimetry, Medical and Health Surveillance).

Project description and preliminary results

The results of the literature review show that only a small proportion (0.02%) of papers related to citizen-science are related to ionizing radiation: 18 publications were detected by a PubMed search with key words "citizen-science" or "citizen science" and "radiation", 5 with "nuclear disasters" and 2 with "dosimetry". After reviewing the abstracts only two relevant publication was found (Brown et al. 2016)[1] which showed the *Safecast* tool and monitoring programme was successful in using citizen-science for radiation measurement and communication after Fukushima" and Adachi et al 2015[2] which brought together 216 high-school students from Japan, France, Poland and Belarus who wore electronic personal dosimeters and kept a journal of their whereabouts and activities, resulting in a scientific publication by the students demonstrating that the personal external individual doses in locations where residence is currently allowed in Fukushima Prefecture and in Belarus are well within the range of estimated annual doses due to the terrestrial background radiation level of other regions/countries.

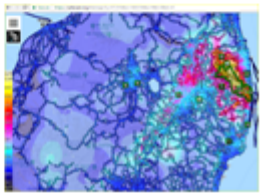

Figure 1. Mapping with SAFECAST. *Source: http://safecast.org/tilemap/*

The lessons learnt from SHAMISEN[3] also highlight the importance of public involvement in the practical post-accidental recovery that make them more sufficient in their daily life to prevent their health and improve well-being.

Figure 2. The structure of the SHAMISEN SINGS project.

BENEFITS of citizen science participation (after nuclear disasters):

- Education/training on radiation, dose measurements & Radiation Protection (RP) and RP culture;
- Awareness and control of the dosimetric situation and how it changes allows adjusting personal / family behaviour to optimize radiation protection, safety and health and well-being;
- Reduction of stress and anxiety of affected populations about accident consequences and increased trust in official dose and radiation protection information.
- Pooling together citizen measurements provides an important, real-time source of information for the public and stakeholders about spatial distribution of doses promoting effective decision making processes.

In collaboration with relevant stakeholders (including the general population), SHAMISEN-SINGS aims to develop accessible and reliable dosimetric and health monitoring tools, to answer their needs, avoiding unnecessary anxiety and improving response and dose and health monitoring after an accident.

Conclusions:

Citizen- science is a very useful approach in post-accidental recovery and can be used successfully with wider applications. Involving local populations/stakeholders in gathering data about doses, provides them a perspective on their own dosimetric situation, reducing excessive anxiety and helping them to gain control over their daily lives in contaminated areas. It also provides important information to support dosimetric monitoring of affected territories, assisting in local decision-making processes and in information and training of the populations.

Funding information:

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[1]Brown A, Franken P, Bonner S, Dolezal N, Moross J. Safecast: successful citizen-science for radiation measurement and communication after Fukushima. Journal of Radiological Protection. 2016 Jun 6;36(2):S82.
[2]Adachi et al. Measurement and comparison of individual external doses of high-school students living in Japan, France, Poland and Belarus-the 'D-shuttle' Project. JRP. 2016 36(1):49-66
[3]SHAMISEN Project web: http://radiation.isglobal.org/index.php/ni/shamisen-project

Enhancing Citizen Participation in preparedness and recovery in radiation accidents: review of existing APPs for citizen based dose measurements

Paola Fattibene[1], Jean Francois Bottollier-Depois[2], Sara Della Monaca[1], Liudmila Liutsko[3-5], Francois Trompier[2], Joan Francesc Barquinero[6], Leonardo Barrios[6], Cecile Challeton-de Vathaire[2], Vadim Chumak[7], Cinzia De Angelis[1], Didier Franck[2], Cristina Nuccetelli[1], Takashi Ohba[8], Koichi Tanigawa[8], Elisabeth Cardis[3-5]

[1]ISS, Rome, Italia; [2]IRSN, Fontenay-aux-Roses, France; [3]ISGlobal, Barcelona, Spain; [4]CIBERESP, Madrid, Spain; [5]UPF, Barcelona, Spain; [6]UAB, Barcelona, Spain; [7]NRCRM, Kyiv, Ukraine; [8]FMU, Fukushima, Japan.

1. Background

Experiences after Fukushima accident did show that self-made radiation measurements create opportunities for:

- providing information to individuals
- empowering individuals to take an active role in their own decisions, thus regaining control on their lives
- increasing insight of individual exposure and official limits
- compare and integrate official data from off-site monitoring

On the contrary, Chernobyl experience demonstrated a deficiency of public involvement in data collection and dissemination, due to lack of training, education, methodological unity, etc. and evidenced the need for development of tools suitable to this scope.

Use of these technologies should be encouraged, but minimum quality standards should be fostered and misuse be avoided.

2. Project description and goals

The EU project SHAMISEN SINGS, funded under the CONCERT call 2017 and started on October 2017, aims at enhancing Citizen Participation in preparedness to, and recovery from, radiation accidents using novel tools and mobile apps for data collection of radiation measurements, health and well-being indicators.

Work Package 2 is focused on the usage of plug-in devices and apps for self-made radiation measurements. Here we report a list of gaps which deserve further studies that we identified from an analysis of the scientific literature and online information.

3. Types of citizen based radiation measurements

The types of citizen based tools can be classified in five groups

1. Mobile apps able to convert to dose the signal coming from the *CMOS sensor* (used in the phone cameras) which is then used as *Ionizing radiation detector*

2. Mobile apps calculating exposure based on data from network of environmental radiation measurements

Credits: IRSN

3. Solid state or gaseous detectors that can be connected to the smartphone (via cable, BT or WI-FI) with display, storage and sharing of data through a dedicated mobile apps.

4. Autonomous solid state or gaseous detectors. Most detectors of type 3 and 4 for public are Geiger Müller tube and photodiode.

Source: https://mightyohm.com/blog/2014/11/a-spotters-guide-to-the-sbm-20-geiger-counter-tube/

5. Website for sharing measured data: https://www.openradiation.org

4. Main results from the literature

- Information and communication technologies and uses have evolved rapidly since Fukushima (7 years ago). In parallel the number of mobiles is increasing and it is estimated that 70% of the world's population will use smartphones by 2020.
- Devices and mobile apps were tested mainly by producers and in fewer cases by independent researchers.
- The tests were carried out in laboratory radiation fields (^{60}Co or ^{137}Cs) and mainly measured the response to dose and dose rate.
- Many mobile apps and devices studied are no more available.
- Mobile apps and detectors offer various possibilities: geolocalization, data storage, data sharing, continuous monitoring.

5. Gaps which deserve further studies

- Tests in environmental radiation fields are missing.
- Response at low dose rate should be evaluated, because 95-99% of measurements performed by publicfall in that range.
- Questions should address how cosmic radiation affects the response or how to evaluate the detector inherent background.
- Detector parameters other than its response to dose and dose rate should be evaluated, e.g. response stability through days, in different environmental and detector temperatures, the effect of using an incorrect calibration.
- How far improving characterization and calibration procedure would improve the measurement quality and reliability?
- Parameters such as reliability and quality of ergonomy, scientific content, connectivity, geolocalization, data sharing were ignored in most of previous studies.
- In particular, accuracy of geolocalization (if any) and quality of connection to internet or to mobile phone also play a relevant role in the good usage of these devices.
- The fast turn-over of technologies of detectors and mobile apps calls for a continuous going-on study of the tools on the market.
- Other questions related more to social aspects that should be addressed are: How will these data be used by institution, media, public in case of nuclear emergency? How will data be or can be trusted? Can it help in the management of a nuclear emergency? How can these tools be useful to educate public on radiation, radiation effect and risk? Finally, legal aspects should be explored (cf. responsibility for wrong or inaccurate geolocalization or dose rate measurements).

Funding information, references and web sites

SHAMISEN SINGS is funded by CONCERT (Agreement Nº 005/2017), EU Joint programme for the Integration of Radiation Protection Research.

SHAMISEN SINGS web: http://radiation.isglobal.org/index.php/en/shamisen-sings-home
SHAMISEN Project web: http://radiation.isglobal.org/index.php/ni/shamisen-project.ll