Ref. Ares(2019)6806809 - 04/11/2019

This project has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 662287.

EJP-CONCERT

European Joint Programme for the Integration of Radiation Protection Research

H2020 – 662287

D9.29 Guidelines on tools for communication of uncertainties

Lead authors: T. Perko, SCK•CEN, and L. Benighaus, DIALOGIC

Contributors: Tafili V. (EEAE); Oughton D. and Tomkiv Y. (NMBU); Sala R., Germán S., López S., and Oltra C. (CIEMAT); Duranova T. (VUJE); Raskob W. and Müller T. (KIT); Nishizawa M. (Litera Japan), Wolf H.V., Thijssen P. (University Antwerp), Camps J., Turcanu C. (SCK•CEN); Benighaus C., Moschner J., Renn O. (DIALOGIC).

Reviewer: Turcanu C. (SCK•CEN, WP5 leader) and CONCERT coordination team

Work package / Task	**WP9**	**T9.1**	**ST 9.1.5**
Deliverable nature:	**Report**		
Dissemination level	**Public**		
Contractual delivery	**M34 (CONCERT M53)**		
Actual delivery date:	**M34 (CONCERT M53)**		
Version:	**1**		
Total number of pages:	**136**		
Keywords:	**Uncertainties, communication, communication tools, nuclear or radiological emergency, risk communication**		
Approved by the coordinator:	**M54**		
Submitted to EC by the	**M54**		

Disclaimer:

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Acknowledgement: This work was carried out as part of the task 5.2 IV of the CONFIDENCE project. CONFIDENCE is part of CONCERT. This project has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 662287.

Executive Summary

This Deliverable presents a summary of the work carried out in the CONFIDENCE project on various aspects of communicating about uncertainty. The report is structured into seven chapters, together with a series of Annexes providing additional background information on the methods and approaches used by the various partners.

Chapter 1: Guidelines for communication about uncertainty

Communicating about uncertainty requires identifying the facts relevant to recipients' decisions, characterizing the relevant uncertainties, assessing their magnitude, drafting possible messages, and evaluating the success of those messages (Fischoff & Davis, 2014, p. 13671).

Uncertainty communication needs to be strategic (in that it follows the objectives of emergency management and planning), theory based (e.g., behavior, information processing, social science, risk communication, etc.) and evidence-based (i.e., using empirical data, surveys, experiments etc.). It should not be based on gut feelings and subjective opinions on "what may work" or what experts "would like to tell". Uncertainty communicators also need to consider public perceptions, motivations, expectations and concerns, which are likely to differ from experts. In addition, authorities and scientists (both natural and social) need to link up to communicate uncertainty to the people.

In order to achieve this, extensive research has been conducted on different tools (App, SMS, maps, numerical, narrative or mixed messages and video) for uncertainty communication to be applied in potential nuclear or radiological emergencies. Details of this research is presented in the following chapters, while this first chapter uses results to formulate guidelines for efficient and effective communication about uncertainties that can be used in nuclear or radiological emergencies.

Chapter 2: Theoretical background: Tools and approaches for improved communication of uncertainty in emergency situations

This chapter provides a systematic overview of international literature and an online search of communication tools that have been conducted in the first phase of the CONFIDENCE project.

Results show that methods and tools suggested for nuclear and radiological emergencies differ significantly in what procedures and communication tools are seen as appropriate and recommendable. There are many suggestions of how to address uncertainties during a crisis communication. The chapter summarizes these suggestions, documents the evidence provided with each suggestion and draws some lessons for improving communication before and in crisis situations.

The tools vary significantly, ranging from sophisticated online and app solutions to approaches of behavioural change through role models, internal and external improvement of organizational structures and decision making directed predominantly to experts and authorities. Promising areas for communicating uncertainty in emergency situation are the IT and Apps for emergency and Multi-Tools for broader usage of various target groups. These include a wide scope of uncertainties, such as social and ethical uncertainties, on the one hand, and scientific (technical and model or conceptual) uncertainties, on the other hand.

Chapter 3: Applied communication tools for nuclear emergencies and uncertainty communication: an overview of tools in Japan

This chapter aims to investigate developments in the use of electronic safety information for nuclear and radiological emergency in a global context. It firstly addresses psychological gaps between laypersons and experts in building perception and making risk decisions, followed by a section that gives an overview of public communication failure during the radiological emergency in Fukushima in 2011. Further, the chapter demonstrates the need to develop more effective communication tools for uncertainty management and assesses the current state of such tools in use. Finally, it discusses challenges for providing digital information nowadays and in the future.

APPs as a tool for emergency communication

This section reports on the current development of newly devised tools for safety information prepared for nuclear and radiological emergencies such as APPs.

Identified advantages of APPs include:

- Visual (more comprehensive for laypersons)
- Swift (time lags are minimised), and
- Tailored (to individual preferences and requirements).

On the other hand, issues needing further attention include:

- False alerts
- Costs (more costly than developing web-based information)
- Labour intensive (frequently updates necessary for APP)
- Tedious (people do not download APP as they find it too time consuming)

The chapter concludes that uncertainty communication has been and remains a challenge in the area of nuclear and radiological emergencies. It suggests that development of new electronic-based information tools may reduce the degree of uncertainty in providing trustworthy safety information to local residents and enhance risk preparedness and management in nuclear ad radiological emergencies at different phases.

Chapter 4: Communicating uncertainties regarding radiological risks via news media: the effectiveness of numerical and narrative messages

This chapter reports on the effect of the framing of different communication messages on a receiver of the message. Food risk and the safety of foodstuffs in the aftermath of a nuclear or radiological emergency, as well as proper uptake of iodine pills in case of a radioactive release, are highly sensitive issues to communicate. This chapter tests whether detached numerical messages, emotionally-involving narrative messages, or messages combining both elements are more effective in persuading the public to follow the advice from authorities. We employed a survey-embedded experiment on a sample of the general Belgian population (N=1085), during which respondents were presented with a mock news article presenting either a (1) numerical, (2) narrative, or (3) a combined message (numerical and narrative elements) and tested their subsequent evaluation of the article.

The results of our study show that these types of messages have different effects in different contexts. For the food related messages (recovery communication), the numerical messages appear to be more effective than narrative or combined messages in terms of eliciting higher credibility and acceptance in the field of food safety communication after radiological emergencies. For the iodine pills uptake related messages (preparedness communication), the only significant difference was between a control group (not exposed to any communication about iodine pills) and other groups (exposed to numerical, narrative or combined messages). The difference between numerical, narrative or combined stimulus for the iodine tablets messages was not statistically significant.

Chapter 5: Visualisation of uncertainties through maps

This chapter focuses on communication tools, how these can be developed and improved in the case of a nuclear emergency, and how uncertainty information can be included so that the stakeholders and affected population gain a better understanding of the crisis situation and be better equipped to take the appropriate actions. In order to gain new insights and gather evidence, CONFIDENCE partners organized six stakeholder workshops in Spain, Belgium, Slovak Republic, Slovenia, Greece and Norway, and tested selected communication tools at the NERIS 2019 workshop, ERPW2019 and the RICOMET 2018 conference. The key tools for discussion and reflection were visual aids and maps. These workshops included key stakeholders from the area of radiation protection, emergency management, communication and students.

In preparation for the workshops, the CONFIDENCE partners exploratorily analysed issues related to maps from real emergencies and exercises. Studies identified the following issues: maps lacking contextual information (e.g. on-going release or predicted release; missing legend); a huge diversity of measurement units used (µSv/h, mR/h); use of a diversity of colors and largely unrelated to the meaning of the color (e.g. blue for the extremely low release, below legal norms); zones for protective actions indicated using country borders; scientific uncertainties not presented (e. g. related to time of release, meteorological conditions), low doses presented in many different ways (e.g. white color, blue color, units), no indication of health impact.

Specific findings from the studies were used to develop concrete suggestions for effective communication through maps. For example that cities and towns as well as roads should be visible; use of more contrast colours; increased transparency of layers from calculations; indication of priority zones, add information on special Civil Protection objects such as hospitals, population density; include information on the source and meaning of uncertainty in the legend; make the borders of countries more visible; ensure that the title of the map is informative and that scale information is included.

Chapter 6: Improving SMS for early warning systems

Supplementary to testing maps in emergency situations, the work presented in this chapter focussed on short messages that could be sent via mobile phones, but also WhatsApp and messenger services. Confidence partners conducted tests of SMS via workshops with lay people and students, as well as with experts and stakeholders, in Spain, Greece, Sweden and the CONFIDENCE training course. In addition to this approach, SMS were tested during the ERPW2019 with conference participants, and during a training course with young researchers.

In general, SMS messages are accepted and used in everyday life, and people would be likely accept them also as a means of warning via mobile phone. Comparing results from the various country reports, people's opinions varied significantly about what would be an ideal SMS message that could be used for emergencies and warning. Noting the different languages and cultures in Europe, a one-fit-all-solution with a unique character of a SMS seems not feasible.

As a general rule, however, a good SMS should be of medium length. A very short message reduces the message to a minimum, which could cause confusion and panic (or fright??), a long one could be open to misinterpretation and a limited uptake of the information by the receiver. In the early phase of an emergency, communicating unclear or uncertain information like the extent of damage and release of radioactivity is recognised, but needs frequent updates (like sending several messages) and additional communication means. SMS should be designed individually and tailored for each country and also each nuclear power plant.

Further in-depth studies specifically on the effect of SMS in a stressful situation like an emergency is advised, with a larger group of research participants. The findings from conferences and cases from Spain, Sweden, Greece and the CONFIDENCE training course highlight the need to continue testing information messages for nuclear emergency communication, maybe with experimental methods, in order to be better prepared for a future accident. Both the content of the messages and the preferred channels (SMS, WhatsAPP…) should be further investigated. The tests with SMS messaging also show that it is necessary to tailor messages to both experts and the general population, as it would be assumed that relevant differences would exist between them.

Chapter 7: Video to address risk perception factors in the waiting rooms for thyroid measurements

Previous experiences with nuclear or radiological emergencies show that waiting rooms are a bottleneck for emergency management. Uncertainties in waiting rooms can be partially addressed by communication. Communication tools for waiting rooms can be in different forms, from pre-prepared face-to-face answers on frequently used questions, to printed material (e.g., leaflets and posters), and audio and video material. The CONFIDENCE video developed relating to thyroid measurements aimed to address all psychometric risk characteristics in order to mediate in a trust building process between the affected people and experts. The video is open source and available on the internet.

CONTENT

1 Communication Guidelines

Communicating uncertainty requires that the facts relevant to recipients' decisions are identified, that the relevant uncertainties are characterized and their magnitude assessed, and that possible messages are drafted and their success evaluated (Fischhoff & Davis, 2014, p. 13671).

Uncertainty communication needs to be strategic, meaning that it should follow the objectives of emergency management and planning. It should be theory based with respect to, for example, behavior, information processing, social science, risk communication, and evidence-based in the sense that is should use empirical data, surveys, or experiments. It should not be based on gut feelings and subjective opinions on "what may work" or what experts "would like to tell". This means that uncertainty communicators need to consider public perceptions, motivations, expectations and concerns, all of which are likely to differ from those of the experts. In addition, authorities and scientists (from both natural and social sciences) need to collaborate in order to communicate uncertainty successfully.

Within CONFIDENCE, and as described in the following chapters, an extensive research programme has been conducted on a range of different tools, including APPs, SMS, maps, numerical, narrative or mixed messages and video linked to uncertainty communication following potential nuclear or radiological emergencies. Based on the results of these studies, we have formulated guidelines for efficient and effective communication about uncertainties.

1.1 General suggestions on communicating uncertainty

- Decision-making involves uncertainty. Uncertainty in nuclear or radiological emergency management should be admitted and communicated. The more uncertain the information, the more communication is needed.
- Be honest and open about what you do not know. Many words and expressions of common language can be used to express uncertainties. Instead of "uncertainty" the following words can be used: "likely, "probably", "not certain". Uncertainties related to safety and radiological risks (especially related to low doses) can be expressed in many different ways, including: "there is considerable trust in …", "many experts and scientists consider …", "it is widely held that …". The verbs that express uncertainty are: "may", "might", seem". Words that can describe the uncertain status of an emergency include: "preliminary findings", "based on current measurements", "based on current insights", "as a first assessment", "further measurements are needed".
- Uncertainties can be reported in verbal, numeric, graphical or digital form. It is possible and advisable in some circumstances to use all of them simultaneously.
- Information on the following types of uncertainties that present in nuclear or radiological management may be communicated: nature of uncertainties, magnitude of uncertainties, conflicting scientific evidence, scientific controversies, moral, societal, legal and other

contextual uncertainties, statistical uncertainties, scenario uncertainties, level of theoretical understanding, level of empirical information (e.g., the empirical data that are lacking), quality of data, quality of model structure, limitations of methods, choices with respect to indicators, points of departure, important assumptions and practical limitations (e.g., the availability of iodine pills).

- When describing risks, be aware of the framing effects of wording, for example the use of the word “lives lost” versus “lives saved”.
- When explaining protective measures use positive action steps, for example: “*drink only bottled water*” instead of “*don’t use tap water*”.
- The aim is to take emergency management decisions that are robust with respect to the underlying uncertainties.

1.2 How APPs can be used in communication about uncertainties

- Applying APPs for nuclear or radiological communication is nowadays not avoidable.
- Develop systems and APPs solely for the purpose of nuclear safety or integrate them into existing systems that are already used to inform and warn public about natural disasters like floods, fires and extreme weather conditions, after accidents in chemical factories, and attacks.
- Carefully select which APPs to apply since there is a broad selection of existing technical tools, but the overall quality and the functionality of the different APPs vary greatly.
- Given the great potential for a targeted use of various APPs for communicating uncertainty in the case of nuclear accidents, this topic should be further investigated.
- Be aware of following issues related to APPs: False alerts, Costs (more costly than developing web-based information), Labour demanding (frequently updates necessary for APP), Tedious (people do not download APP as they find it time consuming to do so)

1.3 How to communicate about uncertainties related to the consumption of food products

- Provide precise, but clear and unambiguous numerical data to support your communication in order to enhance a message’s credibility vis-à-vis the public. A few well-chosen numbers may represent the most adequate strategy in eliciting positive reactions.
- Target subgroups of the population to enhance overall persuasion levels. If an assessment of issue attitudes among a population is possible, we suggest to intensify communication to those consumers who are inclined to be critical towards the given issue, whereas those with a more positive stance might need less frequent messages in order to be persuaded. Consumers with a critical attitude towards the food industry and nuclear energy, for instance, may need to be provided with more and different types of evidence in order to change behaviors (such as the boycott of a safe-to-consume product). Furthermore, efforts towards enhancing the public’s

trust in authorities should be undertaken, as low levels of trust may inhibit consumers readiness to accept a communicated message.

- Provide numerical data if the threat related to the communicated message is distant rather than imminent. This includes risk communication that aims to prepare for nuclear emergencies. If a threat is imminent, such as an acute food risk, we suggest to broaden the scope of messages by also providing more emotionally-involving messages, such as personal testimonies.

1.4 How to communicate about uncertainties related to a time of the iodine pills uptake

- When recommending the intake of iodine pills, communicate clearly not only a foreseen time of the intake (e.g. "*wait for instructions on when to take the pill"*) but also why one needs to wait with the intake (e.g. "*20 to 40 percent less protection if iodine pills are taken too early"*).

- The question of why to wait with the intake can be communicated in numerical, narrative or a mixed way. For instance "*Iodine pills protect far less if taken too early, xy (name and expertise of a trusted source e.g. family doctor*)" or "*The impact of iodine pills is reduced by more than 40 percent if taken too early*".

- Make sure that messages are repeated many times on many different communication channels – the one message, many voices, rule.

1.5 Visualisation of uncertainties through maps

- In order to aid the decision-making on the various countermeasures, a range of additional information should be available on maps besides the radiological situation (e.g. cities, population size, roads, drinking water reservoirs, evacuation routes etc.). However, since it is also important to keep the maps simple, interactive interfaces where different layers with additional information could be turned on and off when needed should be available (used?).

- The design of the maps should be carefully thought through to make sure that it represents information in the most comprehensive way. The choice of color coding should take into account existing color codes that are already in use, the way different colors are perceived by people (e.g. red=danger); it should have enough contrast with the base map and be visible for people with disabilities.

- Maps should include informative legends with supplementary information on uncertainty among other things.

- It is extremely hard for people who are not used to maps and have not received any training to start using them in an emergency situation. Therefore, appropriate training and exercises for the use of maps are needed for the various stakeholders that will need to be involved in the decision-making.

- Where possible, uncertainty should be indicated on the maps and there are several solutions to how these could be presented, for example by varying brightness of colors, level of transparency and color saturation, using glyphs and error bars. However, this representation will have to be situation-specific, since studies in Chapter X suggested that even the expert participants were unable to articulate what their preferred uncertainty visualization methods were because they were convinced that this strongly depends on the task.

- As part of further research work, a set of four topics targeting format, design data and uncertainty could serve as an analytical tool, to further investigate reasons for potential misinterpretations and misleading information.

1.6 How to formulate short text messages for emergency warnings

- To inform or to warn local residents and general population by using SMS (short text messages) is a rather new and effective communication practice among early notification systems. People nowadays use mobile telephones and smart phones constantly, thus this type of system could effectively warn people about the ongoing emergency.
- The SMS should be strategically predesigned and methodologically tested before the application. Specific attention should be paid to the information needs of residents and their understanding of the message.
- Content of the SMS should warn people, (e.g. “Warning!”), clearly indicate what happened (e.g. “Accident at ABC Nuclear power plan”) and where (e.g. “in place, country”). Uncertainty should be expressed (e. g. “Release of radioactivity not yet confirmed”) and the message should tell people what to do (e.g. “Stay inside, close windows and shut down ventilation system”). People should be informed about where they can get more information (e.g. “Listen to local news, check updates at hyperlink”). The name of the organization behind the SMS should be included in the message, e.g. “Federal crisis center”.
- Send the SMS in local language but also in English language.
- The optimal length of the SMS is approximately 200 characters, but the specificity of the local language should be taken into account.
- In the early phase of an emergency, there will be a need to communicate uncertain information like extent of damage and release of radioactivity. Therefore, frequent updates (like sending several messages) on the situation will be required and hyperlinks to additional communication means should be included.
- SMS should be designed for each country and each nuclear power plant (e.g. name of the NPP).

1.7 How to address uncertainty in waiting rooms

- The standard information that has to be communicated in waiting rooms (decontamination center, emergency rooms, measurement room etc.) includes the following: What is radiation and what is contamination; Health symptoms of radiation; Description of the decontamination process; Radionuclides e.g. ^{131}I , ^{137}Cs, ^{136}Cs, ^{60}Co for the different types of accidents; Explanation on how internal or external contamination is measured; Identification and the expertise of institution that is providing measurement service.

- The information material should be designed in a way that people in a stressful situation can process it: that they can understand, comprehend, and remember the information. Avoid complex terms (e.g. “Contamination is like being wet from a rain and irradiation is like sunbathing”); formulate positive statements (e.g. “Drink bottled water” instead of “Don’t drink tap water”); address psychometric risk characteristics (e.g.: familiarity “*Germanium detector measures potential radiation on the same way as thermometer measures a body temperature*”, dread characteristic, e.g. break down the process in different steps e.g. First you will do this, than you go there, followed by…”; effect on children e.g. use images of children at the communication material)
- Communication tools in waiting rooms should be in diverse formats: leaflets, posters, videos, and other multimedia. Face to face communication is the most efficient, but also the most resource-consuming.
- Create video material, which can inform people in a waiting room about how measurements will be done and what will be measured in the next room and by whom these measurements will be performed

2 Theoretical background: Tools and Approaches for Improved Communication of Uncertainty in Emergency Situations

This chapter was published as NERIS 2018 workshop proceedings (Benighaus, Benighaus, Perko, Moschner, & Renn, 2018)

2.1 Introduction

Addressing scientific and societal uncertainties in a nuclear emergency during pre-and-post radioactive release is not only an issue of decision-making, but also of public information and communication. Therefore, developing tools to deal with communication about uncertainties, either of technical or social nature, is crucial to improving protection, health and well-being of the affected population, and to enable informed decision making by the affected population as well as by experts.

There are many definitions of uncertainties in literature, however a common definition of uncertainty related to risk doesn't exist (Aven and Renn, 2009). In fact, the risk literature often defines risk concept with expression of uncertainty e.g. (Hoffman et al., 2011; Rosa, 2003) as well as, a probability distribution e.g. (Graham and Weiner, 1995; Paté-Cornell, 1996) and as an event, e.g. (Abbott et al., 2006; Verhaegen and Bergmans, 2015). If risk is defined by risk probability or as an event, the understanding, interpretation and judgement of risk may also lead to uncertainties, since is risk usually expressed in numerical form as odds or subjective probabilities, which is difficult for many people to process, especially in stressful situations, e.g. (Schwartz et al., 1997; Sohn et al., 2001). Due to this, systematic error in making judgements under uncertainty often appears. This systematic error has been investigated extensively, mainly by information processing scholars. For instance, Tversky and Kahneman (1974) classified heuristics in the decision-making process related to uncertainties in three categories depending on the situation when this systematic error can appear: 1.) representativeness, which is employed when people need to judge probability of instances or scenarios; 2.) availability of instances or scenarios, which is employed when people need to assess the frequency of the plausibility of a particular event; and 3.) adjustment from an anchor, which is usually employed from an anchor, which is employed in numerical prediction (Tversky and Kahneman, 1974).

Different interpretations of uncertainties are acknowledged also in the CONFIDENCE project. The uncertainty as defined in the CONFIDENCE project "can include stochastic uncertainties (i.e. physical randomness), epistemological uncertainties (lack of scientific knowledge), endpoint uncertainties (when the required endpoint is ill-defined), judgemental uncertainties (e.g. setting of parameter values in codes), computational uncertainties (i.e. inaccurate calculations), and modelling errors (i.e. however good the model is, it will not fit the real world perfectly). There are further uncertainties that relate to ambiguities (ill-defined meaning) and partially formed value judgements; and then there are social and ethical uncertainties (i.e. "how expert recommendations are formulated and implemented in society, and what their ethical implications are", French et al., 2018, c.f. French 2017). The following definition of uncertainty is used in the project:

"Uncertainty is a situation which involves imperfect and/or unknown information related to the investigated nuclear emergency case. Uncertainty is the lack of certainty, a state of having limited knowledge or information where it is impossible to exactly describe the existing state related to the emergency, a future outcome, or more than one possible outcome including consequences. Due to a lack of knowledge, lack of information or lack of trust in information the emergency stakeholders have difficulties to make informed decisions what to do or not to do, how to react and what actions (advised or not advised) will they take. In such situation stakeholders need to make decisions under uncertainty" (Perko and Abelshausen, 2017).

To include communication about uncertainties in public communication strategies is highly advised by different EU projects, as well as by risk communication researchers, for instance in PREPARE, EAGLE, ARGOS etc. since it helps people to make informed-decisions (Perko et al., 2015; Perko et al., 2017; Perko et al., 2016a; Perko et al., 2016b; Ropeik, 2011; Sandman, 1987; Shirabe et al., 2015). It is also advised to emergency actors to admit uncertainties in communication to public(s) (IAEA, 2012, 2014; OECD/NEA, 2015; Perko, 2016; Perko et al., 2016). However, systematic removal of uncertainty from public information is common in practice, especially related to emergency situation. Jensen et. al. (2017) found that though scientists often try to thread uncertainty into their discourse (e.g. a limitations section), it has been observed that this information is systematically removed as scientific discovery is prepared for public communication (Jensen, 2017).

The FP7 project EAGLE found out in discussions with experts that this systematic removal of uncertainty from public information related to ionising radiation is often done due to lack of methods and tools to communicate uncertainty information (http://eagle.sckcen.be/en/Deliverables).

This study was conducted to identify and analyse the methods and tools to improve the communication of uncertainty in crisis situations such as nuclear emergencies. Therefore, a systematic overview of international literature and an online search of communication tools have been conducted.

Results show that methods and tools suggested for nuclear emergencies differ significantly in what procedures and communication tools are seen as appropriate and recommendable. There are many suggestions of how to address uncertainties during a crisis communication. The chapter summarizes these suggestions, documents the evidence provided with each suggestion and draws some lessons for improving communication before and in crisis situations.

2.2 Method

The following steps were conducted:

(1) A systematic review of the literature on methods and tools for communicating uncertainty was performed to get an overview about the current state and focus of crisis communication;

(2) A categorization of tools and approaches for communicating about risk and uncertainties in relation to ionising radiation;

(3) An identification of relevant evaluation criteria for testing information and communication approaches;

(4) An evaluation of the identified tools on the basis of the evaluation criteria.

Review of literature and approached tools

The authors conducted a literature search in the Web of Science focusing on methods, online tools, reports of projects and communication campaigns of how uncertainty in the event of nuclear emergency has been communicated. The search produced around 80 sources which seemed relevant to analyze (step 1).

Categories

The sources have been compared for identifying elements and components that are common in all the listed tools and approaches. The grouping of the elements led to the identification of seven categories used to classify the approaches and tools (step 2):

(1) *Visualisation*, such as the traffic light model, uncertainty maps, or animations;

(2) *Specific design* of the message, for instance placing certain information in the front, while uncertain information at the end of the message;

(3) *IT and apps*, like disaster apps, individually tailored crisis information, partly connected with GPS;

(4) *Improved organization* by trainings of volunteers, inclusion of opinion leaders, fast distribution of crisis messages by various means (sirens, mobile phones, radio, TV etc.);

(5) *Role models* that put emphasis on recruiting ambassadors with high trust potential;

(6) *Decision making* to support communication managers to get to sound (and quick) decisions based on good judgements;

(7) *Multi-tools* that cover more than one of the above-named categories.

Evaluation of the tools and evaluation criteria

In a third step a review of the state-of-the-art literature on criteria for risk communication has been performed. Numerous studies in the last 30 years have suggested different criteria to evaluate and describe risk communication. The authors searched in the Web of Science by using keywords such as criteria, risk communication, risk governance, uncertainty in different combinations and selected around 40 peer-reviewed articles, book chapters or reports. These articles were checked if they included the criteria for communicating risk and uncertainty.

Table 1 presents the 11 criteria which have been chosen as the most relevant for the performed study from the initial list of 37 criteria. As part of the selection process the researchers decided to focus on those criteria that relate to methodological characteristics and highlight approaches such as “uncertainty analysis”, “quality of communication”, “resilience”, “social acceptance”, “ethical acceptability” or “trust“.

In the fourth and last step the categorized tools and approaches that have been identified in the review of the available literature were evaluated using the criteria reported in Table 1. At this point it is important to note that the criteria are not applicable or suitable for assessing all the tools equally, since these tools have been developed for different purposes and in response to different stakeholder needs.

Table 1: Evaluation criteria for uncertainty and radiation

Criterion	Explanation	Selected references
Uncertainty analysis	Addresses uncertainty as a knowledge gap and describes the level of robustness of the found data, models, distribution, and effects.	Refsgaard et al. 2007, Renn 2008, Kasperson 2014, Uuotalo 2015
Radiation	Covers radiation and protection especially in nuclear emergency situations as a topic	Perko 2016, 2916 a, 2016b
Effectiveness	With respect to (a) the exposure of detected information, (b) the expected degree in understanding the given information, (c) resulting behavioural changes of people that were confronted with certain information, and (d) induced social impacts in a wider field.	Rowe and Frewer 2000
Efficiency	As the highest effect resulting from a certain effort, which is using a certain tool in case of this study.	Leiss 2002, Aven and Renn 2010
Quality of communication	The form of exchanged information, degree of dialogic communication and opportunity of participation.	Lundgren 1994, Leiss 2002, Renn 2006, Renn 2008,
Resilience	As a characteristic that defines the tool as unsusceptible against external overloading.	Renn and Klinke 2015, IRGC 2005, 2017, Renn 2008
Social acceptance	Decision if a new technology/method is accepted or merely tolerated by a community (Taebi 2017).	Sjöberg 2004, Flynn and Bellaby 2007, Aven and Renn 2010, Taebi 2017
Ethical acceptability	In order not to discriminate any social group, including a fair and social equal treatment.	IRGC 2005,2017, Aven and Renn 2010, Perko, Raskob and Jourdain 2016
Politically and legally realizable	Feasibility as the possibility to implement tools in the real world, taking political and legal reservations into account.	IRGC 2005, 2017, Aven and Renn 2010
Quality of the message	Meaning to be understandable and clear to everyone in the target group.	Chess et al. 1989, Weinstein et al. 1992, Lundgren 1994, Renn 2006, Weinstein et al. 2006,Renn 2008
Trust	Judgement whether the institution/source matches the expectations of social actors and public (after Renn 2008).	Renn and Levine 1991, Renn 2008, Siegrist et al. 2000, Löftstedt 2003, Peters et al. 2007, Tateno and Yokoyama 2013

The fit of methods and tools was rated separately for each criterion on a scale from zero to three. Addressing uncertainty was rated on a scale ranging from zero (meaning that the connection is not clear), over one (meaning there is no link to uncertainty), over two (partly addressing uncertainty to three (stating the tool is clearly addressing uncertainty).

The extent to which the tools cover radiation was coded as zero (no clear connection); one (no link to radiation), two (partly connected to radiation but not specifically designed for radiation); three (clear coverage of radiation protection during nuclear accidents).

All other criteria were treated similarly, zero: (can't be clearly analysed), one (no explanation given), two (partly given) and three (strong connection to research criteria). All collected data was evaluated by using Excel software.

2.3 Results and discussion

The literature and online research resulted in a database of 80 communication tools, linked to scientific articles and studies. All tools were assigned to the seven categories (see figure 1) and rated according to the way they fit the evaluation criteria.

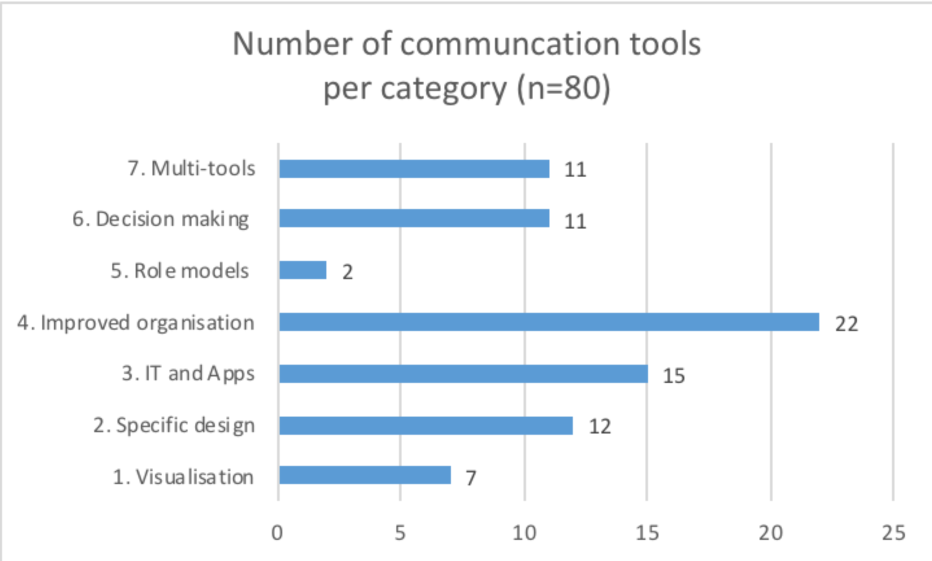

Figure 1: Number of communication tools per category (n=80)

The analysis of tools shows that the categories of improved organization and IT and Apps yielded the highest score for communicating uncertainty followed by specific design, multi-tools and decision making. The categories of tools and theis charracteristics with regard to communication of uncertainties are given in Table 2.

Table 2: Categories of tools and their characteristics to communicate uncertainties

Category	Characteristic of the category	Communication of uncertainties
1. Visualization	• usage of visualization tools, • suitable to synthesise and communicate complex information to people, but bears the risk of failing to engage users, • enables experts to communicate changes that might cause uncertainty of risks to citizens in a simple and understandable way, • no dialogic communication possible, • could assess risks wrongly and can confuse users.	Covers the criteria only partly (e.g. mapping), needs to be combined with other tools of communication, addresses stochastic, epistemological uncertainty

2. Specific Design	• risk/crisis communication collage, • written or numeric format communication as "Answer Fact Sheets", technical or numerical uncertainty • using message maps containing only key messages to educate and inform a specific audience, • question and answer sections.	Addresses technical or numerical uncertainty, but poor performance on criteria, especially social and ethical uncertainty, partly communicative aspects
3. IT/Apps	• IT and apps which are suitable for communicating with a broader population, • specially designed apps for risk communication, • warning apps (e.g. NL-Alert, NINA, KATWARN and FEMA), Wireless Emergency Alerts (WEAs) tweets • app for specific groups or organisations internally with information (e.g. CrisisGo).	Many criteria met, high for effectiveness, efficiency, partly trust, social acceptance, for communication suitable for broader population, but not for "hard-to-reach" target groups, ethical aspect is critical, addresses many uncertainties for example modelling, epistemological
4. Improved organization	• combined tools used by improved organization in different ways informing, engaging with the public using the other categories such as visualization, specific design of Apps	Huge effect due to coverage of many criteria, but less effective on communication quality, stochastic, epistemological, judgement uncertainty
5. Role models	• integrative Risk Governance Approach with the need of a new and wider form of risk definition and emergency communication throughout different social fields, including trust, capacity of understanding, transmitter-receiver-models, systemic risks or epistemological uncertainty, • public Outrage that describes a gap between the risk perception and experts and citizens	Only few are available, for instance Risk Governance Model or Public outrage performance on criteria effectiveness and efficiency, addresses ambiguities, social and ethical uncertainty
6. Decision-making	• Tools (e.g. RODOS or ERICA) for decision making, these are more useful for experts and public authorities and internal communication.	Not as stand-alone, more useful for experts and public authorities and internal communication, complicated to understand for non-experts, but tailored messages are feasible for public use during crises, value judgements
7. Multi-tools	• all instruments and approaches that combine various categories, • by providing sound emergency-response information, • e. g. guidelines	Combination of various categories, broader use and very practical, high diversity, however, possibility of confusion, many uncertainties covered for instance ambiguities, social and ethical uncertainty

2.3.1 Visualization

Most of the recognized visualization tools covered the criteria only partly. Although most tools assess uncertainty, they lack the connection to radiation risks. Additionally, tools are created to provide only partial information, which means that they need to be combined with other communication tools in order to get a full range of information responding to risk perception and behaviour. Visualisation of environmental changes thus seems suitable to synthesise and communicate complex information to people unfamiliar with the topic but bears the risk of failing to engage users (cf. Grainger et al. 2015, 315). To sum up, these tools are helpful to provide complex general information, but do not especially match the challenges present in emergency situations, as they can confuse users (social uncertainty).

2.3.2 Specific design

All collected tools with a "specific design" address uncertainty, but include only partly communication aspects. Most of the tools have a rather poor performance on the demanded criteria. As the main difference between the tools referred to the extent of possible interaction, tools are described in order from low participation/ unilateral communication to higher participatory options.

One major difficulty in creating a proper design is the wide variety of people being confronted to the message. The response on numeric and verbal terms differs widely, depending on the personal understanding of probability and time windows. Thus, information can be under- or overestimated, which results in inappropriate reactions (social uncertainty). The best way to design messages is to use only short forecasts, accompanied by detailed action plans (cf. Doyle et al. 2014, pp 97).

2.3.3 IT and Apps

IT and apps meet many criteria, as they rate high for effectiveness, efficiency, partly trust (depends on the topics and the source, API 2016), and social acceptance. They are suitable for communicating with a broader population, except "hard-to-reach" target groups for instance no-internet users, elder population, socially vulnerable groups (ethical aspects and uncertainty).

Although apps were supposed to be useful and credible, the problem may arise that participants feel too safe to use them (cf. Reuter et al. 2017, 7). Thus, crisis management via social media, although having a wide range and being easy and fast to distribute information, is not a simple tool when it comes to its effective use. There are risks of false information spreading, exclusion of specific groups and misunderstanding of the message (cf. Stern 2017, pp.11). Online communication additionally leads to less secondary crisis communication than conventional mediums (cf. Utz et al. 2002, 45): people in directly affected areas wish to inform others about risks but have low effectiveness as they miss a useful information-traceability system (cf. Acar and Muraki 2011, 399).

2.3.4 Improved Organisation

In total 5 out of 22 tools have been categorized under "improved organisation". These tools are rated highly effective according to coverage of "uncertainty" and "radiation" (especially social and ethical uncertainties). They include a broad approach to informing people, engaging with the public, and therefore educating and sensitizing citizens for risks in the case of nuclear emergencies (Matahri et al. 2017). Traditional tools such as annual reports, newsletters, websites, magazines, Press data centre, press conferences can be integrated in this approach. The tools in this category work best if various channels, including those in social media, such as YouTube, Twitter, Facebook are addressed simultaneously.

2.3.5 Role models

There are only two tools available for role models, but they showed a good performance on most criteria, especially on effectiveness and efficiency and illustrating conceptual or social uncertainty, but role models need a lot of effort to use in practice.

2.3.6 Decision-making

Looking at tools for decision making, these are more useful for experts and public authorities and internal communication than for the general public. They do not stand-alone and need in-depth background knowledge. Tailored messages are feasible for the public during crises situations.

2.3.7 Multi-tools

The category of multi-tools includes all instruments and approaches that combine various categories. As such, they normally have a broader use and are very practical, especially in accomplishing a high diversity of utilization possibilities.

2.4 Conclusions

The tools vary significantly, ranging from sophisticated online and app solutions to approaches of behavioural change through role models, internal and external improvement of organizational structures and decision making directed predominantly to experts and authorities.

Promising areas for communicating uncertainty in emergency situation are the IT and Apps for emergency and Multi-Tools for broader usage of various target groups. These include a wide scope of uncertainties, such as social and ethical uncertainties, on the one hand, and scientific (technical and model or conceptual) uncertainties, on the other hand.

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3 Applied communication tools for nuclear emergencies and uncertainty communication: an overwiev of tools in Japan

This chapter was written as a report for the CONFIDENCE milestone by Nishizawa M., Litera Japan

3.1 Introduction

Providing timely and trustworthy safety information to local residents is a primary importance during nuclear and radiological emergencies. Past experiences have shown that delayed distribution of safety and/or evacuation information have resulted in additional radiation exposure to local residents or led to overestimation of their health risks from the exposure. Consequently, it often led to the loss of trust in relevant parties such as operators, (nuclear) authority, central/local government, and technology itself. Enhanced communication tools for presenting information about radiological emergency is a therefore pre-requisite for gaining trust from the public.

Process of risk communication is comprised of collecting accurate data; providing the data; and explaining the meaning of the data (Fischhoff, 1995). Presenting mere scientific data thus not enough – they needed to be presented in a comprehensive way. Radiological information may be presented in the forms of verbal, numerical, graphical and digital information.

With the increased use of the Internet, a number of national and local governments in many parts of the world have attempted to develop better communication tools such as electronic information in the forms of smart phone applications (APPs) (CONFIDENCE, 2017) or designated websites.

Presenting digital information such as APP may be viable as a public communication tool as it can deliver individually-tailored safety information swiftly and tailored to individual users with differing requirements. Automatically monitored safety data may be sent to the user directly with or without alert. Electronic and visualised data in the form of coloured maps or photos is more comprehensive in providing target population with digital orientation than plain text messages.

This chapter aims to investigate the present development and the use of electronic safety information for radiological emergency in a global context. It firstly addresses psychological gaps between laypersons and experts in building perception and making risk decision, which will be followed by a section that gives an overview of public communication failure during the radiological emergency in Fukushima in 2011. Further, the report demonstrates the need to develop better communication tools for uncertainty management and assess the current state of such tools in use. It then discusses challenges for providing digital information for now and future.

3.2 Uncertainty communication

3.2.1 Rational of this chapter

Risk is often accompanied by uncertainty. Conveying uncertainly in risk communication is always a challenge to risk managers. Studies of risk communication in the past have shown that risk-related controversies in which even experts are divided on safety issues, or those that are closely bound with values, ethics, religious beliefs or world views, tend to be intense (Nishizawa and Renn, 2006). This makes forming a consensus more difficult. Worldwide disputes over genetically modified crops provide a symbolic example.

Several elements are attributed to the varying levels of uncertainty – such as risk perception derived from heuristics (psychological short-cuts); risk amplification mechanism; and divides between laypersons and experts in the ways to perceive the extent of risks (Renn, 2008).

Uncertainty communication about radiological risks is of particular challenge. Experiences in the past nuclear emergencies show that authorities have often failed to give the public accurate, reliable and timely safety information (The Investigation Committee on the Accident at the Fukushima Nuclear Power Stations of Tokyo Electric Power Company (the so-called Government-led Investigation Report, Final Report, 2012). The insufficient evacuation information or confused advice during the onset of the nuclear emergency in Fukushima had forced many to leave their residents without comprehensive safety information and some had left for the areas with even higher exposure levels. Confused or contested safety information had resulted in over-estimation of exposure risks amongst the local residents and many concerned families with children had temporarily left the areas or some had decided not return to Fukushima. The debate over low-dose radiation exposure from the reactors at Fukushima continues within and beyond Japan even eight years after the accident - risk perception remains high in contrast to experts' scientific risk assessment.

One lesson we have learned from this bitter experience is the need to develop more easily-accessible, reliable and comprehensive tools that can inform individuals of the health information and assist their decision during radiological emergency for their protective actions with digital orientation.

To date, TV and radio have been used as prime tools for transmitting safety information for affected communities. With the increased use of the Internet and Smart-phones, however, new tools have been developed. Smartphone APPs are one particular example. APPs for iPhone/Androids designed to send relevant alerts or warnings have been deployed in many countries in North America, Europe and Asia. They are useful as they send clear and visual information directly for individual person.

3.2.2 Risk perception, heuristics, risk amplification

Risk communication is a primary tool to address uncertainties, thereby conveying the meaning of scientific assessment and risk management, sharing safety-related information, and exchanging views and values amongst varying stakeholder groups. Its ultimate aim is to build trust through human interactions. However, the essence of effective risk communication is yet to be fully understood and consequently, gaps in perceptions about risks between experts and non-expert remain large.

Many cases are reported where experts estimate certain risks low, whereas laypersons are highly afraid of them and try to avoid them. Typical example are genetically modified foods, food additives and pesticides.

One of the reasons why such division arises derives from psychological observations that people understand/perceive risks by certain heuristics. An example is availability heuristic. Once we are heavily exposed to dreadful images many times, we are prone to believe that such event may happen to us too. It is widely known that the fatality rate increase by road accidents up to 3% and as many as 1,600 more people died on the road as people were afraid of flying in the aftermath of the 9.11 attacks in New York (BASF, 2017).

Risk is often amplified via conventional media or mouth-to-mouth in today's form SNS such as Facebook and Twitter. Social risk amplification therefore takes place as a result of eco-chamber effects in SNS communities. People tend to access information that confirms their belief (termed, confirmation bias).

Uncertainty communication for nuclear emergency poses a particular challenge. As radiation is not seen and tangible, people tend to calculate its risk high and fear radiation excessively (IAEA, 2004). It is often categorized into a risk of "creeping" danger (Renn, 2008). Moreover, radiation science is often not taught at school and despite the fact that people are exposed to natural radiation via sunlight, medical devices and foods, they associate radiation with more dreadful events such as nuclear bombs.

It is therefore necessary that communication tools for timely, easily understandable, yet scientifically accurate and adequate information provision during nuclear emergency are developed.

Before we assess the levels of such tools for development, we may present the public emergency communication in the case of the Fukushima Daiichi NPP nuclear accident and review what had gone wrong.

3.3 Case from emergency communication in Fukushima

It is widely agreed that the accident at the Fukushima Daiichi nuclear power plant occurred in 2011 was triggered by natural events combined with technical failures and was a human induced disaster as well (the Investigation Committee on the Accident at the Fukushima Nuclear Power Stations of Tokyo Electric Power Company, 2012; National Diet of Japan, 2012). From this unfortunate lesson, we learned that human and organizational factors associated with emergency planning, response and decision-making for nuclear safety need to be more carefully reviewed and enhanced. Elements of social sciences, especially risk management and risk communication, play key roles.

3.3.1 Long-term effect from radiation - high perception being built

The earthquake and associated tsunami and the accident at the Fukushima Daiichi nuclear power plant occurred in March 2011. It was the largest disaster in Japan's post-war period (since 1945). The accident forced a large number of local residents to take shelter outside Fukushima Prefecture. As of 2015, four years after the disaster, as many as 100,000 people have yet to return home. According to the Fukushima Prefectural Government, the number of deaths in the elderly due to associated physical and mental stress during the long-term evacuation has amounted to nearly 2,000. While a large number of people still wish to return home, they are reluctant to do so, primarily due to the fear of unnecessary exposure to radiation but also due to the lack of infrastructure such as supermarkets and hospitals that would allow them to live a normal life again.

The average level of radiation in Fukushima has steadily declined to less than one tenth of its peak, for example, levels in Fukushima City have decreased from 2.7 µ (micro) Sv/h in 2011 to 0.2 µSv/h in 2015. However, there is still concern about the adverse health effects of radiation in Fukushima. In some residential areas, the level of radiation remains higher than the average radioactivity of Japan. Some areas are above 4 mSv/year. For reference, the natural radiation exposure in Japan is 2.1 mSv/year, and worldwide average radiation level is 2.4 mSv/year. In particular, the child-rearing generation is concerned about the potential long-term health effects of radiation to children.

The government-led clean-up process for radioactive materials is initiated when radiation levels are more than 1 mSv/year above background radiation levels. Yet, many local residents have demanded their living areas to be remediated to the radiation level before the accident and express concerns about living in areas where the radiation exceeds more than 1 mSv/year which is a public exposure limit suggested by the IAEA.

The value of 1 mSv/year is a long-term "goal/target" to be achieved during the recovery phase through intensive clean-up activities announced by the Japanese government in 2011, yet, it was interpreted as the de-facto safety "standard" to be achieved.

This is not surprising. The failure of crisis communication at an early stage seems to have strongly influenced the perceptions of the public regarding safety. Not only the government but also academia in Japan failed to provide swift, consistent, and reliable scientific information to the society on the accident and associated risk as noted in a following section. It was reported that governmental evacuation advices were not clear enough and evacuation actions had got delayed.

The consequent loss of trust in the government and science has resulted in conflicting and contested opinions being expressed in the conventional as well as the social media and on social network services such as Twitter. Although international bodies, such as the World Health Organisation (WHO) and United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), concluded that the effects on the health of local residents of Fukushima from the radiation derived from the effected nuclear reactors is likely to be negligible, some researchers and citizen groups have raised concerns about the adverse health effects from low-dose, long-term exposure to radiation. They argue that additional radiation from the troubled reactors in the residential area above 1 mSv/year could cause serious health effects such as cancer and argue that exposure to elevated radiation for a long-period of time, even in low doses, can cause cancer and hereditary disease, especially amongst children.

Public anxiety for long-term health effect due to radiation had affected many residents evacuated from the affected areas of Fukushima and some are hesitant to return home despite the fact that radiation levels had decreased in the last eight years and that the areas have been officially declared to be safe to return and live again. Iitate Village is one of such areas.

3.3.2 Case from an affected village, Iitate Village, Fukushima

Iitate is a small village in northern part of Fukushima that used to be known for its organic farming and for raising cattle. However, after the accident, it became known domestically and internationally as a village badly affected by the nuclear fallout. The village is located 25 - 45 km from the Fukushima Daiichi nuclear power plant. Initially, it was outside the mandatory evacuation zone that was set after the explosions. Nevertheless, it was later discovered that the radiation level was higher than initially estimated due to nuclear fallout blown by the wind. Of the approximately 6,500 people who lived in the area before the accident, virtually all left the village as a precautionary measure when the evacuation zone was widened two month after the disaster. As of April 2013, the level varied from 4.5 µSv/h in a heavily contaminated area to 1.4 µSv/h in a less contaminated area. By January 2016, the value had decreased even more, to less than 1 µSv/h, at the majority of measured areas; according to the official data from Fukushima Prefecture.

The Iitate Village municipality asked the Risk Communication Advisory Group (RCAG) to plan and implement an emergency communication programme in September, 2011. The author was its primary architect as its only expert on risk communication. Its role was to help scientific experts explain the science of radiation and the health effects of radioactive materials to local residents who had been evacuated from areas contaminated by nuclear fallout from the Fukushima Daiichi nuclear power plant.

In order to deploy a pilot study, the author selected one particular residential complex (Y) in Fukushima City where approximately 250 had taken refuge. Nearly 40% of the refugees were children under the age of 12. Parents and grandparents were particularly concerned about the health effects of radiation on their children. In order to design such a programme, the author visited the sheltering site with a graduate student for initial group interviews in September 2011. Twenty residents, ranging in age from 25 to 80, were interviewed to assess their level of knowledge of radiation and to determine their needs. The interviews lasted one day.

The interviews revealed that the interviewees had received little information about radiation from the local government or from schools during the six months after the accident. When asked about their sources of information, they said it was primarily television or the internet. They expressed anger, disappointment and fear and said that they needed safety information that was trustworthy. The information they had received from the media was contradictory and largely frightening and, consequently, they could not fully trust it. Many felt abandoned, frustrated and scared and without any substantial safety information to protect their families (Nishizawa, 2018a).

The case of Iitate was complicated as the local residents felt abandoned and had persistent mistrust towards scientists and authority. As a result, one-way risk communication failed. Hence, interactive and a dialogue-based communication was used not only to deliver accurate information but also to create mutual understanding and build trust.

In the last eight years, hands-on communication programs have been reportedly conducted in Iitate Village by different groups of experts, yet, as of 2018, fewer households have returned to the village.

One may concludes that in the event of an emergency, it is essential to deliver information concisely and within a short period of time as initial information is crucial in perception building as to nuclear emergency. It is hard to overturn the risk perception once it has firmly been built (Nishizawa, 2018b).

3.3.3 Simulation, measurement and information provision during the emergency

What has caused the situation where a gap exists between expert risk assessment and public risk perception about radiation risks to human health?

One of the attributes is certainly the insufficient provision of radiation data to the public during the onset of the emergency. That is, adequate monitoring of radiation levels and the provision of such monitored data was not provided right after the explosions of the tsunami affected nuclear reactors.

Japan uses simulation system to predict the spread of nuclear fallouts in emergency called SPEEDI. SPPEDI is a system to “predict” based on ERSS (Emergency Response Support System) which determines the emergency situation based on computer-assisted calculation conducted at the designated offsite centre. During the Fukushima disaster, the offsite centre was in paralysis as it was designated to an evacuation zone and necessary monitoring of the radiological levels did not occur.

As illustrated later, Fukushima Prefectural Government was not able measure radiological levels as 23 out of their 24 monitoring stations were out of use as they were hit by strong earthquakes and tsunami on the 11 of March. After 13th of March, central government assisted the prefectural government by dispatching cars for necessary monitory of the air and soil yet monitoring had faced hardship due to bad road conditions the lack of gasoline in the aftermath of the earthquakes. The off-site centre itself was designated to evacuation zone on the 12 of March. The lack of actual measurement data, the data from SPPEEDI was seen not accurate and not used properly used/publicly disclosed in the Fukushima accident. Both the government-led investigation report and the Diet report on the disaster, however, suggest that SPEEDI could have been used even if the offsite centre was in paralysis and ERSS was not obtainable.

TE offsite centre was moved to the City of Fukushima and therefore it was not able to give monitoring information between 12 and 15 of March to the media (Interim Report, 2011). The lack of evidence-based data and its immediate disclosure during the first couple of days after the disaster had led the public skepticism about the extent of the disaster and contributed to the construction of distrust towards authority and high risk perception about radiological risks.

Instead, aerial measurement conducted by the Nuclear Incident Team from the US Department of Energy (DoE) was widely made public in Japan. US flew over Fukushima for two days and obtained detailed data（Figure 2 below). The media therefore relied on the data from the DoE for reporting the disaster and the map was probably the first comprehensive radiation map made available to the public of Japan.

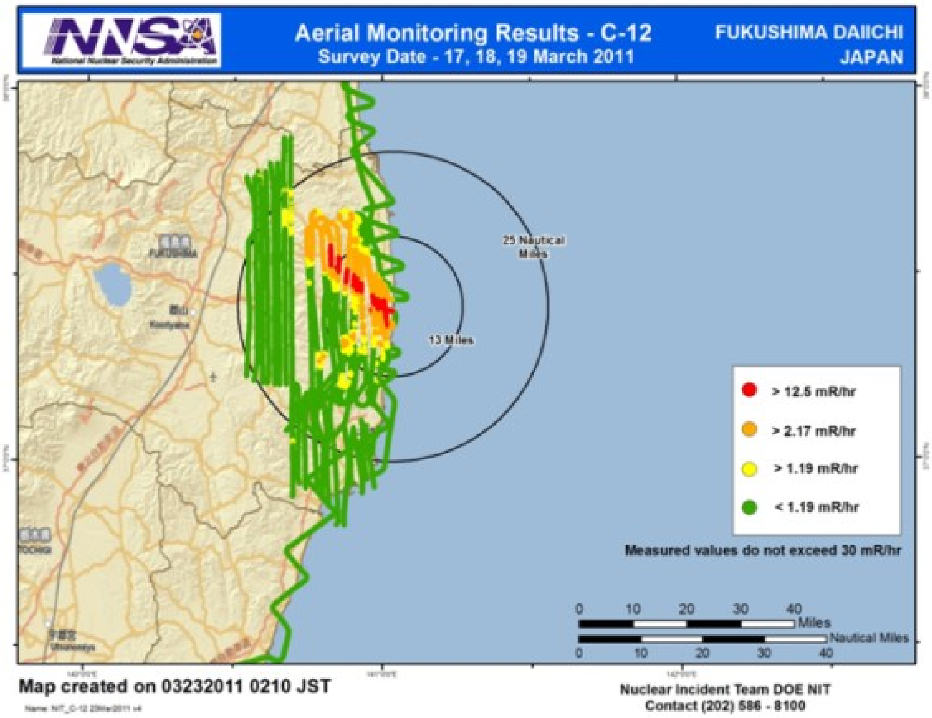

Figure 2 DoE assessment data

As noted, IAEA's dose limit for public exposure to radiation is 1 mSv/year (IAEA 2015) and Japan adopts their standard, too. In an emergency situation, however, the public exposure is accepted to range between 20 mSv/year to 100 mSv/year. In recovery period, Member States are advised to aim to reduce the public exposure based on ALARA principle, and eventually achieve the exposure level to 1 mSv/year.

In the Fukushima accident, critical voices demanded that the exposure level (like orange and yellow in the DoE map) needs to be lowered immediately, and claimed that any exposure value higher than 1 mSv/year was immediate high risk to local population. In short, they demanded all the affected residential areas (except for red coloured areas in the DoE map) needed to achieve low exposure level (green). This pressured the central government and let to commence "decontamination" or "removal of contaminants" in virtually all the affected areas despite IAEA standards. Notwithstanding, many families had left Fukushima and did not return in fear of future health effect. Many families have left apart.

Consequently, enormous public money has been used for this action, and Japanese policy has internationally been criticized for inadequate decision making. Primarily elderly households have partially returned (less than 20%?) despite the decontamination actions in the last eight years.

The Fukushima Daiichi nuclear accident shows that it is of prime importance to build more secure measurement monitoring infrastructure and to develop a direct and effective methodology for measurement information dissemination to the public.

This gives us further lessons that because mapping of exposure level is easily comprehendible by sending visual images, it can lead to misinterpretation. It can put pressure on policy makers for making inadequate policy-decisions that may immensely affect local population.

This section investigates the current state of the development of APPs for emergencies and post-emergency phase in Japan and beyond. To date, local government use conventional tools, such as TV and radio in order to inform affected locals in case of nuclear emergency. With the widespread use of the Internet, more electronic and personal devices such as the Internet (web), SNS (Twitter), email and Smartphone APPs are used.

3.4 APPs as tool for emergency communication

3.4.1 Emergency alerts in Europe, North America and Japan

As of the 8th of November 2018, the author has investigated by downloading eight different APPs available on her smartphone (Figure 3). Those APPs are:

- NINA (German official warning APP)
- KATWARN (German official warning APP)
- FEMA (US Federal warning APPS)
- Volusia County (Florida, US)
- City of Nagoya (City, Japan)
- Yahoo! Japan (Private, Japan) in conjunction with J-Alert
- Tottori Prefecture (Japan) – solely designed for nuclear emergencies
- Alertswiss-App (Swiss official warning APP) - Bundesamt für Bevölkerungsschutz BABS

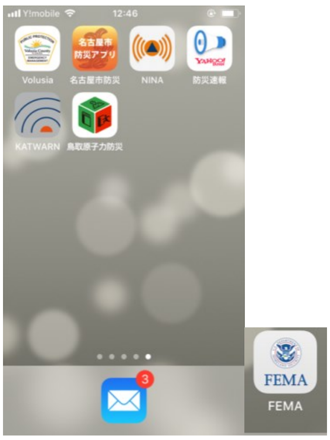

Figure 3 Apps on iPhone (From left: Volusia, City of Nagoya, NINA, Yahoo Japan, Katwarn, Tottori Prefecture and FEMA. Swissalert is omitted)

These APPs send alerts and warnings based on official (evacuation) information such as heavy rains, floods, hurricanes, terrorist attacks directly relevant to individual locations and some show nearest sheltering locations on Google Maps too. It should further be noted that KATWARN is unique in a sense that it can also send safety information tailored to subjects such as concert and Oktoberfest (they say they give detailed information such as emergency exists).

Amongst these, FEMA and Alertswiss explain emergency safety information (under "Emergency Safety Tips") related to nuclear power plants and nuclear explosion. Alertswiss explains (under "Gefahren") and suggests what actions needed to be taken when a particular disaster occurs. Other APPS probably send nuclear-related alerts too, yet, they do not clearly say so in their APPS. APP developed by Tottori Prefecture (No. 7) is an exception that it is designed solely for nuclear emergencies.

It should be noted that several more APPs are available in Europe and elsewhere:

- Disaster Alert (PDC Global) by Pacific Disaster Center: https://itunes.apple.com/de/app/disaster-alert-pdc-world-hazards/id381289235?mt=8

(from the website: "Disaster Alert is a free, mobile app that provides individuals, families, and their loved ones with the information they need to stay safe anywhere in the world. Built on PDC's DisasterAWARE® platform, Disaster Alert™ offers near real-time updates about 18 different types of active hazards as they are unfolding around the globe.")

- Disaster Management Apps: 9 Features That Save Lives: https://3sidedcube.com/disaster-management-apps-features-save-lives/
- French official alert system (SAIP): https://www.interieur.gouv.fr/Actualites/L-actu-du-Ministere/Fin-de-l-application-SAIP

3.4.2 Emergency alerts in nuclear emergency in Japan

Monitoring the level of radiological exposure and associated alerts for nuclear emergencies in Japan are responsibilities of individual local governments. The central government, operators and relevant public organisations are thereby support the tasks of the local governments.

In radiological emergency, local governments send safety information via TV and (special) radio to each household in affected areas. This means that local government's first need to measure exposure levels and then decide to send safety/evacuation information for local residents.

The unfortunate experience in Fukushima has led the central government to tighten safety standards for nuclear reactors and to enhance the monitoring and provision of radiation data in preparedness for any future accidents.

APPs for emergency information developed in Japan at the national level

The central government of Japan provides official emergency alerts called J-Alert. It is the best known system and sends emergency-related information, yet it does not include nuclear related emergency. Alerts and warnings from J-Alert is given to mobile phone carries and other private APPS such as one provided by Yahoo Japan. Yahoo APPS gives information as to earthquakes, tsunami, heavy rains, typhoon, tornados, landslides, flooding, heavy snow, volcano eruption, heat wave, special alerts/warning (severe alarming) and alerts based on Law for Protection of Citizens (means missiles from foreign countries). It does not seem that these APPS do not specifically say they send alerts related to nuclear emergency.

N-Alert is solely developed by Nuclear Safety Regulatory Agency (NSR) emergencies and sends safety information about 30 nuclear sites across Japan (Figure 4). There is no direct APPI of N-Alert itself, yet it sends alerts by emails for its subscribers.

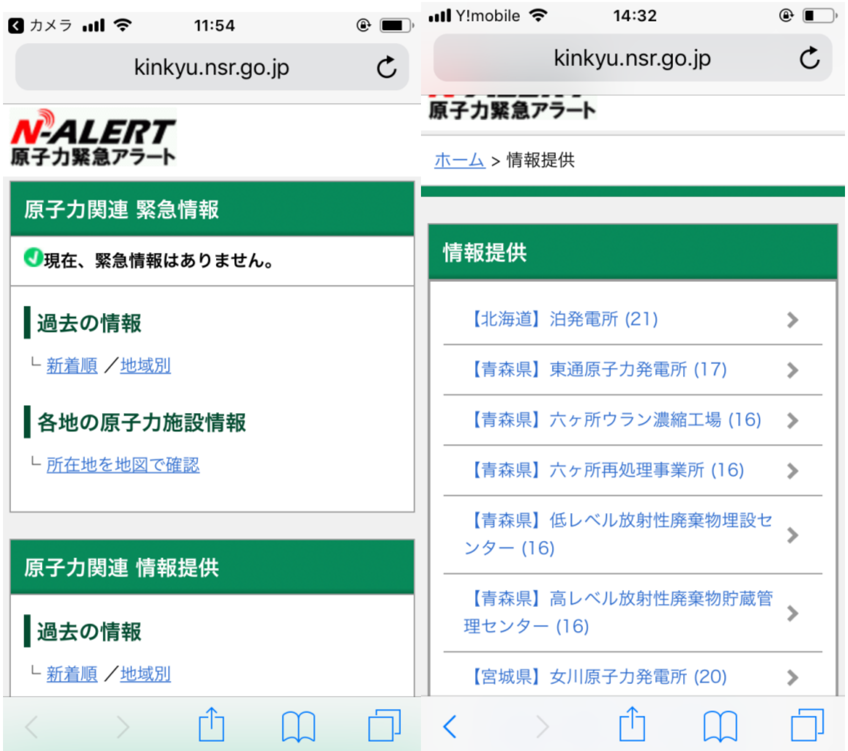

Figure 4 N-alert

For instance, N-alert has sent an email titled “No abnormality” for the situation of nuclear power stations in Fukushima when an earthquake in the intensity of 4 occurred at 11pm on the 23rd of November 2018.

APPs for emergency information developed in Japan at the regional/local level

To date, some municipalities of Japan provide APPS for natural disaster-derived emergencies and I selected the City of Nagoya as it is the third largest city in Japan. It does not send alerts but one can obtain formation related to earthquakes and water-related information such as floods/heavy rains/tsunami. It also provides GPS assisted root finders for going home and temporary shelters. It does not clearly say it will send alerts. I asked the largest city of Japan, Tokyo (Metropolitan City of Tokyo), and it says it is considering to introduce an APP for the future. Both Nagoya as well as Tokyo do not have any nuclear reactors.

APPs for emergency information about radiological emergency developed in Japan at the regional/local level

There are 54 nuclear reactors in Japan and individual municipalities where those nuclear sites are located have developed their original systems/tools for emergency communication. Those tools include web-site information, email alert system and mobile App for personal device. According to cabinet office, those municipalities primarily develop web sites that provide safety information specific to nuclear safety and emergency. Amongst those four specific municipalities have been investigated, namely, Tottori Prefecture, City of Tsuruga (located in Fukui Prefecture), City of Nagaoka (located in Niigata Prefecture), and Fukuoka Prefecture.

1. Tottori Prefecture: Tottori Nuclear Safety APP

Tottori Prefecture has three nuclear reactors operated by Chugoku Electric Company. All of them are now under investigation for newly introduced safety standards by the Japan’s Nuclear Authority, NSR. The Prefectural Government has developed a unique APP solely designed for nuclear emergencies. As

Figure 5 shows, the App sends safety information such as measurement vales of radiation from monitoring posts (Figure 6), and in case of an emergency, its changes its colour from green to red; sends advice on evacuation (indoor preparation or immediate evacuation); sends information for places where scans and shelters are available; and provide navigation maps for road congestions.

Figure 5 Tottori APP

This APP also aims to improve literacy about radiation and contains good texts for readings (Figure 7). It gives concrete instructions/advices what to do/ not to do at different emergency situations. Tottori Prefectural Government also uses Twitter for other emergencies such as floods and heavy rains.

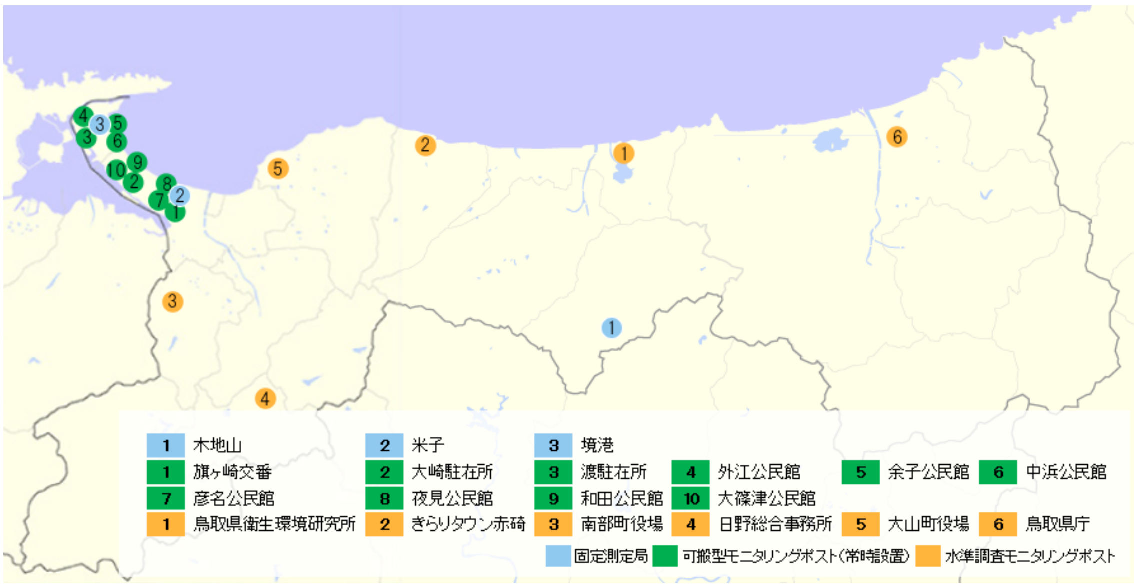

Figure 6 Monitoring posts

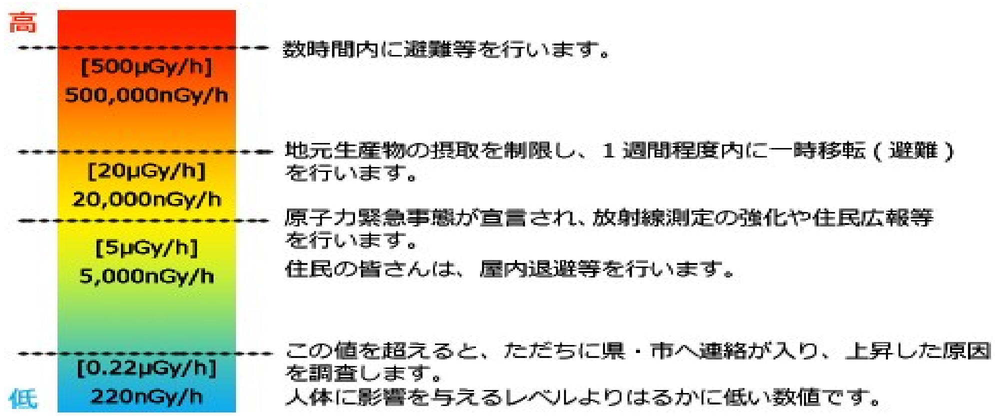

Figure 7 http://monitoring.pref.tottori.lg.jp/

As Figure 8 below shows, it uses Google map and gives exposure value from the nearest measurement post. Its screen is shown in green colour as there is no acute radiation-related alert.

Figure 8. Tottori Prefecture App on iPhone

Tottori Prefecture also adopts a unique email alert system called “Anshin Toripi Mail”. It covers wider areas relevant to public safety such as heavy rain and high tide, and integrated as a part of the Tottori Nuclear Safety APP. Once subscribed, it sends mails directly to personal device in differing three colours, namely blue, yellow and red, signaling the urgency and kinds of alerts. Actual examples (sent alerts) are shown as below:

A yellow-screened mail means alert (chui, in Japanese) and once the alert has been removed, it sends a mail in blue (Figure 9). Red means warning (keikai, keiho in Japanese) such as special alert/evacuation advice released in life-threatening or serious weather conditions or incidents such as missile attacks. (*Telephone interview, Tottori Pref. Mr Ota, 19.Nov)

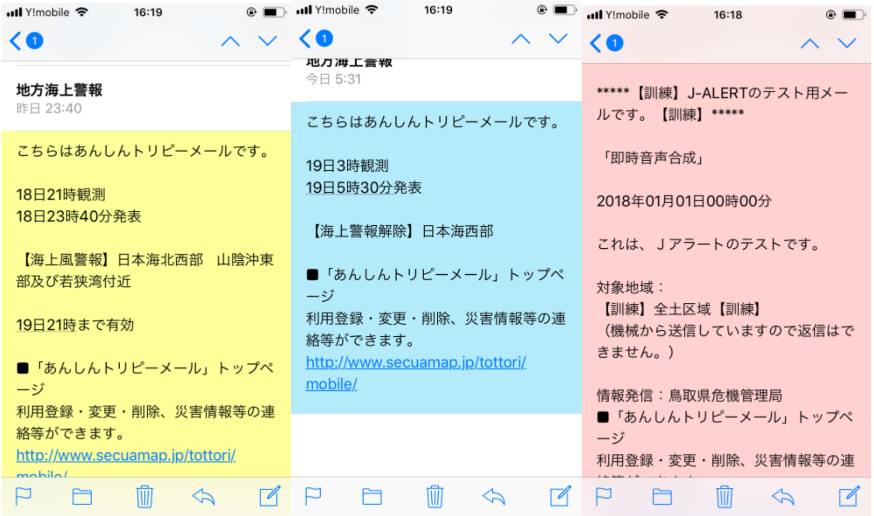

Figure 9. Alerts from Tottori Prefecture

Tottori Prefecture also uses Twitter (called Tottori Bosai Toripi) which sends similar safety information via Twitter: https://twitter.com/tottori_bousai.

Note: This attempt by Tottori Prefecture is a rare example as evacuation planning is still debated at local governments (NRS, telephone interview).

2. City of Tsuruga

Two commercial nuclear reactors are located in the City of Tsuruga – both of which are currently being reviewed for their safety in accordance with the new safety standard by NRA and not in operation. The city government sends nuclear-related alerts by conventional tools such as TV, radio, public speakers and emails sent to personal devices for nuclear emergencies (Figure 10). This is a standard way of communicating with local residents as to nuclear alerts. Email is not graphic but in letters.

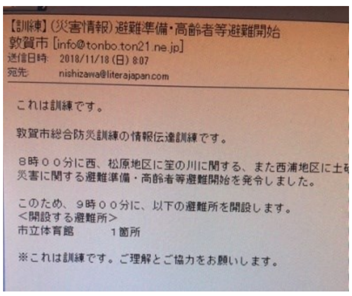

Figure 10 System used by the city of Tsuruga

3. The City of Nagaoka

Six nuclear reactors are located in the City of Kashiwazaki and Kariwamura Village and is the largest nuclear generation site of Japan run by Tokyo Electric Co. None of the reactors are currently in operation. City of Nagaoka is one of the seven municipalities that are adjunct to the nuclear site. The city is located within 30 kilometers from the nuclear site.

It has developed a website specific to nuclear safety. Real-time monitoring (updated every 10 minutes from their 65 automated monitoring posts within the city) data is accessible via the site (Figure 11).

Since the monitoring posts are run automatically, they will remain operated even high-dose radiation was released in a severe accident (Telephone interview, 20 Nov. city of Nagaoka). The site is also linked to real-time data from monitoring posts within Niigata Prefecture set by the Prefectural Government and those on the nuclear generation sites by Tepco (Tokyo Electric Co.). The given information can be translated by one’s favorite language by the use of Google Translation.

Figure 11 Designated websites from Nagaoka City

The unique and hands-on safety information is provided by selecting an area on the "Regional Maps". Once a specific area is chosen, it shows - 1) meeting points (for chartered busses) and sheltering places for emergency evacuation; 2) meeting points for sheltering 3) (desirable) evacuation routes on maps (Figure 12). Necessary information such as addresses and telephone numbers of are also given next to the map.

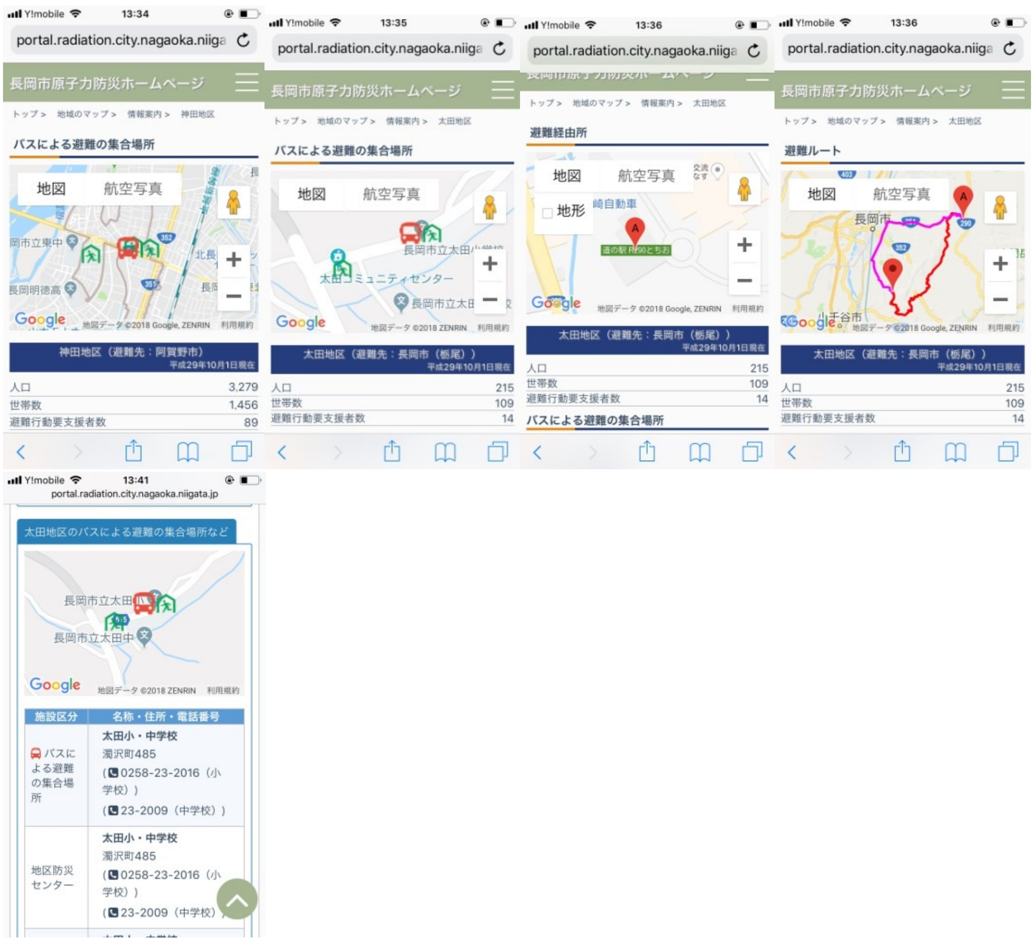

Figure 12 Evacuation maps from City of Nagaoka

Furthermore, the individual area maps will change its colours in nuclear emergency either in blue, green or red (Figure 13). Blue means "alert" (EAL UPZ 1-2) when no indoor evacuation or evacuation is necessary. Green is "Advice for indoor evacuation" (UPZ3) and red is "Evacuation Advice"(Telephone interview, 20.11.). Desirable and detailed actions are instructed for each phase.

Figure 13 Different alerts, City of Nagaoka

4. Fukuoka Prefecture

Fukuoka Prefectural Government provides safety information about radiation on its web-site: http://houshasen.pref.fukuoka.lg.jp/. Two commercial nuclear reactor sites, Sendai and Genkai Sites are located in Fukuoka Prefecture and in total five nuclear reactors are in operation run by Kyushu Electric Co. They were the first reactors to be restarted in Japan in 2015 after the Fukushima accident in 2011. The site gives real-time monitoring data from different monitoring posts located within the prefecture (Figure 14).

Figure 14 Radiation maps from Fukuoka Prefecture

It also linked to the website of Kyushu Electric which provides real-time radiation-related data from their two operation sites (Figure 15).

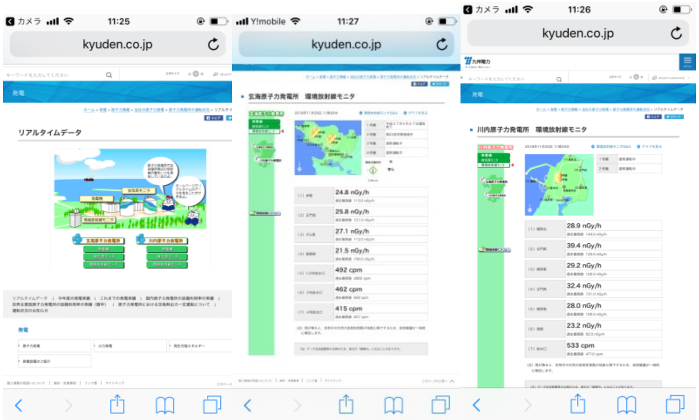

Figure 15 Real-time monitoring data from Kyushu Electric Co.

3.5 Discussions: advantage and disadvantage of APPs

It should be noted that, while APPs are good tools to provide people with easily-accessible, clear/visual information, they have some weaknesses that may need to be improved, such as false alerts. Alerts for earthquakes occur fairly often nowadays in Japan, but many deleted APPs due to false or mis-alerts. Mis-alerts disturb sleep at night. The author had personally deleted Yahoo! App as false alerts occurred multiple times after midnight.

As demonstrate in the previous sections, few local governments of Japan such as Tottori Prefectural Government use APP for convening nuclear safety information. Telephone interviews with local governments revealed that developing APP and its maintenance for updates are costly and downloading an APP is seen tedious by local residents. That is the reason why Nagaoka city Government did not develop APP, but instead provides visual and hands-on information via its website.

3.5.1 Development of APP for post-emergency monitoring in Fukushima

The use of APP for post-accidental area may be treated differently as it serves a different purpose – it can more personally tailored for individual health protection. Japan's NSR is currently developing APP that can calculate individual exposure value in Fukushima on a daily/monthly basis (reported in Nikkei Shimbun, 29. October, 2018). APP estimate the values based on the data from varying monitoring posts/routes in Fukushima and matches individual behavioral patterns via GPS. It is intended to be used for residents in Fukushima Prefecture. It will be released in 2019. NRS is now considering if it will exempt background radiation and shows only additional radiation value (Interview NSR 8.11.2018).

3.6 Conclusions

This chapter has investigated the current development of newly devised tools for safety information to be prepared for radiological emergencies such as APPs.

We have identified advantages of APPs being:

- Visual (more comprehensive for laypersons)
- Swift (time lags are minimised), and
- Tailored (to individual preferences and requirements).

On the other hand, we have noted issues for further improvement such as:

- False alerts
- Costs (more costly than developing web-based information)
- Labour intensive (frequently updates necessary for APP)
- Tedious (people do not download APP as they find it tedious to do so)

We have concluded that uncertainty communication has been and remains a challenge in the area of nuclear and radiological emergencies, and that development of newly devised electronic-based information tools may lessen the degree of uncertainty in providing trustworthy safety information to local residents and enhance risk preparedness and management in radiological incidents and emergencies at different phases.

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4 Communicating Uncertainties regarding Radiological Risks via News Media: the Effectiveness of Numerical and Narrative Messages

This chapter is summarised from two CONFIDENCE papers. The first, reporting a communication in case of food contamination by Wolf H.V., Perko T. and Thijssen which is in the second revision for Journal of Environmental Communication and the second paper by Wolf H.V., Perko T. and Thijssen, reporting a communication in case of Iodine tablets. The second paper is to be submitted in Journal of contingency and crisis management. This research forms part of a PhD project conducted by Hanna Valerie Wolf, funded by the Flemish Research Foundation (FWO) at the University of Antwerp, Belgium. The field work and part of the analysis has received funding from the CONFIDENCE project.

Some uncertainties that people face before, during and after a radiological emergency are addressed by risk communication. Sound risk communication drives people's attention, is well understood by lay people, crucial information is remembered and recalled when needed and, most importantly, people will agree with it and follow the advised behaviour.

Unfortunately, experiences from different emergency responses and studies show that sound communication about radiological risks is difficult to achieve. This study investigates what kind of communication is most effective and what kind of communication achieves better response by a population in a radiological emergency. More specifically, we look at whether communicated messages containing numbers (e.g. "20 to 40 percent less protection if iodine pills taken too early") or narrative messages (e.g. "Reduced protection if iodine pills taken too early") are more effective.

First results revealed that for post-emergency communication on the consumption of food from Fukushima, numerical messages were perceived as more effective than narrative or combined messages, and that numerical messages led to higher message acceptance than both other conditions. In the case of the iodine pills, no statistical significance has been observed between the experimental groups. The more extensive results of the experiments can aid in setting up effective, targeted communication strategies to reduce uncertainties for pre- and post-nuclear emergency situations that take into account the predispositions of different population groups.

4.1 Theoretical background

4.1.1 The use of numerical and narrative evidence in persuasive communication

From persuasive communication research - and evidence effectiveness research in particular - we know that different evidence types may result in considerably different perceptual and behavioral responses. So-called 'evidence' is needed to substantiate an argumentative claim, in order to persuade the listener or reader that a claim is indeed true, and to advocate a change in behavior. Ths change behaviour can be consuming food products, in the case of food risk communication, or waiting with an uptake of iodine tablets, in the case of emergency communication. Evidence as such is thus central to any (effective) communication and can be defined as "data (facts or opinions) presented as proof for an assertion" (Reynolds & Reynolds, 2002, p. 429).

The literature commonly applies a dyadic differentiation between numerical and narrative evidence (e.g., Wojcieszak & Kim, 2016), with some scholars differentiating more narrowly between statistical, anecdotal, causal (e.g., Hoeken, 2001), and sometimes expert evidence (Hornikx & de Best, 2011). A recent article by Wojcieszak and Kim (2016) defines numerical messages as "arguments that utilize numbers to advance a point of view" (p.787), which entails "empirically quantified descriptions of events, persons, places, or other phenomena" (Church & Wilbanks, 1986, p.108). Narrative messages have been defined as "a cohesive representation of events and characters, with an identifiable structure" (Wojcieszak & Kim, 2016, p.787), testimonials (e.g. de Wit, Das, & Vet, 2008), but also as vivid descriptions and metaphors, which often departs from the notion of evidence and focuses on the stylistic characteristics of the message type. Since these operationalizations differ considerably, it is not surprising that authors note varying effects of the messages (e.g., Hoeken, 2001; Hornix, 2005).

Our focus in this chapter is a comparison between a detached, numerical message that presents evidence in the form of an absolute number, a narrative message in the form of a personal testimony that allows the reader to empathize with the depicted personal experience and a combination of the two. We believe this operationalization provides the starkest contrast between the two evidence types, as absolute numbers are less dependent on subjective interpretations on the side of the recipient than for example percentages or frequencies and a personal testimony is more empathy-evoking than merely stylistic characteristics.

4.1.2 The Persuasive Effects of Numerical and Narrative Messages

Despite the aforementioned comparability issues in terms of operationalization, both numerical and narrative messages have been found to exert manifold effects on message recipients, which include effects on the evaluation of a message's quality, its acceptance and attitudinal as well as behavioural changes elicited by the message. Prior research largely stems from persuasive as well as health and risk communication and has predominantly relied on experimental designs. The results regarding which evidence type is superior in effectiveness have remained inconclusive, with some reviews stating that narrative evidence is more persuasive (e.g., Reinard, 1988), while others find more persuasiveness in numerical evidence (e.g. Allen & Preiss, 1997). Authors have pointed out various explanations for the effects they found, ranging from individual characteristics (e.g., Slater & Rouner, 1996), the level of vividness in a message (Baesler & Burgoon, 1994) to the sheer length of an article or the amount of evidence included in a stimulus (Han & Fink, 2012). Despite the difficulty to answer the question of superiority conclusively, several interesting patterns in response to the different messages have been observed.

In terms of message evaluations and acceptance, Limon and Kazoleas (2004) find that despite increased attempts to dispute numerical evidence, overall, it is perceived as credible, and thus persuasive, by the receiver – yet not necessarily as more persuasive than narrative evidence, a result some authors concur with (Wojcieszak & Kim, 2016; Mazor et al., 2007). Notwithstanding, other authors assert that numerical messages are rated as more persuasive (e.g., Kim et al., 2012; Hoeken & Hustinx, 2009; Hornikx, 2005; Hoeken, 2001; Allen & Preiss, 1997; Baesler & Burgoon, 1994), credible and verifiable (Lindsey & Yun, 2003), believable (e.g., Zebregs et al., 2015), of higher writing quality (Slater & Rouner, 1996) as well as of higher informational value (Greene & Brinn, 2003) than narrative messages. Kopfman et al. (1998) note that numerical evidence "received higher ratings of appropriateness, effectiveness, reliability, knowledgeability, credibility, and thoroughness" (p.291) than narrative messages. Some authors note that people tend to prefer narrative evidence on relatively personal issues (Hastall & Knobloch-Westerwick, 2013; Knobloch-Westerwick & Sarge, 2015; Peralta et al., 2016), whereas numerical information may be perceived as more useful for abstract and complex topics, as well as for distant threats such as climate change (Peralta et al., 2016). Risk communication on sensitive issues such as food risk and safety hinges on being perceived as credible and verifiable by the public.

Besides positive message evaluations, a number of authors conclude that numerical evidence is particularly effective for cognitive processing. A study by Kopfman et al. (1998) found numerical evidence to be significantly more effective than narrative evidence for all cognitive reactions measured, including the total, positive and negative thoughts produced about the investigated topic of organ donation. Findings by Limon and Kazoleas (2004) support this result to the extent that they also find that numerical messages lead to more cognitive responses than narrative messages. Yet, they argue that this difference might be "a result of difficulty in disputing someone's story" (p.296) as opposed to disputing more distanced, numerical evidence – a thesis that has been put forward by Kazoleas (1993), too. Research by Slater and Rouner (1996) adds an interesting perspective to this thesis: In their experiment they find considerable differences in the effects of numerical and narrative evidence on the "valence of message responses between value-protective and value-affirmative recipients" (p.228), namely that value-affirmative recipients (i.e., recipients who process value-congruent messages as a means to reinforce existing beliefs) use numerical messages to reinforce existing beliefs, while value-protective recipients (i.e., recipients who defend their values against value-discrepant messages) tend to counter-argue against numerical evidence. Defensive strategies when presented with numerical evidence have also been noted by Thorne et al. (2006), who interviewed cancer patients and found that those patients who were philosophically or biomedically sceptical tended to discount numerical information more often and came to disregard it as 'only numbers' (p.326). Numerical messages may thus more readily be perceived as biased than narrative messages, since personal experiences are more difficult to discount.

Furthermore, several scholars have investigated the effects of numerical and narrative messages on emotional responses. De Wit et al. (2008) investigated how evidence type influences the perceptions of personal risk of HBV among homosexual men and found that such perceptions were highest after exposure to narrative messages. Narrative messages appeared to be more likely to induce the emotional response of increased risk perception. Like other authors, they propose that this may be the case because narrative evidence is one the one hand "less affected by defensive message processing resulting from the threat to important self-beliefs" (p.110) and on the other hand more difficult to discount, as its influence does not depend as much on cognitive elaborations of the message content as the case for numerical data.

The findings presented above all relate to the public as a whole. However, message effects research should also consider how different messages affect subgroups of the population, not least because individual background characteristics have been found to strikingly influence message effects (e.g., Slater & Rouner, 1996). Prior research has identified several important mediating variables when it comes to the effectiveness of numerical and narrative messages. Among these are the actual numerical capacities of a person and, relatedly, a personal predisposition toward numbers, which describes a measure of a person's comfort in dealing with numbers in their daily lives. An interesting finding in terms of persuasion comes from a recent study in the field of political communication by Merola and Hitt (2016), who find that highly numerate people perceived numerical evidence as persuasive enough to even overcome party cue effects. They observed that when a message by an opposing party included numerical evidence, highly numerate individuals accepted it despite a predisposition against the party – a result that was found to be reverse for people with low numeracy skills, who tended to exhibit similarly defensive strategies as the ones described above (e.g., Thorne et al., 2006; Slater & Rouner, 1996). While a predisposition towards numbers has been found to be relevant both to the cognitive and affective processing of numerical information (e.g., Merola & Hitt, 2016; Knobloch-Westerwick et al., 2015), conversely, a highly empathic predisposition appears to havethe opposite effect: those individual scoring high on trait empathy seem to be less susceptible to the persuasiveness of numerical evidence (Wojcieszak & Kim, 2016; Knobloch-Westerwick et al., 2015), and are instead more favourable towards narrative messages.

Wojcieszak and Kim (2016) tested the effect of evidence in commentaries read by participants who were asked to either empathise with the story or to stay detached and objective. They found that narratives indeed led to greater immersion, in particular in the empathetic condition, yet, numerical messages were found to lead to greater self-perceived attitude changes in the objective condition. This is a powerful finding, considering the attitude shifts measured in their study changed in the direction advocated in a counter-attitudinal message, which is particularly relevant for risk communication of food safety, where people tend to boycott food products after food risks. Research by Sharot (2017) shows that highly analytic people performed worse than those with lower analytic skills in correctly assessing data when it concerned an issue they had a strong opinion on. She explains that "the greater your cognitive capacity, the greater your ability to rationalize and interpret information at will" (Sharot, 2017), which makes changing someone's mind with numerical data difficult even in case of high analytic skills, if said person has formed a strong belief on an issue. Thus, numerical skills may only benefit the effectiveness of numerical messages when these messages concern a non-contentious topic, or when they are aligned with his or her prior attitudes. We thus believe prior attitudes towards nuclear energy to be a strong mediator of message effects elicited by both numerical and narrative evidence.

4.2 Method

Within a representative face-to-face survey of the Belgian population (N=1086), conducted over a 3-month-period from December 2017 to February 2018, the authors ran two parallel experiments: The French-speaking language group was exposed to a pre-emergency news article manipulation targeting uncertainties related to waiting for instructions for the intake of iodine pills, the Dutch-speaking group to a post-emergency news article manipulation targeting uncertainties related to the safe consumption of food from Fukushima. The two experiments consisted of 3 experimental conditions each (1 numerical message, 1 narrative message (personal testimony), 1 combined message); control questions were included in the respective other conditions. Each participant read one news article and answered post-test questions regarding their recall and acceptance of the message, their message ratings, and their behavioural intentions regarding the uncertainty communicated. In addition, the authors tested whether the effectiveness of different messages differs for people with different predispositions (e.g. sociodemographics, preference for numbers, empathic score).

Stimulus materials

The stimuli were presented as newspaper articles on food products from the Fukushima region in Japan, which was affected by a nuclear accident in 2011 or newspaper articles on the correct uptake of iodine tablest in case of a nuclear or radiological emergency. The newspaper article form was selected since people most frequently use mass media, such as newspapers, radio and television when they actively seek information: a) about a food safety (Tiozzo, Pinto, Mascarello, Mantovani, & Ravarotto, 2018) and because newspapers in Belgium followed the Fukushima accident closely and they reported similar issues related to the accident as other mass media (Gallego et al., 2016; Vyncke, Perko, & Van Gorp, 2016) or b) about the iodine tablets predistributed to a population in vicinity of nuclear installations in Belgium (Van Bladel, Pauwels, & Smeesters, 2000).

The numerical stimulus expressed the risk of food consumption from Fukushima in terms of absolute numbers, e.g. “Below legal limit of 100 Becquerel per kilogram, yet Fukushima’s farmers still battle stigma” or “Beans from Fukushima contained 6 Becquerel per kilogram – a negligible dose of radiation”. The numerical stimulis related to iodine tablets uptake presented the risk in terms of absolute numbers, e.g. “Nuclear emergency: 20 to 40 percent less protection if iodine pills takeh too early” or “The impact of iodine pills is reduced by more than 40 percent if taken too early”.

The narrative stimulus expressed the risk in the form of a personal testimony including direct quotations, for the food contamination: e.g. “Fukushima farmers: Our vegetables are safe to eat, yet we still battle stigma” or “The level of radioactivity in beans I sell is negligible. Asahi Nakamura, Fukushima farmer”. Narrative stimulus related to the iodine pills uptake: Nuclear emergencies: “Reduced protection if iodine pills taken too early” or “Iodine pills protect far less if taken too early, Jullie Deckers (42) teacher.”

The combined stimulus used both expressions, e.g. for the food related messages: “Fukushima farmers: Our products are below legal limit of 100 Becquerel per kilogram, yet we still battle stigma” or “The beans I sell today contain levels of 6 Bacquerels/kg - a negligible dose. Asahi Nakamura, Fukushima farmer” or e.g. for the iodine related messages: “Iodine pills protect 20 to 40% less if taken too early, Julie Deckers (42), teacher.”

The stimuli were kept equivalent in terms of the core argument, and kept as similar as possible in terms of length and wording (Figure 16).

Figure 16 Stimuli (Translated from Dutch and French to English)

Condition 1 (numerical)

Below legal limit of 100 Becquerels per kilogram, yet Fukushima’s farmers still battle stigma

Six years after the Fukushima disaster, farmers from the region still struggle with selling their food – although it has been deemed safe for consumption by authorities.

Tokyo | Products from Fukushima are carefully checked by official food-safety regulators. Food products may contain no more radioactivity than the permissible limit of 100 Becquerels/kg to be safe to eat - the level found in vegetables from Fukushima lies well below this limit.

This week, rice, carrots and strawberries from Fukushima are on offer in supermarkets – containing no detectable radioactivity. Some bags of beans contain 6 Becquerels/kg - a negligible dose of radiation compared to the natural radiation that is present everywhere.

Yet, as if the 2011 meltdown at the Fukushima nuclear plant wasn’t traumatic enough, the word “Fukushima” on a supermarket label is often enough to discourage shoppers from buying a product.

Beans from Fukushima contained 6 Becquerels/kg - a negligible dose of radiation.

Allaying fears about contamination was a core theme discussed during a recent event in Tokyo focused on the role agriculture could play in Fukushima’s recovery.

The event gathered representatives from organizations such as Oxfam Japan to speak about

the challenges facing producers in Fukushima, along with some of the major success stories.

(hw/tp)

Nuclear emergencies: 20 to 40 percent less protection if iodine pills taken too early

Iodine pills might soon be available in all Belgian households to prevent the development of thyroid cancer in case of a nuclear emergency. But for the pills to be effective, waiting for official instructions is crucial.

Brussels | By 2018, every Belgian should have preventive iodine pills at hand to protect him- or herself in case of a nuclear emergency. This is what Maggie De Block (Open VLD), minister of Public Health, said in spring 2017. Should the new regulation be adopted, iodine pills will soon be available from pharmacies all across the country.

However, it is important to take iodine pills only when advised to do so by authorities, officials stress, as a premature ingestion of preventive iodine may not result in the desired protection. Yet, many citizens are unaware of these consequences.

The impact of iodine pills is reduced by more than 40 percent if taken too early.

While people may instinctively assume that taking iodine pills as fast as possible is the safest option, officials warn that the impact of the pills is reduced by more than 20 percent if taken one hour too early, and by more than 40 percent if taken three hours before advised to do so.

People are thus urged to wait for official instructions before taking iodine pills or giving them to children in case of an emergency.

(hw/tp)

Condition 2 (narrative)

Fukushima farmers: "Our vegetables are safe to eat, yet we still battle stigma"

Six years after the Fukushima disaster, farmers from the region still struggle with selling their food – although it has been deemed safe for consumption by authorities.

Tokyo | Asahi Nakamura, a vegetable farmer from Fukushima, notes that all his products are carefully checked by official food-safety regulators. "My vegetables are not contaminated by radioactivity", he says, "the levels lie well below the permissible limit."

His offer of the week includes rice, carrots and strawberries, which he assures contain no detectable radioactivity. The bags of beans he sells contain a dose of radiation, "but this dose is negligible compared to the natural radiation that is present everywhere", he says.

Yet, as if the 2011 meltdown at the Fukushima nuclear plant wasn't traumatic enough, the word "Fukushima" on a supermarket label is often enough to discourage shoppers from buying a product.

"The level of radioactivity in the beans I sell is negligible"
- Asahi Nakamura, Fukushima farmer

Allaying fears about contamination was a core theme discussed during a recent event in Tokyo focused on the role agriculture could play in Fukushima's recovery.

The event gathered representatives from organizations such as Oxfam Japan to speak about

the challenges facing producers in Fukushima, along with some of the major success stories.

(hw/tp)

Nuclear emergencies: "Reduced protection if iodine pills taken too early"

Iodine pills might soon be available in all Belgian households to prevent the development of thyroid cancer in case of a nuclear emergency. But for the pills to be effective, waiting for official instructions is crucial.

Brussels | By 2018, every Belgian should have preventive iodine pills at hand to protect him- or herself in case of a nuclear emergency. This is what Maggie De Block (Open VLD), minister of Public Health, said in spring 2017. Should the new regulation be adopted, iodine pills will soon be available from pharmacies all across the country.

However, it is important to take iodine pills only when advised to do so by authorities, officials stress, as a premature ingestion of preventive iodine may not result in the desired protection. Yet, many citizens are unaware of these consequences.

"Iodine pills protect far less if taken too early"
- Julie Deckers (42), teacher

"Like many people I assumed that taking the pills as fast as possible is the safest option", says Julie Deckers, teacher and mother of two, who witnessed an official demonstration of the pills' functioning, "but that's not the case. Iodine pills protect far less if taken only one hour too early."

People are thus urged to wait for official instructions before taking iodine pills or giving them to children in case of an emergency.

(hw/tp)

Condition 3 (combined)

Fukushima farmers: "Our products are below the legal limit of 100 Becquerels/kg, yet we still battle stigma"

Six years after the Fukushima disaster, farmers from the region still struggle with selling their food – although it has been deemed safe for consumption by authorities.

Tokyo | Asahi Nakamura, a vegetable farmer from Fukushima, notes that all his products are carefully checked by official food-safety regulators. Food products may contain no more radioactivity than the permissible limit of 100 Becquerels/kg to be safe to eat. "The levels found in my vegetables lie well below the permissible limit", he says.

His offer of the week includes rice, carrots and strawberries, which contain no detectable radioactivity. Some bags of beans contain 6 Becquerels/kg, "but this dose is negligible compared to the natural radiation present everywhere", he says.

Yet, as if the 2011 meltdown at the Fukushima nuclear plant wasn't traumatic enough, the word "Fukushima" on a supermarket label is often enough to discourage shoppers from buying a product.

"The beans I sell today contain levels of 6 Becquerels/kg – a negligible dose"
- Asahi Nakamura, Fukushima farmer

Allaying fears about contamination was a core theme discussed during a recent event in Tokyo focused on the role agriculture could play in Fukushima's recovery.

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the challenges facing producers in Fukushima, along with some of the major success stories.

(hw/tp)

Nuclear emergencies: "20 to 40 percent less protection if iodine pills taken too early"

Iodine pills might soon be available in all Belgian households to prevent the development of thyroid cancer in case of a nuclear emergency. But for the pills to be effective, waiting for official instructions is crucial.

Brussels | By 2018, every Belgian should have preventive iodine pills at hand to protect him- or herself in case of a nuclear emergency. This is what Maggie De Block (Open VLD), minister of Public Health, said in spring 2017. Should the new regulation be adopted, iodine pills will soon be available from pharmacies all across the country.

However, it is important to take iodine pills only when advised to do so by authorities, officials stress, as a premature ingestion of preventive iodine may not result in the desired protection. Yet, many citizens are unaware of these consequences.

"Iodine pills protect 20 to 40% less if taken too early"
- Julie Deckers (42), teacher

"Like many people I assumed that taking the pills as fast as possible is the safest option", says Julie Deckers, teacher and mother of two, who witnessed an official demonstration of the pills' functioning, "but that's not the case. Iodine pills protect 20% less if taken only one hour too early, and 40% less if taken three hours before advised to do so."

People are thus urged to wait for official instructions before taking iodine pills or giving them to children in case of an emergency.

(hw/tp)

Figure 16 Stimuli (Translated from Dutch and French to English)

4.3 Results and discussion

The resuts of our study show that different types of messages have different effect in different contexts. For the food related messages, the numerical messages apper to be more effective than narrative or combined messares in terms of eliciting higher credibility and acceptance in the field of food safety communication after radiological emergencies. For the iodine pills uptake related messages, there was the only significant difference between a control group (not exposed to any communication about iodine pills) and other groups (exposed to numerical, narrative or combined messages). The difference between numerical, narrative or combined stimulus was for the iodine tablets messages not statistically significant.

The findings related to the food messages are in accordance with prior research on evidence effectiveness (e.g., Kim et al., 2012; Hoeken & Hustinx, 2009; Hornikx, 2005; Hoeken, 2001; Allen & Preiss, 1997; Baesler & Burgoon, 1994; Lindsey & Yun, 2003; Kopfman et al., 1998) with regards to the effects of numerical messages compared to narrative messages. We furthermore confirm the finding by Peralta et al (2016) that numerical information may be perceived as useful for abstract topics and distant threats, as the case for food risks related to nuclear emergencies. Despite several prior studies observing defensive strategies among consumers who engage in discounting counter-intuitive numerical information (e.g., Thorne et al., 2006; De Wit et al., 2008), we do not find support that numerical messages are perceived as more biased than narrative messages. Such bias perceptions may strongly hinge on the source of a message and the respondents' trust in this source, an information we omitted from our experimental setting. We also do not find support that narrative messages lead to higher risk perceptions than numerical messages, an emotional response observed by De Wit et al (2008). This may in part be due to the fact that their study concerned a more imminent threat – contracting a rather common virus through sexual intercourse – whereas our study deals with a possible food contamination that most Belgians will likely not be exposed to and where exposure can easily be avoided at this point. Furthermore, we cannot confirm previous findings that personal predispositions towards numerical information and the reported level of empathic concern. It is important to notice, that food related messages are part of the recovery communication.

The communication related to the iodine pills is part of the preparedness communication. Communication during the preparedness stage *'is designed to address the public's awareness and knowledge gaps (…), to elicit desired preparedness behaviour (…), to ensure adequate understanding, and to educate about what actions to take (…)'* (Sheppard, Janoske, & Liu, 2012, p. 11). This can reduce the public's vulnerability and mitigate harmful effects (Coombs, 2010), by changing the beliefs which determine behaviour (Fishbein & Ajzen, 1975). Previous research has shown that providing preparedness information is only effective if the information is actionable and dense, meaning that it must come from multiple sources and is broadcasted across multiple channels (Wood et al., 2012). This can explain limited effect of types of messages related to iodine pills. Results show that – although the different type of messages (numerical, narrative or mixed) – they are all equally effective in communicating iodine pills uptake. Communication about the effectiveness of iodine pills invariably has a positive effect on preparing people for a nuclear emergency and right time for taking action. People who read the newspaper article had better knowledge on when to uptake the iodine tablets and accepted the advice to wait with the uptake largely than people in the control group.

4.4 Conclusions

Food risk and the safety of foodstuffs in the aftermath of a nuclear or radiological emergency as well as proper uptake of iodine pills in case of a radioactive release are highly sensitive issues to communicate.

Food risks receive extensive attention by the news media, which require messages to be carefully drafted to minimize harm and avoid unnecessary boycotts. Once a food risk is deemed eliminated, communication efforts must rebuild trust among consumers. The latter is a particularly difficult task after a radiological contamination. A time of iodine pills uptake is extremely important issue to communicate during a nuclear or radiological emergency, since people tend to uptake the pills immediately instead of waiting for the instructions from authorities.

This chapter tests whether detached numerical messages, emotionally-involving narrative messages, or messages combining both elements are more effective in persuading the public to follow the advice from authorities. We employ a survey-embedded experiment on a sample of the general Belgian population (N=1085), during which respondents are presented with a mock news article presenting either a (1) numerical, (2) narrative, or (3) a combined message (numerical and narrative elements) and test their subsequent evaluation of the article.

The resuts of our study show that type of message have different effect in different contexts. For the food related messages (recovery communication), the numerical messages apper to be more effective than narrative or combined messares in terms of eliciting higher credibility and acceptance in the field of food safety communication after nuclear or radiological emergencies. For the iodine pills uptake related messages (preparedness communication), there was the only significant difference between a control group (not exposed to any communication about iodine pills) and other groups (exposed to numerical, narrative or combined messages). The difference between numerical, narrative or combined stimulus was for the iodine tablets messages not statistically significant.

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5 Visualisation of uncertainties through maps

This chapter summarises national reports in annex written by Tafili V. (EEAE, Greece); Oughton D. and Tomkiv Y. (NMBU, Norway), Sala R. (CIEMAT, Spain), Duranova T. (VUJE, Slovak Republic) and Perko T. (SCK•CEN). The researchers were following a protocol in annex written by L. (DIALOGIC, Germany).

This chapter focuses on maps as communication tools, how these can be developed and improved in the case of a nuclear emergency, and how uncertainty information can be included so that the stakeholders and affected population gain a better understanding of the crisis situation and be better equipped to take the appropriate actions.

In order to gain new insights and gather evidence, CONFIDENCE partners organized a series of discussions with stakeholders and students in Spain, Belgium, Slovak Republic, Greece and Norway/Sweden. Tests with stakeholders were also conducted during several conferences (NERIS 2019 and RICOMET 2018).

These workshops included key stakeholders from the area of nuclear emergency management, radiation protection, and nuclear emergency communication.

Work of the testing of maps was finalized in summer and fall of 2019.

5.1 Practical backgroung: Uncertainties related to radiological maps produced and used for nuclear emergencies

This exploratory analysis was presented at the CONFIDENCE session at the RICOMET 2018 conference and published in proceedings by Benighaus L., Camps J. , Perko, T., Turcanu C. and Benighaus C.

The way we visualize information related to radiological releases in emergency situations is of extreme importance for decision-making, both for experts involved in emergency management, as well as for the potentially affected population. Experts produce a series of maps (e.g. ongoing or predicted releases, doses to the population, radioactive contamination, affected areas). They use different software tools and standards (e.g. specialized systems such as RODOS, GIS, Google maps) and apply different visualizations (e.g. colors, contours, measurement units). Decision-makers at different levels (from federal level to mayor of a local community) and first responders need to interpret these maps and advise the population on protective behavior (e.g. don’t consume vegetables from your garden). Mass media often refer to these maps and they publish those on-line (e.g. interactive maps); maps also appear in social media (e.g. blogs, tweets). Affected population needs to understand these maps in order to know what and when to take certain actions or not in case of an emergency (e.g. which roads to take during an evacuation, at what time).

This subchapter focuses on uncertainties, miss-interpretations, miss-communications originating from maps produced and used by experts, media and population in recent nuclear emergency exercises (international INEX-5 workshop, Belgian exercise at a NPP) and measurements of (limited traces of) radioactivity in the air from radiological releases (106, 103-Ruthenium, 131-Iodine) are analyzed and uncertainties identified.

Expoloratory results show that radiological maps can be of great use in visualizing the affected environment and thus of great added value in emergency management. Unfortunately, radiological maps analyzed in the context of this research were often a source of uncertainty, miss-interpretation and caused communication issues.

The following issues in visualisation on maps have been identified:

- maps lacking contextual information (e.g. on-going release or predicted release; missing legend);
- a huge diversity of measurement units used (µSv/h, mR/h);
- diversity of colors has been used unrelated to the meaning of the color (e.g. blue for the extremely low release, below legal norms);
- zones for protective actions indicated using country borders;
- scientific uncertainties not presented (e.g. related to time of release, meteorological conditions), low doses presented in many different ways (e.g. white color, blue color, units), no indication of health impact.
-

The following sub-chapters report on the tests of different maps conducted by CONFIDENCE partners. The objectives of the tests were to learn more about the general understanding of emergency maps among a small sample of stakeholders (experts and decision-makers), and to find which uncertainties were expressed and raised. Furthermore, suggestions and recommendations were expected for an improved design and practicability of these cartographic solutions, and on how to show uncertainties while reading, using and interpreting the maps.

5.2 Method

Project partners agreed to use five different cartographic solutions that could be demonstrated as examples of a visual aid in case of a nuclear emergency. These examples of maps were provided by the Karlsruhe Institute of Technology (KIT), one of the CONFIDENCE project partners. The examples of maps depicted a hypothetical but realistic case of a nuclear accident, with an expected fallout of radioactivity. In this simulations, the epicentre of the emergency was the facilities of KIT in Karlsruhe, Germany - a research complex where in reality there is no nuclear power plant.

The participants (see overview in Table 3) discussed the maps and shared comments with the facilitator of the workshop. The discussions were structured arounf the following questions:

- How should maps or other visual aids be designed that they become suitable for communicating nuclear preparedness or emergency responses?
- What are the main elements a map should contain? What should be included, what excluded to avoid cognitive overload?
- How should uncertainties be visualized in the map? What kind of uncertainties should and can be expressed in maps?

The maps tested in Spain, Belgium, Slovak Republic, Greece and Norway and with stakeholders participants at the NERIS 2019 workshop and RICOMET 2018 are presented below (Figure 17). Detailed methodology for the discussions in different countries can be found in the national reports given in Annex.

Table 3 An overview of the methods that were used for testing maps and the types of stakeholders that participated in the discussions

Country/Event	Method for input collection	Number of participants	Participants
Slovak Republic	Workshop	21	Decision-makers involved at different levels of the emergency preparedness, response and recovery management activities.
NERIS workshop 2019	Workshop	19	Experts and decision-makers from various countries
Spain	Interviews	3	Expert decision-makers from different emergency planning and response organisations
Greece	Workshop	15	Students of Inter-University Postgraduate Course in Medical-Radiation Physics
Norway/Sweden	Discussions during lectures	15 + 23	Students of the course on radiation in the environment and NEA/SU Radiation Protection course
RICOMET 2018 conference	Discussion after presentation	53	Experts with different tasks in emergency management

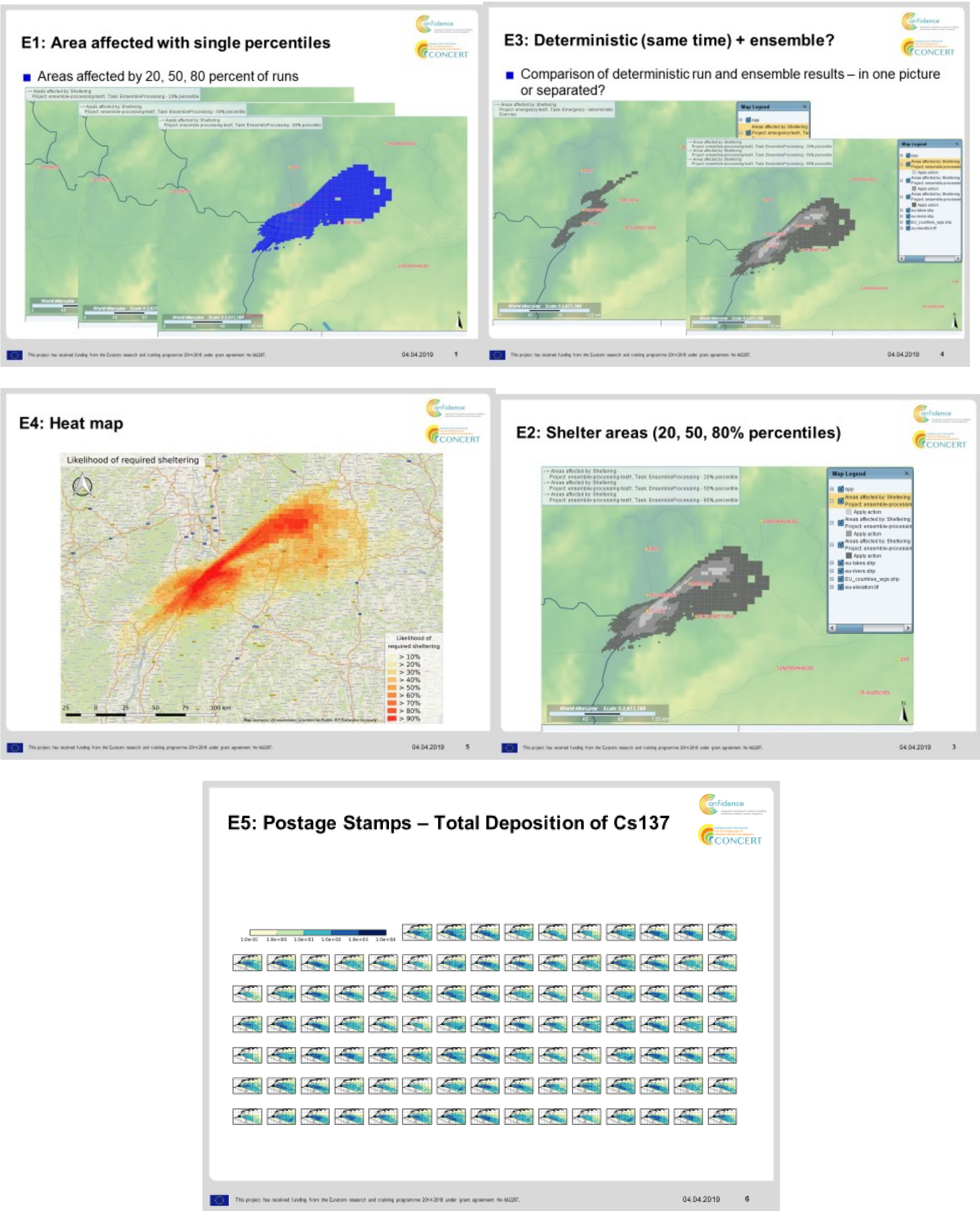


Figure 17 – A set of maps that has been discussed with the participants in different countries

5.3 Results and Conclusions

The following section summarises national and conference reports (see Annex) written by Duranova T., Sala R., Tafili V., Perko T., Oughton D.

The feedback received by participants in the testing of the maps can be categorized under the 4 key categories listed below.

a. *Format of the map*. This category summarises comments on the map as the basis or "canvas" that the information about the specific emergency will be placed onto. Such basic map information could include, for instance, cities and main infrastructure.
b. *Design of the map*. The "look and feel" of the map layout, which includes colours selection and use of graphics to indicate different zones.
c. *Supplementary data.* The elements that make the map more understandable for users, such as the legend and the title.
d. *Uncertainty representation.* Specific ideas about how uncertainty could be incorporated into maps.

The views expressed by the participants in these workshops that took place in different countries are summarized below.

a. *Format of the map*.

- The basic maps could use the format of Google Maps or other common map format that people use on their mobile phones as familiarity with the format will be beneficial.
- The maps should include additional information that will be useful in decision-making on the various countermeasures. This information could include roads and evacuation routes, villages and towns, population density, Civil Protection objects, hospitals, water reservoirs, crops, and flocks etc.
- Some additional information will be useful when maps are presented to the public, for instance, maps should contain evacuation routes
- Distance and wind direction are key elements to be included in a map. At the same time, it should be recognized that possible changes in wind direction and behaviour of the radioactive material on the ground will constitute an important source of uncertainty.
- To reduce complexity of information presented on maps, non-interactive or interactive interfaces can be used.

b. *Design of the map*.

- The map should contain concentric circles around the centre of the emergency, that would indicate the different emergency zones as this would be helpful for establishing the different protection measures.
- Concentric circles could be used instead of coloring the areas, in order to make clear where an emergency zone begins and where it ends.
- There are several aspects that should be considered when choosing color coding for the maps: it should have enough color contrast with the base map, be suitable for those who are color blind or have limited or partial blindness, and carefully selected (e.g. orange and red shades should not be used for low doses).
- Color codes should match with the once already in use in nuclear emergency drills and exercises within the country
- Colors should be also transparent enough to make streets, roads, borders of countries, cities and other additional information visible on the existing map.
- Representation of any data that are not necessary should be avoided, in order to make the map simpler.

- Digitalisation and automatic system of maps sharing are needed. The maps should be electronic in order to present layers of information.
- There should be at least two areas indicated on the same map: the first area where countermeasures have been implemented and the second area where the countermeasures are recommended.
- Tutorials and explanations should be available to understand information about likelihood correctly.
- Transparency of layers from calculations, indicating priority zones.

c. Supplementary data

- The information on the probability of sheltering provided in terms of percentages is perceived as very useful in terms of decision-making.
- Information on source of uncertainty and meaning of uncertainty should be included in the legend.
- Informative title of map and scale information is needed.
- Colour codes should be clarified in the legends.
- Doses or units should be avoided.
- Include a reference about the validity period and the date of the next update.

d. Uncertainty representation.

- Uncertainties can be presented on maps as colour hue and colour value (in other words lightness and brightness), transparency, or colour saturation. Uncertainties can be presented on maps as well with extrinsic techniques, i.e. when additional graphical objects are used to represent uncertainty, typically approaches using glyphs or error bar.
- Nature of task that a stakeholder has in emergency management has an important role for the usability of uncertainty visualization (in our testing often domain experts were unable to articulate what their preferred uncertainty visualisation methods were because they were convinced that this strongly depends on the task).
- Complementary approaches are needed to characterize static and dynamic methods for signifying uncertainty visually, for user tasks related to uncertainty signification, and for the ways in which interactivity can apply to enable user access to data, its uncertainty and their combination.

In general, participants expressed the view that *"s*ome maps are suitable for experts but not for general population or first responders", as well as that "maps for decision-makers are not appropriate for the general public".

The interviewed experts highlighted the usefulness of maps to decide and communicate about preparedness and response to a nuclear emergency; but, at the same time, they all agree that there are many uncertainties that are difficult to represent in the maps. Some of them highlighted that real measurements in the potentially contaminated zones are needed to take good decisions for the protection of the population.

"The fundamental advantage of the maps is that they delimit very much the areas in which you have to act because deposition depends on a specific wind direction. They help to delimit the contaminated area, define the dominant wind direction, and in case there had been rain, where the largest deposition will be. That is true, but you also have uncertainties, clearly."

Finally, it has also been shown that training is important for effective empirical analysis of complex information display interpretation, but it is usually not carried out to a sufficient extent.

6 Improving SMS for early warning systems

This chapter summarises national reports in annex written by Tafili V. (EEAE, Greece); Oughton D. and Tomkiv Y. (NMBU, Norway), Sala R. (CIEMAT, Spain), Duranova T. (VUJE, Slovak Republic) and Perko T. (SCK•CEN). The researchers followed the protocol included in annex written by Benighaus L. (DIALOGIC, Germany).

This chapter focuses on text messages and how these can be developed and improved to inform the affected population in the case of a nuclear emergency.

Different test of the proposed messages were carried out at the CONFIDENCE training course in Slovak Republic (SCK•CEN and VUJE), in Spain (by CIEMAT), Greece (by EEAE) and Sweden during the ERPW conference (by NMBU).

The objective was to learn more about the contents and the length of text messages. Besides, the researchers were interested in assessing the general understanding and acceptance among lay people, experts and decision-makers and also to see which uncertainties were expressed and raised.

6.1 Method

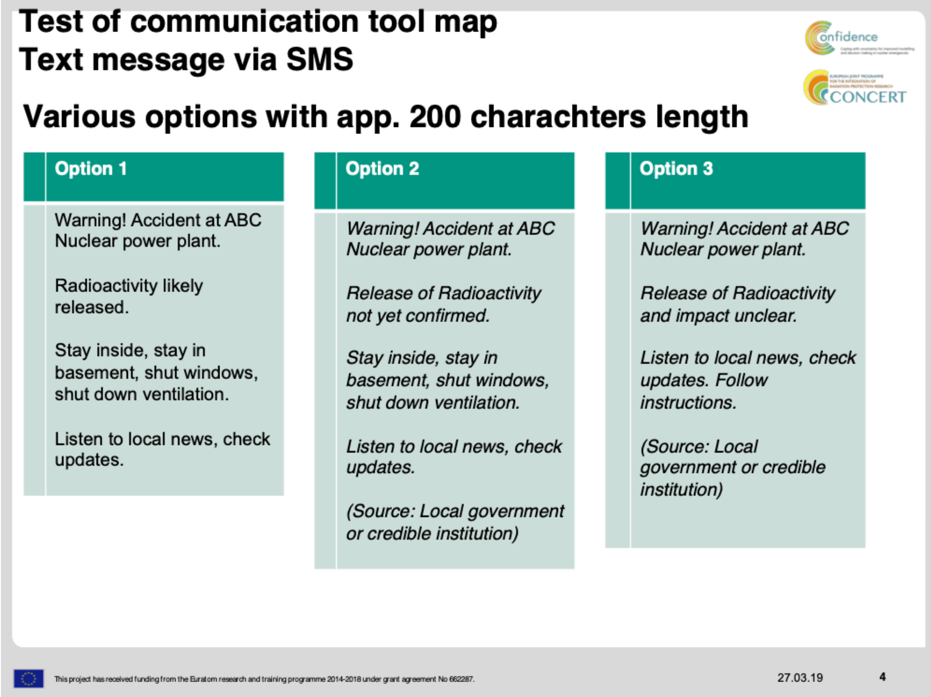
6.1.1 Messages tested

Confidence partner DIA set up the research protocol (see annex) and developed examples of short text messages based on existing experiences from Tsunami warning (FIA, 2019). This different text messages to communicate a nuclear emergency were prepared to show to participants as examples and to stimulate the discussion. Specifically, three exercises were proposed to project partners leading the tests in the three involved countries:

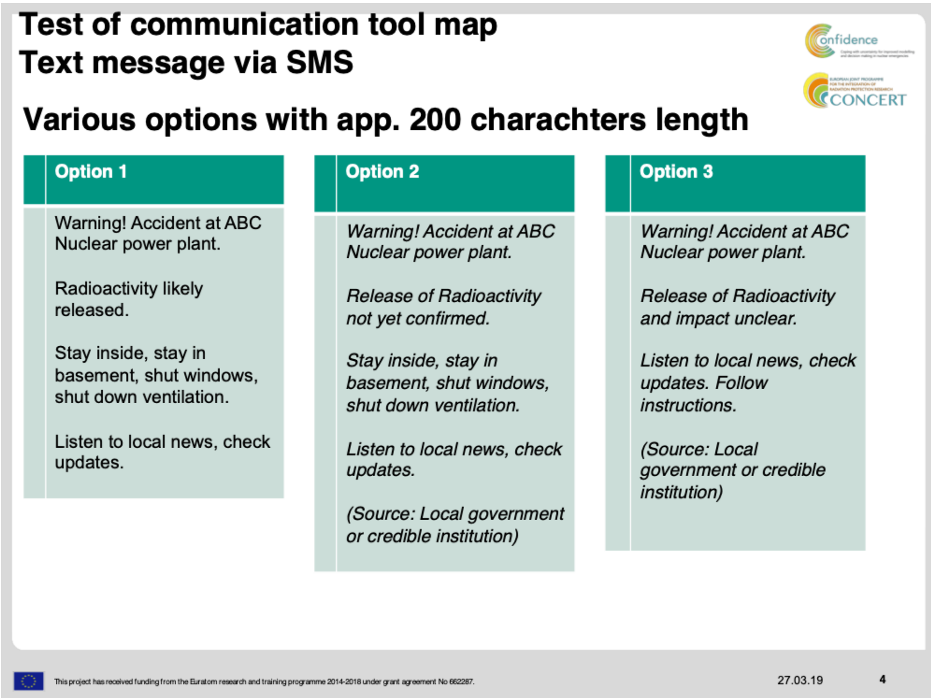
1. <u>Exercise 1: Discussion about text messages of various lengths.</u>

Length	Text message
100	Warning! Nuclear accident at ABC Nuclear power plant. Stay inside, shut windows. Listen to local news, check updates.
87	Warning! Nuclear accident at ABC Nuclear power plant. Stay inside, shut windows. Listen to local news.
69	Warning! Nuclear accident at ABC Nuclear power plant. Stay inside, shut windows.
57	Warning! Nuclear accident at ABC Nuclear power plant. Stay inside.
36	Warning! Nuclear accident happened today.
23	Warning! Nuclear accident
15	Nuclear accident
7	Accident

2. Exercise 2: Discussion of various text messages with approximately 200 characters length.



3. Exercise 3: Writing of the ideal text message



It was proposed that the facilitator of the sessions or interviews presented the text messages and distributed print copies of them, allowing some time for participants to read the messages. Discussion should focus on the collection of first reactions and general comments.

6.1.2 Sample

In Spain CIEMAT conducted two different tests: one with sample of eleven students from "Universitat Autònoma de Barcelona", studying sociology or environmental sciences. Students were recruited from the faculties, advertising the study in the classrooms. A second test was carried out with a sample of three experts, who also participated in the test of the maps:

a. A decision-maker from the General Directorate of Civil Protection and Emergencies, specifically, a technician in Emergency Planning.

b. A researcher working on radiological impact assessment at CIEMAT.

c. The Head of Emergency Planning of the Spanish Nuclear Safety Council (CSN).

In Greece, the test was conducted by EEAE, during a workshop with students. EEAE invited the students of the Inter-University Postagraduate Course in Medical-Radiation Physics to a one-hour workshop, indicating only that emergency preparedness and response communication tools will be tested, without including more details.

Norwegian partners (NMBU) tested an example of emergency text message with the participants of the European Radiation Protection Week meeting in Stockholm, ERPW2019, during the two one hour long poster sessions. This meeting comprised of over 300 participants of various backgrounds, from PhD students to authorities, and predominantly from Europe but including other parts of the world. Input from about 25 participants was gathered during this time.

In Slovak republic (SCK•CEN and VUJE) tested examples of SMS with the CONFIDENCE training course participants. 25 participants, from 15 countries were experts and communicators with different tasks in nuclear or radiological emergency manement.

The overview for different methods and participants is given in Table 4.

Table 4 Overview of the methods that were used for the SMS-testing maps and the types of stakeholders that participated in the discussions.

Country/Event	Method for input collection	Number of participants	Participants
Spain	Workshop + interviews	11+3	Students and experts
Greece	Workshop	15	Students
Norway/Sweden/radiation protection week	Test during poster session and breaks	25	Conference particiapants, experts and scientists
CONFIDENCE Training course, Slovak Republic	Round table discussion and simulation of the emergency	25	Experts responsible for different tasks in an emergency management including communicators

Procedure for data collection

General instructions were given to partners regarding the procedure for data collection. For instance, it was recommended to enable an in-depth discussion with participants and to test the text messages for a minimum of 15 minutes up to an hour. Regarding the data collection technique, it was recommended to use one-on-one-Interviews or other group techniques, such as workshops or focus groups.

General questions were proposed to stimulate the discussion during the interviews, workshops or focus groups:

1) How does the ideal (perfect) text message for various stages of a nuclear emergency look like?
2) How should a text message be designed to show and express the various types of uncertainties, while at the same time providing enough certainty that people will take the required protective actions?
3) What kind of uncertainties can and should be communicated? Who decides about what to include and what to leave out?
4) Which aspects of uncertainty are likely to be misunderstood and how can improved communication deal with it?
5) How can communication avoid the well-known cognitive biases when dealing with probabilities and other measures of uncertainty?

Besides, other specific questions were suggested:

1. Have a look at the text messages for the case of a nuclear accident
2. How does a person living near the power plant perceive nuclear risks and radiation?
3. How will he/she most likely behave?
4. What is missing in the existing text messages?
5. What could easily be misunderstood or misinterpreted?
6. How are the various aspects of uncertainty addressed and explained?
7. Is there any evidence about how these uncertainty messages are understood and perceived?
8. What is needed now for a further development of written information? What needs to be improved?

In Spain, experts were invited to participate by email. Once they accepted to participate, a PDF file containing the text messages was provided to them (by email, translated to Spanish), familiarizing themselves with the materials before the interview. A date and time for the interview was scheduled. The test of the text messages was conducted by means of telephone interviews. During the interview the researchers asked them to display the text messages at their own computers. Based on the protocol provided by project partners, a first general discussion on nuclear emergency preparedness was proposed and then the discussion was focused on nuclear emergency communication. After the warm-up discussion it was followed the structure of three exercises: discussion about text messages of various lengths, discussion of various text messages with approximately 200 characters length, and writing of the ideal text message. Specific questions for the three exercises were prepared:

Exercise 1 specific questions:

- Which is the most suitable message to communicate a nuclear accident to the population?
- Why?
- What kind of information is missing?
- Is the length of the text important in this type of communications?
- Can any of these messages rise doubts or led to incorrect interpretations?
- What questions do not solve these messages?
- How can these messages be improved?

Exercise 2 specific questions:

- What is missing in this text messages?
- What could be misunderstood?
- What should be improved?
- Which one would you chose? Why?

Exercise 3 specific question:

- What would be the ideal text message to communicate a nuclear emergency?

With students different data collection techniques were used. Three personal interviews were carried out face-to-face, one focus group and two group interviews, depending on their availability and their schedules. The procedure was very similar to the one followed with experts. In the case of this face-to-face data collection, a PPT file was projected during the focus group session while printed material was used in the case of interviews. All participants fill in the given materials. Written notes were taken and the sessions were audiotaped as well. The focus groups with students had a duration of 60 minutes, the average duration of the interviews with students was 24 minutes, and the average duration of the interviews with experts was 44 minutes.

In Greece, the workshop was organized on June 4, 2019 in EEAE premises in Athens, Greece. The number of students-participants was 15 (9 male – 6 female). It was held in the Greek language, however the material tested (map & text messages) were not translated to the Greek language. The communication tools under testing were presented on screen and were also distributed in print copies to the participants. The workshop was facilitated by Ms. Vasiliki Tafili, with the help of Mr. Sotirios Economides. The workshop was not considered necessary to be recorded. Notes were kept throughout the workshop by Ms. Evgenia Mestousi and Ms. Vasiliki Tafili. The workshop agenda included 4 distinct parts:

- A session of short introduction of CONFIDENCE project, with emphasis on the work of the WP5 and the subtask of testing communications tools used in nuclear emergencies.
- Presentation of the text messages and discussion divided in 2 parts: general and specific questions/discussion.
- General discussion – closing of the workshop.

NMBU collected input about an example of SMS messages (see Figure 18) through direct interaction with the participants, input via a menti.com questionnaire and through post-it notes and printouts of the messages where they could write their suggestions and questions. Main questions proposed were:

- What would your immediate reaction be to this message?
- Is this message appropriate as a means of informing the public?
- How could this message be improved?
- What would be the most trustworthy source in your country?

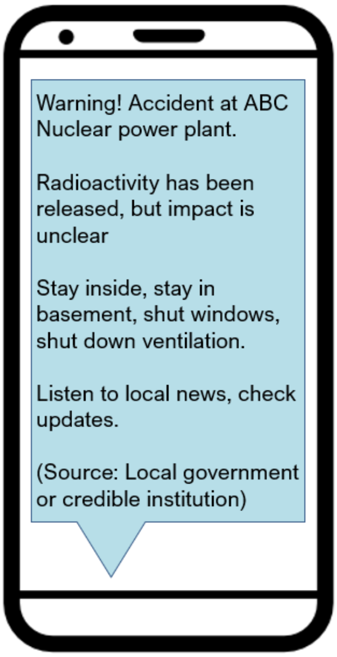


Figure 18 – The example of a text message discussed with participants of the ERPW2019

6.1.3 Analysis

The discussion were transcribed and analysed qualitatively in order to derive conclusions and recommendations.

6.2 Results

Results section summarises national reports (see annexes) written by Sala R., Tafili V., T. Perko and Oughton D.

The test carried out in Spain shows that the proposed text messages are well understood by participants, and most of them (except those messages containing less information) are well accepted and perceived as useful for informing the affected population in case of a nuclear accident.

In general, participants prefer those messages containing exhaustive information. Despite they are aware that the more concise the better, they claim especially for comprehensive information about what to do. The information source also appears as a key issue when informing. In the view of many of the participants, it transmits legitimacy and trust in the information provided. In a similar sense, the idea of transmitting proactivity is very well valued by participants ("we are working on it despite not yet confirmed"). The need to include something to get further information (for instance, a phone number or a link) is also highlighted.

Thus, from this qualitative test in Spain, the ideal message should contain information about what is happening, what to do, and how to get further information, together with the information source that is expected to be official and trustworthy.

Regarding uncertainties expressed, some participants suggest that sometimes specific parts of the messages can create greater alarm among the population. So that, it looks really important to consider in-depth each word of a text message.

Some differences among experts and students can be pointed out. While experts seem to prefer "not yet confirmed" instead of "likely released", students prefer "not yet confirmed" and give interesting reason for it. Similarly, while experts prefer not to start the messages with "Warning!" (arguing that it can cause alarm), students claim to do it, in order to get the attention of the population. These differences should be investigated further.

The test carried out in Greece shows that:

- It was proposed to include a reference of the competent authority
- they would like to see a message developed on the principle of graded approach: they would send up to 3 messages in a time frame of 2-3 minutes, saying: what is happening, providing details on what happened and details on what people need to do.
- Regarding the length and the writing style of the text messages, participants highlighted that there is no need for long texts, and asked for short messages with clear instructions.
- Participants disagreed on the number of the text messages required to convey effectively the initial information about a nuclear accident. They view that only one sms is not adequate was initially expressed.
- There was a consensus among all students that "I do not know" is something that cannot be said/expressed in a text message during a nuclear emergency ("Release of Radioactivity and impact unclear"). For the majority of the participants, the "I do not know" means dishonesty on behalf of the authorities. Furthermore, the argument that, in case of high uncertainty, advice should be given according to the worst case scenario was expressed.

The test from NMBU shows that immediate reactions to the message varied between the participants. Those who were familiar with such communication tool were more likely to follow the advice given in the message. Participants from countries where text messages are not used for emergency communication or where trust in governmental institutions and authorities is low would treat the message with suspicion and turn to other sources for confirmation (e.g., from people who reside in the areas close to the accident source).

Participants in general agreed that emergency text messages could potentially be a good way of informing public. However, for the countries where such systems are not yet in use, some communication will need to be done to warn, prepare people that such systems are active and will be utilized in emergencies.

As the initial reaction many participants suggested that the first thing they would think about would be their children (or pets). It was noted that the reaction would be very dependent on which time of day the message came through – during a weekday when everybody was at work and separated from family, or on a Sunday morning when families were likely to be together. Specific messages would have to be developed for schoolteachers, doctors etc.

Among things that could be improved participants suggested:

"Warning! Accident at ABC Nuclear power plant. "

- Include location of the accident, people don't know where all the different NPPs are
- Google maps link
- Time of the accident

" Radioactivity has been released, but impact is unclear"

- State that responsible actors have started measurements
- "Radioactivity has been released, experts are working to assess the impact" or "radioactivity has been released, experts are working on reducing the impact"
- "… impact is unclear but we are working on it"
- "Emergency organisations are working on it and will inform you ..(give time).."
- "impact is unclear" should be removed as it might scare people. Perhaps a range could be given (e.g. low-medium) and when more information will come

"Stay inside, stay in basement, shut windows, shut down ventilation. "

- Including more information/advice for those that have to go to work or have been outside
- Not all people have basements, so saying "stay in the basement" might frighten those that don't have one. Exchange with something like "stay as low in your house as possible"
- Add "seal windows"
- If fireplaces or fire-based heating systems are common in the country, one should inform people to stop them as fire uses up oxygen.
- What about drinking water

"Listen to local news, check updates."

- Include a link to the website (or twitter, Facebook account) with updates
- Link to more information
- "Follow local news" rather than listen to. It might not be a radio

(Source: Local government or credible institution)

- Depends on who you ask (UK)
- Local governments should not be informing in this situation, it should be radiation protection authorities (Norway)
- Hopefully support organization to decision maker (CZ)
- Don't know

Participants showed a difference in opinion as to whether this emergency messages would be too scary or too friendly. Some participants mentioned that regular updates should also come through text messages, especially with regard to "unclear impact", including a message once it's "safe".

<u>The test carried out at the CONFIDENCE training course</u> shows that receivers of the SMS wished to have more information made available. They suggested to include hyperlink to more information in the SMS. The information in local language has been translated by google translate. In addition, receivers of the SMS consulted google maps to locate the emergency and assess the distance. In general, the SMS with aprox. 200 characters was perceived as the best option. The most accepted uncertainty expression was "Release of radioactivity not yet confirmed'.

6.3 Conclusions

Looking at results from various country reports, the views from people vary significantly when looking at the perfect character of a SMS and used for emergencies and warning. A good SMS shuld be of medium length, as a general rule. A very short message reduces the message to a minimum, which could cause confusion freight, a long one could lead the receiver to misinterpretation and a limited uptake of the information.

Pointing to different languages and cultures in Europe, a one-fit-all-solution with a unique character of a SMS seems not feasible. SMS should be designed individually and tailored for each country and also each nuclear power plant.

In the early phase of an emergency, communicating unclear or uncertain information like extent of damage and release of radioactivity is recognised, but needs frequent updates (like sending several messages) and additional communication means.

The findings from Spain, Sweden, Slovak Republic and Greece highlight the need to continue testing information messages for nuclear emergency communication, maybe with experimental methods, in order to be better prepared for a future accident. Both the content of the messages and the preferred channels (SMS, WhatsAPP…) should be further investigated. Besides, the tests with SMS messaging show that it is necessary to consider both experts and the population, as presumable relevant differences exist among them.

The most accepted uncertainty expression was “Release of radioactivity not yet confirmed’.

7 Video to address risk perception factors in the waiting rooms for thyroid measurements

Perko T., SCK•CEN

7.1 Context

On August 22nd 2008, ^{131}I was incidentally released from the Institut des Radioelements (IRE), a producer of medical isotopes located in Fleurus, Belgium and this release continued for several days. The Belgian public health authorities organised a thyroid measurement campaign on 1-2 September, especially for small children and pregnant women in order to respond to the concerns among the local population about the possible health effects (Perko, Thijssen, Turcanu, & Van Gorp, 2014). SCK•CEN was asked to perform the thyroid measurements. SCK•CEN provided 4 out of the 5 measurement teamsin total, the teams were equipped with high-purity germanium detectors. All detectors had been calibrated in advance and were checked regularly during the measurement campaign (Van der Meer et al., 2010). More than 1000 people were measured, including all children from the local schools. No thyroid contamination was detected (FANC, 2008).

One of the main lessons learned in the two days long measurement campaign was that more attention should be paid to communication in the waiting rooms.

Waiting room was a bottleneck of the emergency (Figure 19). People, mainly pregnant women, young parents, children were waiting for hours to be measured. Most of them didn't know what radioactive iodine is, what they will be measured for, by whom and how. The atmosphere in the waiting room was stressful and gave the affected population feeling of uncertainty (Perko, 2015).

Figure 19 Waiting room during the measurements (Source: Belga pucture)

After the event, the experts providing the measurement concluded that communication should be prepared in advance and should be a part of the overall measurement strategy. Therefore, they suggested to actively provide information about topics like health effects of radiation and radiation measurement principles. This information material should focus on various target audiences (children, pregnant women, teachers and general public) and be disctributed already in a waiting room (Van der Meer et al., 2010).

The following questions from local residents were reoccurring:

- What and how are experts going to measure?
- How to explain that the expert is going to measure the possible existing radioactivity in the body and will not be exposing the measured person to radiation?
- What does mSV mean?
- How to communicate with pregnant women in order to address their concerns?
- How to explain the results of the measurements? (most people don't know that body itself contains some radioactivity)
- What is iodine, radio-iodine or cesium ^{137}?
- What are iodine tablets and why shouldn't one take them immediately?

7.2 Risk perception factors

Communication needs to address risk perception factors. The figure bellow presents how the above described radiological accident was perceived by the Belgian population and specifically, if there were any differences in the perception of an accident at a nuclear installation between the general population in Belgium (N=1035) and the population that has been exposed to the radiological accident (INES=3) in 2008 in Fleureus, Belgium (N= 104).

Figure 20 shows that a nuclear accident is perceived as strongly feared event with fatal consequences, that a nuclear accident has delayed effects, is a result of a human tampering with nature, is perceived as rather unknown to science and unknown to exposed people. Interestingly, we did not observe any strongly significant differences in risk perception of an accident between the general population and affected population, except for the 'catastrophic potential' factor, where affected population perceived a nuclear accident as less catastrophic than general population and for 'unknown to science' factor, where affected population perceived a nuclear accident as more unknown than general population.

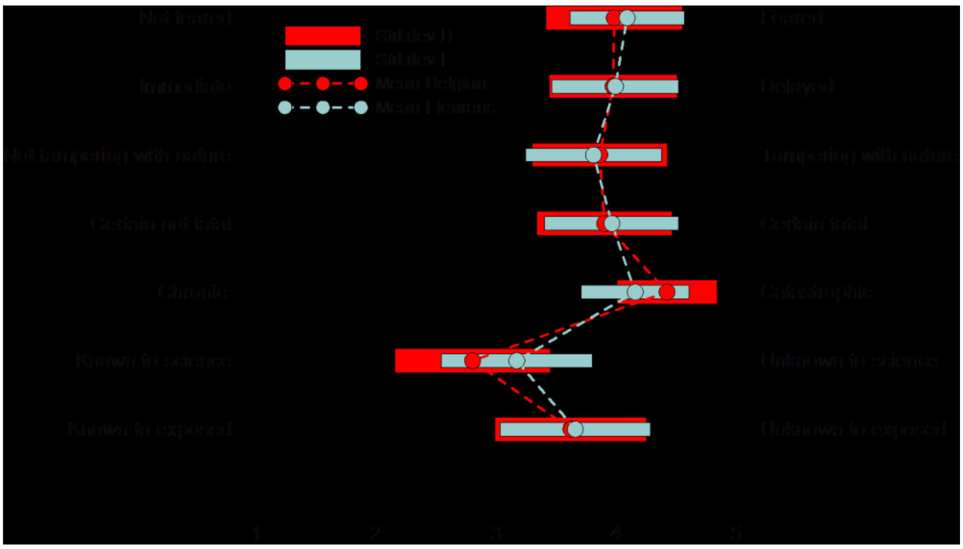


Figure 20 Risk perception of an accident at a nuclear installation in Belgium; Differences between the general population (N=1035) and the affected population (N=104)

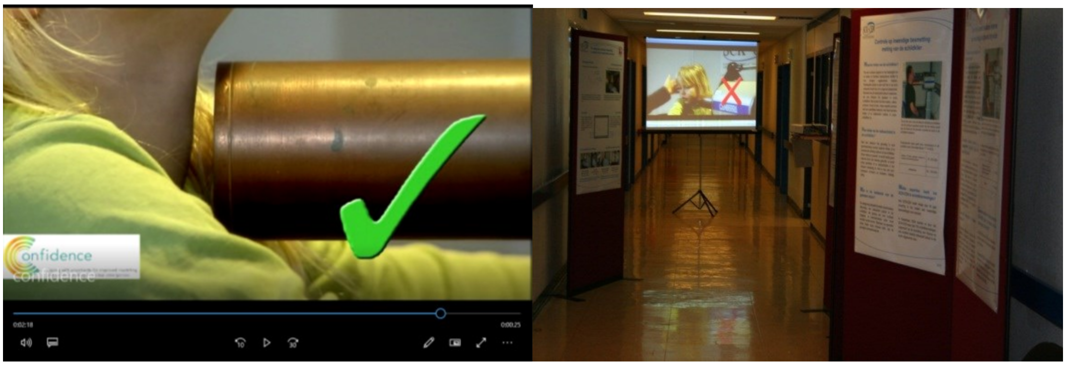
7.3 Video

The video was developed with an intention to use it during the most critical moment when a critical mass of affected people is waiting for the measurements of the potential uptake of the radioactive iodine in the thyroid. It can be projected in an evacuation center, a waiting room, a decontamination center, an internal contamination measurements place. The video can be projected in a waiting room, so that people in a stressful situation get visual information on how the experts are going to measure potential radioactivity in their body and what exactly will they be measuring. It presents competences and expertise of the team, the procedure of a measurement; shows the detector, the position in which the measurement is taken, demonstrates that it is not dangerous (presents a child being measured) and most importantly, the video demonstrates what people can do to prepare themselves for the measurement.

By this short video, most of the risk perception factors are addressed: people get familiar with the measurement procedure, they get control over a situation, fear of effect on children is diminished and trust building process between the affected person and the measurement expert is established before they meet.

The video is accessible at: https://player.vimeo.com/video/368520124

Figures below represent the snapshots of the CONFIDENCE video



7.4 Conclusions

Previous experiences with nuclear or radiological emergencies show that waiting rooms are bottleneck of emergency management. Uncertainties in waiting rooms can be partaly addressed by communication. Communication for waiting rooms should be developed and tested in advance, before an emergency occurs. Communication tools for waiting rooms can be in different forms, from pre-prepared face-to-face answers on frewuently used questions, to printed material, for instance leaflets and posters, and audio and video material. Thee CONFIDENCE video related to thyroid measurements addresses all psychometric risk characteristic and mediate in a trust building process between the affected pople and experts. The video is open source and available on the internet.

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8 Annexes

8.1 Research protocol for testing of communication tools

Summary

This study focusses on communication tools, how these can be developed and improved in the case of a nuclear emergency, and how uncertainty information can be included so that the stakeholders and affected population gains a better understanding of the crisis situation and is better equipped to take the appropriate actions.

In order to gain new insights and gather evidence, Confidence partners organized six stakeholder workshops in Spain, Belgium, Slovak Republic, Slovenia, Greece and Norway. Main areas to discuss and reflect are: text messages, visual aids and maps, as well as apps that are designed for warning people in case of emergencies or disasters. These workshops will include key stakeholders from the area of radiation protection, emergency management and communication.

Introduction

In the case of a nuclear accident, public authorities and other institutions in charge need to reach out to the affected and non-affected population, giving accurate, unbiased and truthful information about the radiation exposure, the areas that are likely to be affected and potential protective measures. Of special interest are recommendations for actions such as sheltering, iodine intake and evacuation. Here, experts see that the content of messages, the design of the communication and the channels play a central role for avoiding unnecessary harm to the population.

It is widely acknowledged by experts and stakeholders that in the case of a nuclear emergency the public expects and seeks for reliable, precise and transparent information about the current situation. Details should be provided by a trustworthy source and updated regularly.

A part of a literature study carried out recently, around 80 communication tools could be identified and structured into various categories. In a broader sense, the existing tools differ significantly in their use, goals and target, but yet promising new approaches for nuclear emergencies refer to an increased use of visualisation, digital tools and combinations thereof (Benighaus et al. 2018).

In the aftermath of the Fukushima accident 2011, many municipalities and state governmental agencies developed and tested new web-based tools and digital apps. These give detailed and tailored information to be better prepared for a major accident, to provide real-time measures of the background radiation and to suggest protective actions. In Europe, numerous apps also exist that are designed to warn the population about risks and accidents more broadly (Nishizawa 2018).

So far, there is little empirical evidence how well these new communication tools fare in comparison with traditional warning systems such as brochures, radio and TV messages and sirens. There is also much controversy among experts about the effectiveness and reliability of these new tools.

Modern means of communication and digital channels have the potential to play an important role in the interaction between emergency management, science and various target audiences. Last, but most important, it can better visualize and explain sources of uncertainty, point to measurement or model weaknesses, and highlight the ambiguities in making prudent judgements for appropriate actions.

Beyond nuclear emergencies, there are many more established warn apps for informing people about natural or other technological hazards. They inform and alert users about major incidents, like floods, earth quakes, fires in the neighbourhood, or any other risk or potential harm one can experience. It is possible to draw analogies from the experiences with these general warning apps to their application in the field of nuclear emergencies.

DIALOGIK (Germany) and SCK-CEN (Belgium) will carry out a study and engage with Confidence project partners in analysing communication tools. The planned study intends to discuss and review text messages, maps, existing digital tools like warn apps, digital maps and social media approaches with experts and stakeholders in various countries in Europe.

Up to six internal workshops with Confidence project partners are planned to shed some light on the feasibility and usefulness of digital tools on the local, regional and national level. The emphasis here will be on the techniques, methods and procedures to include uncertainty in the communication material. This study will be part of the work package 5.3 of developing and testing communication tools (5.3iV).

Theoretical background

Addressing scientific and societal uncertainties in a nuclear emergency during pre-and-post radioactive release is not only relevant for decision-making, but also for the affected public in its various constituencies. Therefore, developing tools to deal with communication about uncertainties, be it of technical or social nature, is crucial to convey an accurate understanding of the situation and to improve protection. The goal of communication is to enable and empower informed decision making by the affected population.

Different interpretations of uncertainties are acknowledged in the CONFIDENCE project. The uncertainty as defined in the CONFIDENCE project "can include stochastic uncertainties (i.e. physical randomness), epistemological uncertainties (lack of scientific knowledge), endpoint uncertainties (when the required endpoint is ill-defined), judgmental uncertainties (e.g. setting of parameter values in codes), computational uncertainties (i.e. inaccurate calculations), and modelling errors (i.e. however good the model is, it will not fit the real world perfectly). There are further uncertainties that relate to ambiguities (ill-defined meaning) and partially formed value judgements; and then there are social and ethical uncertainties (or ambiguities) (i.e. how expert recommendations are formulated and implemented in society, and what their ethical implications are)" (French et al., 2018, c.f. French 2017).

The following definition of uncertainty is used in the project: "Uncertainty is a situation which involves imperfect and/or unknown information related to the investigated nuclear emergency case. Uncertainty is the lack of certainty, a state of having limited knowledge or information where it is impossible to exactly describe the existing state related to the emergency, a future outcome, or more than one possible outcome including consequences. Due to a lack of knowledge or lack of trust in the validity and reliability of the information, the emergency professionals face the difficulty to make informed decisions what to advise or what not to advise, how to react and what actions (advised or not advised) they should take. In such situation stakeholders need to make decisions under uncertainty" (Perko and Abelshausen, 2017).

Research proposal

Frame

Confidence project partners in Belgium, Greece, Slovenia, Slovak Republic, Norway and Spain will conduct one stakeholder workshop each with up to 10 persons. Participants will bring in their expertise from the field of nuclear radiation protection, communication and emergency management. The main objective is to collect, discuss and process expert knowledge from different European countries. DIA and SCK-CEN will coordinate the work together with the project partners, analyse the results and elaborate the report.

Goals of the Stakeholder Workshops

In the countries of the project partners, the workshops all follow the same approach and aim at evaluating warning messages, visual aids and maps, as well as warning apps for their use in nuclear emergencies, with a special focus on communicating uncertainties as part of the messages.

Project partners

The following partners will be involved in this study and the conduction of the workshops (see appendix for more details):

Short name	Partner	Role
DIA	DIALOGIK Stuttgart, Germany	Proposal, analysis and report
KIT	Karlsruhe Institute for Technology, Germany	Elaboration of maps and tools
SCK•CEN	Belgian Nuclear Research Centre SCK•CEN	Proposal, analysis and report, workshop
NMBU	Norwegian University of Life Science	Workshop
VUJE	Department of Safety Analysis, Slowak Republic	Workshop
EEAE	Greek Atomic Energy Commission (EEAE)	Workshop
CIEMAT	Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas, CIEMAT, Spain	Workshop

Target group and participants

The participants will be experts from radiation protection agencies, safety officers in nuclear power plants, communication and engagement specialists, as well as professionals in web-based communication.

Research questions

During the stakeholder workshops, the researchers intend to respond to the following questions:

Text messages

- How does the ideal (perfect) text message for various stages of a nuclear emergency look like?
- How should a text message be designed to show and express the various types of uncertainties, while at the same time providing enough certainty that people will take the required protective actions?
- What kind of uncertainties can and should be communicated? Who decides about what to include and what to leave out?
- Which aspects of uncertainty are likely to be misunderstood and how can improved communication deal with it?

- How can communication avoid the well-known cognitive biases when dealing with probabilities and other measures of uncertainty?

Area of maps and visual aids:

- How should maps or other visual aids be designed that they become suitable for communicating nuclear preparedness or emergency responses?
- What are the main elements a map should contain? What should be included, what excluded to avoid cognitive overload?
- How should uncertainties be visualized in the map? What kind of uncertainties should and can be expressed in maps?

Web-based Apps:

- How should web-based apps be designed to reach the target groups and be used as intended by the provider?
- Who will use these apps? How can different target groups be reached?
- What specific requirements are requested for nuclear emergencies?
- What analogies can be drawn from well-established apps in other areas of emergency and hard information have compare to standard warn apps? Is there an option to combine them?
- What are special features of apps (such a constant updating) that facilitate information about uncertainties?

Method

- Face-to-Face-Workshops or Online-workshops as a web-Seminar
- Brief input on each of the three topics mentioned above and discussion
- Reaching a consensus or a conclusion on the questions raised above

Documentation and report

- Summary report of each workshop, and audiotape (if possible): Project partners provide a country report (7 to 10 pages)
- Deliverable for the Confidence project: DIA and SCK-CEN will analyze and summarize the country reports

Outline of the Workshop Agenda

Main topics, focussed on nuclear emergency and uncertainty communication:

- Decision making tools (Rodos), mapping solutions and visualisations
- Methods to address various forms of uncertainty
- Effective means of communication and reach out to public, including apps
- Recommendations for improving the existing communication tools and practices

Expected results of this study

The research will engage a number of experts from up to six countries. Their task is to assist in gaining new insights and practical advice of how to improve communication in a nuclear emergency with special emphasis on uncertainty.

The researchers will draw on the theoretical and practical expertise of professionals in the fields of nuclear emergency management, communication and web-based messaging. The experts will evaluate different approaches for communication, provide advice on how to improve the present practice, including specific recommendations for covering uncertainty, and to assess the applicability and usefulness of web-based tools and apps for this purpose. Furthermore, the results will serve as a basic reservoir for drafting communication guidelines.

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Schedule of workshops

Attached readers find a draft of the agenda for the workshops in each of the countries. To enable comparisons and cross check, these main topics and examples of tools should be followed, but discussions can vary slightly. If possible, the workshop should be audio-taped to enable a detailed documentation.

Agenda Confidence workshop Communication tools

Chaired by: NN project partner from Confidence

Participants: Internal, colleagues engaged in the field of radiation protection, emergency management and preparedness, also external experts from the same field

Venue	Date and timing
Premises of the project partners (face-to-face) Or Online, via Web-Seminar	Up to 2 hours, February till Mid-March 2019

Goals of the workshop

- Discuss and review communication and messages in case of a nuclear emergency

Agenda

0.00 Welcome and Warm-up (Host and facilitator)

0.10 Communication in nuclear emergency in (Country name), in Europe and International

- Status-quo communication and practice in each of the partner countries in nuclear emergencies
- Brief exchange of experiences and viewpoints from the participants
- Methods, tools and techniques to address and explan various forms of uncertainty

0.20 Session 1: Design of text messages

- Presentation of message: Appropriate message design for each stage and phase of a nuclear emergency (pre and post disaster)
- Working questions:
  - How does a person living near the power plant perceive nuclear risks and radiation?
  - How will he/she most likely behave?
  - What is missing in the existing text messages?
  - What could easily be misunderstood or misinterpreted?
  - How are the various aspects of uncertainty addressed and explained?
  - Is there any evidence about how these uncertainty messages are understood and perceived?

- What is needed now for a further development of written information? What needs to be improved?

0.45 Session 2: Maps and visuals

- Presentation of existing emergency maps
- Working questions:
  - Is there any evidence of how these maps are understood and used by the targeted audiences?
  - What are the potential advantages of a map compared with other means of information?
  - How should visualisation of maps be designed to reach the desired effects?
  - How are the various aspects of uncertainty addressed and visualized in the maps?
  - Is there any evidence about how these uncertainty messages are understood and perceived?
  - What is needed now for a further development of maps? What needs to be improved?

1.15 Break

- Informal gathering

1.30 WEB-based tools and apps

- Presentation of existing tools (Tools and examples from Japan and Germany)
  - What is your impressions after you have seen the examples from Japan and Germany?
  - What do you think about using these tools in your country,
  - Do you believe that these apps are also appropriate for communication on nuclear power plants and emergencies?
  - How do you see the added value of digital communication tools compared to the established fomrats of communication?

  Where do yoiu see the potential for these tools, and where do you see problems?
  - How are the various aspects of uncertainty addressed and visualized in the apps if at all?
  - Is there any evidence about how these uncertainty messages are understood and perceived?
  - Would you see a special potential of apps versus other tools that make them more suitable for conveying uncertainty information (for example being able to update information constantly)?
  - What do you recommend for further development of communication tools?

1.50 Summary and closing remarks (if possible, extend for finding areas of consensus)

- New insights, transfer into practice, what needs to be done, key points for further development of communications tools (Host and facilitator)

2.0 Termination of the workshop

8.2 Case study Slovak Republic: testing maps

Tatiana Duranova, VUJE, Slovak Republic

Slovak national workshop on Tools approaches for improved communication of uncertainty in emergency situations and Visualisation of uncertainties

- **General organisation of the workshop**: duration, description of the stakeholder group, programme and organisation of discussion
- **General questions**:
  - How should maps or other visual aids be designed that they become suitable for communicating nuclear preparedness or emergency responses?
  - What are the main elements a map should contain? What should be included, what excluded to avoid cognitive overload?
  - How should uncertainties be visualized in the map? What kind of uncertainties should and can be expressed in maps?
- **Specific questions to the map that was provided by JRODOS team**:
  - Is there any evidence of how these maps are understood and used by the targeted audiences?
  - What does it show? How do you interpret the information that is given?
  - Look at the legend: What is OK for you, what information is missing?
  - Look at the colours, any areas of improvements?
  - What kind of measures would you put forward based on this map?
  - What are potential advantages of a map compared with other means of information?
  - How should visualisation of maps be designed to reach the desired effects?
  - How are the various aspects of uncertainty addressed and visualized in the maps?
  - What is needed now for a further development of maps? What needs to be improved?
- **Additional specific questions from JRODOS team to additional maps**:
  - Is the information displayed (likelihood) useful to you?
  - Is it understandable (without manual/explanation)?
  - Is it understandable (with manual/explanation)?
  - Use of transparency ok/helpful?
  - Use of colour gradients ok/helpful?
  - What colours to use? Grayscale? Predefined? Generated
  - Prefer smooth or grid cell view?
  - How many steps in legend?
  - Should the information be aggregated, i.e. create isolines, isoareas, maximum/minimum, predefined multiple images e.g. 3 images with single color for >30%, >60%, >90%?
  - Add default additional overlays of information like main wind direction, time interval, road map...? (some may already be available in JRodos)

- Single images i.e. 20 ensembles = 20 maps to present? (probably not feasible with larger ensembles)

- **General discussion**

WP5.2.4&WP6.2 Slovak stakeholder workshop, 5.3.2019

General organisation of the workshop

CONFIDENCE WP5.2.4 & WP6.2 Slovak national workshop on Tools and approaches for improved communication of uncertainty in emergency situations and Visualisation of uncertainties was held in March 5, 2019 with proceeded workshop of WP5.3 in March 4, 2019 on Stakeholders preferences and priorities for future uncertainty management at national level.

The workshop took place in the premises of VUJE in Modra-Harmonia where majority of participants have been accommodated.

There were 21 participants representing different groups of stakeholders as follows:

- Nuclear Regulatory Authority (NRA SR)
- Public Health Authority (PHA SR)
- Civil Protection and Crisis Management Offices at national (Ministry of Interior – Civil Protection and Crisis Management Division), regional level (Trnava region - Bohunice NPP, Nitra Region - Mochovce NPP) and municipality level (Piestany Municipality, Bohunice NPP)
- Police (regional directorate of Trnava and Nitra regions)
- Slovak Medical University in Bratislava (monitoring network and education)
- Police Academy (Public Administration and Crisis Management)
- Slovak Hydrometeorological Institute (monitoring network)
- VUJE, Technical support organisation.

The panel was composed of usual decision-makers involved at different levels of the emergency preparedness, response and recovery management activities.

The workshop was organised according to the agreement among the research teams from WP5.2.4 and WP6.2. The main goal of the workshop was to discuss and test the maps used as communication tool and to receive feedback on visualisation of uncertainties. The facilitation team was composed of Tatiana Duranova and Jarmila Bohunova from VUJE. Recording was made during the discussion by Jarmila Bohunova in parallel to the audio recording (was not of high quality at the end and was not possible to use it for report preparation).

The workshop was organised in three parts:

1) First part was dealing with general questions,
2) Second part was dealing with specific questions using the map on likelihood on required sheltering
3) Third part was dealing with additional specific detailed questions given by JRODOS developers' team.

General discussion closed the workshop.

Stakeholder's direct citations and quotes are given in *Italic*.

1) **General questions**:
   - How should maps or other visual aids be designed that they become suitable for communicating nuclear preparedness or emergency responses?
   - What are the main elements a map should contain? What should be included, what excluded to avoid cognitive overload?
   - How should uncertainties be visualized in the map? What kind of uncertainties should and can be expressed in maps?

The map content should be designed under the information included and, more important, under the stakeholder to whom it is designed. *Within the emergency planning and preparedness stakeholders are differentiated, for example map of contamination, if we use not correct colour the panic can occur, on the other side for the advisor or competent authority the colour scale could be designed differently.*

The colour coding should be designed also for those who are colour-blind or have limited or partial blindness.

The basic maps could have format of those used at Google or open street applications or common format for mobile phones as people nowadays are using GPS maps and are not familiar with other maps; *they have no good orientation on maps*. The relief map could be useful. The scale should be given on the map.

There is the pre-defined map content in relation to crisis management under the law in Slovak Republic. Two scales should be used (1:100 000 and 1:10 000) and following elements included at the map:

- Sirens
- Emergency zones
- Evacuation routs
- Sectors (16 sectors)
- Civil Protection objects/subjects/premises/installations
- Check points
- Civil Protection Crisis Staffs and
- Contamination, doses and affected areas with countermeasures suggested.

Only paper maps are used up to now under the law. It is the problem to have paper maps available and to include all information under the requirements in it. The map with so many information becomes unclear and complicated.

The maps should be electronic.

There are or were different software with databases and GIS available but the licences are limited or the databases are not connected to GIS. Some authorities have available particular layers which are exchanged with others but the information is not complex at one place. Even within the Ministry of Interior there is not agreement between different branches on use of maps and data (Police, Civil Protection and emergency planning).

The exchange of information in the area of Civil Protection is done from top (District, regional level) down (municipalities, local level). The Decree specifies the information required and the way how data have to be exchanged, but all is done on paper maps. The persons responsible for maps preparation are trained and prepared for that actions and way of communication. *The problem is with mayors who are changed with new elections. The Civil Protection offices at district level have to ensure the training and preparedness for graphical part of emergency documentation development and preparation. The training is done each 5 years and there is responsible person in municipality for this area of preparedness. Each school within the emergency planning zone (EPZ) should update the Civil Protection emergency plans including maps since 2015*.

Slovak Hydrometeorological Institute could require from World Meteorological Organisation (WMO offices in Toulouse or Redding) contamination maps (also for example for volcanic ash) which are based on calculations with the updated meteorological conditions.

The Police are communicating with Ministry of Transport and Integrated Rescue System,

Nuclear regulatory Authority is sending agreed layers from RODOS and RTRAC DSS in electronic form used as an input for Civil Protection decision support system and also in text form information about countermeasures in particular sectors of EPZ.

It was stressed that *digitalisation and automatic system of maps sharing is needed; it could not remain on paper maps basis*.

The uncertainties related to all data which are changing with time step could be presented on maps. Among them could be meteorological conditions, protective measures, changes of evacuation routs, the availability of resources, population density.

Meteodata could be visualised in time "t" which are certain. If we take into account model results - they have their uncertainties coming from the model parameter's uncertainty. The models have to be validated. Uncertainties presented in graphical form should have +/- values in which range they are changing with time. The map legend could include mini-scale, some table where it will be indicated +/- 20% in plane text.

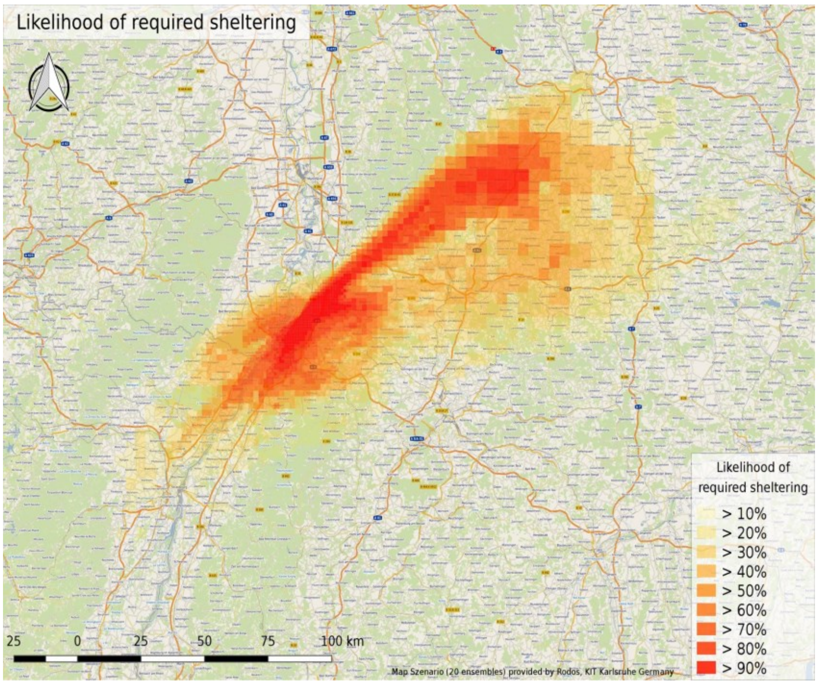
Regarding the monitoring it has to be distinguished on map: data already verified (solid scale) and data unverified (cross-hatched scale).

Regarding the advice on countermeasures (sheltering, evacuation, etc.) it has to be distinguished on map - recommended area for countermeasures and area where countermeasures have been implemented.

Crisis Staff of District for their decisions needs to have information not only on sectors, but also about the villages and towns which are within the sector. *As soon as 1 m^2 from the municipality area is affected by countermeasure, the countermeasure should be implemented within the whole municipality. In relation to civil protection the worst case is taken into account for radiological and chemical accident and within the radius 5 km the whole sector is taken into account when decision on* *countermeasures are made*. Not only constant build-up area from municipality has to be taken into account when decision on countermeasure is made, but the whole municipality, because the responsibility is on the shoulders of mayor also for those, who is on the territory of municipality, for example tramps or newly built-up just in time of the accident. The mayor has to take care about all who is in time of accident at the whole area of municipality.

2) **Specific questions to the map that was provided by JRODOS team**:
   - Is there any evidence of how these maps are understood and used by the targeted audiences?
   - What does it show? How do you interpret the information that is given?
   - Look at the legend: What is OK for you, what information is missing?
   - Look at the colours, any areas of improvements?
   - What kind of measures would you put forward based on this map?
   - What are the potential advantages of a map compared with other means of information?
   - How should visualisation of maps be designed to reach the desired effects?
   - How are the various aspects of uncertainty addressed and visualized in the maps?
   - What is needed now for a further development of maps? What needs to be improved?
   - How should maps or other visual aids be designed that they become suitable for communicating nuclear preparedness or emergency responses?

The following map has been provided for answering specific questions:



The map is misleading, sheltering is deterministically given by the emergency levels, legend is not unambiguous, it is not visible what information is under the "plume".
The map title and its interpretation is not clear, there is no information about the source of uncertainty (data, measurements, model results,…).

For whom this map is? Is it for inhabitants or for advisors and decision makers? How to interpret it? If there is 60% - I will shelter, if it is 30% - should not, will think about it.

It was agreed among participants that the map is suitable for advisors, but is not suitable for Civil Protection officers and is not suitable for population. In general more information about the sources of uncertainties is missing.

As the decision making process is based on the sectors in Slovakia, it was assumed, that in such a situation with given meteorological conditions the area for advised countermeasures will be even wider (central sector and two on left and two on right side in addition for conservativism).

In relation to the Legend it could be good to have in addition the information what is the number of people from population under each of the colour codes representing different level of uncertainty. The colours are not differentiated enough to have the information visible. The isopleths could help. The map info is covered by not transparent layer of colour.

Based on the information given at the map one can say, *when it is 60% we are going to implement sheltering, when it is under that level we will recommend sheltering. But where is that threshold, when we are going to implement, what other criteria? Other say 50% is the threshold for sheltering, fewer than 30% will recommend*.

Taking that into account we can use only two colours in map for public: one - implementation of sheltering, other one - recommendation of sheltering.

Regarding the decision on countermeasures advice the deterministic calculation will be used, the sector in wind direction + two sectors on each side, so the areas with 30% probability will be included as well and in addition monitoring results have to be taken into account. If there is monitoring station in the area with recommended sheltering the sheltering should be confirmed.

The solid sector should be advised for sheltering because people would not accept sheltering in one village and not in other!

The map advantages are: visualisation of current situation in the area, more information at one place, spatial orientation.

The current map should be improved with isopleths included, more contrast colours instead of smooth and hardly differentiated and including of the time information for the current map.

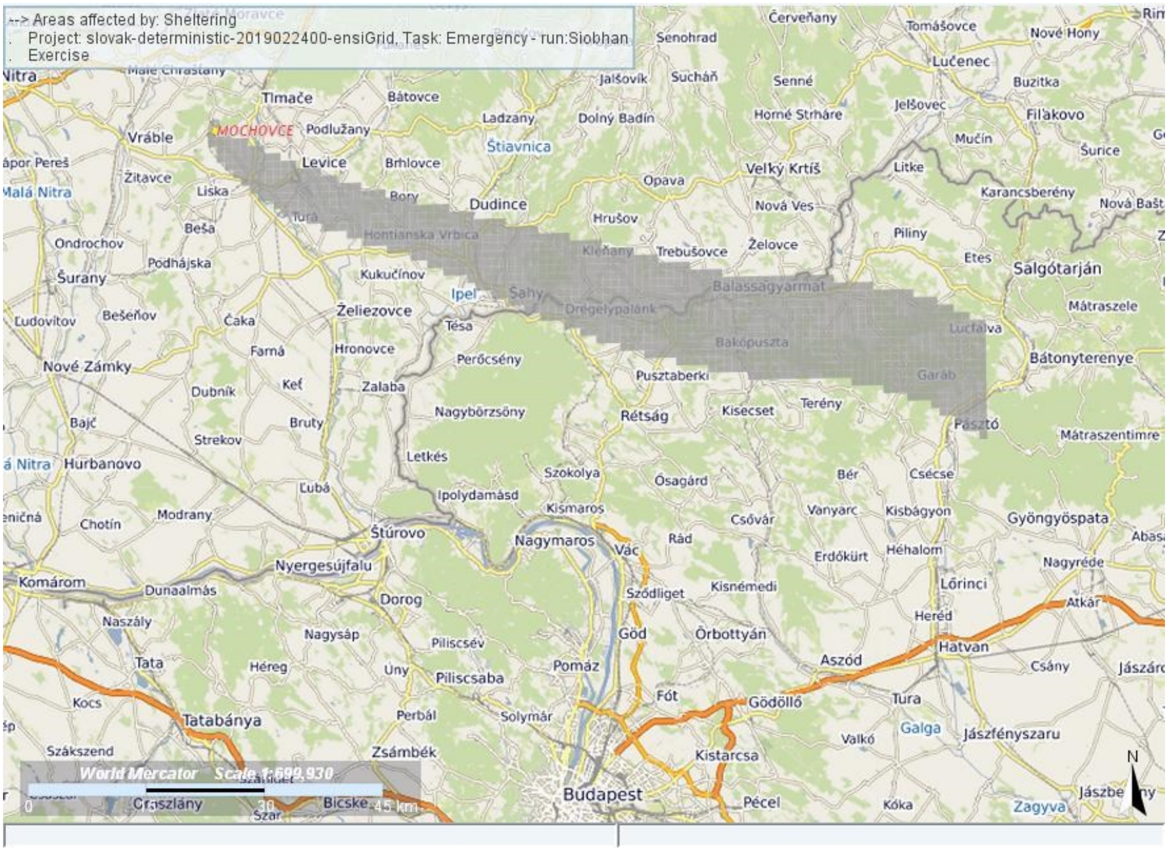
3) **Additional specific questions from JRODOS team to additional maps**:

- Is the information displayed (likelihood) useful to you?
- Is it understandable (without manual/explanation)?
- Is it understandable (with manual/explanation)?
- Use of transparency ok/helpful?

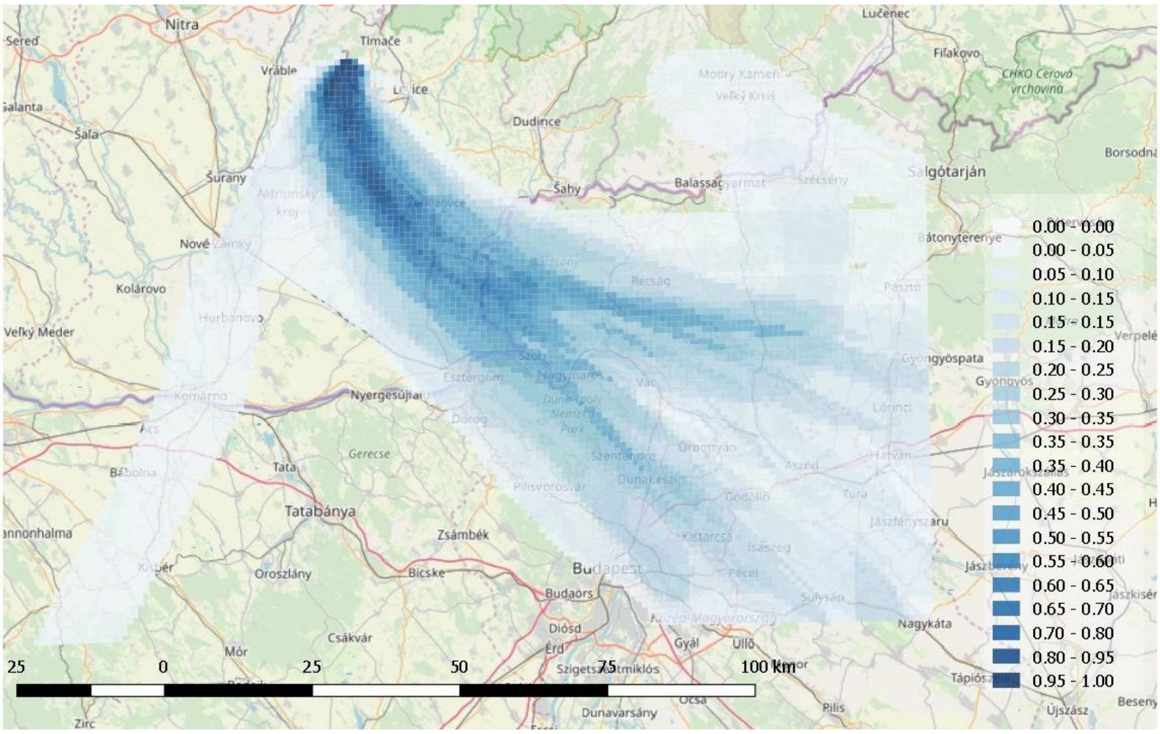
- Use of colour gradients ok/helpful?
- What colours to use? Grayscale? Predefined? Generated
- Prefer smooth or grid cell view?
- How many steps in legend?

- Should the information be aggregated, i.e. create isolines, isoareas, maximum/minimum, predefined multiple images e.g. 3 images with single color for >30%, >60%, >90%?
- Add default addional overlays of information like main wind direction, time interval, road map...? (some may already be available in JRodos)
- Single images i.e. 20 ensembles = 20 maps to present? (probably not feasible with larger ensembles)

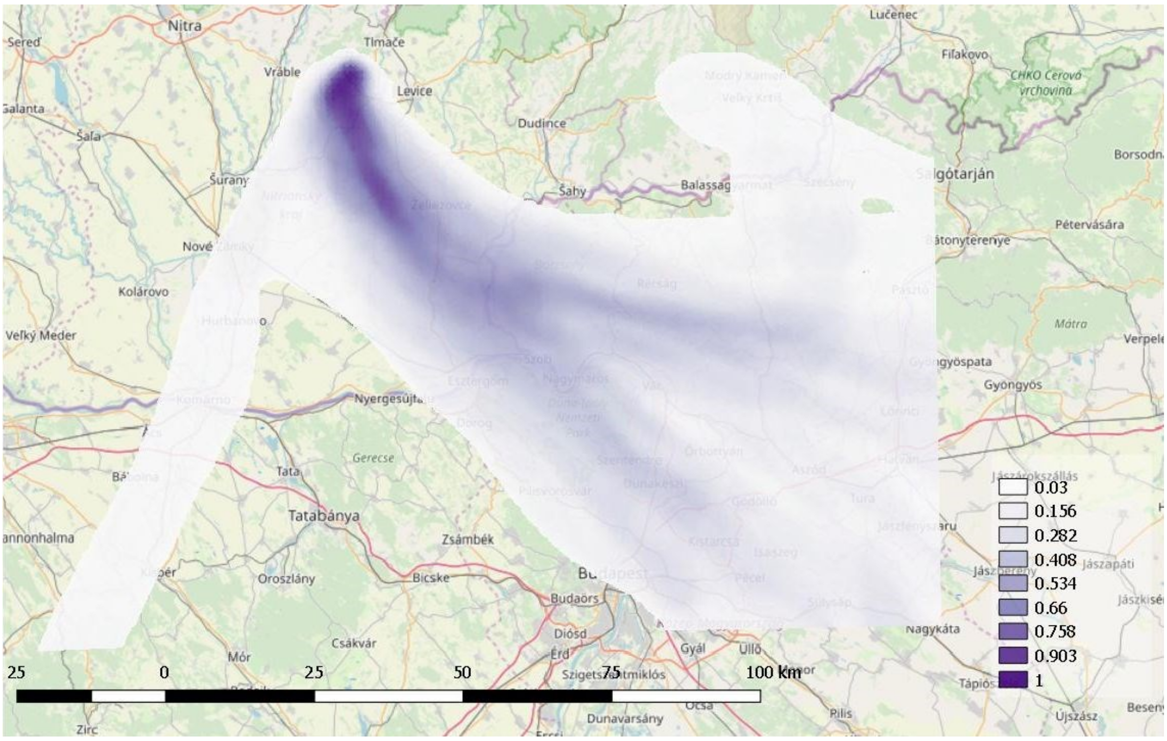
The discussion continued using following maps:



Deterministic calculation



Probability - raster

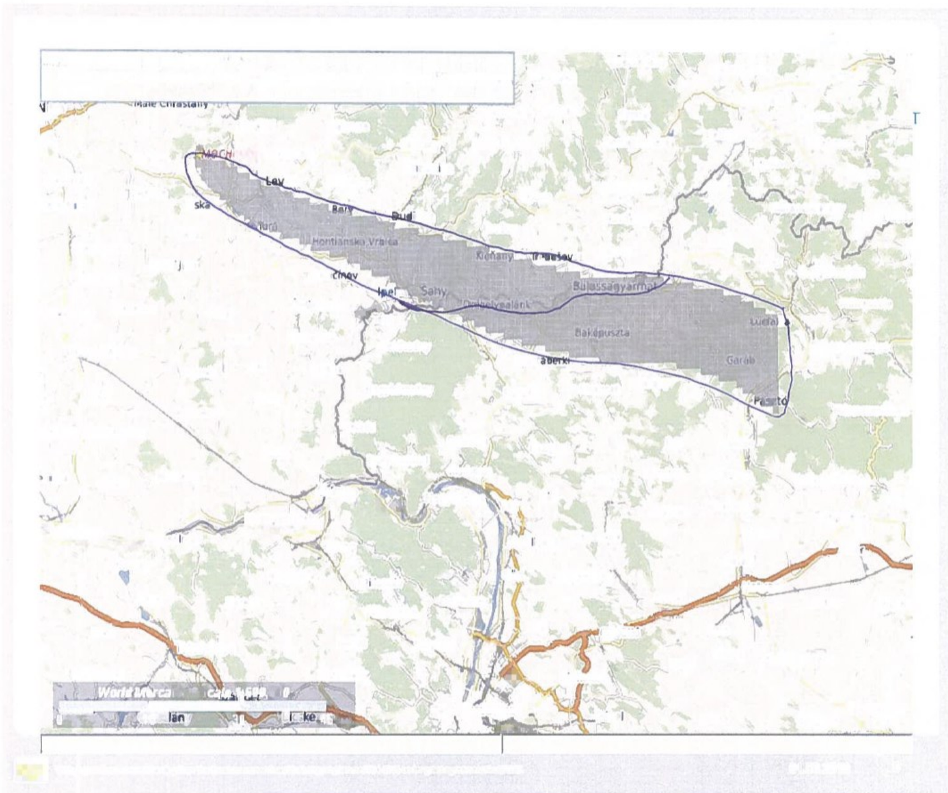


Probability - smooth

The additional specific questions have been discussed using the maps with deterministic calculation and ensemble calculations based on Mochovce NPP scenario.

It was expressed by the majority of participants that it is difficult to understand information about likelyhood correctly without the manual or explanation.

The first map with deterministic calculation shows sheltering which has to be implemented or recommended in the area bounded by grey colour. The map will be useful for decision making on the area where sheltering should be implemented. The Civil Protection representative from the Regional Crisis Staff used the map for further processing regarding the estimation of boundaries as it is shown below.



He has drawn the boundary which represents the area of interest where decision on sheltering should be made. Looking at the map he will go for information regarding the municipalities. Each municipality which is even partly affected by advised countermeasure will be included in consideration as a whole. He has picked up the border line with Hungary and stressed that the National Warning Point which is under responsibility of Ministry of Interior in collaboration with National Competent Authority (Nuclear Regulatory Authority of the Slovak Republic) will contact Hungary representatives and IAEA based on bilateral agreement and international convention on Early Warning System.

It was stressed that such kind of information should be sent in time so other parts have time to prepare the countermeasure and implement it. *Even 3 hours after an accident sheltering is reasonable* was noticed by one participant.

It was stressed the process of the announcement of the emergency classification of incidents and accident at nuclear installation, a 3-level classification, as to severity under the Regulation of Nuclear Regulatory Authority on details concerning emergency planning in case of nuclear incident or accident. The levels of severity are:
1st degree - Alert,
2nd degree - State of emergency on the nuclear facility area,
3rd degree - State of emergency within the nuclear facility surrounding.
The last one is corresponding to General Emergency.

The discussion continued with the probability maps “blue colours used”.

The transparency of maps layers over the GIS data is conditional. *The “blue” maps and colour gradients are much better than the “red” one*.
It was suggested that more colours is better than grayscale.
It was also suggested that the different colours could be used for areas which are under the decision on countermeasures and other one for the areas which will be out of consideration to have it directly visible as a result of advice.
The grid cell view was preferred to the smooth view.
Regarding the steps in Legend that one with fewer steps is more transparent and better arranged.
It was suggested to use “semaphore” colours and put them in relation to >30%, >60%, >90% and as additional information to introduce isolines.
The layers of cities and towns as well as roads should be visible.
Single images - all 20 maps for each ensemble have no sense. It should be good to have in addition to the ensemble maps only one deterministic with the result closest to the real situation.

To summarise the discussion participants expressed shortly their suggestion on changes:

- More contrast colours
- Transparency of layers from calculations,
- 3 intervals in the Legend,
- Provide “deterministic” and probability raster maps,
- Indicating priority zones,
- To add layers of special Civil Protection objects, hospitals, population density,
- Include information on source of uncertainty and meaning of uncertainty in the Legend,
- The borders of countries should be more visible,
- Informative Title of map and scale information.

The workshop summary:

The discussion was very good, everybody contributed. The participants were also solving problems with electronic and hard copy maps which are still in use at regional level and also at the local level. Not all are using electronic form and are passing information in such a way. There is lack in GIS tools at different levels (licence is out of, no money for new development, old tools not compatible with newest, etc). Combination of maps, drawings with affected sectors and accompanying text with indication of villages and areas/districts/municipalities is in use.

Discussion to maps itself was very good and productive. The questions given fits well the discussion.

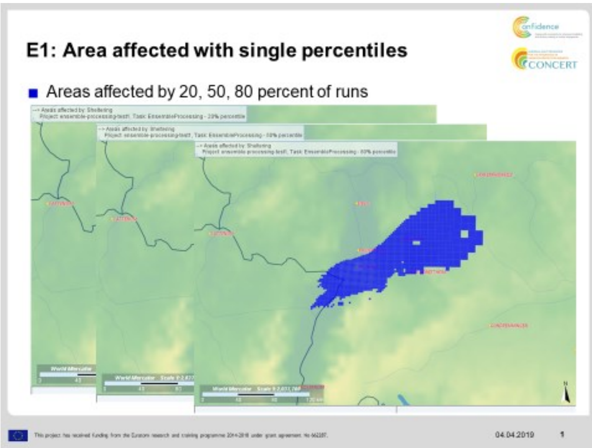
What was missing was introductory presentation with uncertainties influencing the result. It was not enough to say about ensembles. Some participants, especially those from the Nuclear Regulatory Authority who are working with different kind of tools they were interested in more details about the process itself, what is behind uncertainties, how it is processed. They missed that information also at the maps. As they are working with uncertainties in a way that they “conservatively take the worst case” it could be good to have discussion about different sources of uncertainties but also what is the basis. Sometimes it seems they are refusing uncertainties, but on the other hand they are talking about “conservative worse case”. How to define one and another and compare, where the worst case among all uncertain information is and how it is connected or influenced - these areas could make discussion more complex. It could be different with other group of stakeholders. Participants at Slovak workshop were advisors who are preparing information on the basis of different knowledge and then real decision makers who are going to implement countermeasures.

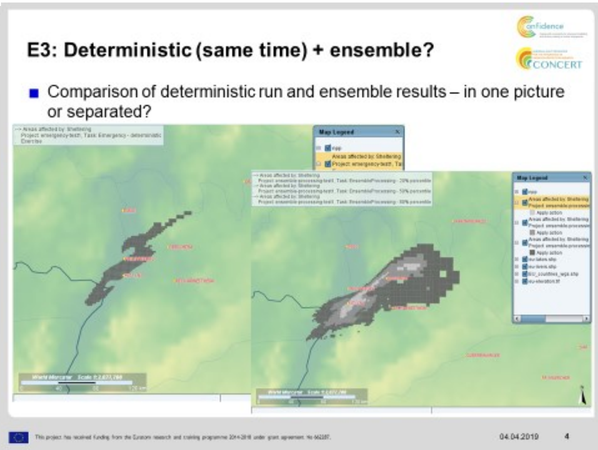
8.3 Case study at Neris Workshop: testing maps

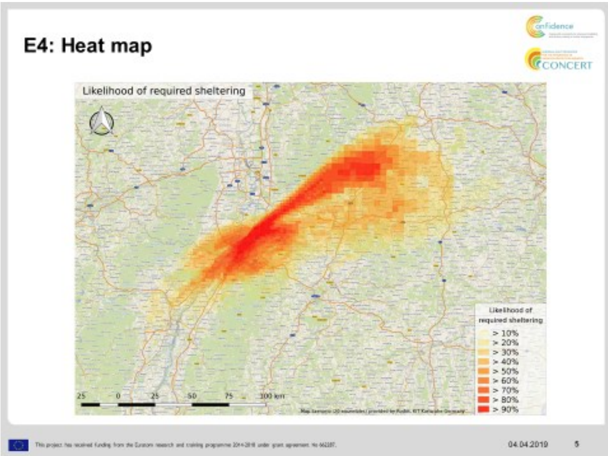
Tanja Perko, SCK•CEN, Belgium

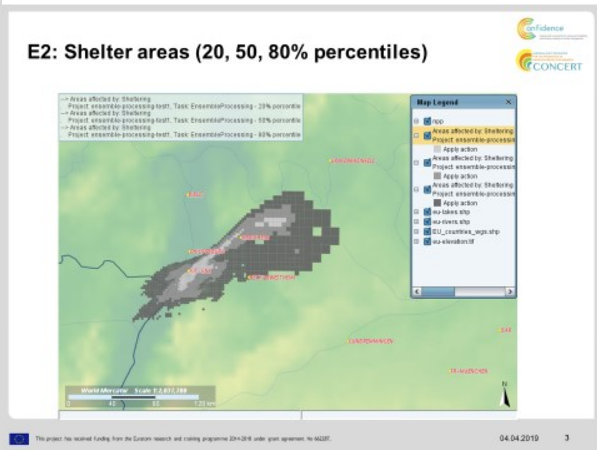
Testing maps (communication tools) ; NERIS workshop, 4th of April, 2019

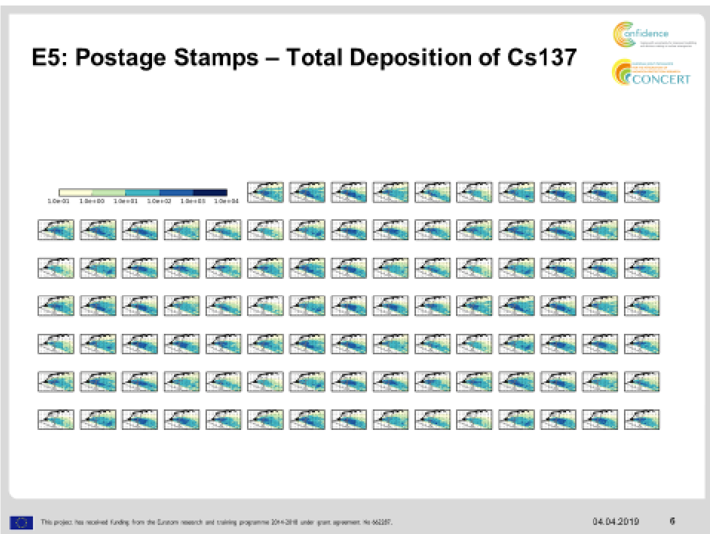
Maps tested:











Evaluation results per respondent (N=19)

Map example: way of visualisation of uncertainties	Can these visulisations help you in decision making? (6 very helpful , 1 not helpful at all)
E1: Area affected with single percentiles	
E2: Shelter areas (20, 50, 80% percentiles) in one picture	
E3: Shelter areas (20, 50, 80% percentiles) in one picture + best estimate assessment	
E4: Heat map	
E5: Postage stamps	

Results:

19 respondents evaluated the maps. Map E2 and E4 got the highest evaluation scores

map																				average
E1	5	4	2	4	4	5	6	6	5	6	4	4	4	2	2	2	2	2	4	3,8421
E2	4	5	4	6	5	5	3	3	2	5	5	5	6	4	3	6	3	3	5	4,3158
E3	3	5	3	5	2	3	2	2	2	2	6	6	5	6	2	5	4	3	5	3,7368
E4	6	3	6	3	6	4	1	3	4	2	3	3	6	5	3	5	5,5	5	6	4,1842
E5	1	3	1	2	2	2	1	1	1	1	1	1	2	1	1	1	1	1	2	1,3684

Discussion in small groups:

- Does the map/result represent an uncertainty of the situation in an appropriate manner?
- Is the approach appropriate?
- Is the colour coding appropriate?
- Does this visualisation help you in your decision making?
- Could you suggest some other visualisations?

No.	Respondent's description	Comments
1	Person form PHE, he does environmental assessment to support government – advice on public health	E5 – all these plums are running in the same direction **E2**-This is the best way. However, I miss boundary lines E1- too many maps E4- It looks too much as a plum. You get wrong impression and may interpret it wrongly.
2	Person form PHE, scientific advice in emergency on public health	**E1**- this is the best presentation. However, it should be 3-4 maps on one page. E2- would not work
3		E4 is too much as a plum. It is great for an expert, but I would not dear to go to decision maker with this map. **E2**- Here you should decide which percentiles you want. 10 in too little, maybe 85% would be ok. the problem is, that decision-makers are used to see 100% and are not used to less. This way they would misperceive this map, since percentiles would probably change… E2 is aldo good for the event phase, for decision on sheltering. E5 – is not for sheltering, it is for other type of protective actions. With this maps I would not go to a decision-maker. **E3**-this one is also good

No.	Respondent's description	Comments
1		E1 – I the most useful for decision-makers. For decision maker is not important to know in percentiles. Specially for sheltering. It should be indicated as Yes – shelter here, or No sheltering here for decision-makers. E2 – for decision-makers is not important in percentiles E5 – It is nice for planning and understanding in case of the event. However, this map is too complex for decision-makers.
2		E4- is not ok in the case that area is too big and sheltering cannot be implemented. This map is good for evaluation. E1 – it is good map but probability should be lower.

3		E2- I do not like the color. E4- I do not like it either. E1 – I the best map for decision makers. E3- I confusing with different areas.
4		E4- Colors are scary. E5- It is impossible map to show it to decision-maker. E3- I would prefer to have separate pictures. E1 – For a decision-maker, this map is the best.

No.	Respondent's description	Comments
1		E3- Should be more informative. E4- I don't like the "heat map".
2		E3- is confusing E1- It is not clear. It is not enough to have just YES- NO sheltering. It must be more information on the map. In addition, borders are missing. E2- I can distinguish here well. I would use this map. However, borders are missing.
3		E1- "Area affected". What does it mean? You need a border line.

No.	Respondent's description	Comments
1		I would like to have all – experts need all of them E2- I like it. E1- this is the best for decision-makers E3- is also ok.

2		E1- there is one point out of the cloud/spot. You should erase it (not, if there is my house) E3- as expert I like this one. E5- there are too small maps, not useful for experts neither decision-makers. Type is ok, but it should be one map per screen. (we are printing this out, thus is not useful on paper)

No.	Respondent's description	Comments
1		E5- it is useless E1- here are you saying something, but you are showing something else. (percentiles are more, but map only one) E2- the "map legend" should be out of the map E4- I would use this one for decision-makers. Color should be changed. If we are still in prognosis, you need such maps. But only in prognosis – for forecasting.
2	Rodos and CMD person	E1- Is good under a condition, that you would have 3 maps on one page (for each percentile separate map) E2- it is better than E1. Yu have all information. E3- It gives too much of information for decision maker. For me it is ok. E4- this is good for decision makers since it shows roads, the most important information for decision-makers. You should change color and title.

No.	Respondent's description	Comments
1		E4- it is easy to understand it . Decision-makers can decide based on these data.
2		E4- This one is good. Only color should be changed, maybe in blue. It is also great that you have indication of NPP areas on the map.
3		E4- I like it the most. Should be other color. Decision-makers should could than decide to which level they wish to go. E2- it is less informative than E4 E5- these stamps and maps are too small. Not usefull.

		E5- It looks like post stamps that decision-makers can use to send a resignation letter after the emergency. E4- this option it the best among all here presented. E3- It is also useful, because it indicates what is the most likely, what is the less likely… Are there only a meteorological data or also other included in this calculations and presentations?

No.	Respondent's description	Comments
1	Radiation protection specialists, IJS	E5- there are too many maps for a fast decision. It is for sure not ok for decision-makers. E4-super E1- this one is easier for first respondents since it doesn't request any decision to be taken. It would be the best option to merge E1 and E4, to have one color and real map with roads, cities…

8.4 Case study Spain: testing maps

Roser Sala, CIEMAT, Spain

In the framework of Confidence Project, specifically in Task 5.2.4 “Testing communication tools”, a test of different maps for emergency communication was foreseen. This document describes the main results of the test carried out in Spain.

Objective

The objective of the test was to learn more about the general understanding of emergency maps among a small sample of experts in Spain and, also, to find which uncertainties were expressed and raised. Furthermore, suggestions and recommendations were expected for an improved design and practicability of these cartographic solutions, and to show uncertainties while reading, using and interpreting the maps.

Case and map

As agreed with project partners, five different cartographic solutions were shown as examples of a visual aid in case of a nuclear emergency. Specifically, Confidence partner, Karlsruhe Institute of Technology (KIT), provided examples of maps that show the fictitious but realistic case of a nuclear accident, with an expected fall out of radioactivity. In this simulations, the epicentre of the emergency was the KIT Karlsruhe facility in Germany, a research complex where in reality no nuclear power plant does exist.

Sample

Three Spanish experts were interviewed for this subtask. The first interview was carried out with a decision-maker from the General Directorate of Civil Protection and Emergencies, specifically, a technician in Emergency Planning. The second interview was carried out with a researcher working on radiological impact assessment at Research Centre on Energy, Environment and Technology (CIEMAT). The third interview was carried out with the Head of Emergency Planning of the Spanish Nuclear Safety Council (CSN).

Procedure

Experts were invited to participate by email. Once they accepted to participate, maps were provided to them by email, in order they could familiarise themselves with the cartographic materials before the interview. A date and time for each interview was scheduled.

The test of the maps was conducted by means of telephonic interviews, with an interviewer and an observer. During the interview they were asked to display the maps. Based on the protocol provided by project partners, we started with a general discussion regarding the usefulness of maps for decision-making during an emergency, and then in-depth discussion about each of the maps was initiated (see sub-section “Protocol”).

Feedback from the participants was collected. Written notes were taken during the interviews (by the observer) and the sessions were audiotaped and transcribed as well. The average duration of the interviews was 44 minutes.

Maps used for the test are shown in Annex 1.

Protocol

The interview was carried out based on the following protocol:

1. Introduction:
    - *Introduce interviewer, CIEMAT, and the project.*
    - *Confidentiality and anonymity are guaranteed.*
    - *Thank participation.*
2. Interviewer introduces the test of the communication, and what is expected by the participants
3. Interviewer introduces the general questions.

    General questions:
    - *How should maps or other visual aids be designed to become suitable for communicating nuclear emergency responses?*
    - *What are the main elements that a map should contain?*
    - *What should be included, what excluded to avoid cognitive overload?*
    - *How should uncertainties be visualized in the map?*
    - *What kind of uncertainties should and can be expressed in maps?*
    - *What are the potential advantages of a map compared with other type of information?*
    - *How should visualisation of maps be designed to reach the desired effects?*
4. Interviewer ask participant to display the maps
5. Interviewer introduces specific questions and ask interviewee to have a look at each of the provided maps.

    Specific questions for each map:
    - *What does it show?*
    - *Do you understand it?*
    - *How do you interpret the information that is given?*
    - *Look at the legend: What is OK for you, what information is missing?*
    - *Look at the colours, any areas of improvements?*
    - *What kind of measures would you put forward based on this map?*
    - *Is it useful for decision-making? In what sense?*
    - *How are the various aspects of uncertainty addressed and visualized in the map?*
    - *What aspects should be improved?*
6. Last comments and conclusion
7. Finish

The protocol was used in a flexible way in the sense that interviews were carried out semi-structured.

Analysis

The discussion and the main issues raised were transcribed and analysed qualitatively in order to derive conclusions and recommendations.

Results

General questions

The interviewed experts highlighted the usefulness of maps to decide and communicate about preparedness and response to a nuclear emergency; but, at the same time, they all agree that there are many uncertainties that are difficult to represent in the maps. Some of them highlighted that real measurement in the potential contaminated zones is needed to take good decisions for the protection of the population.

> *"The fundamental advantage of the maps is that they delimit very much the areas in which you have to act because deposition depends on a specific wind direction. They help to delimit the contaminated area, and define which the direction of the dominant wind is, and in case there had been rain, where the largest deposition will be. That is true, but you also have uncertainties, clearly."* (Interview 2)

Regarding the main elements that a map should contain, interviewees pointed out the need of concentric circles around the centre of the emergency, indicating the different emergency zones.

> *"It would help us that the map had concentric circles around the nuclear power plant, including the distances of the planning zones. It would be useful for establishing the different protection measures."* (Interview 1)

The need of different colours is raised as well, as shows the following quote:

> *"The maps that we produce for the drills are very similar to these, but we use some colours... some colour-codes. Usually the red areas are where evacuation levels are reached, the blue areas are close to the sheltering levels, and the green areas are the areas where maybe you only need an alert or an emergency pre-alert. We need to know the expected effects in a specific area."* (Interview 2)

A third issue that is pointed out is the need to include information about roads, population, reservoirs, crops, and flocks for a better planning of sheltering or evacuation measures.

> *"I believe that it should have more detailed information, for example, not only about population centres, but even the roads. Because based on the population size and the evacuation routes different protection decisions could be taken. So, the roads, the possible evacuation routes, yes… they should figure as well. Another relevant aspect would be reservoirs, because water is very important in terms of deposition, also the crops and flocks. I mean that the more detailed information the better."* (Interview 2)

Interviewees agreed that distance and wind direction are key elements to be included in a map. But, at the same time, possible changes in wind direction changes appear as an important uncertainty. Another highlighted uncertainty is the behaviour of the radioactive material on the ground.

Specific questions for maps

Interviewees 1 and 2 go more in depth into each map, trying to understand each one and giving their impression about the different cartographic representations, their colours and their legends. Instead, interviewee 3 did not want to do it and only discussed the maps in general terms. So, more quotes have been extracted from interviews 1 and 2.

Table 1 summarizes different relevant quotes from interviewees regarding each of the maps.

Map	Comments
E1	"I do not get it. I cannot see it well enough... I cannot read it well. The percentile... what does it mean here? All has the same colour, and then... I don't understand it." (Interview 1) "It seems that the total affected area is shown but many information is lack." (Interview 2) "You can see a blue spot, but it gives you very little idea of the area." (Interview 2)
E2	"It seems more useful than the previous one, because here there is a colour scale that tells us the zone where it is more important to apply the sheltering in place measures. This helps us to prioritize, to decide…" (Interview 1) "What I do not understand is why the farthest areas are the ones that are supposed to be in dark grey, it makes more sense to colour in dark grey the nearest ones… which percentile is it? The colours are confusing." (Interview 1) "The legend is not easy to understand. It is not clear. You know that there is a gradation, but you don't know what it corresponds to." (Interview 1) "It is not clear where the NPP is sited, it should be clearly marked." (Interview 1) "In this one the affected area is divided in 3 percentiles. I imagine that it is reflecting the sheltering areas based on the probability of the plume." (Interview 3) "I do not know very well which is which, if the darkest is 80% and... or not, the other way around, if you assume that the leakage takes place in KIT CN1, maybe 80% is the clearest, 50 is medium and 20 is the darkest of all, the darkest grey, but it is a bit confusing." (Interview 2) "Here the map categorizes the territory by zones and by percentiles, but it rise to many uncertainties…" (Interview 2)
E3	"I don't understand it well." (Interview 1) "Is it referring to deterministic damages? I really don't understand very well what emergency deterministic exercise means." (Interview 2)

E4	“Yes this one seems interesting to me. Because a colour scale is provided, it is much easier to interpret. It has the legend and you can see the different radiation of the... red is greater, which is 90% and is the closest to the nuclear power plant, the wind direction goes there or there... yes I see it well. This one is really useful.” (Interview 1) “I've been looking at it with the legend provided and it seems that the sheltering zone would be almost 100km long, which is a very wide area.” (Interview 1) “The heat map, this can be interpreted as exactly where the plume is going to go, that is, where the plume is going most likely and where the sheltering will be clearly required.” (Interview 2)
E5	“I do not understand anything. It is not useful.” (Interview 1) “I can interpret that it is like an evolution of the caesium deposition. I understand that these are like screenshots, that is, in the case of a leakage you will have different screenshots with the temporal evolution of the caesium deposit. But I cannot distinguish if this refers to the moment of the release, that is, from when the release is produced until it is deposited, or if it is a forecast of the temporary evolution once the caesium has been deposited, let’s say in 1 year.” (Interview 2)

Table 1. Summary of relevant quotes of interviews for each of the maps

To sum up:

- Map 1 seems to contain very limited information.
- Map 2 provides more information than Map 1, but the legend and the colours generate some confusion.
- Map 3 seems to be difficult to understand.
- Map 4 is perceived as obvious and useful for decision-making.
- Map 5 is very difficult to understand.

Table 2 summarize how experts evaluated the maps when they were asked the following question: How can these maps help you in making decisions? (Rate from 6 - very useful to 1 - nothing useful).

MAPS	E1	E2	E3	E4	E5
Interviewee 1	4	2	4	6	1
Interviewee 2	4	4	2	6	3
Average	4	3	3	6	2

Table 2. Quantitative assessment of the maps by interviewees

Interviewee 3 did not want to participate in this quantitative assessment. Map 4 got the highest evaluation scores while map 5 got the lowest.

Conclusions and recommendations

In general terms, map E4 is the preferred one by all interviewees. It is perceived as the easiest to understand, and more clear than the others. At the same time, it seems that it contains more useful information for decision-making about sheltering than the others (roads, name of the towns, etc.). The information on the probability of sheltering provided in terms of percentages is perceived as very useful in terms of decision-making.

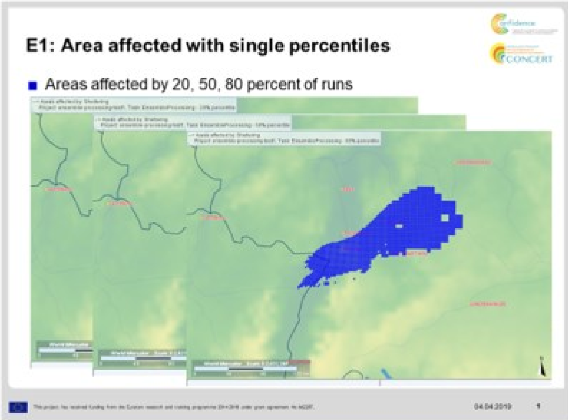
The maps including percentiles (E1 and E2) are not well understood: interviewees claim that more information about what the percentiles exactly mean is needed. The map E3 creates confusion among the consulted experts and in the map E5 experts declare that many information is missing.

In general, they all agree that, in the five maps, relevant information for decision-making is still missing, such as the evacuation routes. No clear evidence of novelty is perceived, in relation to the maps they have been using so far.

They all agree that it is very difficult to represent uncertainty in the maps, so that the maps are only one of the information they should manage for decision-making about protection measures.

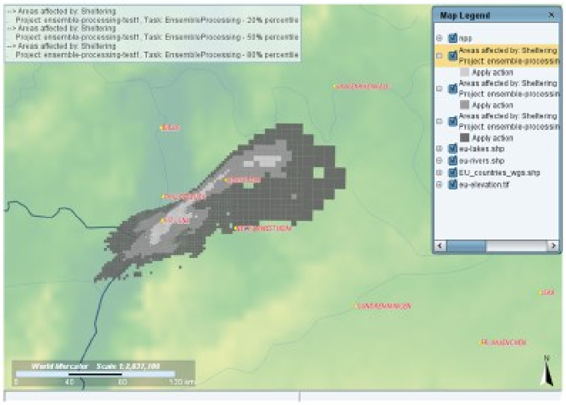
The findings of this test highlight that more efforts are needed to improve cartographic solutions for nuclear emergency communication and decision-making. The maps provided for this test are not easy to understand by Spanish experts and not well accepted, because they don no perceive clear benefits from the ones in use. Main recommendation from the consulted Spanish experts is to include more information (such as evacuation roads or reservoirs and to clarify the colour codes and legends.

Annex 1. Maps provided by email to Spanish experts (by means of a pdf document)



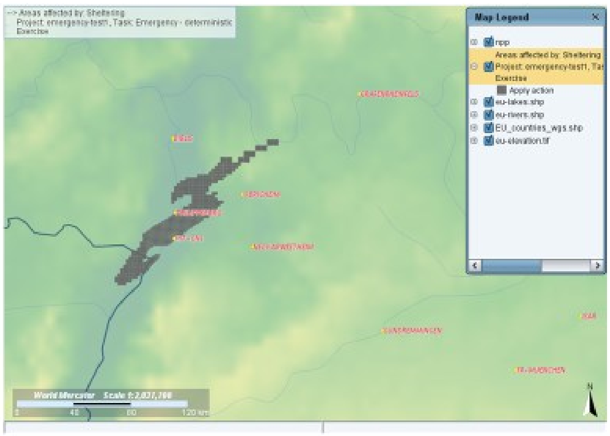
This project has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 662287

E2: Shelter areas (20, 50, 80% percentiles)

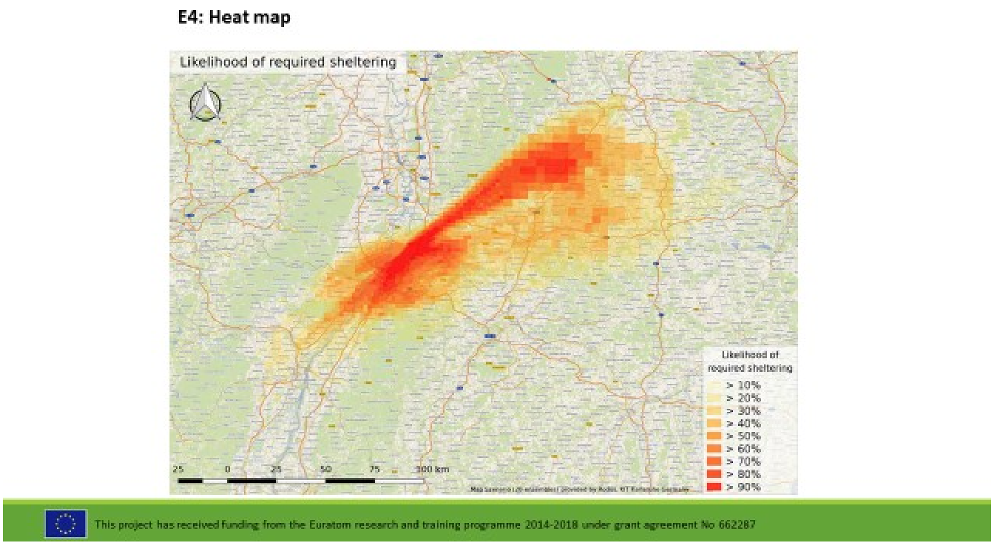


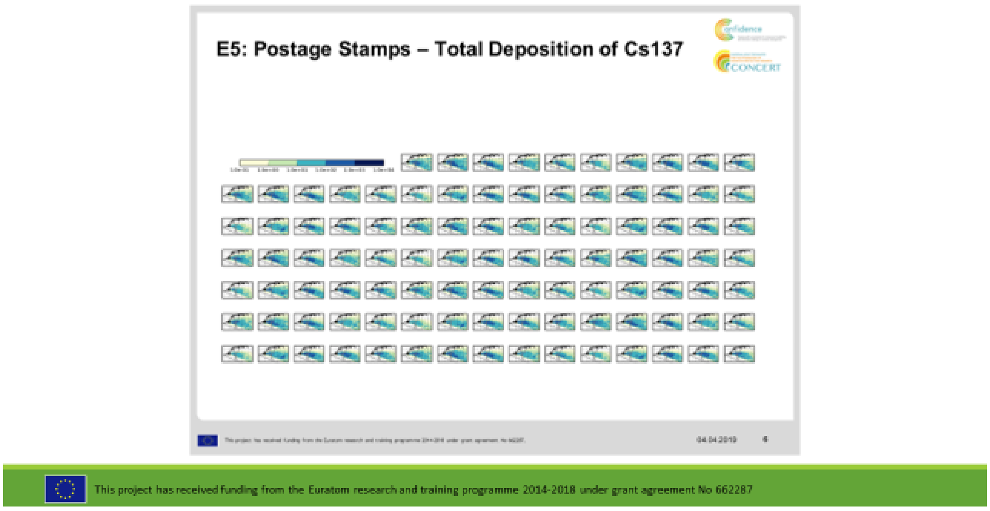
This project has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 662287

E3: Deterministic (same time) + ensemble?



This project has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 662287


E4: Heat map
Likelihood of required sheltering
Likelihood of required sheltering
> 10%
> 20%
> 30%
> 40%
> 50%
> 60%
> 70%
> 80%
> 90%
25 0 25 50 75 100 km
This project has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 662287


E5: Postage Stamps – Total Deposition of Cs137
04.04.2019
6
This project has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 662287

8.5 Case study Spain: testing communication with text messages

Roser Sala, CIEMAT, Belgium

In the framework of Confidence Project, specifically in Task 5.2.4 "Testing communication tools", a test of different text messages for emergency communication (via SMS or similar channels) was foreseen. This document describes the main results of this test carried out in Spain.

Objective

The objective of the test was to learn more about the general understanding and acceptance among lay people, experts and decision-makers in Spain and, in particular, to see which uncertainties were expressed and raised. Furthermore, suggestions and recommendations were expected for an improved design and practicability of these text messages, and to show uncertainties while reading and using the messages.

Material for the test

As agreed with project partners, different text messages to communicate a nuclear emergency were shown to participants as examples. Dialogik partner provided these examples of messages derived from a study about communication during tsunami incidents. Specifically, three exercises were carried out with participants:

- Exercise 1: Discussion about text messages of various lengths.
- Exercise 2: Discussion of various text messages with approximately 200 characters length.
- Exercise 3: Writing of the ideal text message.

In Annex 1 and 2 the material provided to participants (in Spanish) is shown.

Sample

The total sample is composed by two different sub-samples:

1. A sample of three **experts**, who also participated in the test of the maps:
    a. A decision-maker from the General Directorate of Civil Protection and Emergencies, specifically, a technician in Emergency Planning.
    b. A researcher working on radiological impact assessment at CIEMAT.
    c. The Head of Emergency Planning of the Spanish Nuclear Safety Council (CSN).
2. A sample of eleven **students** from "Universitat Autònoma de Barcelona", studying sociology or environmental sciences.

Procedure

<u>Experts</u> were invited to participate by email. Once they accepted to participate, a PDF file containing the text messages was provided to them (by email), in order they could familiarise themselves with the materials before the interview. A date and time for the interview was scheduled.

The test of the text messages was conducted by means of telephonic interviews. During the interview we asked them to display the text messages in their own computers. Based on the protocol provided by project partners, we started with a general discussion on nuclear emergency preparedness and then we focused on nuclear emergency communication. After this warm-up discussion we followed the structure of three exercises, with in-depth discussions about each of the messages (see next sub-section, Protocol). Feedback from the participants was collected.

Students were recruited from the faculties, advertising the study in the classrooms. Three personal interviews were carried out face-to-face, one focus group and two group interviews, depending on their availability and their schedules. The procedure was very similar to the one followed with experts. In the case of this face-to-face data collection, a PPT file was projected during the focus group session while printed material was used in the case of interviews. All participants fill in the materials shown in Annex 2.

Written notes were taken and the sessions were audiotaped as well. The focus groups with students had a duration of 60 minutes, the average duration of the interviews with students was 24 minutes, and the average duration of the interviews with experts was 44 minutes.

Protocol

Both the interviews and the focus group was carried out based on the following protocol:

1. Welcome and give thanks for participation.
2. Interviewer introduce herself/himself, CIEMAT, and the project.
3. Interviewer introduces the test, and what is expected by the participants.
4. Confidentiality and anonymity guarantee.
5. Permission for audiotaping.
6. Interviewer show a press release on nuclear accident as initial stimulus to introduce the topic and the general questions.

   General questions:

   - *What do you have in mind about a nuclear accident?*
   - *What do you think it would happen in case of a nuclear accident?*
   - *What would you do?*
   - *How do you think you would be informed?*
   - *By which channels?*
   - *What type of information should be communicated?*
7. Interviewer introduces specific questions and ask interviewee/participants to have a look at the slides or provided papers.

   Exercise 1 specific questions:

   - *Which is the most suitable message to communicate a nuclear accident to the population?*
   - *Why?*
   - *What kind of information is missing?*
   - *Is the length of the text important in this type of communications?*
   - *Can any of these messages rise doubts or led to incorrect interpretations?*
   - *What questions do not solve these messages?*

- *How can these messages be improved?*

Exercise 2 specific questions:

- *What is missing in this text messages?*
- *What could be misunderstood?*
- *What should be improved?*
- *Which one would you chose? Why?*

Exercise 3 specific question:

- *What would be the ideal text message to communicate a nuclear emergency?*

8. Last comments and conclusion
9. Finish

The protocol was used in a flexible way in the sense that interviews were carried out semi-structured.

Analysis

The discussion and the main issues raised were transcribed and analysed qualitatively in order to derive conclusions and recommendations.

Results from the experts

General issues

The interviewed experts highlight that in Spain so far it is not planned to inform by SMS messages, but it is perceived as a useful breakthrough. One of the experts think that the Public Alarm System should be maintained. In her view, it would be great to use the PAS and then send the SMS messages.

Exercise 1

In the view of two of the consulted experts, starting with "Warning!" can create alarm, uncertainty, and fear.

Expert 1 prefers message number 2 because she perceives it as more complete in terms of information. She highlights the importance of the sentence "listen to local news". She thinks it can help reassure the population. She reports that it is not necessary to include "check updates". She thinks that messages 5, 6, 7 and 8 are really bad messages: "I would never use them". Regarding messages 3 and 4 she think they can also create alarm: "if you say 'stay indoors' and nothing else people will be anguish and confused about what to do after that". She comments the following:

> *You also have to put that close all the air conditioning services that have: air conditioning, hot air... you do not have to let it air from outside.*

Expert 2 also prefers message 2 because it gives the idea that there will be more information about what to do. She thinks it is more reassuring for the population and she suggests to add the information source.

Finally, Expert 3 does not select any of the proposed messages.

Exercise 2

Regarding the second exercise, Expert 1 selects message 2 for two main reasons: it includes the information source, and the sentence “release of radioactivity not yet confirmed” gives the idea that, despite not being confirmed, protection measures are ongoing.

Expert 2 also selects message 2 but she will change “release of radioactivity not yet confirmed” for “radioactivity likely released”. In her view the “radioactivity likely released” is better because it means that there has been a release and they are not establishing the seriousness. She thinks that “release of radioactivity not yet confirmed” can generate more uncertainty.

Expert 3 does not selected any of the proposed messages.

Exercise 3

In exercise three, Expert 1 suggests to start with “We inform you that an accident has happened at the XXX NPP” instead of “Warning”. She claim for adding that the sheltering will not be very long and a phone number to register and receive further information.

Expert 2 suggests to add something to convey peace and serenity, for instance a reliable information source.

Expert 3 highlights the need to be transparent with the population. He emphasises public trust in the information as a key issue.

Results from the students

General issues

As a first reaction, participants are divided in those who think there will be overreaction in case of a nuclear accident: “everybody will run away!” and those who think people will follow instructions:

> *I think that, yes, people will respond better than we think, because when you are afraid and you have no idea, the only thing you can do is to trust those who know a little what is happening.*

A first issue that students raise is the need to communicate to the population as soon as possible, as it is shown in the following quote:

> *They should inform at the very beginning, just when they know that something serious is happening. Although they do not know the consequences that the accident can have, despite it could has only insignificant consequences.*

In parallel, there is some discussion related to the dilemma of information and alarmism. Some participants think information can increase panic and chaos, while others think that fear can help people to protect themselves.

Participants highlight the importance of mobile phones and social networks (mainly Twitter because of its immediacy) as important channels to get information about the emergency. But, at the same time, there is a perception of low trust of everything that comes from social networks. So that, by using social networks as channels for emergency communication, there is a risk of creating confusion and alarm. In that sense, the classical channels such as radio are perceived as more trustworthy channels. Public address system is also perceived as necessary. The need of a fast channel that could reach all those in the region is point out by many participants. Some participants point out the need of someone there in person (such as policemen or firemen), coordinating the population and informing about the recommended actions.

Some of the students report they would prefer to be informed by SMS rather than WhatsApp, because it is perceived as a channel that reaches more people. Other participants report that currently they do not receive noting important by SMS, only ads. In that sense, SMS messages may go unnoticed. Even, some participants state that it is better by radio than SMS because more information can be given. The idea of a floating message was also rise:

> *A floating message that interrupts anything you're looking at, forcing you to look at it, it would be fantastic.*

There is certain misunderstanding about how the official information sources will contact the population in the zone. But there is a claim for official information. Some of the cited trusted sources are regional and local governments, firefighters, police, and civil protection. In general, firefighters and police are more trusted than governments.

Regarding the content of the messages, participants agree that messages should be clear, concise, and easy to understand. One student synthesizes it as follows:

> *We need they tell us what has happened (if they know) or what is going on, what will they do to solve it, and what do we have to do to help with the situation and to collaborate.*

There is a strong claim for information about behaviour: *"what to do",* and the need of updating is highlighted as a key aspect for people to keep calm.

Exercise 1

Then participants reviewed the different text options (see Annex 2). When we ask participants about the most suitable message to communicate a nuclear accident to the population, all agree that options one and two were the best ones. Messages 5, 6, 7 and 8 were perceived as very bad, because they contain very little information. Specially, information on what to do was really missed. Participants argue: "This type of message is worthless, it can only create generalized panic". In general terms, messages with more information about what to do are perceived as better.

Below we will summarize the comments of the participants in relation to each of the proposed messages.

<u>Message 1</u>

Many participants rate this message as the best one. Main reason is that it is the one that gives you more complete information, as stated by one student: "it tells us what happens and what to do" or "*I think that the more recommendations the better. It reassures me by saying what to do...".* Some participants commented about some parts of the message:

- *The last sentence does not contribute to anything.*
- *Perhaps it could also contain an emergency phone number.*
- *I don't understand well this 'stay indoors', it will be better to say 'If you are indoors remain, if you do not, go indoors'.*
- *Why local news? Perhaps it would better to say "listen the news".*

Message 2

It is also perceived as a good message. Even some participants prefer it to 1, because it is more concise: “the greater the length of the message the less people will read it, because people look for short messages, some quick explanation”.

Messages 3 and 4

These two messages are perceived as less useful than 1 or 2, because some information of what to do after staying indoors is missed.

Messages 5 to 8

These four messages are perceived as bad because many information is lacking. Participants perceive they would contribute to create panic among the population and chaos. Participants think they convey fear and anguish, because they do not know what to do. In the view of students, the less information the more confusing. Even, in message 8, you don’t know what kind of accident had occurred.

To sum up, the length is important (short better than large *the maximum must be said with the minimum words*) but concise information on what had happened and what to do is essential. If not, the message rise many doubts and led to chaos and panic. As a ways to improve messages 1 and 2, the possibility of giving a link that contain some link for further information is suggested.

	M1	M2	M3	M4	M5	M6	M7	M8
S1	5	4	4	3	2	2	2	1
S2	6	5	4	3	2	2	1	1
S3	5	5	4	3	2	4	2	1
S4	6	5	2	2	1	1	1	1
S5	6	6	4	3	2	2	1	1
S6	6	6	4	4	2	1	1	1
S7	6	6	4	4	1	1	1	1
S8	5	6	5	5	2	2	2	1
S9	6	6	5	3	2	1	1	1
S10	5	6	5	4	1	1	1	1
S11	6	5	4	3	1	1	1	1
AVERAGE	5.63	5.45	4.09	3.36	1.63	1.63	1.27	1

Table 1. Quantitative rating (from 1 to 6)

Exercise 2

Table 2 summarises the selection of participants as well as some explanations they give for the selection they did.

Participant	Option 1	Option 2	Option 3	Why?
S1		X		*Because in this you have the source of the information. It is the one that gives you more information on how to act, and is more credible because it comes from a relevant institution.*
S2		X		*Maybe I would prefer the one stating "not yet confirmed", because there is the possibility that it has not happened. Instead, in number 3 "unclear" means that they are not sure about the magnitude.* *In number 3, "follow instructions" is too general, I prefer to know exactly what I am supposed to do.*
S3		X		*"Not yet confirmed" sounds better to me, I don't know exactly why... I prefer it. It sound more preventive...* *I would add "stay indoors so that the particles do not enter", I like to be fully informed about the reasons why.*
S4		X		*I prefer the second one, because there is more information, but I prefer "radioactivity likely released" more than "not yet confirmed" or "unclear". The word "likely" makes me more attentive and more aware about what is happening.*
S5		X		*I have chosen this because it has the source and has the instructions.*
S6		X		*The "radioactivity leakage not yet confirmed" sounds more precautionary. And it gives you a credible source. I would like to have the source at the very beginning.*
S7		X		*I like the second one, because you have the information source. Anyway, "not yet confirmed" can create alarm...* *I don't like number 3 because it doesn't tell you what to do, well only this "follow instructions", it does not reassure me.*

S8		X		*Number 2 is in fact a combination of 1 and 3, right? In addition to suggesting what you have to do, it also tells you about the need to listen to the news. And, above all, it gives you the source. I have chosen the 2 for that reason, because it gives you everything.*
S9		X		*I like the second one, that is "release of radioactivity not yet confirmed" because it means it may be or may not, but it is clear they are looking at it, they are investigating it.*
S10	X	X		*I don't like the third one: "follow instructions", which instructions? It is not clear enough.*
S11		X		*The information source in an essential content. The basements... I guess because it is safer, because there are no windows. But... do you have a basement?*

In general, most of the participants select message number 2. The main reason they give is the presence of the information source. This makes message number 2 better than 1. Students report that when the information source is missing, it may create distrust.

> *Actually, a message that ends with this or that begins with the source of who is telling you conveys more security and more confidence, I will believe it more and give it more importance.*

Participants also report that the more information about what to do the better. In that sense, message 3 is perceived as more poor regarding instructions.

> *In number 3, it says "follow instructions" but it really does not give me any instruction other than "listen to the news" and it makes me distrustful.*

Most of the participants agree that "release of radioactivity not yet confirmed" is the better way to inform about what is happing, because it transmits a more proactive and preventative message, in the sense that despite it is not yet known protective measures are already being taken.

Finally, some participants claim that it is worth to add a phone number to contact with emergency services in case of health problems.

Exercise 3

In exercise 3 we asked participants to write the ideal message to inform about a radioactive emergency.

Some common aspects among the messages can be observed. Nearly half of them (five) start the message with a warning word such as "Danger" or "Alarm", while the others start directly with the actual message.

Regarding the nature of the event, nearly all (nine) say explicitly that it was a "nuclear accident". Approximately half of them (six) talk about a possible or a current radioactive leak while the others do not mention it. Almost all of the participants (ten) specified an exact location of the event, but only one shown the specific time when the accident took place.

All of the messages included instructions for physical protection such as staying indoors or closing the windows. Regarding the information, eight of the messages advise to follow news channels to obtain live updates or follow official accounts on social networks. Of those eight messages, six of them offer a link to follow the developments of the events. Two of the messages offer a contact to call in case of emergency.

More than a half of the messages mention the information source. Among these, all show the source at the end of the message with one exception where appears at the start of the message.

They added some characteristics compared to the predefined messages shown in exercises one and two. One of the most significant is the inclusion by some participants of links to follow the live news or official social network accounts. Another noticeable thing is the inclusion of the time of the accident by one of the participants. The majority of them wrote longer messages in order to give all the information they think it was important for the public.

Conclusions and recommendations

The test carried out in Spain shows that the proposed text messages are well understood by participants, and most of them (except those messages containing less information) are well accepted and perceived as useful for informing the affected population in case of a nuclear accident.

In general, participants prefer those messages containing exhaustive information. Despite they are aware that the more concise the better, they claim especially for comprehensive information about what to do. The information source also appears as a key issue when informing. In the view of many of the participants, it transmits legitimacy and trust in the information provided. In a similar sense, the idea of transmitting proactivity is very well valued by participants ("we are working on it despite not yet confirmed"). The need to include something to get further information (for instance, a phone number or a link) is also highlighted.

Thus, from this qualitative test in Spain, the ideal message should contain information about what is happening, what to do, and how to get further information, together with the information source that is expected to be official and trustworthy.

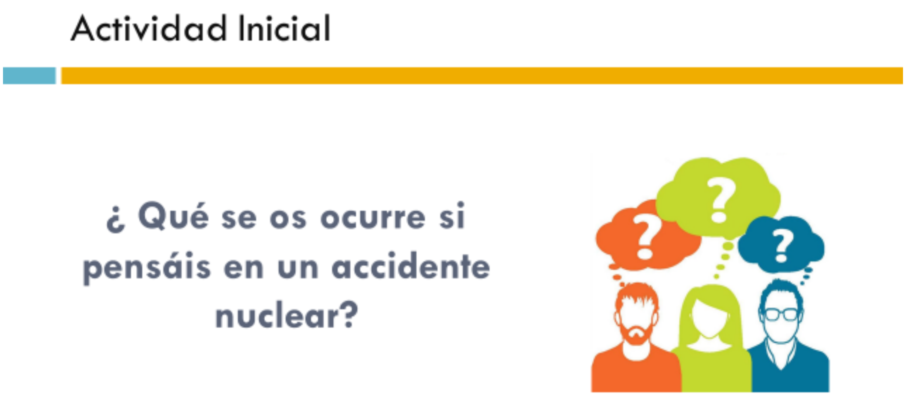
Regarding uncertainties expressed, some participants suggest that sometimes specific parts of the messages can create greater alarm among the population. So that, it is really important to consider in-depth each word of a text message.

Some differences among experts and students can be pointed out. While experts seem to prefer "not yet confirmed" instead of "likely released", students prefer "not yet confirmed" and give interesting reason for it. Similarly, while experts prefer not to start the messages with "Warning!" (arguing that it can cause alarm), students claim to do it, in order to get the attention of the population. These differences should be investigated further.

The findings of this test highlight the need to continue testing information messages for nuclear emergency communication, maybe with experimental methods, in order to be better prepared for a future accident. Both the content of the messages and the preferred channels (SMS, WhatsAPP…) should be further investigated. Besides, the Spanish test shows that it is necessary to consider both experts and the population, as presumable relevant differences exist among them.

Annexes

Annex 1. Slides provided by email to Spanish experts and showed to the participants in the interviews and focus groups




Detectada una fuga radiactiva de baja intensidad en la nuclear Ascó I

La emisión salió al exterior y afecta al recinto al aire libre del complejo

Tarragona

Greenpeace sostiene que la fuga fue de un nivel importante

"Aquí falla la comunicación"

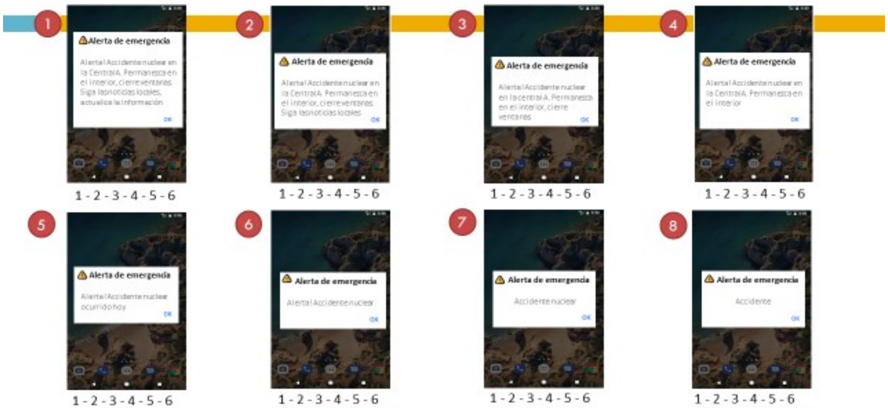
Situación hipotética

Imaginaros que estáis veraneando en l'Hospitalet de l'Infant y que se produce un accidente en la central nuclear de Vandellós

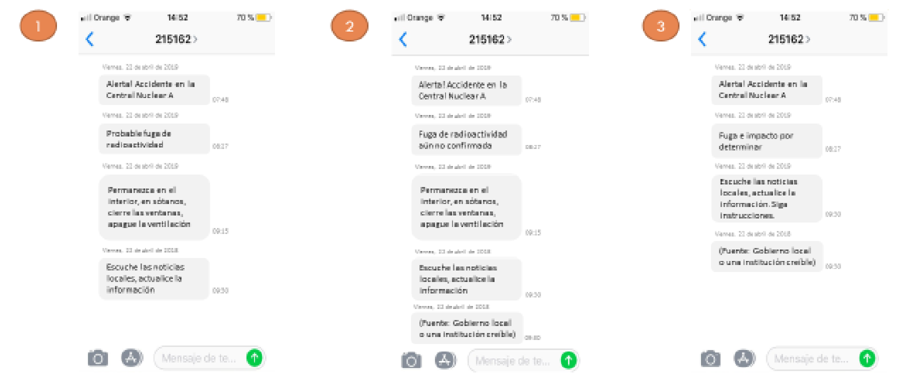
Debate 1.
Preparación ante emergencias

Debate 2.
Herramientas de comunicación

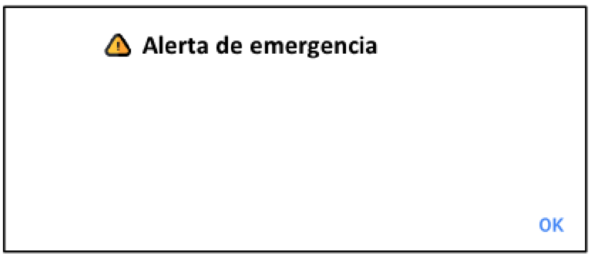
Ejercicio 1: Mensajes



Ejercicio 2: Mensajes

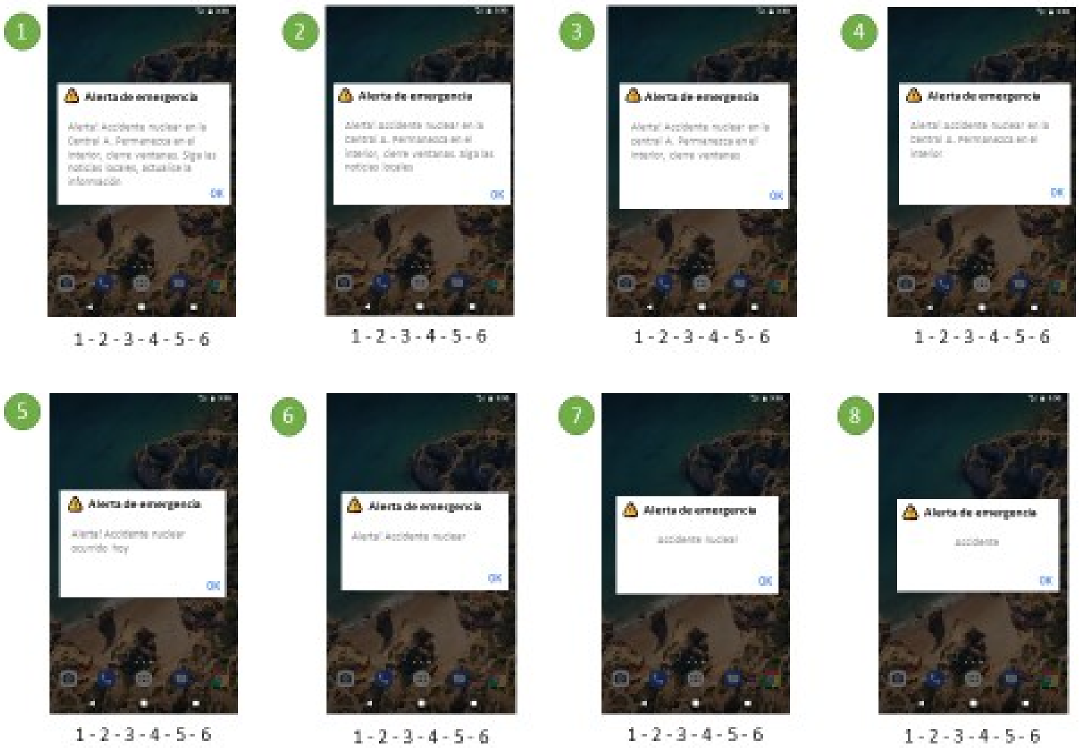


Ejercicio 3: Mensaje ideal

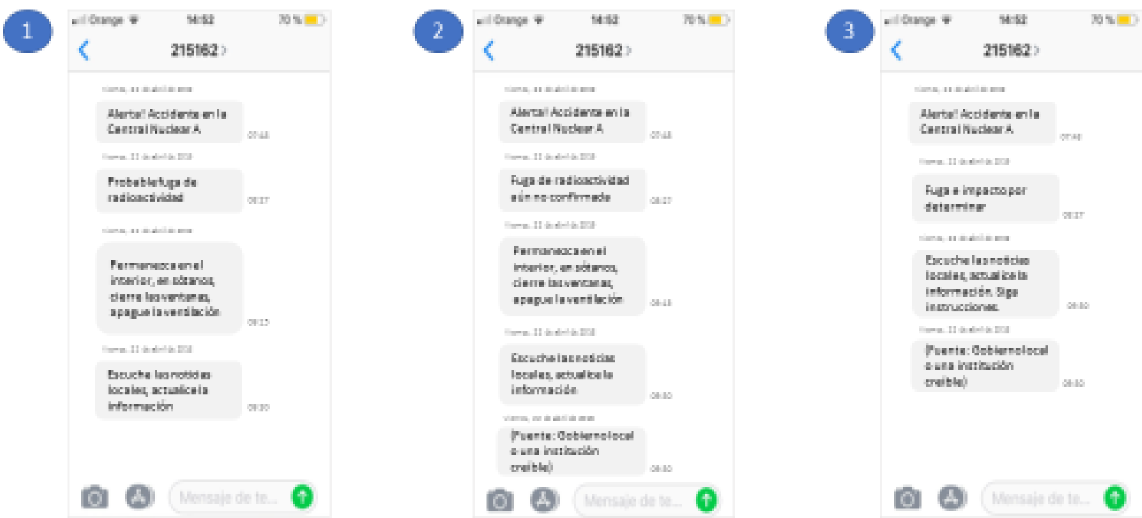


Annex 2: Materials provided to the students

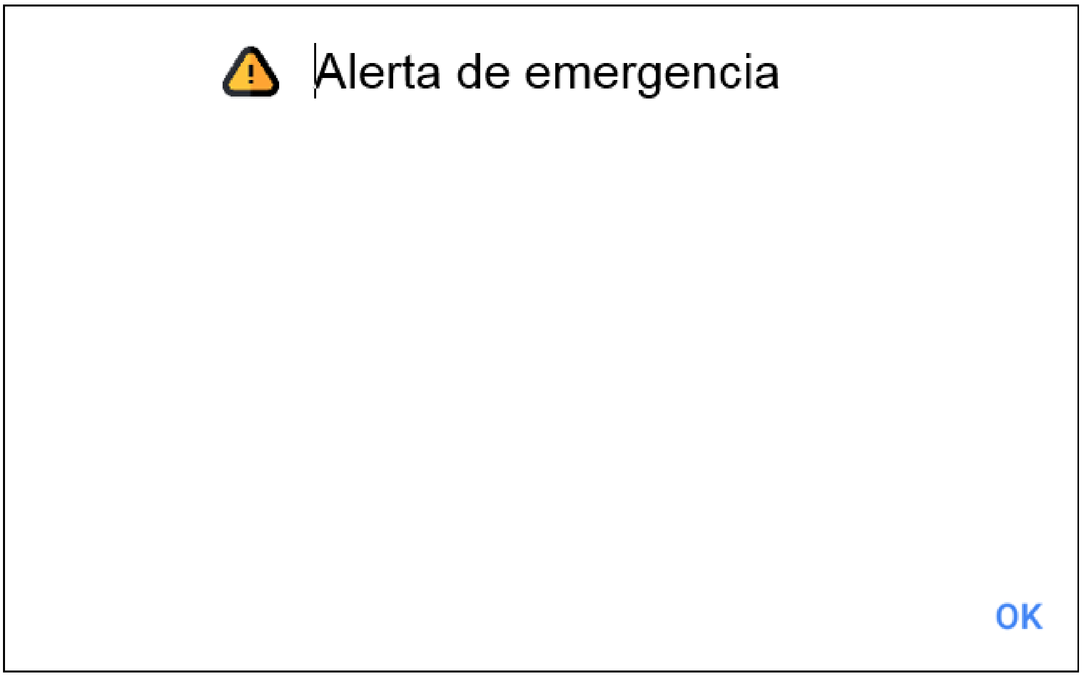
Exercise 1



Exercise 2



Exercise 3



8.6 Case study Greece: testing short text messages and map

Vasiliki Tafili, EEAE, Greece

Objectives and Scope

This document presents the feedback received during the testing in Greece of communication tools used in cases of nuclear emergencies, as part of tasks included in the Work Package 5 (WP5) of the European project CONFIDENCE (COping with uNcertainties For Improved modelling and DEcision making in Nuclear emergenCiEs. HORIZON 2020 EJP-CONCERT, EC GA 662287. https://portal.iket.kit.edu/CONFIDENCE/index.php), which aims to understand and reduce the uncertainties associated with decision making in the management of a nuclear emergency.

With the aim to learn more about the general understanding of tools used in case of nuclear emergencies, a cartographic solution (map) and text messages (sms) were tested in Greece. Main point of interest was the identification of uncertainties that these tools possibly trigger among lay people in case of a nuclear emergency. Along with feedback related to the uncertainty factor, hints and recommendations for an improved design and practicability of cartographic solutions and text messages disseminated through sms were also asked.

Methodology

CONFIDENCE project partner DIA developed examples of short text messages based on existing experiences from Tsunami warning (FIA 2019). The example of the map was provided by KIT Karlsruhe in Germany CONFIDENCE project partner; the map shows the fictitious, but realistic case of a nuclear accident with an expected fall out of radioactivity.

The test of text messages via sms and a map was conducted by EEAE, during a workshop with students. EEAE invited the students of the Inter-University Postagraduate Course in Medical-Radiation Physics to a one-hour workshop, indicating only that emergency preparedness and response communication tools will be tested, without including more details. The main goal of the workshop was to discuss, test and receive feedback on communication tools, such as maps and text messages used in nuclear emergencies for public communication.

The workshop was organized on June 4, 2019 in EEAE premises in Athens, Greece. The number of students-participants was 15 (9 male – 6 female). It was held in the Greek language, however the material tested (map & text messages) were not translated to the Greek language. The communication tools under testing were presented on screen and were also distributed in print copies to the participants.

The workshop was facilitated by Ms. Vasiliki Tafili, with the help of Mr. Sotirios Economides. The workshop was not considered necessary to be recorded. Notes were kept throughout the workshop by Ms. Evgenia Mestousi and Ms. Vasiliki Tafili. The workshop agenda included 4 distinct parts:

1. A session of short introduction of CONFIDENCE project, with emphasis on the work of the WP5 and the subtask of testing communications tools used in nuclear emergencies.
2. Presentation of the text messages and discussion divided in 2 parts: general and specific questions/discussion.
3. Presentation of the map on likelihood on required sheltering and discussion divided in 2 parts: general and specific questions/discussion.

4. General discussion – closing of the workshop.

The following sections present the main points of the discussion. Quotes of the participants are presented in italics.

Text messages via sms

The facilitator presented the text messages as shown in Figure 1 and distributed print copies of them, allowing some time to read the messages. The first round of discussion focused on the collection of general comments and first reactions.

Length	Text message
100	Warning! Nuclear accident at ABC Nuclear power plant. Stay inside, shut windows. Listen to local news, check updates.
87	Warning! Nuclear accident at ABC Nuclear power plant. Stay inside, shut windows. Listen to local news.
69	Warning! Nuclear accident at ABC Nuclear power plant. Stay inside, shut windows.
57	Warning! Nuclear accident at ABC Nuclear power plant. Stay inside.
36	Warning! Nuclear accident happened today.
23	Warning! Nuclear accident
15	Nuclear accident
7	Accident

Figure 1. Text messages of various length about a nuclear accident

Based on the set of questions agreed between the project partners [1], the facilitator asked for participants' first reactions and general comments. The following comments were made regarding the content:

> *"The use of word 'accident' creates panic!* The general public is terrified in the news of a nuclear accident."
>
> *"Some of them are not specific, all messages should include instructions"*
>
> *"I would expect a short text message with clear instructions"*

However, there was also a different opinion saying that *"since we are at initial stage of an emergency, the content is sufficient".*

Some general comments about the timing and the sender of the SMS were also made:

> *"Such an SMS should be sent after the assessment of the situation"*
>
> *"It is important to clarify who is sending the SMS".* It was proposed to include a reference of the competent authority, e.g. *"the regulatory authority assesses the situation at the moment"*.

When participants were asked how they envisage a well-designed text message for a nuclear emergency, which would acknowledge the existing uncertainties, but at the same time would be credible enough to justify protective actions, they responded that they would like to see a message developed on the principle of graded approach: they would send up to 3 messages in a time frame of

2-3 minutes, saying: what is happening, providing details on what happened and details on what people need to do.

Criticism expressed about the text messages as presented in the Figure 1 was that make people think that they need to search for additional information about the situation. The most effective message, according to the participants' views would be the one that would not trigger such a thought/reaction to the public.

Regarding the length and the writing style of the text messages, participants highlighted that there is no need for long texts.

> *"Long texts are not helpful. Simple phrases in plain language is what is needed in these cases"*
> *"We do not want messages that require deciphering"*
> *"Clear instructions shall be included; people shall be encouraged to disseminate these instructions to other people that possibly are not aware of them"*
> *"During an emergency, we observe rational and irrational reactions; the protection of the public is priority. The sms shall be written in rational terms, in order to avoid panic. Specific and clear instructions are needed"*

Participants disagreed on the number of the text messages required to convey effectively the initial information about a nuclear accident.
The view that only one sms is not adequate was initially expressed: *"Only one sms text is not adequate; many text messages are required to be sent one after the other in order to give to the recipient the time to process the information and overcome the feeling of panic".*
On the other hand, someone argued that *"2 or 3 text messages are not helpful. First of all, so many messages may cause technical problems to the platform used. Secondly, people have no idea about nuclear accidents, so I would opt for only one message; I think this way the stress will be under control."*

Then, the participants were asked to identify content that possibly is missing by the specific messages.

> *"We would like more information about the accident country, or at least information about the distance from Greece."*
> *"Only the name of the NPP is not adequate; we need to know the accident country".*
> *'"A web link of the competent authority in charge of emergency management shall be included"*

As the discussion continued and the facilitator posed more specific questions, more specific feedback on behalf of the participants was triggered. Specific comments per message are presented in the Table 1.

Text message	Comments by the participants
Warning! Nuclear accident at ABC Nuclear power plant. Stay inside, shut windows. Listen to local news, check updates.	Short messages with clear instructions. The reference to the authority in charge is missing.
Warning! Nuclear accident at ABC Nuclear power plant. Stay inside, shut windows. Listen to local news.	
Warning! Nuclear accident at ABC Nuclear power plant. Stay inside, shut windows.	Short message with clear instructions. It is better that the shorter ones, because informs about what happened and what is needed. It includes somehow an assessment/ evaluation of the situation. The reference to the authority in charge is missing.
Warning! Nuclear accident at ABC Nuclear power plant. Stay inside.	This could be the 1st of a series of text messages, because it is brief.
Warning! Nuclear accident happened today.	No comment on this one
Warning! Nuclear accident	These 3 messages were rejected. The participants said that these messages would not be effective, because create the feeling that it is a lie!
Nuclear accident	
Accident	

Table 1. Key comments made by workshop participants per text message tested

Then, the facilitator presented the set of 3 text messages options as presented in Figure 3. The phrase "Release of Radioactivity and impact unclear" which is included in Option 3 triggered vivid discussions about whether such an uncertain clause should be part of official information or not.

"Including "I do not know" means that someone is non-expert, non-competent"

"Including "I do not know" raises the issue of credibility"

"In Greece, if you send out a text message so uncertain about the situation, people will do nothing"

"If you find yourself in "I do not know" situation you are not sending an sms. This rule applies to our personal life, applies also in emergencies!"

There was a consensus among all students that "I do not know" is something that cannot be said/expressed in a text message during a nuclear emergency. For the majority of the participants, the "I do not know" means dishonesty on behalf of the authorities.

Furthermore, the argument that, in case of high uncertainty, advice should be given according to the worst case scenario was expressed.

Figure 3 presents a synopsis of the comments made for each one of the text messages options presented.

In addition, participants were asked to discuss their views about the radiation risk from NPPs operating abroad. There was a variation of opinions expressed, e.g. *"we live with this risk", "I am not afraid of this risk", "it is a hell" "it is understood by experts, but it is not clear to the average people", "better information shall be given in advance".*

Message option	Comments
Option 1 Warning! Accident at ABC Nuclear power plant. Radioactivity likely released. Stay inside, stay in basement, shut windows, shut down ventilation. Listen to local news, check updates.	*"Ambiguous"* *"Communicates certainty"* *"Not complete, it would be better to use the word possibly instead of likely"*
Option 2 *Warning! Accident at ABC Nuclear power plant.* *Release of Radioactivity not yet confirmed.* *Stay inside, stay in basement, shut windows, shut down ventilation.* *Listen to local news, check updates.* *(Source: Local government or credible institution)*	*"It prepares you"* *"Confirmation of the accident shall be included"* *"I agree with the use of phrase "Not yet confirmed"* *"There is a graded approach in uncertainty "*
Option 3 *Warning! Accident at ABC Nuclear power plant.* *Release of Radioactivity and impact unclear.* *Listen to local news, check updates. Follow instructions.* *(Source: Local government or credible institution)*	*"It causes panic"* *"Actually says that something has happened, but we do not know almost anything!"* *"It scares you, you do not know how to react"*

Figure 2. Text messages options and relevant comments by workshop participants

This part of the discussion ended with general comments on behalf of the participants regarding the information needed in case of a nuclear emergency abroad and the effectiveness of such a notification system in Greece. It is noted that currently Greece has not in place arrangements for civil protection SMS service in case of emergencies. Thus, discussion on what happened in summer 2018 during fire forest close to Athens (a large number of victims due to lack of notification mechanism, they were not notified to evacuate the area) was inevitable.

"Self-protection instructions should be disseminated to all, even to those that have no access to Internet or sms services."

"Templates for several types of emergencies and situations shall be available for use."

"Sending a notification SMS is the least that a State can do for the protections of its citizens."

"The Greek mentality is not helpful; we are not familiar with civil protection text messages as notification mechanism."

"SMS may be not the best way of communication with the public in case of emergency - other channels are used more, e.g. TV live."

"People will pay attention only to credible persons. Text message in SMS is not personal and is ineffective."

In the end of this national report the hand-written text messages proposed by most of the workshop participants are presented.

Map testing

The next part of the workshop was dedicated to the testing of a map showing the likelihood of required sheltering in the aftermath of a nuclear accident.

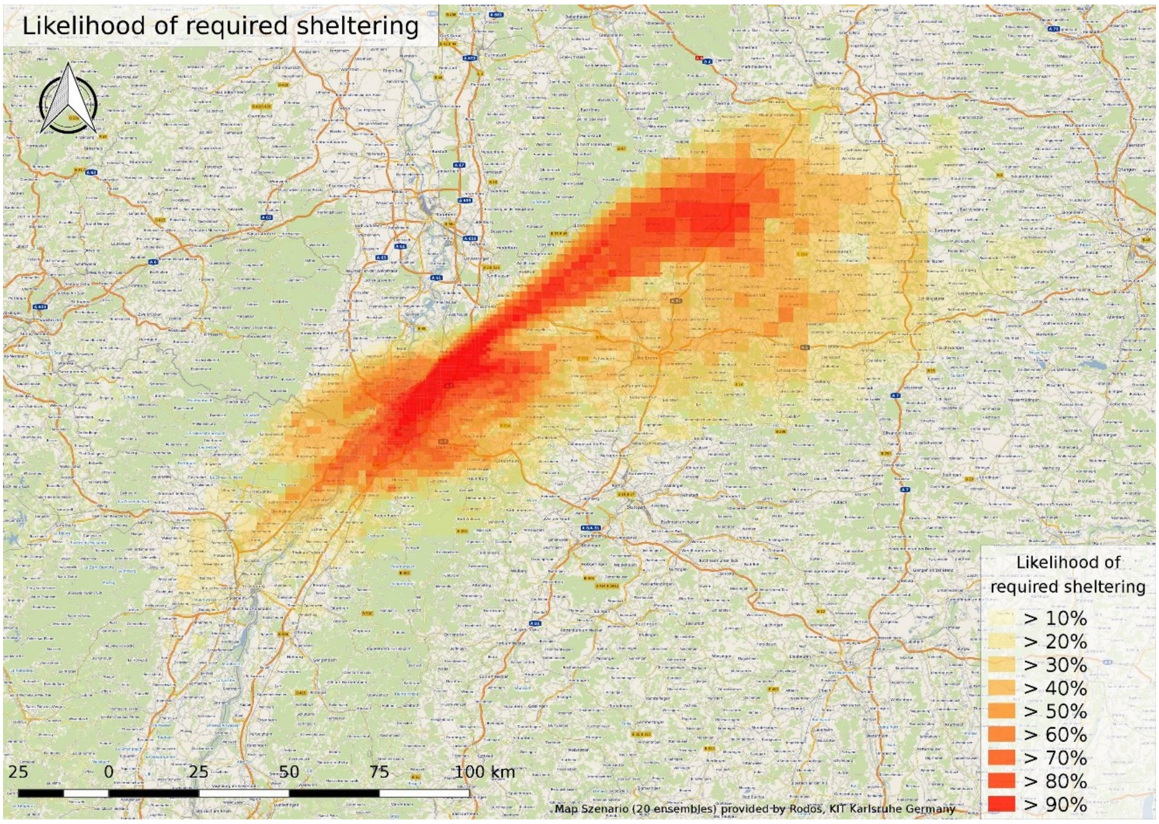


Figure 3. The map which tested as a communication tool during a nuclear emergency

Similarly to the process of testing the text messages, the facilitator provided to the participants the map as presented in Figure 4, both on screen and in printed coloured copies.

In the beginning of the discussion, some of the participants said that the map showed *the radionuclides concentration*, some of them said that the map presented *what is the possibility of staying indoors,* other said that the map shows *the evacuation zones* and others said that the map shows *the danger zones.*

In general, the participants said that the map was understandable. They mentioned that usually these types of maps are used to show the zones of evacuation, foodstuff and water consumption restrictions, as well as the radioactive plume movement. The main views expressed are following below:

> *"I am in favour of the use of maps and in general of visual aids"*
>
> *"There is color contrast"*
>
> *"The wording is understood"*
>
> *"The arrow showing the orientation is redundant"*
>
> *"Dates of how long this info is valid should be included"*
>
> *"It would be good to include a note that the map will be updated"*
>
> *"It is better not to include percentages"*

"A legend on what are the actions expected in each zone should be included"

"The title should be 'Need of required sheltering' instead of likelihood

"Explanations of zones are needed."

"There is no doses reference."

"The map is understandable. It can be shown to the public."

"The zones are not in the map. I cannot say if I need to stay or to leave. We need to approach this map with honesty and transparency."

"The map visualizes the risk. Some of the target audiences will not be able to understand the map."

"The map should not be announced by scientists, but by people that can explain it in simple words!"

The scale used triggered also some discussion. Participants said that maybe the scale used contains too much of detail, more generic categories would be preferred.

Conclusions

In the following section we summarize the opinions exchanged during the workshop.

❖ **Text messages**

- The 2nd and 3rd message of the Figure 1 are considered most effective in terms of public communication.
- Text messages in general are considered appropriate means of information at the initial phase of an emergency; later on, different channels of communication are considered most effective.
- Text messages shall be simple; if the recipients need to decipher them, their effectiveness will be limited.
- The sms shall provide instructions of immediate implementation.
- At an initial stage general information is given; personal safety is a priority at this stage.
- Priority shall be given to texts providing information about the public exposure and foodstuff.
- The worst case scenario shall be the basis of developed text messages, in case that uncertainty about the situation is high.

❖ **Map**

The map is expected to serve both the individual interest of self-protection, but also to provide a general idea of the situation. The areas where improvement was suggested are the color coding and the format of the map. Proposals made include the following:

- A better color contrast would be preferred. Maybe a black-white map would serve as a better background.
- Avoid any data that are not necessary, in order to make the map simpler.
- Consider instead of coloring the areas to circle them, in order to make clear where a zone begins and where it ends.
- Do not include doses or units.
- Include a reference about the validity period and the date of the next update.

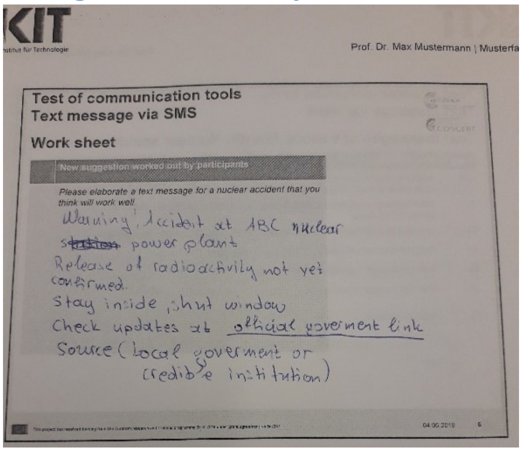
Regarding the legend, participants proposed to include more wording instead of percentages.

References

[1] T. Perko, A. Nagy, L. Benighaus, O. Renn, T. Mueller, W. Raskob, V. Tafili "Tools and Approaches for Improved Communication of Uncertainty in Emergency Situations - Instructions for test at Workshop with students and stakeholders – Text messages via SMS", Working paper, Document number: CONFIDENCE (WP5) - (2019) version 1

[2] T. Perko, A. Nagy, L. Benighaus, O. Renn, T. Mueller, W. Raskob, V. Tafili "Tools and Approaches for Improved Communication of Uncertainty in Emergency Situations - Instructions for test at Workshop with students and stakeholders - Maps", Working paper, Document number: CONFIDENCE (WP5) - (2019) version 1

12 examples of text messages, as proposed by the workshop participants during the workshop


KIT
Prof. Dr. Max Mustermann | Musterfa

Test of communication tools
Text message via SMS

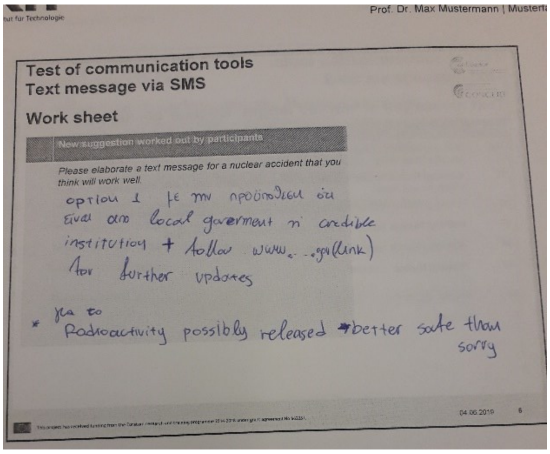
Work sheet

New suggestion worked out by participants

Please elaborate a text message for a nuclear accident that you think will work well.

Warning! Accident at ABC nuclear ~~station~~ power plant
Release of radioactivity not yet confirmed.
Stay inside, shut window
Check updates at official goverment link
Source (local goverment or credible institution)

04.06.2019 6


Prof. Dr. Max Mustermann | Musterfa

Test of communication tools
Text message via SMS

Work sheet

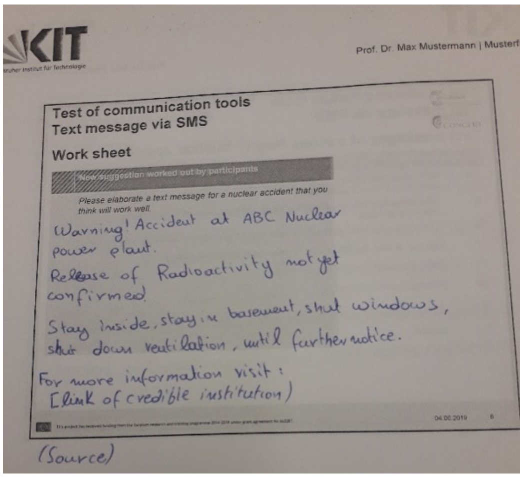
New suggestion worked out by participants

Please elaborate a text message for a nuclear accident that you think will work well.

option 1 με την προϋπόθεση ότι είναι από local goverment ή credible institution + follow www.....gov(link) for further updates

* για το Radioactivity possibly released → better safe than sorry

04.06.2019 6


KIT
Prof. Dr. Max Mustermann | Musterf

Test of communication tools
Text message via SMS

Work sheet

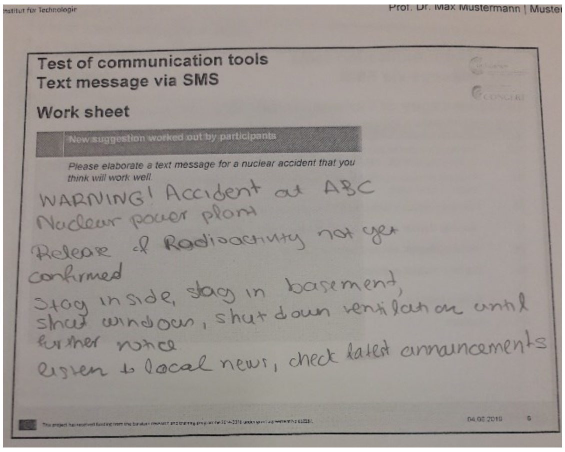
New suggestion worked out by participants

Please elaborate a text message for a nuclear accident that you think will work well.

Warning! Accident at ABC Nuclear power plant.
Release of Radioactivity not yet confirmed.
Stay inside, stay in basement, shut windows, shut down ventilation, until further notice.
For more information visit: [link of credible institution]

04.06.2019 6

(Source)


Prof. Dr. Max Mustermann | Muste

Test of communication tools
Text message via SMS

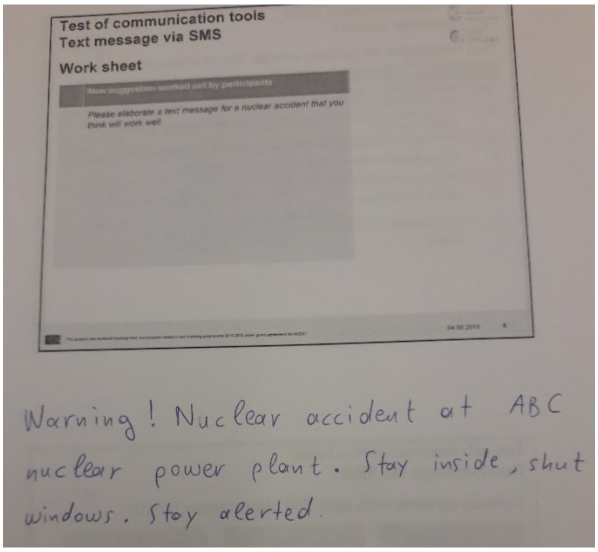
Work sheet

New suggestion worked out by participants

Please elaborate a text message for a nuclear accident that you think will work well.

WARNING! Accident at ABC Nuclear power plant
Release of Radioactivity not yet confirmed
Stay inside, stay in basement, shut windows, shut down ventilation until further notice
Listen to local news, check latest announcements

04.06.2019 6


Test of communication tools
Text message via SMS

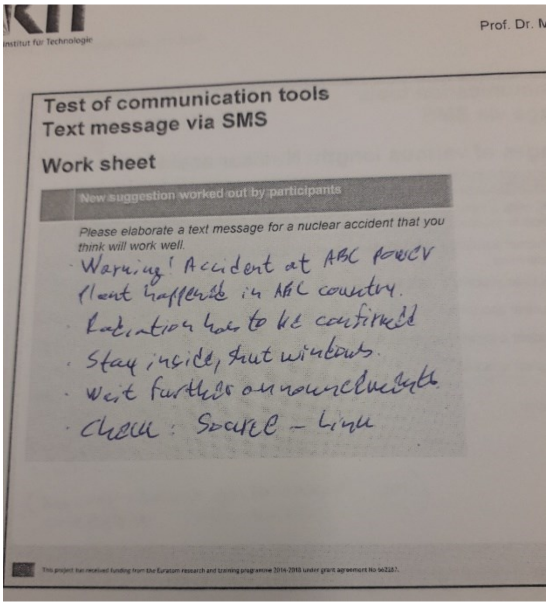
Work sheet

New suggestion worked out by participants

Please elaborate a text message for a nuclear accident that you think will work well.

04.06.2019 6

Warning! Nuclear accident at ABC nuclear power plant. Stay inside, shut windows. Stay alerted.


KIT
Prof. Dr. M

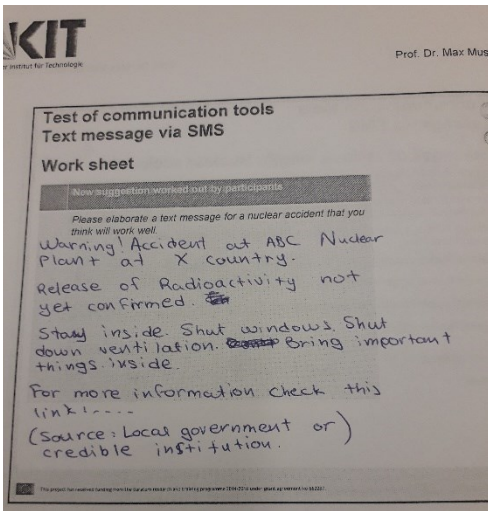
Test of communication tools
Text message via SMS

Work sheet

New suggestion worked out by participants

Please elaborate a text message for a nuclear accident that you think will work well.

- Warning! Accident at ABC power plant happened in ABC country.
- Radiation has to be confirmed
- Stay inside, shut windows.
- Wait further announcements
- Check: Source – Link


KIT
Prof. Dr. Max Mus

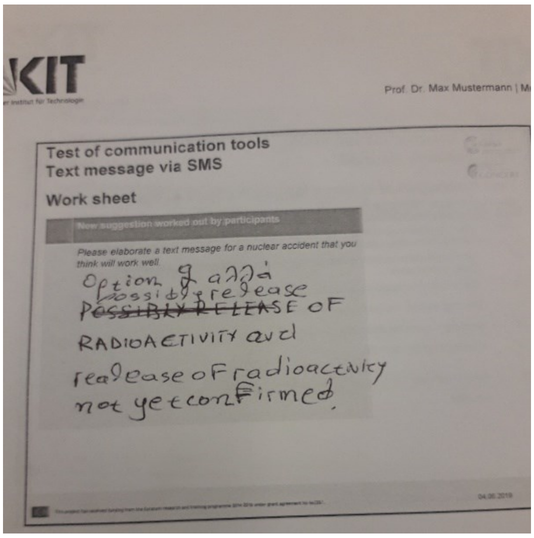
Test of communication tools
Text message via SMS

Work sheet

New suggestion worked out by participants

Please elaborate a text message for a nuclear accident that you think will work well.

Warning! Accident at ABC Nuclear Plant at X country.
Release of Radioactivity not yet confirmed.
Stay inside. Shut windows. Shut down ventilation. Bring important things inside.
For more information check this link!....
(Source: Local government or credible institution.)


KIT
Prof. Dr. Max Mustermann | M

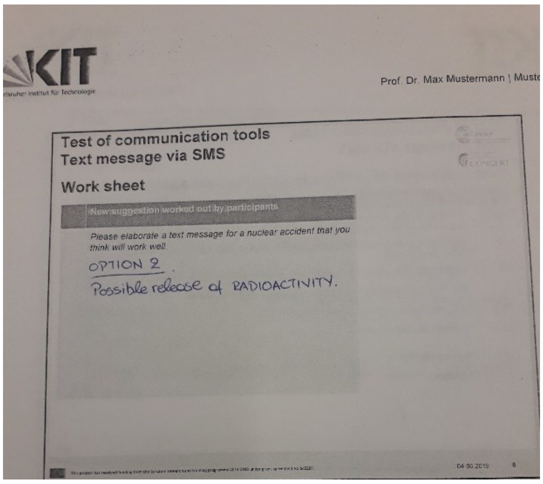
Test of communication tools
Text message via SMS

Work sheet

New suggestion worked out by participants

Please elaborate a text message for a nuclear accident that you think will work well.

Option 2 add possible release
~~POSSIBLY RELEASE~~ OF RADIOACTIVITY and
realease of radioactivity not yet confirmed.


KIT
Prof. Dr. Max Mustermann | Muste

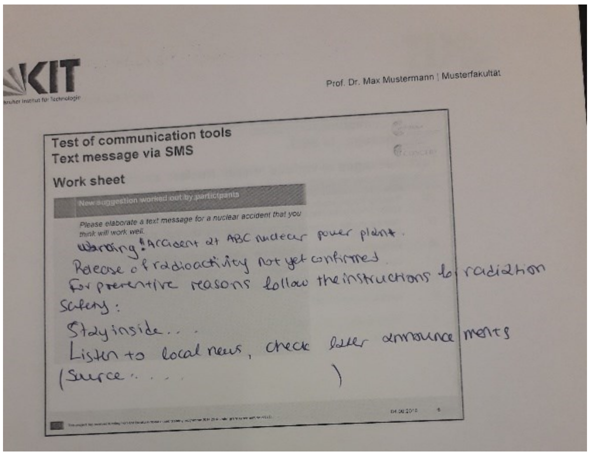
Test of communication tools
Text message via SMS

Work sheet

New suggestion worked out by participants

Please elaborate a text message for a nuclear accident that you think will work well.

OPTION 2
Possible release of RADIOACTIVITY.


KIT
Prof. Dr. Max Mustermann | Musterfakultät

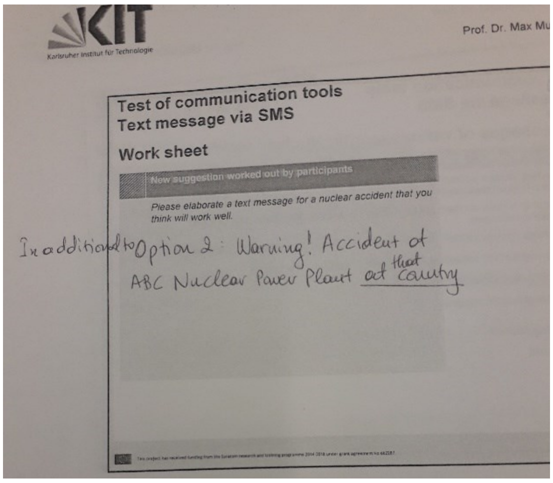
Test of communication tools
Text message via SMS

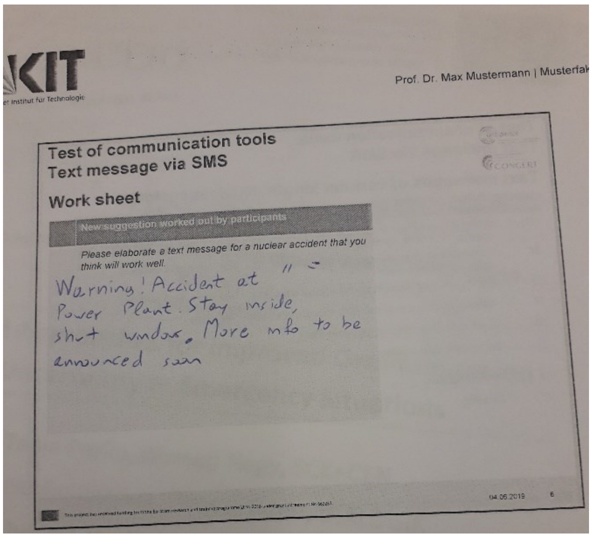
Work sheet

New suggestion worked out by participants

Please elaborate a text message for a nuclear accident that you think will work well.

Warning! Accident at ABC nuclear power plant.
Release of radioactivity not yet confirmed
For preventive reasons follow the instructions to radiation safety:
Stay inside...
Listen to local news, check later announcements
(Source: ...)


KIT
Karlsruher Institut für Technologie
Prof. Dr. Max Mu
Test of communication tools
Text message via SMS
Work sheet
New suggestion worked out by participants
Please elaborate a text message for a nuclear accident that you think will work well.
In addition to Option 2: Warning! Accident at
ABC Nuclear Power Plant at that country


KIT
Prof. Dr. Max Mustermann | Musterfak
Test of communication tools
Text message via SMS
Work sheet
New suggestion worked out by participants
Please elaborate a text message for a nuclear accident that you think will work well.
Warning! Accident at
Power Plant. Stay inside,
shut window, More info to be
announced soon
04.06.2019
6

8.7 Case study Radiation Protection Week: testing of short text messages

Deborah Oughton, Norway

Test with participants of the European Radiation Protection Week 2019 in Stockholm

An example of an emergency text message (Figure 1) was tested with the participants of the European Radiation Protection Week meeting in Stockholm, ERPW2019, during the two one hour long poster sessions. This meeting comprised of over 300 participants of various backgrounds, from PhD students to authorities, and predominantly from Europe but including other parts of the world. The input has been collected through direct interaction with the participants, input via a menti.com questionnaire and through post-it notes and printouts of the messages where they could write their suggestions and questions. Input from about 25 participants was gathered during this time.

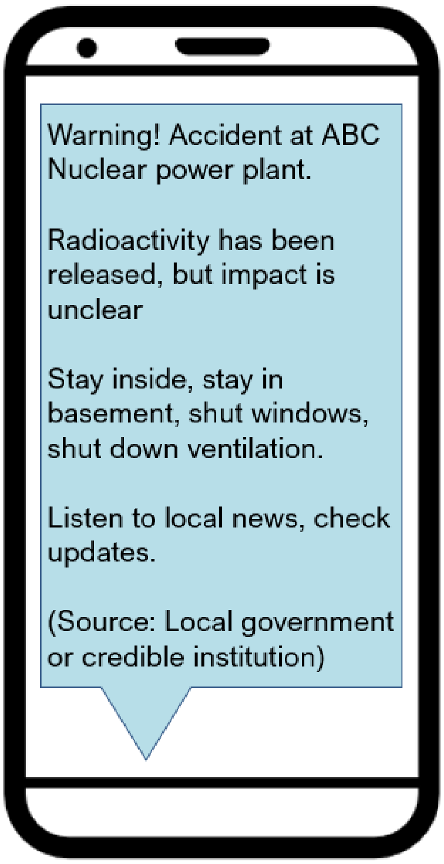


Figure 1 – The emergency text message that was tested on the participants.

Questions

- What would your immediate reaction be to this message?
- Is this message appropriate as a means of informing the public?
- How could this message be improved?
- What would be the most trustworthy source in your country?

Results

The immediate reactions to the message varied between the participants. Those who were familiar with such communication tool were more likely to follow the advice given in the message.

Participants from countries where text messages are not used for emergency communication or where trust in governmental institutions and authorities is low would treat the message with suspicion and turn to other sources for confirmation (e.g., from people who reside in the areas close to the accident source). One participants immediate reaction was “How did they get my phone number?”

Participants in general agreed that emergency text messages could potentially be a good way of informing public. However, for the countries where such systems are not yet in use, some communication will need to be done to warn and prepare people that such systems are active and will be utilized in emergencies.

As the initial reaction many participants suggested that the first thing they would think about would be their children (or pets). It was noted that the reaction would be very dependent on which time of day the message came through – during a weekday when everybody was at work and separated from family, or on a Sunday morning when families were likely to be together. Specific messages would have to be developed for schoolteachers, doctors etc.

Among things that could be improved participants suggested:

“Warning! Accident at ABC Nuclear power plant. “

- Include location of the accident, people don’t know where all the different NPPs are
- Google maps link
- Time of the accident

“Radioactivity has been released, but impact is unclear”

- State that responsible actors have started measurements
- “Radioactivity has been released, experts are working to assess the impact” or “radioactivity has been released, experts are working on reducing the impact”
- “… impact is unclear but we are working on it”
- “Emergency organisations are working on it and will inform you ..(give time)..”
- “impact is unclear” should be removed as it might scare people. Perhaps a range could be given (e.g. low-medium) and when more information will come

“Stay inside, stay in basement, shut windows, shut down ventilation. “

- Including more information/advice for those that have to go to work or have been outside
- Not all people have basements, so saying “stay in the basement” might frighten those that don’t have one. Exchange with something like “stay as low in your house as possible”
- Add “seal windows”
- If fireplaces or fire-based heating systems are common in the country, one should inform people to stop them as fire uses up oxygen.
- What about drinking water

“Listen to local news, check updates.”

- Include a link to the website (or twitter, Facebook account) with updates
- Link to more information
- “Follow local news” rather than listen to. It might not be a radio

(Source: Local government or credible institution)

- Depends on who you ask (UK)

- Local governments should not be informing in this situation, it should be radiation protection authorities (Norway)
- Hopefully support organization to decision maker (CZ)
- Don't know

Participants showed a difference in opinion as to whether this emergency messages would be too scary or too friendly. Some participants mentioned that regular updates should also come through text messages, especially with regard to "unclear impact", including a message once it's "safe".

8.8 Case study Norway and Sweden: testing of maps

Deborah Oughton, Norway

Test with Norwegian environmental science studies students and Radiation Protection students in Sweden

The sheltering map was tested with students from at the faulty of Environmental Sciences and Nature Management at the Norwegian University of Life Sciences as well as students and professionals attending the NEA/SU Radiation Protection course in Sweden. In both cases the map (Figure 1) was shown and discussed with students as part of lectures: in Norway as part of lectures on radiation in the environment given to BSc students (n=15) and in Sweden as part of a lecture on risk communication (n=23). Following a brief introduction to background and purpose, the map was shown and the students given 10 minutes to discuss and comment on the questions below. In both cases the presentations and discussions were carried out in English

Questions

General questions:

- What does the following map show? How do you interpret the information that is given?
- What information is missing? How might they be improved?
- How well do the maps convey uncertainties? be visualized in the map? What kind of uncertainties should and can be expressed in maps?
- Are the maps suitable for communicating with the public?

Reporting

Both groups had difficulty interpreting what the map was intended to convey. Specific comments:

- What is meant by sheltering? How long? How? Where?
- Sheltering for farm animals?
- Background details impossible to see
- Probability in what time frame?
- Useful for seeing areas most at risk, but for sheltering would probably just draw a ring around the maximum distance and advise to shelter within that radius.
- People would probably self-evacuate if they saw such maps.

General comments was that the maps were not appropriate for communication with the public, and likely to cause panic. The radiation protection students were more negative than the environmental science students. The question on colour was not included (to see whether anybody bought that up independently), but when the students were asked during the follow-up discussion, some agreed that another colour might be preferable, although if you wanted people to do what you said, red might also be appropriate.

8.9 Case study CONFIDENCE training course: testing of text messages

Tanja Perko, SCK•CEN and Tatiana Duranova, VUJE

Text messages were tested at the CONFIDENCE Training course “Use of uncertain information by decision makers at the various levels within the decision-making process and its communication”. The training course took place in VUJE, Trnava, Slovak Republic in 13-15 May, 2019 with 25 participants from 15 countries. The test has been conducted on 15th of May.

Method:

A new WhatsApp group “SkAlert: confidence exercise” has been created a day before a discussion. A short SMS has been sent to 25 participants of the workshop from 15 countries, in an early hour before the workshop started.

- *SMS: You are connected to SkAlert. This app will inform you in case of any emergency at your location.*

An hour later (still before the workshop started) the participants got an SMS in a local language.

- *2. Varovanie! Jadrova havariea v jadrovej elektrarni Buhunice. Vypocujte di miestne spravy.*

15 minutes after the first message participants recived the following SMS in English.

- *3. Warning! An accident at nuclear power plant Buhunice. Listen to a local news.*

And later at the course, participants discussed:

How did you feel?

What did you do?

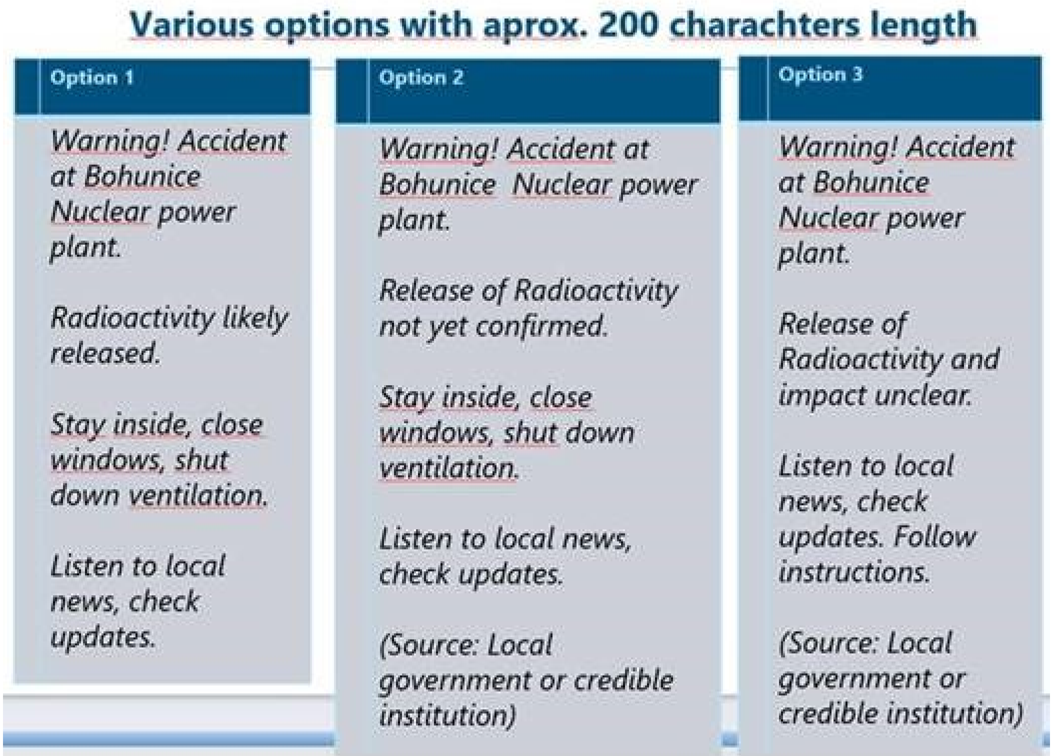
What kind of information did you miss?

Length	Text message
100	Warning! Nuclear accident at Bohunice Nuclear power plant. Stay inside, shut windows. Listen to local news, check updates.
87	Warning! Nuclear accident at Bohunice Nuclear power plant. Stay inside, shut windows. Listen to local news.
69	Warning! Nuclear accident at Bohunice Nuclear power plant. Stay inside, shut windows.

57	Warning! Nuclear accident at Bohunice Nuclear power plant. Stay inside.
36	Warning! Nuclear accident happened today.
23	Warning! Nuclear accident
15	Nuclear accident
7	Accident

Have a look at the text messages for the case of a nuclear accident:

- How does a person living near the power plant perceive nuclear risks and radiation?
- How will he/she most likely behave?
- What is missing in the existing text messages?
- What could easily be misunderstood or misinterpreted?
- How are the various aspects of uncertainty addressed and explained?
- Is there any evidence about how these uncertainty messages are understood and perceived?
- What is needed now for a further development of written information? What needs to be improved?


Various options with aprox. 200 charachters length

Option 1	Option 2	Option 3
Warning! Accident at Bohunice Nuclear power plant. *Radioactivity likely released.* *Stay inside, close windows, shut down ventilation.* *Listen to local news, check updates.*	*Warning! Accident at Bohunice Nuclear power plant.* *Release of Radioactivity not yet confirmed.* *Stay inside, close windows, shut down ventilation.* *Listen to local news, check updates.* *(Source: Local government or credible institution)*	*Warning! Accident at Bohunice Nuclear power plant.* *Release of Radioactivity and impact unclear.* *Listen to local news, check updates. Follow instructions.* *(Source: Local government or credible institution)*

Results

Receivers of the SMS in a local language used google translate to understand the message.

Although it was clear, that this is a test, some of participants checked news (the message was sent very early in the morning – at 6.15)

Participants checked where the NPP is located on Google maps and checked where they are, how far from them is the emergency.

One participant thought that this SMS is spam or that somebody hacked his phone, so he blocked the sender.

A hyperlink to more information was suggested to be included in the SMS.

Some questions were raised with regard to the message:

- *Who is it meant for? For all inhabitants or only for me personally? Or to first responders? Or only for EPZ people living in? Or also for those outside?*
- *Who will select people and their contacts?*
- *Indication of source is missing in the text.*
- *Hyperlink to more info should be included*
- *When? Timing, when last message was sent - complete text with that info."*

Option 2 was preferred by participants as it was more neutral.

Conclusions

Receivers of the SMS wished to have more information made available by SMS, thus they suggested to include hyperlink to more information. The information was in local language and had to be translated by Google translate. In addition, receivers of the SMS consulted Google maps to locate the emergency. In general, the SMS with aprox. 200 characters was perceived as the best option. The most accepted uncertainty expression was "Release of radioactivity not yet confirmed'.