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D9.32 Recommendations for improved communication and stakeholder involvement related to uncertainties

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Abstract

Within the European project CONFIDENCE (COping with uNcertainties For Improved modelling and DEcision making in Nuclear emergenCiEs), a dedicated work package addressed social, ethical and communication aspects of uncertainty management. Among others, it aimed at identifying social uncertainties in emergency situations; investigating citizens' and emergency actors' sense-making of uncertainties in emergency situations and the transition phase, and their subsequent actual or potential decisions; and improving communication of uncertainties.

This document provides an overview of the main findings from this study, alongside with recommendations for identifying, addressing, and communicating social and ethical uncertainties faced by the different actors, including affected citizens, in nuclear emergency situations and the transition phase.

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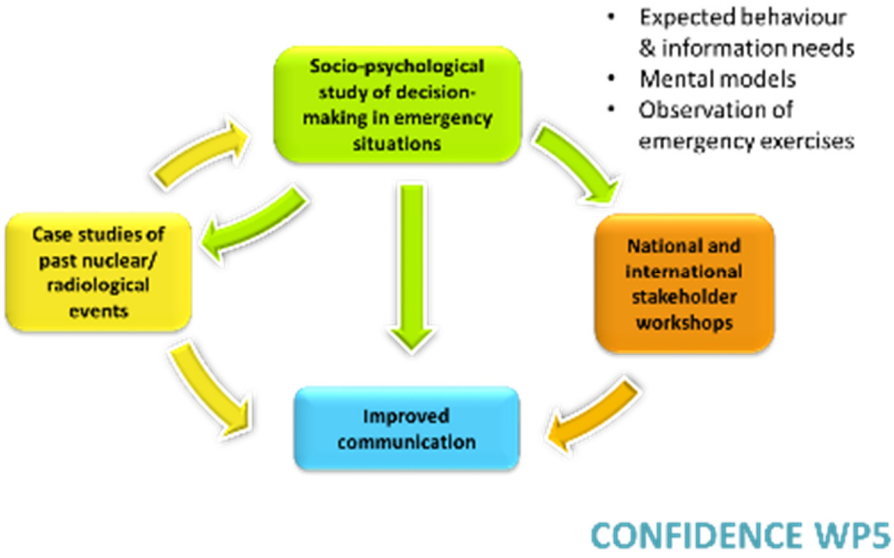
1. Introduction

Previous studies in social science and humanities research attended to several aspects of accident and post-accident decision-making. However, the social, ethical and communication aspects of uncertainty management have not been addressed yet in a structured and multi-disciplinary way. Moreover, there was a need to identify uncertainties that citizens, decision-makers and other stakeholders are facing during an emergency and to investigate how they make sense of and respond to scientific and societal uncertainties, since this can have a strong impact on the efficiency of the overall decision-making process.

A dedicated work package of the CONFIDENCE project focused on social, ethical and communication aspects of uncertainty management (WP5). The research objectives of this work package were: to identify societal uncertainties in emergency and post-accident situations, from the early phase to recovery; to highlight the ethical implications of uncertainty management; to investigate the understanding and processing of uncertain information by lay persons and emergency actors, and their subsequent decision-making behaviour in nuclear emergency situations; and to develop improved communication of uncertainties, specifically for low radiation doses.



Specifically, the following research objectives were addressed:

- Understanding stakeholders' response to uncertainty in past incidents and accidents (Chernobyl, Fukushima, Fleurus, Asco, Krsko);
- Identifying societal uncertainties, and clarifying the implications of the different types of uncertainty and the relationships to ethical issues;
- Gaining new insights into behavioural intentions and information needs in relation to protective actions in emergency situations;
- Assessing differences in mental models of uncertainty management for lay citizens and emergency actors in various national contexts;
- Elucidating the conceptualisation and management of uncertainties during emergency exercises in EU countries;
- Developing and testing improved communication tools through consideration of uncertainty;
- Eliciting stakeholders' preferences and priorities for uncertainty management;
- Drafting a framework for a dialogue between international experts related to coping with uncertainty in emergency and post-emergency situations.

CONFIDENCE aimed at addressing key uncertainties relevant for decision making, reduce them if possible and communicate them such that decisions can be made in a more robust manner, reflecting the complexity of the real situation.

The remainder of this document summarises the findings from CONFIDENCE WP5 and formulates recommendations for addressing social uncertainties in nuclear emergencies, through improved communication and stakeholder involvement. Detailed results on the research conducted can be found in the CONFIDENCE deliverables (https://www.concert-h2020.eu/en/Publications):

D9.25	Report on case studies of nuclear and radiological events	Oughton et al.
D9.26	Paper on planned behaviour in nuclear emergency situations	Turcanu et al.
D9.27	Paper on mental models associated to uncertainty management	Zeleznik et al.
D9.28	Report on observational studies of emergency exercises	Perko et al.
D9.29	Guidelines on tools for communication of uncertainties	Perko et al.
D9.30	Stakeholders' preferences and criteria for uncertainty management	Baudé et al.
D9.31	Report on international experts' dialogues	Baudé and Hériard-Dubreuil

2. Definition of uncertainties

In this part of the CONFIDENCE research, we systematically reviewed the state-of-art knowledge regarding the uncertainty definitions and types in a different range of hazards but mainly focused on the radiological risks. The analysis of 33 peer-reviewed articles (2002-2018) revealed three findings: *First,* there is no agreement regarding the definition of uncertainty, which is mainly defined based on its sources, types or categories rather than by its meaning. *Second*, different actors are faced with different types of uncertainty. The uncertainties faced by scientists tend to be of methodological nature, while those of decision-makers are decision-related and often linked to public reactions and economic issues. Laypeople report uncertainties in the form of lack of trust, as well as emotions and feelings. Furthermore, the majority of articles analysed focused on the uncertainties of the scientific community, while those of the information receivers (i.e. decision-makers and laypeople) received much less consideration. *Finally,* there was no difference in the types of uncertainties put forward across the different risk-related study areas analysed (radiological vs. other risks).

Future research should focus more on the uncertainties of information receivers to understand what information they need to make informed decisions. Ignoring these uncertainties and focusing only on experts' concerns diverges from the primary goal of uncertainty communication, namely to contribute to informed decision-making.

3. Identification of uncertainties faced by emergency actors and affected population

In order to identify uncertainties that decision makers, affected population and emergency responders may face during a nuclear emergency, CONFIDENCE research investigated i) response to uncertainty in **past nuclear emergencies;** ii) the concerns raised in the face of a hypothetical accident; and iii) the behavior of participants in **emergency exercises.** This identification focused on social, ethical and communication aspects of uncertainty management.

i) Seven **case studies of nuclear and radiological events** have been conducted in task 5.1 to elucidate the understanding and response to scientific and social uncertainties in past incidents and accidents, and related ethical issues. This included five recent incidents affecting European countries (Fleurus, Belgium, Asco, Spain, Tricastin, France, Halden, Norway, and Krsko, Slovenia), a retrospective analysis of the management of uncertainties in Norway after the Chernobyl accident, and a study of citizen science after the Fukushima accident. The analysis was primarily based on document review, with support from preliminary media analysis and interviews. The seven cases span from 1986 to 2017 and vary in degree of severity, impact and response. Nevertheless, some general conclusions and traits can be seen, including a range of different challenges and uncertainties.

All cases initially underestimated the potential impact of the accident in terms of the societal impact and communication challenges (including the case of the Krsko "non-event").

There was clearly a wide range of *technical uncertainties* at play that generated, in turn, societal uncertainties. In the early phases these included questions about the *magnitude and range of contamination* (all cases), but also *measurement uncertainties* linked to both *environmental monitoring* (data and measurement quality, different instrumentation and measurement techniques, among others) and *health monitoring* (e.g., thyroid measurements). The question of whether the *discharges had been detectable off-site* was a particular issue for the Asco case in Spain and Fleurus in Belgium. The *need for retrospective analysis* and modelling added an additional layer to the technical uncertainties, in the cases of Asco (detection 4 months later) and Tricastin (uncertain length of release). The *reporting and interpretation of measurements* added another level of uncertainty, including whether ranges or, more commonly, maximum measured values were reported (e.g. Fleurus and Halden cases). *Variability and inhomogeneity of measurements* raised challenges in Norway after the Chernobyl accident, and in Spain in the context of the accident at Asco. *Documenting undetectable levels of contamination* in both workers (Asco) and the public (Fleurus, Asco) was deemed important for reassurance. In the case of Fleurus, the possibility for thyroid screening was offered to potentially affected populations. Public health monitoring was also offered in Norway after Chernobyl, as was monitoring of local produce, although here the focus was on *documenting low levels* rather than undetectable amounts. Having access to *timely and actionable data* was deemed to be a crucial element of citizen science radiation measurement initiatives in Fukushima. *Citizen Science has provided a response for the affected population to cope with uncertainties experienced in relation to the accident, the governmental and the scientific approach and society*.

Some degree of *contradictory information* was seen in all cases, mainly in the communication of health effects (e.g. no expected health effects, but monitoring carried out anyway – Asco, Fleurus, Tricastin, Fukushima), but also linked to food stuff. For instance, farmers could sell their produce on the market, but local population was advised not to consume vegetables from their own garden in the case of Fleurus. Fukushima, Asco and Chernobyl (Norway) also reported *differences in expert opinions*, particularly related to health effects. Media analysis revealed *diverging interpretations of risk between experts (no health impact whatsoever) and* NGO's (possible serious impacts). Although all cases highlighted possible societal impacts these varied from case to case. Tricastin, Asco and Chernobyl/Norway all highlighted possible impacts on agriculture and farming. The Asco case also showed *concerns for tourism and stigmatisation of affected areas*, Fleurus for the *possible lack of medical isotopes*, and Fukushima for a wide range of impacts, including stigma. The question of *compensation to farmers* for losses was quickly raised in Norway and France. These events also resulted in important changes in safety protocols and procedures at many of the installations.

There were also differences in *societal framing of the cases*. The accidents and incidents raised questions on *acceptability of nuclear energy* in Belgium, Spain, France, Slovenia and Japan. In Belgium discussion of thyroid monitoring pointed out difficulties with the *timing of measurements*, given the screening was planned on the first day of school, before teachers and children had bonded. In Norway the accident coincided with a change in government, which created uncertainties about *available resources*. The most important communication uncertainties for all cases were caused by the *delays in providing information to the public*, *incomplete information* and a *perceived lack of transparency*, the latter being contradicted only by the Krsko case.

The case citizen monitoring in Fukushima showed that the accident caused *disruption of family life and breakdown of trust* between society, science and authorities. Interestingly the aftermath of the Tricastin case sparked a successful dialogue and stakeholder engagement initiative, underlining the *importance of a pluralistic approach*. Likewise, citizen science initiatives in Fukushima, while not without their own challenges, also offered important alternative mechanisms of public communication and dialogue. As uncertainties of citizens living in a contaminated environment changed, so did the responsibilities the citizen measuring centres took upon themselves. From emergency response some centres were able to develop into *community centres and alternative information hubs*. *Not only does citizen science directly connect to community life, it also provides individuals a means to empower themselves* amidst a situation they are unwillingly confronted with.

Ethical aspects identified in the seven case studied relate to *vulnerable populations* (e.g. *children*, as highlighted in Asco and Fleurus cases; and *minority cultures* seen in Norway/Chernobyl); sensitivity to *differences in distribution of exposures and impacts*, initiatives to *empower and increase control* of affected populations and issues with *information transparency* highlighted above.

ii) Empirical research was conducted in task 5.2.i through **surveys** in Belgium and Spain, among people living close to nuclear installations (N=314 in Belgium, living within 20 km from Doel or Tihange NPPs, N=302 in Spain, living within 30 km around of Vandellós, Ascó, Cofrentes, Trillo and Almaraz NPPs) and among people living farther away (N=1083 in Belgium, representative for the Belgian 18+ adults; N=506 in Spain, living within an area of 31 km to 100 km around NPPs), in order to identify public concerns in the context of a hypothetical nuclear accident. Responses to an open question revealed that main concerns or uncertainties were related to the *health risks, contamination of the environment, people (e.g children, family), staying/going indoors, finding and taking iodine pills, living the area, or what to do in case of an accident*. These concerns differed between countries, but also between regions in the same country. Moreover, a majority of respondents in all countries evaluate their *level of information or knowledge about protective actions in case of a nuclear accident as very low or low*, particularly people living close to nuclear installations. This shows that information campaigns have to be repeated regularly to bring people's attention to emergency information.

Results also show that *most trusted communicators for both Belgium and Spain are national crisis centres, rescue services, research organisations (universities or research centres) and medical doctors*. In Norway, almost half of the population would trust the Norwegian *authorities* in case of conflicting messages during emergencies, while one third would trust research institutions. National politicians and the media have a particularly low level of trust in Belgium and Spain. Local authorities enjoy more trust than members of the parliament and public representatives, but lower trust than other actors in Belgium and Spain. However, in Norway they are revealed as the preferred information source during an emergency, followed by the nuclear safety authority. In Belgium, local population expressed less trust in scientists from universities and research centres and nuclear safety authorities, than the general public.

iii) The research conducted in task 5.2.iii through observations of **exercises observations** provides insights into the way uncertainties are addressed and handled during emergency exercises. It focused on the information flow and communication between actors, as well as the assumptions and decisions made under emergency exercise conditions. The methodological approach relied on non-participant observation as a technique for the systematic study of human behavior. The objective was to maintain the integrity of unique cases/findings, to crystallize rather than generalize, and contribute to theory and dialogue about nuclear emergency management under uncertainties. 11 national exercises were observed in six countries, as well as one international exercise, with a total of 29 observation points. The research resulted in the identification of a list of 33 uncertainties.

The following *dilemmas*, causing uncertainties or being caused by uncertainties have been identified on the basis of observations: *What is the origin of the first information? Is the information exchange sufficient? Which tools of information exchange are reliable? How to deal with time pressure? Which factors impact information exchange? How is information understood by different stakeholders? Is information consistent? Are all emergency actors informed timely? How to communicate negligible impacts? Is ICT reliable? Which information is public and which information should be restricted to the emergency management teams? How will public communication/information needs be addressed effectively? Which areas will be affected? How serious is the accident? How to decide on protective actions? Which protective actions to apply? How to implement protective actions? Will people follow the instructions or recommendations given? How to deal with long-term consequences? When is the time of the beginning of the release? How to deal with technical aspects (e.g. source term) during the early phase of the emergency? Is radiological assessment consistent? How to interpret dispersion models maps? How to coordinate cross-border aspects? How will coordination and collaboration among emergency response actors be achieved? Is there a gap between legislation (including plans) and reality? Are the preconditions of the functioning systems taken into account? Are all emergency response actors familiar with their roles, procedures and plans? Are the available resources adequate? Are the emergency actors familiar with and trained to use the equipment? Are social and ethical considerations taken into account? What comes first: safety or security?*

Social scientific research on the identification of these uncertainties contributes to *creating awareness about potential challenges* and improving decision-making under uncertainty in nuclear emergencies.

4. Uncertainties arising from potential public behaviour in emergency situations

Nuclear emergency response and recovery is confronted with both techno-scientific and societal uncertainties that influence each other and, in turn, the effectiveness of protective actions for people and the environment. For instance, uncertainty about the effects of low doses raises uncertainties with regards to people's willingness to return in a previously evacuated area, or consume food products with low levels of radioactivity. In turn, public's uncertainty about what to do in case of an emergency raises uncertainties for experts' assessment of health effects from implementing a particular protection action, since these are based on assumptions about people's behaviour, e.g. that they will shelter when advised to do so, or have available and take stable iodine tablets at the right time. Understanding peoples' concerns, motivations, beliefs and value judgments underlying individual decision-making in an emergency situation, is crucial to improving the governance of nuclear or radiological accidents and incidents.

Within task 5.2.i, an empirical study was carried out in three countries (Belgium, Spain and Norway) to investigate citizens' potential behaviour in the case of a nuclear emergency. The study aimed at providing insights into how people (either the general public or people living close to a nuclear installations) assess their reaction to an emergency; what their willingness is to follow official advice concerning protective actions; and which factors are associated with expected behaviour. The latter included descriptive norm (perceived social norm), hazard and resource related attributes, and self-assessed level of knowledge about protective actions in case of a nuclear accident.

Most respondents said they would comply with emergency actions, *except for leaving children at school and avoiding the use of phone*. In case of the latter, less than 50% of respondents in Belgium and Spain say this is likely to happen. In Spain, self-assessed *compliance was markedly higher among respondents living less than 30 km away* from a nuclear installation, compared to those living farther away. The differences between the two populations were, however, not consistent and much smaller in Belgium. *Giving an iodine tablet to children was highly correlated with taking a tablet oneself*. Three actions are generally considered as both easy to undertake and effective to protect against the nuclear risk associated with an emergency situation: dietary restrictions, leaving the area and avoiding drinking tap water. *Staying indoors is perceived, on average, as relatively easy, but less effective*. Taking an iodine tablet is considered as not very easy and only moderately effective.

Self-assessed *compliance increases with higher perception of other residents' compliance* and perceived effectiveness of protective action, but decreases with perceived difficulty. The strength of association between compliance and the most important correlates of behavioural expectation (perceived social norm, effectiveness and difficulty) varied across countries and across actions. Knowing more about protective actions is in general not a guarantee of compliance with the advice from authorities in an emergency situation. Compliance with leaving children at school, as an exception, was, however, positively correlated with knowing what to do in case of a nuclear accident, and the association was stronger in the local population. Opposite to this, higher knowledge was associated with lower expected compliance with refraining from drinking tap water or consuming local food, and leaving the affected area for few days among the Spanish local population.

Higher trust in the nuclear safety authorities as emergency communicator is associated with higher expected compliance mostly among the local populations, and particularly in Spain. Respondents with higher trust seemed somewhat more inclined to comply with staying indoors, avoiding the use of phone, taking an iodine tablet (both Belgium and Spain), leaving children at school (only Belgium) and respecting dietary restrictions (only Spain).

The Belgian results also suggest that significant parts of respondents in both the local and general populations may be *reluctant to consume local food products* with residual radioactivity. Moreover, a *large fraction of respondents may take an iodine tablet contrary to the advice* from authorities.

5. Mental models of uncertainty management in emergency situations

Emergency Preparedness and Response (EP&R) plans are prepared for radiological and nuclear threats at different levels: national, regional, local, off-site, on site, for individual organisations, for nuclear facilities. These plans are usually prepared by responsible authorities/institutions and are very rarely developed in consultation with the publics, especially those which could be affected in an emergency. As a consequence, plans may lack the appropriate information or fail to address the uncertainties, concerns and needs of the possibly affected publics in case of nuclear or radiological accident. As part of the socio-

psychological study of understanding, processing and management of uncertainties an investigation of the mental models[1] of EP&R management was performed in task 5.2.ii. The aims were support and improve communication between EP&R stakeholders, in particular the potentially affected population, and to trace the concepts and understandings of emergency preparedness and responds, in order to identify possible gaps between experts and lay people models.

The methodology included mapping of mental models within several emergency preparedness and response experts and then performing interviews based on structured protocol with lay people in 5 countries: Germany, Greece, Slovakia, Slovenia and Spain. The leading questions for the investigations were: What are the mental models present within the potentially affected public regarding emergency management and associated uncertainties? What are the differences, gaps, misunderstandings and perceptions in the public compared with the ones provided by experts in the field? What are the similarities and differences of mental models between the countries in which the investigation took place?

The figure below illustrates a mental model of reasoning about EP&R.

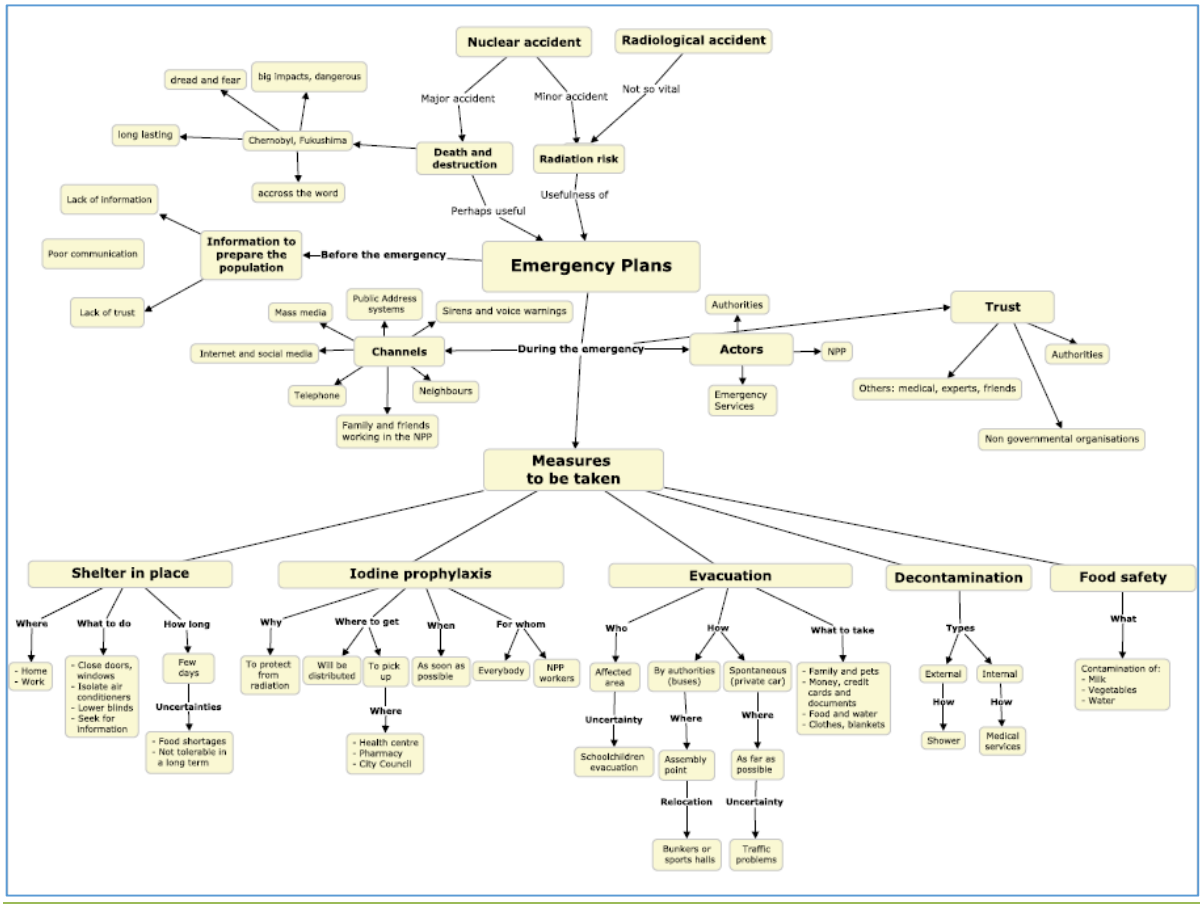


Fig. 1 Mental model of reasoning about EP&R

Participants showed a general idea of the basic elements of EP&R plan, but only *vague knowledge of each specific protective measure*. Interestingly, interviewees differentiated two possible situations in case of accident in a nuclear power plant: major accident or minor nuclear accident. *In case of major accident, they express fatalistic beliefs*, with a scenario of death and devastation, rendering *EP&R plans inadequate*,

[1] Mental models are cognitive schemas through which people explain individual processes or phenomena in which they are participating. (Morgan M.G., Fischoff B., Bostrom A., Atman C.J., (2002) Risk Communication: a mental models approach, Cambridge University Press)

while in case of minor accident, the emergency plan would be useful. The *memory of major nuclear accidents in Fukushima and Chernobyl is still present* and defines the models people have in relation to a nuclear accident. People believe that there is *insufficient information available* for the population. In addition, there is evidence of distrust in the responsible authorities, which makes the communication even more difficult.

Some uncertainties and disagreements coming from the emergency plan are highlighted by participants:

- What information should be available? Currently it is *not clear what information is available and what should be known by all*. New ways of communication should also be used, for instance based on social media, and citizens' measurements should be supported. In addition, there should be exercises performed and practiced at all levels: local and national.
- What to do? *Some people would not follow the instructions as they do not trust the government and institutions*. There would be panic and as they are not really informed, they would use their own imagination what to do.
- Are plans harmonised with behaviour of population? The question is raised whether *plans foresee the real behaviour of citizens*. Some areas of disagreement were pointed out (children in schools and kindergartens, self-evacuation).
- What are the risks they will face? The *associated risk is assessed as very high and some elements of fatalism are present* that nothing can be done.

While there is a clear awareness that in case of an accident it would be better to comply with authorities' instructions, it is not clear for all the interviewees that they would follow these instructions. This is linked with lack of trust in the responsible authorities. *Main uncertainties mentioned will be what to do, where to go, and how would they be informed*. Some of the participants would prefer to place their trust in other actors, for instance non-governmental organisations, medical doctors, expert and scientists.

Some actors are mentioned as reliable sources of information during an emergency: NPP managers, authorities (both local and regional) and the emergency services (Police, Firemen, Civil Protection). Also, some channels are mentioned: sirens and PA system, mass media, Internet, telephone, neighbours, and family and friends working in the NPP.

Several suggestions were developed to improve the EP&R management and have generic value, as they are not depending of nuclear or socio-cultural situation. There should be in all countries *better, more proactive provision of information before emergency.* Risk communication activities should take into account both the national (radiological) threat assessment, as well as the perceptions of risk by publics. *Better understanding of the protection measures* should be achieved, using *modern communication approaches* and also by *inclusion of potentially affected population in exercises*. *Clarification regarding the roles of different emergency response players* should be emphasized and resources should be made available in order to support the increased needs of information during emergencies. *Building of trust* is still among the most important preconditions to assure effective management of real accident.

6. How to communicate about uncertainties?

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.

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 those of experts. In addition, authorities and scientists (in both natural and social sciences) need to connect to communicate uncertainty to the publics.

Extensive research has been conducted in task 5.2.iv on different tools (app, SMS, maps, numerical, narrative or mixed messages and video) for uncertainty communication to be applied in the case of nuclear or radiological emergencies.

Results from a systematic overview of international literature and an online search of communication tools 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 on how to address uncertainties during a crisis communication. The tools vary significantly, ranging from sophisticated online and app solutions to approaches to 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.

Dedicated research has been conducted about applied communication tools for nuclear emergencies and uncertainty communication; this investigated developments in the use of electronic safety information for nuclear and radiological emergency in a global context. It firstly addressed psychological gaps between laypersons and experts in building perceptions and making risk decisions, followed by an overview of public communication failure during the nuclear emergency in Fukushima in 2011. It is demonstrated that there is the *need to develop more effective communication tools for uncertainty management.*

Identified advantages of Apps include: Visual (more comprehensive for laypersons); Swift (time lags are minimised), and Tailored (to individual preferences and requirements). However, issues needing further attention include: false alerts; costs (more costly than developing web-based information); some Apps are labour intensive (frequently updates necessary for APP); some Apps are tedious (people do not download the App as they find it too time consuming)

The conclusion of this part of the research is 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.

Additional research investigated 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 the proper uptake of iodine pills in case of a radioactive release, are highly sensitive issues to communicate. This research tested which of the 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*.

Visualisation of uncertainties through maps has been investigated in detail. This part of the research focused 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. 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 colours and largely unrelated to the meaning of the colour (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 colour, blue colour, 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.*

Supplementary to testing maps in emergency situations, additional research has been carried out 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 are likely to 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.

A video to address risk perception factors in the waiting rooms for thyroid measurements has been developed due to Previous experiences with nuclear or radiological emergencies which 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 a trust building process between the affected people and experts. The video is open source and available on the internet.

7. Uncertainties faced by the local actors and influence of emergency and post-accident arrangements on their capacity to manage these uncertainties

Emergency management plans provide frameworks that defines the responsibilities of different institutional actors. In general, these frameworks do not address in detail the recovery phase. Moreover, beyond this circle of actors, as shown in particular by the European research project PREPARE based on return of experience from Fukushima, local actors (local authorities, economic actors, civil society organisations, scientists, families, etc.) are active from the first hours after an accident, including during the emergency phase. The construction of the response of local actors to the post-accident situation is a social process composed of a multitude of decisions taken in a context marked by uncertainty and according to a broad set of issues which is not limited to the application of external prescriptions insofar as people are the only ones capable and legitimate to decide their future. In this perspective, task 5.3 was developed in the framework of the European research project CONFIDENCE in order to address this issue with the concerned local and national actors, focussing on the emergency phase and the post-accident phase up to 1 year after a major nuclear accident, in order to discuss questions such as: “How local actors are confronted to complexity of emergency and post-emergency situations and to the associated uncertainties?” or “What are the resources for local actors to deal with these and how national emergency and post-emergency arrangements could be improved in the view of capacitating and supporting local actors in their efforts to rebuild dignified living conditions?”. Three national workshops (in France, Slovak Republic and Portugal) have been organised between January and March 2019.

Large-scale nuclear accidents can be at the origin of long-term contamination of territories seriously affecting the human life conditions. All dimensions of life (personal, family, social, health, economic, cultural and political) are affected by these situations, often irreversibly. In particular, the accidental and post-accident process entails a destruction of social cohesion, of social distrust, leaving individuals

isolated and without social recourse, confronted with complex situations where they experiment loss of control over their life. The concept of *dignified living conditions* has been defined as a potential common objective for emergency and post-emergency managers and local actors confronted with the consequences of a nuclear accident. In order to characterize the several categories of anthropological resources that are at the origin of resilience capacities a set of seven complementary criteria (see Fig. 1) has thus been developed. They are grounded on the synthesis of different academic results in the field of philosophy, sociology, developmental economy, psychology and anthropology. It is also grounded on 25 years of experience and research of partners of this research task as regards the living conditions of affected populations in the post-Chernobyl then in the post-Fukushima context.

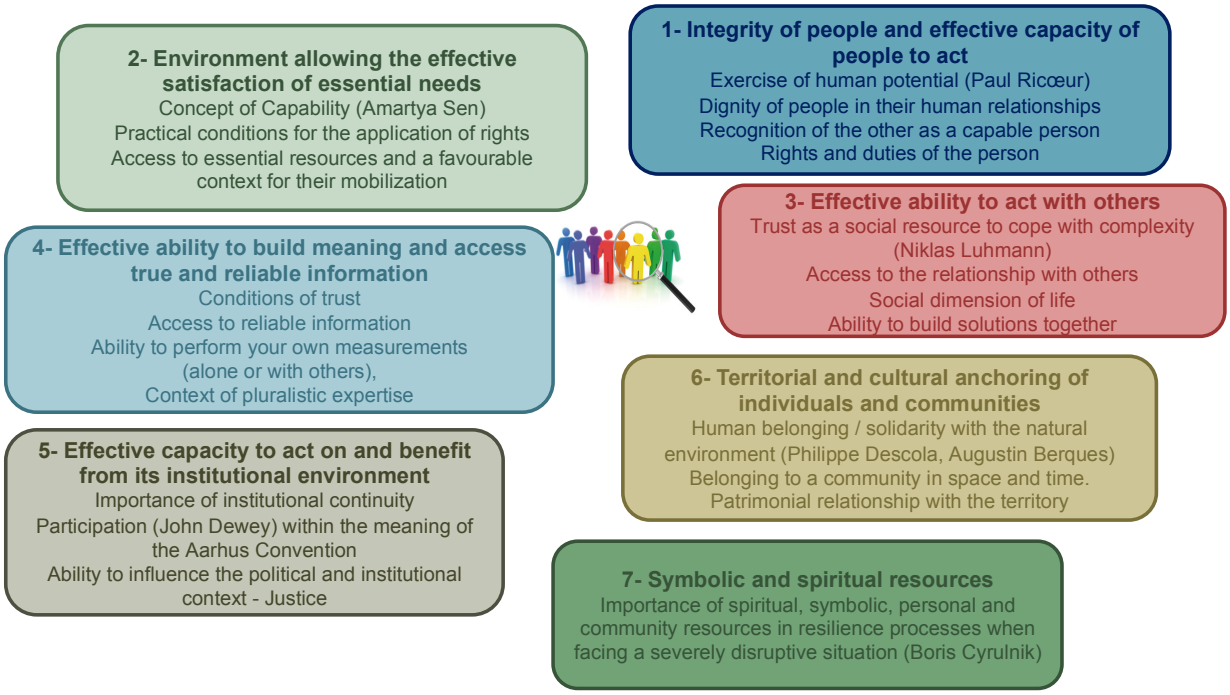


Fig. 2 The seven anthropologic criteria of dignified living conditions

These seven criteria (see Fig. 2) have been developed as part of the methodology of the national workshops in order to analyse and discuss the resilience capacities of local populations confronted to disruptive situations resulting from a nuclear accident. From October 2017 to August 2018, a set of four case studies[2] have been developed in order to illustrate the above-mentioned issues. In parallel to the development of the case studies, the structured dialogue method for the national workshops has been drafted, refined, tested and finalised.

The method enabled bringing together a variety of participants, including specialist and non-specialists, having some knowledge or not on emergency and post-emergency issues. The criteria of dignified living conditions were welcomed in the three national contexts (France, Slovak Republic and Portugal) as an easily understandable tool helping specialists and non-specialists to grasp the specific perspective of local population confronted with emergency. The three workshops took place in different national contexts

Case 1 - Organization of a campaign of independent measurement of ambient radioactivity by a group of university professors a few days after the Fukushima accident, Case 2 - Organization of the evacuation of the city of Litate in such a way as to maximize the chances of preserving the social cohesion of the community, Case 3 - Decontamination of Tominari Primary School in Date, Case 3 - Characterisation of the radiological situation and food quality in the hamlet of Suetsugi.

where the question of nuclear emergency management has a different weight. There are strong differences regarding contemporary history of those countries with consequences on the social and political culture. There are various degrees of awareness and preparation vis-à-vis a large-scale nuclear accident. The workshops methodology has allowed each group of national participants to plunge into the concrete reality of a nuclear accident as addressing it from a local perspective in the context of a realistic case study involving genuine actors. The discussion of the cases confirmed that *local actors may be active players even in the emergency phase*, *and may take autonomous action, individually and collectively*, when facing existential questions, to some extent mitigating failures or gaps of institutional response. *Local actors highlight the need to recreate an environment allowing the satisfaction of basic needs* (in particular for vulnerable people e.g. children, elderly people, ...). This includes *rebuilding the meaning of existence* in general, and the deployment of meaningful actions in particular. While doing this, local actors tend to *balance the various dimensions* of the situation (e.g. health, environment, links between generations, social bonds, attachment to territory, link with the meaning of their life including its spiritual dimension, …) in a global approach and comprehensive understanding of the situation. In this, radiation protection represents an important dimension, among others important aspects of life. *Should one stay? Will the territory become habitable again? When will it take place? Can we project ourselves into a future on this territory (or in relocation) and if so how?* This is a fundamental uncertainty that combines various environmental, health, economic, social, and other factors related to the meaning of pursuing a life (including from an intergenerational perspective) or an activity in a contaminated site of varying degrees of severity.

A major conclusion of this work asserts the need to *introduce or strengthen the degree of flexibility and subsidiarity in the national response frameworks in order to adapt to the specificity of local contexts or to unforeseen situations* that are likely to arise in the event of a major nuclear accident. Adaptability and subsidiarity appear to be a condition for maintaining a relationship of trust between populations, local authorities and national authorities, contributing at the same time to the efficiency of emergency response. An important challenge is to articulate the action of the public sphere with the action of civil society. In this perspective, *local actors should be provided with technical tools and expertise to enable them to build together meaningful local strategies*. With the help of these tools possible alternative scenarios and choices should be made explicit. This requires the ability to train local authorities. *Emergency and post-emergency preparedness and management policies should prepare and support the deployment of local measurement capacity in the event of an accident, including by informing and training local authorities and networks of local actors*. From this point of view, it seems useful to *identify teams of non-nuclear-related researchers capable of taking measurements*, and to *strengthen the links between non-institutional actors with professional measurement capacities*. *Inter-comparison* between institutional measurement and non-institutional measurement (local or external) should also be organised in order to promote confidence in measurement results. It is underlined that *local networks are vested with trust by local actors and in this perspective should be proposed to disseminate and share information*. It should be noted that *transparency is not only required by local actors on established facts but also on the running uncertainties* along the emergency and post-emergency management.

In particular, one question appears central to the participants in this articulation: *How to support local actors in the construction of meaningful strategies, while preserving their autonomy? Food management, for instance, cannot be based solely on the existence of standards. Everyone should be able to control its exposure* within the limits it considers as appropriate (for itself, for family and children, etc.), even if these limits are more restrictive than the official standards.

It seems difficult for public policies to encourage the deployment of a local measure in emergency situations because of the risk of exposure of local actors carrying out the measurement, who are less trained and equipped with protections than measurement professionals. This might be overcome by *implementing in advance appropriate policies for the protection of voluntary workers*.

It is also noted that emergency and post-emergency policies should be prepared to identify possible environmental contamination in areas beyond the perimeters defined by the zoning. Since emergency and post-emergency managers will probably not be able to carry out measurements beyond these boundaries, it important that local actors have the capacity to perform measurements by themselves. This kind of initiative should be welcome and be supported and accompanied if a problem is detected. This requires the *preparation of actors (associations, local actors, etc.) with the capacity to intervene in these "outside" areas, in particular to carry out measures*. If a problem is identified, the answer cannot be built solely on technical bases but should be part of a meaningful local strategy. Investing in education and training at local level should be a political imperative.