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TERRITORIES Workshop on: Communication of uncertainties of radiological risk assessments to stakeholders

Lead Author: Almudena Real (CIEMAT)

With contributions from:

Martin Steiner (BfS), Lindis Skipperud (CERAD/NMBU), Rodolphe Gilbin (IRSN), Alan Tkaczyk (UT), Marie Simon-Cornu (IRSN)

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Abstract

On 16 November 2017, the first TERRITORIES workshop planned under CONCERT Sub-subtask 9.3.4.3 (*Development and implementation of E&T activities for appropriate audiences*), led by CIEMAT, was organized in Oslo on "Communication of uncertainties of radiological risk assessments to stakeholders".

The objective of this workshop was to discuss the implications and relevance of uncertainties in radiological risk assessments (in long-lasting exposure situations) for different stakeholders, and work out how these uncertainties could be better communicated, obtaining feedback from regulators, industry, scientists and the general public on these issues.

The TERRITORIES workshop on "Communication of uncertainties of radiological risk assessments to stakeholders" had 30 participants from 10 different countries. All participants were extremely active in the discussions held during the workshop, even during the coffee breaks. Special mention must be made of the chairs of the sessions, the speakers and the moderators and secretaries of the group work sessions, without whom the workshop could not have been carried out.

List of acronyms

ALLIANCE:	European platform on radioecology research (http://www.er-alliance.eu/).
BfS:	German Federal Office for Radiation Protection.
BIOPROTA	Forum to address uncertainties in the assessment of the radiological impact of releases of long lived radionuclides into the biosphere (http://www.bioprota.org/)
CEPN	French research and development centre in the fields of optimisation of radiological protection and comparison of health and environmental risks associated with energy systems.
CERAD	Norwegian Centre for Environmental Radioactivity.
CIEMAT	Spanish Centre for Energy, Environment and Technology.
CR	Concentration Ration.
DCRL	Derived Consideration Reference Level.
DSS	Decision Support System.
E&T	Education and Training.
EJP-CONCERT	European Joint Programme for the Integration of Radiation Protection Research under Horizon 2020 (http://www.concert-h2020.eu/en).
EnviroCase	Finnish consulting company for managing environmental research and risk assessments.
GEP-mines	Pluralist Expertise Group on Uranium Mining Sites in Limousin area in France.
IAEA	International Atomic Energy Agency (https://www.iaea.org/).
ICRP	International Commission on Radiological Protection (http://www.icrp.org/).
IPCC	Intergovernmental Panel on Climate Change.
IRSN	French Institute for Radiation Protection and Nuclear Safety.
Kd	Solid/liquid partition coefficient.
MELODI	European platform on low dose radiation risk research (http://www.melodi-online.eu/).
MODARIA II	IAEA programme on Modelling and Data for Radiological Impact Assessments (http://www-ns.iaea.org/projects/modaria/modaria2.asp).
ERIS	European platform on preparedness for nuclear and radiological emergency response and recovery (http://www.eu-neris.net/).
NGO	Non-Governmental Organization.
NMBU	Norwegian University of Life Science.
NORM	Naturally Occurring Radioactive Materials.
NRPA	Norwegian Radiation Protection Authority.
RAP	Reference Animal and Plant.
SCK•CEN	Belgian Nuclear Research Centre.
SKB	Swedish Nuclear Fuel and Waste Management Company.
SSM	Swedish Radiation Safety Authority.

TERRITORIES	To Enhance unceRtainties Reduction and stakeholders Involvement TOwards integrated and graded Risk management of humans and wildlife In long-lasting radiological Exposure Situations. TERRITORIES is an European research project funded in the framework of the EJP-CONCERT [grant agreement No 662287] of Horizon 2020 (http://territories.eu/; https://territoriesweb.wordpress.com/).
UPM	Polytechnic University of Madrid, Spain.
UT	University of Tartu, Estonia.
WHO	World Health Organization (http://www.who.int/en/).
WP	Work Package.

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1. Introduction and objectives

TERRITORIES (To Enhance unceRtainties Reduction and stakeholders Involvement TOwards integrated and graded Risk management of humans and wildlife In long-lasting radiological Exposure Situations), is part of the EJP-CONCERT project. TERRITORIES has three main objectives:

- To meet the requirements that emerged after the recent Fukushima experience and the publication of International and European Basic Safety Standards.
- To reduce uncertainties to a level that can be considered fit-for-purpose (graded approach).
- To bridge NORM vs post-accident (after transition phase) exposure situations, monitoring *vs* modelling, human *vs* wildlife population, experts *vs* decision makers *vs* the general public in management (integrated approach).

One of the aims of CONCERT Sub-task 9.3.4 on strategic and integrated communication, education and training, led by UT, is to "i*dentify and communicate to appropriate audiences the existing capabilities, key uncertainties, needs and knowledge gaps in radiological risk assessment and management for humans and wildlife in long-lasting radiological exposure situations*".

The Sub-subtask 9.3.4.1, led by NMBU, is in charge of identifying key factors contributing the most to overall uncertainties when linking models simulating environmental dispersion and transfer processes, exposure and resulting dose estimates together, to finally characterize and manage risks associated with long-lasting radiological exposure situations. To reach this objective, a workshop was planned to be organized in 2017.

The Sub-subtask 9.3.4.3, led by CIEMAT, is in charge of the development and implementation of education and training activities for appropriate audiences, including stakeholders, professionals and students. Three workshops were planned to be organized, with the aim to encourage the discussion on key issues on risk assessment in long-lasting exposure situations, including socio-ethical aspects, between researchers and stakeholders.

After considering different options, it was decided that the workshop under Sub-subtask 9.3.4.1, and one of the workshops under Sub-subtask 9.3.4.3 should be organized together (one after the other) in 2017. Therefore, it was agreed to organize a two-day workshop on "Key factors contributing to uncertainties in radiological risk assessment", followed by a one-day workshop on "Communication of uncertainties of radiological risk assessments to stakeholders", in Oslo.

The joint organization of the workshops would allow optimizing TERRITORIES resources and would facilitate the participation of interested stakeholders in both events, since the workshops are thematically strongly connected. In addition, the scientific knowledge presented in the workshop on "Key factors contributing to uncertainties in radiological risk assessment" would be a useful background for the workshop on "Communication of uncertainties of radiological risk assessments to stakeholders".

The workshop on "Key factors contributing to uncertainties in radiological risk assessment" had the objective to discuss the key factors contributing the most to overall uncertainties when linking deposition and ecosystem transfer to human and ecosystem radiological impact and risk assessment models, obtaining feedback from modellers, experimentalists and stakeholders.

The workshop on "Communication of uncertainties of radiological risk assessments to stakeholders" had the objective to discuss the implications and relevance of uncertainties in radiological risk assessments for different stakeholders, and work out how these uncertainties can be better

communicated, obtaining feedback from regulators, industry, scientists and the general public on this subject. In this workshop, the focus was on the uncertainties related to radiological risk assessments in long-lasting exposure situations (both NORM and post-accidental exposure situations). Ethical and social uncertainties were not explicitly addressed in this workshop.

A key aspect of the workshop on "Communication of uncertainties of radiological risk assessments to stakeholders" was to find out the most relevant uncertainties related with risk assessments for different stakeholders (regulators, industry, scientists and members of the public). The workshop aimed to learn which is the acceptable level of uncertainty for different stakeholder groups, how does each stakeholder group manage such uncertainties, and how can TERRITORIES provide guidance on addressing and reducing the most relevant uncertainties for each stakeholder group. During the workshop, the communication of uncertainties to the different stakeholder groups was also discussed, as well as how this communication can be improved.

2. Workshop organization

To address the organization of both workshops, an organizing committee was established, consisting of the TERRITORIES participants Lindis Skipperud (CERAD/NMBU, Norway), Almudena Real (CIEMAT, Spain), Martin Steiner (BfS, Germany), Rodolphe Gilbin and Marie Simon-Cornu (IRSN, France) and Alan Tkaczyk (UT, Estonia).

A survey was made among the TERRITORIES members to find out suitable dates for the workshops. Taking into account the availability of the TERRITORIES members, it was finally decided to have the workshops on 14-16 November 2017. The NMBU, as local organizers, looked for an adequate venue to celebrate the workshops. The Thon Hotel Slottsparken in Oslo was finally chosen.

The organizing committee held several video conferences to prepare the programme of both TERRITORIES workshops. The draft titles of the lectures and potential speakers were proposed. Once the draft programme was agreed, the proposed speakers were contacted, asking if they were willing to participate in the workshops.

The detailed **programme** of the workshop on "Communication of uncertainties of radiological risk assessments to stakeholders" is in Annex 1. The workshop started with two introductory talks. The first one, "Overview of uncertainties in radiological risk assessments", was presented by Rodolphe Gilbin (IRSN). Since we did not know in advance the expertise of the workshop participants, it was considered necessary to have this introductory talk to facilitate the later discussions during the workshop. The second talk, given by Lindis Skipperud (CERAD/NMBU), summarised the main issues discussed during the workshop "Key factors contributing to uncertainties in radiological risk assessment", because some participants were unable to attend both workshops, although they were encouraged to do so.

After the introductory talks, the workshop was structured in two sessions: "*Implications and relevance of uncertainties for stakeholders*" and "*How to communicate uncertainties*". As can be seen in the programme (Annex 1), there were two group work sessions for discussion in addition to the presentations made by the representatives of the different stakeholders. To encourage the active participation of all the attendees in the discussions, they were divided into four small groups (7-9 persons): regulators, industry, scientists and general public. Each group had a moderator (if possible not involved in TERRITORIES) and a secretary (a TERRITORIES member). The secretary was in charge of taking notes and presenting a summary of the discussion in the plenary session that followed the group work session. To stimulate the discussions, the organizing committee prepared in advance some questions (Annex 3), which were distributed to all participants.

Regarding the **dissemination** of the workshops, once the programme was agreed, the events were announced using different tools. The programmes were disseminated through the TERRITORIES blog (https://territoriesweb.wordpress.com/) and webpage (http://territories.eu) (Annex 2).

The workshops were also announced in the following webpages: EJP-CONCERT Project (http://www.concert-h2020.eu/en/Events/20171114_TERRITORIES); the Radioecology Exchange (http://www.radioecology-exchange.org/news-and-media/news/territories-project-%E2%80%93-workshops) and NERIS (http://www.eu-neris.net/index.php/home/newsletters/142-territories-workshops.html) (Annex 2).

In addition, the information of the TERRITORIES workshops was distributed by e-mail to all TERRITORIES members and to the European Radioecology Alliance (ALLIANCE) members.

The information of the TERRITORIES workshops was also disseminated in Spain through the national Horizon 2020 webpage (https://eshorizonte2020.es/mas-europa/otros-programas/euratom/eventos/workshops-proyecto-territories_ejp-concert-h2020) (Annex 2).

The workshop on "Communication of uncertainties of radiological risk assessments to stakeholders" had **30 participants from 10 countries** (Croatia, Czech Republic, Estonia, Finland, France, Germany, Japan, Norway, Spain and Sweden) (Annex 4). Among the participants, there were scientists, regulators, industry representatives, and experts on general public-related issues. There were also representatives of several European platforms on radiation protection (ALLIANCE, NERIS and MELODI) (Figure 1).

Figure 1. Participants of the TERRITORIES workshop on "Communication of uncertainties of radiological risk assessments to stakeholders" (photograph: Almudena Real).

The TERRITORIES workshop on "Communication of uncertainties of radiological risk assessments to stakeholders" was sponsored by the Centre for Environmental Radioactivity (CERAD), a Centre of Excellence at the Norwegian University of Life Sciences (NMBU), Norway.

3. Minutes of the workshop on "Communication of uncertainties of radiological risk assessments to stakeholders"

The workshop started with the presentation **"Overview of the uncertainties in radiological risk assessments"** (Rodolphe Gilbin, IRSN). The focus of the talk was on the scientific point of view of risk assessment and characterisation. The definition of risk assessment, which includes the identification of uncertainties, was given and the risk assessment methodology was explained. The presentation focussed on the risk assessment for non-human species, which usually implies a tiered approach. In the tiered approach, the degree of uncertainty is reduced as more specific data are available (higher tiers). The ERICA integrated (tiered) approach was described. The different phases of a risk assessment were presented using the example of the Pluralist Expertise Group on Uranium Mining Sites in Limousin area in France (GEP-mines), in which the objective was to propose management options that can reduce the impacts for human populations and ecosystems. In the concluding remarks the different dimensions of uncertainty in radiological risk assessments were highlighted. Uncertainties are the consequence of an imperfect knowledge of aspects related with exposure and effects analysis (e.g. bioavailability, dosimetry for non-human biota, radiological vs. chemical effects, etc.). It was also stressed that the tiered approach is consistent with stakeholders' needs and provides a level of detail that corresponds to the nature and complexity of the risk being addressed. For the screening tier, the international recommendations and guidelines are a useful source for consensual models (concept of RAPs, Reference Animals and Plants) and "best estimate" parameter data (CR, Kd, DCRL, etc.). At higher tiers, variability (aleatory uncertainty) is usually considered through probabilistic risk assessments (e.g. temporal variability of exposure, variability of living conditions) and the conceptual model is possibly refined (e.g. bioavailability).

Lindis Skipperud (CERAD/NMBU) presented a summary and the main conclusions of the **TERRITORIES workshop on "Key factors contributing to uncertainties in radiological risk assessment"**, held at the same venue on 14-15 November 2017 (see Deliverable 9.73 for more information about this workshop).

3.1. Minutes from session 1: Implications and relevance of uncertainties for stakeholders

The session was chaired by Eduardo Gallego (UPM, Spain, representative of NERIS).

3.1.1 Overview of the presentations

Representatives of the different stakeholders (regulators, industry, scientists and general public) made a short presentation on the implications of uncertainties in radiological risk assessment for each of them. The summary is presented below.

Implications of uncertainties for regulators *(Michael Egan, SSM)*

Regulators are responsible of taking "on the ground" decisions. The first priority of the regulator is to find out the knowledge that is available. There is a need to guide the assumptions to be made, taking into account that choices should be motivated with reference to scientific knowledge. It is important to prioritise safety-significant issues, not to spend efforts in unimportant issues.

Two types of "long-lasting" exposure situations were discussed:

- Existing long-lasting exposure situations (e.g. contaminated areas). The burden is often on the regulator to ensure that appropriate countermeasures are in place. In this case, models are tools to guide understanding (and to a certain extent forecasting), but measurements are critical for decision making, since decisions are usually site- or situation-specific. The main communication challenges include the appropriate levels of protection and related countermeasures and the uncertainties surrounding expectations for the future.
- Planned long-lasting situations (e.g. solid radioactive waste disposal). The burden on the operator is to demonstrate understanding, according to the nature of the potential releases from the facility. The models must indicate the potential impact. The purpose of the models is not to forecast the radiological situation, but to demonstrate compliance, since the regulator needs to be able to judge suitability and adequacy. The communication challenges include making assumptions visible (in both protection criteria and models) and ensuring transparency, e.g. by using sensitivity analyses (even deterministic).

A graded approach will help to prioritise safety-significant issues, provided that these issues have been identified first. It implies an iterative development to uncover what is important (e.g. radionuclides, potential pathways, sensitive species) and then to quantify the importance. The effort must focus on demonstrating the adequacy of the approach.

Things should not be made more complicated than needed. The risk-informed decisions should be guided by scientific understanding (rather than vice versa), showing the route that led to the approach taken. Don't lose sight of the heuristic value of assessment models. They are tools to explore rather than to provide "the" answer.

An example was presented ("the road to Davy's bar"), to show that to get a simple answer, sometimes a complex situation needs first to be understood (through R&D activities). Complexity can be adequate in some situations (e.g. when information is available).

Complexity can't be ignored (source terms, ecosystems, environmental processes). However, complex models are "data hungry", make handling correlations more difficult, are often highly context-specific, and not necessarily easy to use for practical decision making.

The issue was addressed how regulators deal with uncertainties in models. Regulators cannot expect uncertainties to be eliminated, but they need to be managed according to their significance. Transparency is desirable for robust decisions.

Implications of uncertainties for the industry *(Lauri Parviainen, Posiva, representative of BIOPROTA).*

The presentation focused on the BIOMASS methodology for "reference biospheres" for solid radioactive waste assessments. At present, the methodology is being reviewed and updated by BIOPROTA and MODARIA-II WG6 (IAEA).

The purposes of the BIOMASS methodology include, among others, to demonstrate compliance with regulatory requirements and regulatory developments, to contribute to public, policy makers' and scientists' confidence and to guide research prioritising.

In the case of solid radioactive waste, the results of the assessments are projections of possible futures, not predictions. They are based on assumptions within the assessment context, which include unverifiable aspects, like for example human behaviour in the far future. Assessments are based both on plausible assumptions and scientific knowledge, and therefore only partially amenable to common uncertainty analysis procedures).

The assessment philosophy includes both cautious and equitable assumptions. The cautious assumptions are made to show that a "safety-related number" is not exceeded. The equitable assumptions are usually associated with best estimates and support the optimization and selection among viable options. When communicating the results of the assessment, the assumptions need to be clear, especially if you are initially cautious and later decide to be realistic.

In the case of solid radioactive waste, a peculiarity is the very long time frame considered. For different time frames, different types of calculations might be required. During the first period (i.e. first hundred years) a repository could still be under some form of control and an assessment could build upon operational safety assumptions. However, after this period there is no control at all.

Societal assumptions also need to be made, for example related with farming technologies, changes of habits in time, etc.

Communication is a relevant issue for public acceptance. It is important to use methods appropriate for the intended audience. It must be considered that complex things cannot be made simple by just using simple language. Some recommendations to improve communication include:

- Use a range of complementary communication techniques: face-to-face discussions, video presentations, CD-ROMs and interactive software, and 3-D models.
- Use moving images for communication with a wide audience, as they have more impact than static posters.
- Use interactive media.
- Use authors trusted by stakeholders to translate technical information into community-accessible language.

Implications of uncertainties for scientists *(Deborah H Oughton, NMBU)*

There are many different views within the scientific community about uncertainties. The European project ERICA published a useful document on this issue in May 2006: "Scientific Uncertainties: Transcript from the End User Group Workshop" (ERICA Deliverable 7e, available from https://wiki.ceh.ac.uk/download/attachments/115017395/FP6+ERICA+deliverable+D7e+-+22+May+2006.pdf).

The enormous philosophical and technical literature on risk, probability and uncertainty illustrates the complexity of this issue. There are often disagreements among experts about probabilities and their consequences. Many people argue that the acceptability of risks is more than a matter of the probability and level of harm. But there is disagreement between experts (and the public) concerning the role of these additional factors in practical risk management.

When scientists communicate about risks, they usually make 7 typical mistakes:

1. Not appreciating the many dimensions of uncertainties (technical and numerical, model and conceptual, epistemological, social and ethical).
2. Not recognizing complexity and not acknowledging that not all uncertainties can be quantified.
3. Focusing too much on probabilities when ranking risks.
4. Mixing facts (the size of the risk) and values (the acceptability of the risk).
5. Not appreciating the different perspectives within and between public and experts.
6. Unbalanced conservatism: The example of Fukushima dose estimates was mentioned, highlighting that the dose values obtained using estimation models of the government were four times higher than the real dose values.
7. Underestimating the public's ability to understand uncertainties.

Implications of uncertainties for the public *(Thierry Schneider, CEPN)*

The talk largely focused on post-accident existing exposure situations. According to the ICRP definition, existing exposure situations are exposure situations that already exist when a decision on the need for control has to be taken. Some common features of this type of exposure situation include:

- often places of living and day-to-day activities are affected;
- activity levels and exposures need to be measured;
- the distribution of individual doses can be very wide;
- multiplicity of exposure pathways;
- in many cases, the exposure can be at least partially controlled by exposed individuals themselves (self-help protection); and
- protection of the environment should be considered.

The experience gained after the accidents in Chernobyl and Fukushima has shown that the management of long-term consequences is not straightforward, and that there is a disturbance of the daily life. In both scenarios there were similar consequences, including loss of confidence in authorities and experts, strong worry about health (especially in the case of children), feeling of discrimination and exclusion, helplessness and abandonment. In most of the cases the experts provide technical answers, but they do not consider daily-life aspects (e.g. to return to the home in a contaminated territory or not).

When uncertainties of environmental contamination are considered, it should be taken into account that the "zoning" of contaminated areas is based on average contamination levels. However, individual exposure levels might be highly variable due to the heterogeneity of contamination and individual living habits. It is difficult for the public to understand the contributions of various locations/activities (home, school, forests…) to dose. There is uncertainty regarding the dose that people could receive in the future if they go back to the contaminated territories (need to better anticipate the distribution of exposures according to activities), the effects of decontamination actions and remaining hot spots. People are often concerned about the temporary storage of radioactive material close to their homes.

The uncertainties of food contamination are of major concern, as was made evident after the Chernobyl accident. The uncertainties relate to: the producer, who wants to know in advance the potential activity levels of produced food (learning processes, which include the characterization of local situations and the identification of efficient countermeasures); the interpretation of reference

levels; the contamination level of the daily meal (monitoring of daily meals); as well as regaining a quality label of produced food.

Uncertainties related with internal contamination also exist. After the Chernobyl accident, some increase in internal contamination was observed. This is also an issue in the Fukushima area. Although the large majority of people has received very low doses, there is still a concern in the case of children (development of the 'babyscan').

The main conclusions of the talk were:

- ICRP dialogue seminars point out the importance of developing monitoring strategies adapted to the needs of local inhabitants.
- In the post-accidental context, some crucial points are: availability of equipment, training of experts and development of opportunities for a dialogue to favour joint assessments.
- Questions to be dealt with in the perspective of post-accidental preparedness include: How to share information, including the role of social media? How to help to interpret and understand the results?

3.1.2 Group work session

The topic to be discussed was "**Implications of uncertainties for different stakeholders"**. To stimulate the discussion, several questions were distributed to all participants (Annex 3).

The main aspects discussed in each group during the session are described below.

- ***Regulators/decision makers work group*** *(moderator: Michael Egan, SSM; secretary: Astrid Liland, NRPA)*

  The regulator needs to have an idea of the magnitude of the uncertainties and to know which uncertainties are relevant for a given situation. In planned exposure situations, the uncertainties are translated into a suitable degree of conservatism: the approaches applied are in general very conservative, to ensure safety. It is important to be aware that conservatism is usually already built-in in the various models. To add safety factors beyond this could lead to over-conservatism and higher costs than necessary.

  In existing exposure situations, there is a need to be more realistic in order to have a margin for optimization. In existing exposure situations, measurements can be carried out, and these data should be the basis for decisions. Models will help to assess the potential consequences of these decisions and the impacts during and post-remediation.

  Uncertainties are more relevant in those situations where the doses are above the limits, and that therefore remediation actions and/or optimization have to be performed.

  Decision support systems (DSS) provide a single value (a number), but say nothing about its uncertainty. A reasonable range of possible values, based on scientific knowledge, can be useful for decision makers and regulators. Uncertainties will always be there, but is important to advice decision makers and regulators how to address them.

It should be remembered that the result given by a model is just one of the factors that will be taken into account to make a decision. Other factors, which might be more important than the "dose estimation", include economic or societal aspects.

TERRITORIES can help to define a range of uncertainty, which can be helpful for optimization purposes. It can also give advice on good practices for stakeholder involvement in the decision-making process.

- ***Industry work group*** *(moderator: Lauri Parviainen, BIOPROTA; secretary: Lindis Skipperud, CERAD/NMBU)*

The main risk for the industry is "regulation", since it can imply constraints. It would be helpful for the industry to know in advance when the regulations are going to be changed. It is desirable to have similar practices in different European countries. From the industry point of view, the regulations should be kept "simple", so that it is easy to understand what needs to be done. It would be useful to have guidelines on how to interpret and apply the different regulations (e.g. guidelines on what to do if you are above the acceptance levels).

NORM-related regulations are new. If the costs of the regulations are too high, the industry would consider moving to another country. In addition, NORM regulations are so strict in some countries that it is difficult to carry out certain activities (e.g. in Norway NORM restrictions make it difficult to build/improve roads and tunnel constructions).

The acceptance/clearance levels to be applied in NORM and post-accident exposure situations must be set in such a way that they are applicable. One concern of the industry is that the regulators set a number for "acceptance levels" (limits), without uncertainties, which could be too conservative. The set levels for NORM and post-accident exposure situations might result in large volumes of "waste", which cannot be disposed of. When setting the acceptance/clearance levels, the risk perception is also a problem. The challenge is to set levels which are manageable and also have public acceptance.

From the industry point of view, knowledge is needed to be able to handle future challenges, even without knowing what will happen in the future. The industry suffers from a "lack of trust", but it is hard to predict future needs of countermeasures/remediation actions.

To cope with the uncertainties, it is important to increase knowledge. Education and training activities as well as working together with other experts would allow having an understanding of possible solutions, other scenarios, other experiences (e.g. U-mining companies have experience that can be useful for other industries).

To help the industry needs in terms of reducing uncertainties, TERRITORIES can facilitate the transfer of knowledge and bring stakeholders together for discussion. Sharing the work on key case studies (NORM and post-accident exposure situations) would provide important knowledge. TERRITORIES can also produce guidelines to support decision making in different situations (NORM, post-accident). TERRITORIES can also help to improve the communication of uncertainties by making the knowledge behind uncertainties (or the lack of it) more transparent.

- ***Scientists work group*** *(moderator: Jean-René Jourdain, IRSN; secretary: Rodolphe Gilbin, IRSN)*

There is not a unique definition of uncertainty for scientists. It varies depending on the scientific domain considered (modeller, experimentalist, social science, etc.). For scientists dealing with models and experiments, the uncertainties are linked to a "benchmark value", and a "number"

helps to qualify and quantify the uncertainties. For social science, uncertainties are more related with perception and the "number" means understanding of the impact of the uncertainties (perception, meaning, acceptance).

The definition of uncertainty could be different depending on the target (risk assessment, measurement, source term, etc.).

It is important to differentiate between variability and uncertainties. The (epistemic) uncertainty can be assessed and possibly reduced, whereas variability cannot be reduced (can only be taken into account with statistical methods).

Scientists are more focused on improving the precision of the measurements/data and on quantifying uncertainties, while social dimensions are less addressed.

Scientists can help people to understand and deal with uncertainties. Scientists can also help to identify uncertainties, determine which ones are feasible to be quantified and reduced, and select the ones that are most important (prioritization). Stakeholders should help scientists to prioritize which uncertainties should be addressed first.

Scientists can also show the impact of putting effort into a given type of uncertainty, by balancing the efforts necessary to reduce uncertainties against the impact that reduced uncertainties will have on the risk assessment output.

In radiation protection (management, regulations) usually a number is used, without its uncertainty. This "number" has been defined for regulatory purposes on the basis of up-to-date knowledge. Since knowledge usually improves with time, it might be necessary to change this "number", which involves communication aspects. Scientists must explain/communicate the uncertainties linked to the "number" (in different disciplines such as radiobiology, radioecology, etc.).

- ***General public work group*** *(moderator: Eduardo Gallego, NERIS; secretary: Thierry Schneider, CEPN)*

When considering the uncertainties associated with NORM and post-accident exposure situations, the general public acknowledges that there is a difference between the dramatic situation in the early phase after an accident (application of emergency countermeasures) and a NORM situation.

The main concern of the general public is about risk, but putting risk into perspective is not trivial (e.g. comparing the doses received after an accident with medical exposures). There is uncertainty of how this risk can affect their family health and their daily life (working, living and social activities). In affected areas, the main uncertainty for the general public is the future situation, notably how long the problem will last and the type of decisions that the authorities will make.

The major uncertainty of the general public is who they can trust and who can make suitable decisions. Communication is important to deal with uncertainties of the public. Several aspects need to be considered: the general public is not homogenous (large variety of points of view and interests in the risk assessment), the cultural and country-specific situation, the possible lack of a radiation protection culture (discussions on radiation protection issues often take place only after an accident happened).

The problem is not to explain the uncertainties to the general public, but first to know what is at stake for the public and then to address uncertainties in the perspective of addressing their concerns. There is a need to start from the concerns of the public.

Figure 2. During the workshop on "Communication of uncertainties of radiological risk assessments to stakeholders" (photograph: Lindis Skipperud).

3.2. Minutes from session 2: How to communicate uncertainties?

The session was chaired by Thierry Schneider (CEPN, France).

3.2.1 Overview of the presentations

Eduardo Gallego (UPM, representative of NERIS) made a presentation on "**How to communicate uncertainties to stakeholders"**. The talk began with the reminder that "stakeholders" include a wide variety of groups: regulators/authorities/decision makers, scientists, industry, environmental NGOs, journalists/media, local representatives, citizens, etc. It is a heterogeneous collective, since some of them may have some technical background and some have not. Each of them may require a different approach for communication of uncertainties. A key point, applicable to all stakeholders, is generating trust, which is quite challenging in the case of uncertainties communication.

It was illustrated how uncertainties have been reported in real examples with different target stakeholders (nuclear risk studies, performance assessment for high-level radioactive waste disposal, Intergovernmental Panel on Climate Change (IPCC): CO_2 emission scenarios, impact on climate change, daily weather forecast, epidemiological study from normal operation releases from nuclear power plants and the post-accident situation in Fukushima).

The real key question is how to generate trust among stakeholders, considering the existing uncertainties. The ICRP, in its publication 111, highlights the importance of the participation of the public, being the responsibility of the authorities to create the conditions and provide the means to favour the involvement and empowerment of the public.

The role of co-expertise was also highlighted. The process of co-expertise relies on:

- the establishment of opportunities for a dialogue, allowing experts to listen and discuss together with the affected public their questions, concerns, challenges, expectations;
- the assessment conducted jointly by locals and experts on the situation of the people and their community;
- the implementation of projects to address the problems identified at the individual and community levels with the support of local professionals, experts and authorities; and
- the evaluation and dissemination of the results.

The co-expertise promotes the practical radiological protection culture within the affected communities. This progressively allows everyone to interpret results of measurements, build

benchmarks, and take decisions. Co-expertise has been implemented, for example, in Belarus and in few communities in Fukushima.

There is a need to be prepared to communicate easy and understandable messages (be clear and concise). Honesty must be above all as well as transparency (explain the reasons for the uncertainties). In communication it is important to develop empathy and common understanding (co-expertise).

The second presentation of the session, made by Yevgeniya Tomkiv (NMBU), was on "**Uncertainty and risk management: a matter of risk interpretation"** (the presentation was prepared by Catrinel Turcanu (SCK•CEN), who could not finally attend the workshop). It was highlighted that the concept of risk is a central issue for environmental policy and it has been the focus of both technological and sociological or psychological studies. While scientific risk analysis aims at assessing, for instance, average expected damage per unit of time, other aspects, e.g. perception or voluntary consent, may have a higher weight in evaluating risks. Scientific estimates must be integrated with risk perception. Studying risk perception can contribute to improve risk governance policies.

Governance of radiological risks poses several challenges, including scientific and societal uncertainties, differing opinions about and interpretations of risk, disagreement between experts, asymmetrically perceived risks and benefits, societal distrust and stigma associated to affected areas.

The analysis of decision making processes, with focus on the management of scientific and societal uncertainties, is the issue addressed in a work package of TERRITORIES. A deliverable on the societal uncertainties in long-lasting exposure situations, including some examples for NORM scenarios, will be published in 2017.

In risk assessments, a number of estimates are needed, not only health consequences. For example, estimations related with vulnerable groups, economy, environment and culture are also relevant.

Communication of uncertainties is important and must reveal decision-relevant elements. It is important to maintain trust (communication of uncertainties increases public confidence in regulatory processes). For scientists, uncertainty obscures theoretical questions; for decision makers, it obscures choice (when should action be taken, which is the best option, what is possible). Communication of uncertainties influences decision making.

In conclusion, it was stressed that communication is not only providing knowledge, but also tackling ethical issues. Communication has to be a two-way communication, a dialogue. Communication of uncertainties leads to better decisions, and should be included in the decision-making process.

3.2.2. Group work session

The topic to be discussed was "**How to adequately communicate uncertainties"**. To stimulate the discussion, several questions were distributed to all participants (Annex 3).

The main aspects discussed in each group during the session are described below.

- ***Regulators/decision makers work group*** *(moderator: Astrid Liland, NRPA; secretary: Almudena Real, CIEMAT)*

  There is a need to build and maintain confidence of the public under normal situations, not only when an "accident" occurs.

  Communication should not be a one-way process: there is a need to be aware of public concerns and the most urgent needs of the public. A dialogue will be beneficial for both sides: each part can learn from the other. The public is part of the solution, not part of the problem.

It is important to explain the facts, the uncertainties, but not to make a value judgment. The government has certain responsibilities (e.g. ensure that activity levels in food do not exceed limits), but once these duties are fulfilled, other aspects will emerge. It is important to provide information and support so that people can make their own decisions in a private context (e.g. to eat mushrooms that they picked).

There is a need to be transparent in communicating uncertainties and the values that are considered to make decisions.

Some weaknesses in adequately communicating uncertainties include the misunderstanding of the concept "communication". Communication is not just giving information. Not everybody is a good communicator. The terminology used in radiation protection often hampers communication.

Some tools and approaches that can be useful for improving communication include: teach the teachers and train the trainers; dialogue seminars; TV and radio; select good communicators to communicate with the public; use modern technologies to communicate with young people (e.g. 80% of people under the age of 30 use YouTube).

- ***Industry work group*** *(moderator: Ari Ikonen, EnviroCase, Ltd; secretary: Danyl Pérez-Sánchez, CIEMAT)*

It is important to communicate as much as possible and to be as specific as possible, so that the public trusts the industry. There is a need to be honest about what it is known and what is unknown (uncertainties) to sustain public trust.

It must be taken into account to whom you are communicating, since the knowledge of the public on specific issues can vary. For example, the public living close to a nuclear power plant usually has more knowledge on radiation issues than people living in distant areas.

To avoid a misunderstanding of what the industry tries to communicate, the issues to be communicated must be clear. The balance between too much information and too little information could be a challenge, but it is more important how the information is given (quality of information is more important than quantity).

It can be helpful to communicate together with the regulators when possible, without giving the impression that the regulators are not independent. It is important to show that the industry is interested in doing research to improve knowledge (e.g. performing joint research projects together with regulators and scientists).

In the case of NORM, there is a new situation where the industry needs to handle communication of radiation risks, not only chemical risks.

Some tools and approaches that can be useful for communication include: keep telling the boring good news; work seminars.

- ***Scientists work group*** *(moderator: Alicja Jaworska, NRPA; secretary: Marko Kaasik, UT)*

Decision makers often feel that communicating uncertainties/lack of knowledge is too complex. It is easiest to communicate a single average value or a best estimate value. They think that people are not able to understand the complexity. Science can help to communicate the range of assessment results obtained (interval) due to the uncertainties. As scientists, we cannot think about acceptance.

There is a need to communicate what is not known and explain to the public why uncertainties cannot be better assessed. Is also important to better communicate the impact of uncertainties on risk assessments.

It is suggested not to wait for the emergency situation to happen to give information. The general public should have a basic knowledge on radiation protection-related issues (including uncertainties). It is desirable to have better education for everybody.

When communicating, it is important to be aware of the knowledge of the audience (public, authorities, scientists, etc.). Media have a strong responsibility in communication, since the way they present the information will influence the reaction of the audience.

One of the main weaknesses is that in many cases communication is not done by the right person or organization. At the political level decision makers do not know enough about science. Scientists know too much to communicate well. Politicians have to be more educated on the topics that they are going to communicate. There is a need to find the proper way of communication about science.

The tools and approaches that could be useful for communication include: organizing public debates on scientific issues, involving authorities, NGOs and scientists; taking into account the cultural differences between countries; pointing out key scientific publications on risk, e.g. WHO publication about the health effects of the nuclear accident in Fukushima.

- ***General Public work group*** *(moderator: Thierry Schneider, CEPN; secretary: Deborah Oughton, NMBU)*

The main uncertainties that concern the public are: How will the situation affect my daily life, my future, my health, my children's health and life? Who can I trust? Where can I find information? Is 1 mSv/yr safe? Is it safe for my grandchild to visit my house? Is it safe to eat that food? Is it safe for my kid to go to school? What is the difference between "it is safe" and "it is acceptable"?

One of the weaknesses of adequately communicating with the general public is that often experts do not take time to listen to the public and to understand their needs and concerns.

Recommendations to improve communication with the general public include: be clear about what is known and admit what is not known; reassure that you will try to find out and come back to them when you might have an answer, which might take days, weeks or even years (e.g. monitoring could be quick; whether or not radiation causes cardiovascular effects will take decades).

People need to know what they can do to avoid/reduce their exposure to ionising radiation in an existing exposure situation.

The knowledge of some statements could possibly be useful for communicating with the general public, as for example:

- We do not have evidence of any effect at doses below…

- We do not have grounds to believe…

Figure 3. Discussions continued after the group work sessions (photographs: Almudena Real).

4. Summing up and conclusions of the workshop

The objective of the workshop on "Communication of uncertainties of radiological risk assessments to stakeholders" has been achieved, obtaining feedback from regulators, industry, scientists and the general public on the implications and the relevance that uncertainties in radiological risk assessments have for these different stakeholders. Feedback has also been obtained on the needs and weaknesses concerning communication of uncertainties from different groups of stakeholders as well as on tools and approaches that can improve such communication.

The workshop had a good acceptance, with 30 participants from 10 different countries. It must be stressed that all participants were extremely active in the discussions held during the workshop. Special mention must be made of the excellent work done by the chairs of the sessions, the speakers and the moderators and secretaries of the group work sessions, which has been crucial for the success of the workshop.

Some important points from the discussions of the session "**Implications and relevance of uncertainties for stakeholders"** were:

- It cannot be expected that uncertainties are going to be eliminated (at least in the short term), but they need to be managed according to their significance.
- It is important to differentiate between variability and uncertainties. The (epistemic) uncertainty can be assessed and possibly reduced, whereas variability cannot be reduced (can only be taken into account with statistical methods).
- It is important to acknowledge that some uncertainties cannot be quantified and/or reduced.
- Uncertainties are more relevant in those situations where the doses are above the limits, and in which, therefore, remediation actions and/or optimization have to be performed. In those situations, it is important to know the magnitude of the uncertainties and which uncertainties are relevant for each specific situation.

- There is a need to identify uncertainties, to determine which ones are feasible to be quantified and reduced, and to prioritize those that are most relevant in risk assessments of long-lasting exposure situations (both NORM and post-accident situations). Stakeholders can help scientists to prioritize which uncertainties should be addressed first.
- A balance of efforts needed to reduce uncertainties against the impact that the reduction of uncertainties will have on the risk assessment output is desirable.
- The assumptions made in the risk assessment should be clearly stated. The scientific knowledge that motivates each assumption should be explained.
- Decision support systems (DSS) provide a single value (a number), but don't give information about its uncertainty. A reasonable range of possible values, based on scientific knowledge, can be useful for decision makers. Uncertainties will always be there, but is important to advice decision makers how to address/manage them.
- The problem is not to explain uncertainties, but first to know what is at stake for the different stakeholders (regulators, industry, general public) and then to address uncertainties in the perspective of addressing their concerns.
- To cope with the uncertainties, it is important to increase knowledge, through research efforts. In addition, education and training activities as well as working together with other experts would allow having an understanding of possible solutions, other scenarios and experiences.

During the discussions, the following aspects were mentioned in which TERRITORIES could be helpful:

- To define a range of uncertainties for long-lasting exposure situations (NORM and post-accident situations), which can be helpful for optimization purposes.
- To reduce uncertainties, TERRITORIES could facilitate the transfer of knowledge and bring stakeholders together for discussion. Sharing the work on key case studies (NORM and post-accident situations) would provide important knowledge.
- To produce guidelines to support decision making in different situations (NORM, post-accident situations). This point has been one of the objectives of TERRITORIES, since the project proposal was prepared.

Some important points from the discussions of the session "**How to communicate uncertainties?"** were:

- Communication of uncertainties is important for their acceptance by stakeholders.
- Communication of uncertainties should be included in the decision-making process, since it leads to better decisions.
- The meaning of "communication" is not always clear. Communication is not just providing information. Communication must be a two-way process, i.e. a dialogue.
- A key point is to generate confidence, which is quite challenging when referring to uncertainties communication. This confidence has to be built and maintained under normal situations, not only when an accident occurs.
- It must be taken into account to "whom" you are communicating, since the background knowledge of the stakeholders can be tremendously different. The balance between too much information and

too little information could be a challenge, but the quality of information is more important than its quantity.

- There is a need to be transparent in communicating the scientific basis that is behind the uncertainties and the assessment result values that are considered to make decisions. When communicating uncertainties, it is important to be honest and to clearly state what is known and what is not known. It is also important to explain why uncertainties cannot be better assessed and to make assumptions visible (both in protection criteria and models).
- It is important to better communicate the impact of uncertainties on the risk assessment.
- It is necessary to communicate the adequate amount of scientific information to stakeholders.
- The capability of stakeholders to understand uncertainties should not be underestimated.
- It would be desirable that communication occurs under normal circumstances, not only after an accident happened. Stakeholders should have a basic knowledge on radiation protection-related issues (including uncertainties).
- One of the main weaknesses in communicating uncertainties is that in many cases communication is not done by the right person or organization. At the political level decision makers do not know enough about science. Scientists know too much to communicate well. Politicians have to be more educated on the topics that they are going to communicate. There is a need to find the proper way of communication about science. Not everybody is a good communicator. The terminology used in radiation protection often hampers communication.
- Stakeholders are a heterogeneous collective, with a large variety of points of view and interests in risk assessments. Therefore, different approaches for communication of uncertainties will be required.
- Several tools/approaches were proposed that could support communication: dialogue seminars (public debates on scientific issues, involving authorities, NGOs and scientists); taking into account the cultural differences between countries; selecting good communicators for dialogues with stakeholders; TV, radio and modern technologies to communicate with young people (e.g. 80% of people under the age of 30 use YouTube).

During the discussions, it was suggested that TERRITORIES could help to improve the communication of uncertainties by making the available knowledge behind the different uncertainties (or the lack of it) more transparent.

The participants agreed that the workshop was very fruitful, promoting the dialogue between different stakeholders (regulators, industry, scientists, general public), who need to collaborate to obtain optimised results in radiation protection. They also expressed their interest in participating in the workshops that TERRITORIES is planning for 2018 and 2019. The topics of these future workshops are not yet defined, but the dates have been fixed. The first one will take place in Spain in June 2018, and the second one in the United Kingdom in February 2019. The information on these workshops will be posted in the TERRITORIES blog and webpage.

5. Annexes

5.1. Annex 1: Programme of the TERRITORIES workshop on "Communication of uncertainties of radiological risk assessments to stakeholders"

TERRITORIES Workshop on:

Communication of uncertainties of radiological risk assessments to stakeholders

16 November 2017. Thon Hotel Slottsparken, Oslo, Norway

The objective of this workshop is to discuss the implications and relevance of uncertainties in radiological risk assessments for different stakeholders and how these uncertainties can be better communicated, obtaining feedback from regulators, industry, scientists and "public/social sciences" on this subject.

Time	Lecturer	Title
08:30 – 08:40	Almudena Real (CIEMAT)	Welcome and scope of the workshop
08:40 – 09:00	Rodolphe Gilbin (IRSN)	Overview of uncertainties in radiological risk assessments
09:00 – 09:30	Lindis Skipperud (NMBU)	Summary and conclusions from workshop "Key factors contributing to uncertainties in radiological risk assessment"
09:30 – 10:00	Coffee and tea	
Session 1: Implications and relevance of uncertainties for stakeholders (*Chair:* Eduardo Gallego)		
10:00 – 10:15	Michael Egan (SSM)	Implications of uncertainties for regulators
10:15 – 10:30	Parviainen Lauri (BIOPROTA)	Implications of uncertainties for the industry
10:30 – 10:45	Deborah H Oughton (NMBU)	Implications of uncertainties for scientists
10:45 – 11:00	Thierry Schneider (CEPN)	Implications of uncertainties for the public
11:00 – 12:00	Group work	***Implications of uncertainties for different stakeholders***
12:00 – 12:30	Group work reports and discussion	
12:30 – 14:30	Lunch	
Session 2: How to communicate uncertainties? (*Chair*: Thierry Schneider)		
14:30 – 14:50	Eduardo Gallego (UPM, NERIS)	How to communicate uncertainties to stakeholders
14:50 – 15:10	Yevgeniya Tomkiv (NMBU) Catrinel Turcanu (SCK•CEN)	Uncertainty and risk management: a matter of risk interpretation
15:10 – 15:30	Coffee and tea	
15:30 – 16:30	Group work	***How to adequately communicate uncertainties***
16:30 – 17:00	Group work reports and discussion	
17:00– 17:15	Lindis Skipperud (NMBU) and Almudena Real (CIEMAT)	Closing of the workshops

5.2. Annex 2: Dissemination of the TERRITORIES workshop on "Communication of uncertainties of radiological risk assessments to stakeholders"

TERRITORIES PROJECT BLOG

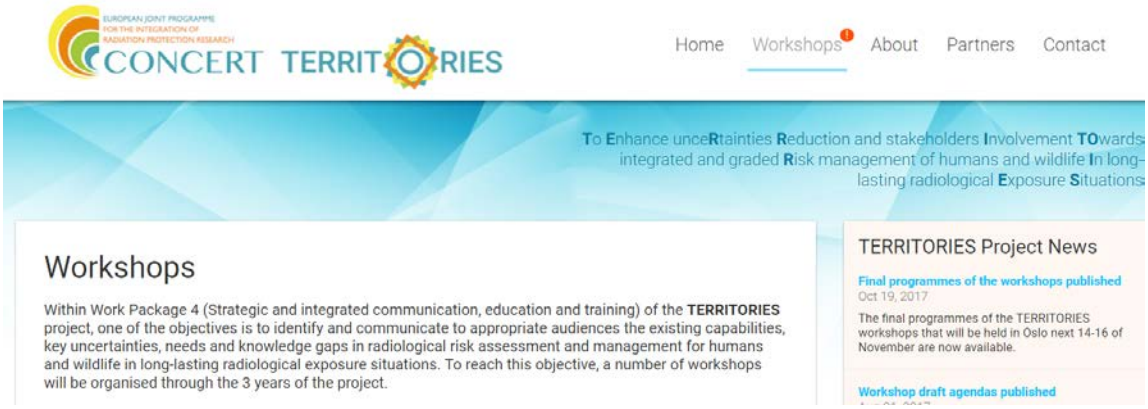
Final programmes of the TERRITORIES Workshops in Oslo

19 october, 2017

The final programmes of the TERRITORIES workshops that will be held in Oslo next 14-16 of November are now available.

Workshop 1: **Key factors contributing to uncertainties in radiological risk assessment** (14-15 November 2017). **TERRITORIES Workshop 1_Final Programme_2017-10-24**

Workshop 2: **Communication of uncertainties of radiological risk assessments to stakeholders** (16 November 2017). **TERRITORIES Workshop 2_Final**



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Workshops

Within Work Package 4 (Strategic and integrated communication, education and training) of the **TERRITORIES** project, one of the objectives is to identify and communicate to appropriate audiences the existing capabilities, key uncertainties, needs and knowledge gaps in radiological risk assessment and management for humans and wildlife in long-lasting radiological exposure situations. To reach this objective, a number of workshops will be organised through the 3 years of the project.

TERRITORIES Project News

Final programmes of the workshops published
Oct 19, 2017
The final programmes of the TERRITORIES workshops that will be held in Oslo next 14-16 of November are now available.

Workshop draft agendas published

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TERRITORIES: 2 workshops - Oslo - Norway

November 14 - 16, 2017

Both workshops will be held in **Oslo, Norway**, **November 14-16th 2017**

Thon Hotel Slottsparken, Wergelandsveien 5, 0167, Oslo

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- **November 14-15, 2017**
  Workshop 1:
  Key factors contributing to uncertainties in radiological risk assessment
- **November 16, 2017**
  Workshop 2:
  Communication of uncertainties of radiological risk assessments to stakeholders

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TERRITORIES project – workshops

Submitted by Claire Wells on Thu, 09/14/2017 - 09:02

TERRITORIES project – workshops

Closing date for registration: **29/09/2017**

Draft program: Workshop 1
Draft program: Workshop 2

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Fecha de inicio: 14 de noviembre

Fecha de Fin: 16 de noviembre

Dirección: Thon Hotel Slottsparken, Wergelandsveien 5, 0167, Oslo

5.3. Annex 3: Questions for the group work sessions of the TERRITORIES workshop on "Communication of uncertainties of radiological risk assessments to stakeholders"

- ***Session 1: Implications and relevance of uncertainties for different stakeholders (1.0 h)***
    - Which is your specific point of view, as regulator/industry/scientist/member of the public, on the uncertainties associated to NORM or post-accident contamination situations (i.e. Define "uncertainty" from your specific point of view as regulator/ industry/scientist/member of the public).
    - How do you cope with these uncertainties?
    - Which are, as regulator/industry/scientist/member of the public, your main concerns about how these uncertainties are being addressed and managed in relation to NORM or post-accident contamination situations?
    - As regulator/industry/scientist/member of the public which are your needs in terms of reducing these uncertainties and how TERRITORIES can help to do so?

- ***Session 2: How to adequately communicate uncertainties (1.0 h)***
    - Which are from your specific point of view, as regulator/industry/scientist/member of the public, the main communication needs regarding uncertainties in NORM or post-accident contamination situations?
    - Which are, as regulator/industry/scientist/member of the public, the main weaknesses in the communication about uncertainties in NORM or post-accident contamination situations?
    - Which communication tools or approaches do you consider, as regulator/industry/ scientist/member of the public, are most useful/effective/appropriate/meaningful to communicate uncertainties?

5.4. Annex 4: Participant list of the TERRITORIES workshop on "Communication of uncertainties of radiological risk assessments to stakeholders"

All participants were extremely active in the discussions held during the workshop (including those held during coffee breaks). Special mention must be made of the chairs of the sessions, the speakers and the moderators and secretaries of the group work sessions, without whom the workshop could not have been carried out.

	Participant	**Organization, Country**
1	Avila, Rodolfo	Facilia, Sweden
2	Egan, Michael	SSM, Sweden
3	Fojtikova, Ivana	SURO, Czech Republic
4	Gallego, Eduardo	UPM, Spain
5	Gilbin, Rodolphe	IRSN, France
6	Ikonen, Ari	EnviroCase, Ltd, Sweden
7	Iospje, Mikhail	NRPA, Norway
8	Jaworska, Alicja	NRPA, Norway
9	Jourdain, Jean-René	IRSN, France
10	Kaasik, Marko	UT, Estonia
11	Kautsky, Ulrik	SKB, Sweden
12	Kuca, Petr	SURO, Czech Republic
13	Kuroda, Yujiro	Fukushima Medical University, Japan
14	Liland, Astrid	NRPA, Norway
15	Mauring, Koit	UT, Estonia
16	Naito, Wataru	AIST, Japan
17	Navrud, Ståle	NMBU, Norway
18	Oughton, Deborah	NMBU, Norway
19	Parviainen, Lauri	Posiva (BIOPROTA), Finland
20	Peltonen, Tuomas	STUK, Finland
21	Pérez-Sanchez, Danyl	CIEMAT, Spain
22	Real, Almudena	CIEMAT, Spain
23	Scheinder, Thierry	CEPN, France
24	Skipperud, Lindis	NMBU, Norway
25	Skuterud, Lavrans	NRPA, Norway
26	Steiner, Martin	BfS, Germany
27	Tkaczyk, Alan	UT, Estonia
28	Tomkiv, Yevgeniya	NMBU, Norway
29	Tucaković, Ivana	Ruđer Bošković Institute, Croatia
30	Vilbaste, Martin	UT, Estonia