STRATEGIC RESEARCH AGENDA FOR THE SHARE PLATFORM FOR SOCIAL SCIENCES AND HUMANITIES RESEARCH RELATING TO IONISING RADIATION

October 2020

1. INTRODUCTION

This document elaborates on priorities for Social Sciences and Humanities (SSH) research on ionising radiation. It covers a broad range of issues and areas relating to the presence of, exposure to, and/or the various uses of ionising radiation (of natural or human-induced origin) in society and the environment.

1. The aim of the Strategic Research Agenda (SRA) is to contribute to the improvement of the radiological protection system and the governance of radiological risks and applications of ionising radiation by coordinating SSH research; supporting specialised, as well as transdisciplinary education and training; enhancing stakeholder involvement, knowledge management and sharing; and identifying gaps in SSH state of the art across disciplines. Enabling SSH research to play a fuller and stronger role through a coordinated SRA mechanism will ensure that societal perspectives on research, policy and practice related to ionising radiation are acknowledged and accounted for.

This document extends an initial version of the Strategic Research Agenda for SSH[1] by adopting a more holistic view on radiological protection to include all civil applications (industrial, medical, energy) of ionising radiations, and situations characterised by the presence of radioactive materials. Hence, it broadens the scope of research to include topics previously not addressed in detail, e.g. nuclear energy and its governance, radioactive waste management, or advanced nuclear technologies. We also build on the achievements and recommendations of recent European projects and incorporate input from a broad range of stakeholders.

Adapting the principles first described in the initial version of the SRA[1], the underpinning tenets that inform the research agenda and priorities are that:

- SSH should support existing and future research, policy and practice, in all areas relating to radiological risks and applications of ionising radiation, to better take into account the concerns, values, expectations and needs of a wider range of stakeholders, including citizens;
- SSH research should be coordinated, shared and integrated into existing scientific and technical research and development (R&D) on ionising radiation or its applications; hence, collaboration with European research platforms, research groups and relevant associations must be an integral component of the agenda;
- Research and innovation relating to ionising radiation and its applications should be conceived of as transdisciplinary and inclusive, integrating science, citizens' and other stakeholders' inputs from the start;
- Social sciences and humanities research on ionising radiation should integrate insights from other application fields (notably health, safety and environmental risk management), as well as from recent methodological evolutions in SSH, and societal changes in general.

[1] Perko, T., Van Oudheusden, M., Turcanu, C., Pölzl-Viol, C., Oughton, D., et al, 2019. Towards a strategic research agenda for social sciences and humanities in radiological protection. *Journal of Radiological Protection*, *39*(3), p.766

From its conception, the SRA is intended as a dynamic document to encourage debate on SSH research priorities and provide guidance for topics to be included in new European, national or institutional research programmes covering radiological protection and applications of ionising radiation. The original SSH SRA identified priorities for future European Commission-supported SSH research in the field of radiological protection. It was structured along six research lines addressing issues that continue to be relevant for all the radiological protection European platforms (ALLIANCE, EURADOS, EURAMED, MELODI, NERIS). Our focus in this SRA revision was to widen the coordinating and conducting of research on ionising radiation and its applications, thereby incorporating the specialism of a larger range of research and technology platforms (e.g. IGD-TP, NUGENIA, SNETP). We had signalled that this SRA would be regularly updated, for example in light of new societal challenges; changing stakeholder needs; or when identified by research performed by the collective's members, under other platforms or in the international research community.
The SRA is structured along six main Research Lines:

- Research line 1: Social, political, psychological, historical and economic factors influencing perceptions, expectations and behaviours regarding radiological protection and applications of ionising radiation;
- Research line 2: Holistic approaches to governance of ionising radiation exposure situations;
- Research line 3: Responsible Research and Innovation in radiological protection and applications of ionising radiation;
- Research line 4: Stakeholder engagement practices in relation to radiological protection and applications of ionising radiation;
- Research line 5: Risk and health communication;
- Research line 6: Radiological protection culture.

While the SRA focuses on research needs, the development of education and training materials and guidance for different professionals drawing on the findings from research results is also advised. SHARE research insights can inspire education and training programmes in two ways: through inclusion of recent SHARE results in specialised courses and training, as well as through stimulating transdisciplinarity in education. Actors involved in the governance of radiological risks should invest resources in E&T addressing the aforementioned topics.

2. DEVELOPMENT OF THE SRA

The process of development of the original SRA is described elsewhere[1]. Subsequently, major changes in the organisation of SSH research in ionising radiation have taken place, including the formal establishment of the SHARE Platform in July 2019 and the drafting of a Joint Radiation Protection Roadmap for radiological protection research[2].
From the start, we also acknowledged that effective adaptation of the SSH research agenda would require continuous engagement with concerned parties, particularly the European technical and research platforms related to radiological protection and applications of ionising radiation. This has taken place in various forms, including meetings with new technical platforms groups; and prioritisation exercises within the CONCERT project, among others.
Following the establishment of the SHARE Platform, a task force was set up to review once more the SRA, with the intention to take a holistic view on radiological protection and to explicitly include all civil applications (industrial, medical, energy) of ionising radiations, and

[2] Impens N., Salomaa S., et al. (2020). D3.7 Second joint roadmap for radiation protection research. EJP-CONCERT European Joint Programme for the Integration of Radiation Protection Research. https://www.concert-h2020.eu/Publications.

the presence of radioactive materials in the environment. Findings from other FP7 and H2020 projects, such as PLATENSO[3], INSOTEC[4], MoDeRn[5], MODERN2020[6], ENGAGE[7], TERRITORIES[8], CONFIDENCE[9], SHAMISEN[10], SHAMISEN-SINGS[11] were notably incorporated in this latest version of the SRA. The proposal from the task force was opened for consultation with the SHARE community and radiation protection platforms on June 9th, 2020 (until August 1st) and the input received was documented and taken into consideration in the revision. Further feedback on the resulting text was collected during a special session devoted to the SHARE SRA organised at the RICOMET 2020 conference, on September 3rd, 2020.
The present version is the final updated version after the last consultation (summer 2020) and RICOMET 2020 event, and the discussion at the SHARE General Assembly (September 4th 2020).
Key features of the Strategic Research Agenda, as agreed upon by the aforementioned contributors and based on the priorities identified in the consultations, are presented in the next section.

3. RESEARCH LINES AND TOPICS

This section summarises the six Research Lines of the SRA and provides details on SSH research topics that should be addressed within these Research Lines.
It is worthwhile to preface this section with a short justification of the way we proceeded in organising the text.
The most important caveat concerns the conceptual and terminological convention adopted throughout the document. While efforts have been made to make the agenda as inclusive as possible and encompassing all various shapes, uses or dimensions of ionising radiation, the research field is multifaceted which makes it difficult to find terminology suitable for all purposes. The most important axis around which the SRA evolves is the concept of radiological protection. This concept is universal enough to serve as the common denominator, to which it is possible to relate the majority of research topics proposed.
Such a terminological convention is helpful for organising the SRA, but does not mean rejection of alternative approaches. Inclusiveness may not entail suppression of differences. We acknowledge this in the next section by distinguishing ***cross-cutting topics***, relevant to the research on ionising radiation in its widest range (all situations of exposure), from ***special topics relevant to particular fields***, for instance medical applications of ionising radiation; existing exposure situations; nuclear emergency preparedness, response and recovery; nuclear facilities involved in the peaceful use of nuclear energy for electricity production. Convergent with Challenge H of the Joint Radiation Protection Research Roadmap[2] , these topics aim at

[3] PLATENSO Building a platform for enhanced societal research related to nuclear energy in Central and Eastern Europe https://cordis.europa.eu/project/id/605140
[4] INSOTEC: (International) Socio-Technical Challenges for implementing geological disposal; https://cordis.europa.eu/project/rcn/97435/factsheet/en
[5] MoDeRn: Monitoring Developments for safe Repository operation and staged closure; https://cordis.europa.eu/project/rcn/93569/factsheet/en
[6] MODERN2020: Development and Demonstration of Monitoring Strategies and Technologies; http://www.modern2020.eu/
[7] ENGAGE: ENhancinG stAkeholder participation in the GovernancE of radiological risk http://www.engage-h2020.eu
[8] TERRITORIES: To ENnhance unceRtainties Reduction and stakeholders Involvement TOwards integrated and graded Risk management of humans and wildlife In long-lasting radiological Exposure Situations https://territories.eu
[9] CONFIDENCE: COping with uNcertainties For Improved modelling and DEcision making in Nuclear emergenCiEs https://portal.iket.kit.edu/CONFIDENCE/
[10] SHAMISEN: Nuclear Emergency Situations: Improvement of Medical And Health Surveillance: https://radiation.isglobal.org/shamisen/
[11] SHAMISEN SINGS: Nuclear Emergency Situations: Improvement of dosimetric, Medical And Health Surveillance - Stakeholders INvolvement in Generating Science: https://radiation.isglobal.org/shamisen-sings/

developing new SSH theories, concepts and practices related to radiation protection and applications of ionising radiation; developing new theories, concepts and practices on translation of nuclear research and innovation; and developing new methodological tools in various contexts.
This SRA is addressed to the largest possible audience engaged in expert debates and decision-making and aims at stimulating transdisciplinary interchange among researchers, policy-makers and civic society representatives.
Throughout the text, the terms of ***Social Sciences and Humanities*** are understood as follows: social sciences refer to such branches of knowledge as sociology, political science, communication studies, economics, psychology or cultural anthropology, whereas humanities cover in particular philosophy, ethics, law and historiography. These disciplines have their own research methods, whether qualitative, (e.g. in depth interviews, focus groups, observations, …), quantitative (e.g. surveys, cost-benefit calculations, ...) or mixed (e.g. social multi-criteria analyses, social network analyses, …).
Furthermore, the term ***stakeholder*** is used to denote any *"individuals or groups (institutional and non-institutional), with a tangible or intangible (yet to be shaped or discerned) interest in the radiation exposure situation and the related radiological protection issues. These may be affecting decisions, be affected by the formulation and resolution of a problem or challenge, or represent an affected party (humans or the environment). In this perspective, stakeholders are constructed in interaction with actors, issues, contexts*"[12]. Stakeholders comprise formal institutions, as well as actors without a predefined institutional role that have to manage their own decision-making processes, stakes, and expectations. These stakeholders might be affected by the exposure to ionising radiation, conduct work (research or practice) in this or related fields, have a legal role in the management of radiological risk or applications of ionising radiation, or act as proxy for other stakeholders (e.g. NGOs representing the environment as a stakeholder), among others.
The ***contexts*** addressed are current or potential exposures in relation to medical treatment, industrial applications, natural radiation, the presence of operational nuclear facilities, decommissioning plans and activities for old nuclear facilities, and nuclear or radiological accidents.

Finally, concerning the concepts of ***risk, hazards and uncertainties***, we recognise the plurality of definitions and understandings; therefore we do not attempt to delimit these concepts in this document. We are interested in the concept of uncertainty in the broadest sense, including not only scientific and technical uncertainties, but also social and ethical uncertainties.

[12] Turcanu C., Abelshausen B., Geysmans R., Van Oudheusden M., Meskens G., Schieber C., Schneider T., Zeleznik N., Pölzl-Viol C. 2019. Final report of the ENGAGE project. CONCERT Deliverable D9.94. www.engage-concert.eu

RESEARCH LINE 1: SOCIAL, POLITICAL, PSYCHOLOGICAL, HISTORICAL AND ECONOMIC FACTORS INFLUENCING PERCEPTIONS, EXPECTATIONS AND BEHAVIOURS REGARDING RADIOLOGICAL PROTECTION AND APPLICATIONS OF IONISING RADIATION

Research line 1 aims at understanding how different actors make sense of, and take decisions related to radiological hazards and risks. This applies to both natural and human-induced radiation, thus ranging from radon exposures, to medical, industrial and research applications, and covering the entire nuclear fuel cycle of nuclear energy production up to, and including, radioactive waste management.

It covers a range of topics addressing the interrelation between individual and societal strategies to interpret and cope with radiological risks, and the various psychological factors (notably risk perception, attitudes behaviours), economic factors and social factors, notably knowledge, culture, and historical memory, among others. It is relevant to various forms of current, future or potential radiological exposures and covers different exposure contexts (e.g. workers, populations living in areas affected by radiological contamination); invited and uninvited participation; different time scales (e.g. different generations); different cultures and different socio-economic and historical contexts.

Relevant cross-cutting topics include:

1.1. Factors (social, economic, psychological) influencing individual strategies to cope with perceived risks, and expectations regarding radiological protection and the use of ionising radiation. Priority areas are the following:

- indoor radon;
- exposures of populations living in areas (potentially) affected by radiological contamination;
- decommissioning and radioactive waste management;
- exposures from new nuclear technologies.

1.2. Media impact (social media, traditional media) on perception of radiological risks and applications of ionising radiation, and individual decision-making (especially with regards to health and well-being). This includes the influence and potential role of citizen journalists or social media influencers in different exposure situations.

1.3. The different understandings of ionising radiation concepts, risks and uncertainty between and within various stakeholder groups and the respective amplification or attenuation of radiological risks.

1.4. Factors influencing perception of radiological risks by individuals and groups exposed to low radiation doses.

Additional topics concerning nuclear facilities include:

1.5. Perception of intergenerational ethics in different actors' behaviour in relation to radioactive waste management.

1.6. How knowledge regarding complex technologies (e.g. the most recent and planned new generations of nuclear reactors; nuclear waste disposal technologies, etc...) is constituted and travels between and across stakeholder groups, and is being shaped and reshaped in that process.

1.7. Attitudes of various publics towards nuclear power in general and in comparison with other sources of energy.

1.8. How nuclear heritage (and history) and inform/interact with people's understandings and relationships to nuclear matters.

Additional topics relevant to emergency preparedness, response and recovery

1.9. Inappropriate responses of individuals and groups (e.g. voluntary evacuation when sheltering is advised) and how to avoid such responses.

1.10. Develop tools to identify and include public needs and concerns in decision-making processes and policies in order to minimise negative health and socio-economic impacts from nuclear and radiological accidents and their management and, where possible, to allow citizens to make their own choices when faced with different risks.

Additional topics relevant to existing exposure situations

1.11. Factors influencing perception of radiological risks and remediation actions in post-accident and other existing exposure situations (e.g. radon or legacy sites).

RESEARCH LINE 2: HOLISTIC APPROACHES TO GOVERNANCE OF IONISING RADIATION EXPOSURE SITUATIONS

This research line focuses on holistic approaches to the governance of ionising radiation in various exposure situations (such as: medical applications, nuclear energy production, radioactive waste management, radioecology, emergency preparedness and response, Naturally Occurring Radioactive Materials -NORM, radon, legacy sites).

Governance can be understood as 'the process of governing' a social system (in this case the social system dealing with ionising radiation in general or in specific application contexts) through formal (institutional) and informal (social) dynamics, taking into account relevant social and natural phenomena and being driven by various interests, values and norms. A holistic approach to governance of a specific issue implies that attention is paid to the broader context in which this issue emerges and evolves, particularly its interlinkages with other issues and its 'place' in the whole. Worth noting is that the definition or choice of the 'broader context' can have a normative character open to interpretation. As examples: reflecting on nuclear energy production in the context of 'sustainable energy governance' needs to take into account not only issues such as climate change and nuclear risk, but also demographic changes such as the emergence of megacities. Similarly, in the medical context of 'health governance', the use of radiation for diagnosis and therapy needs to take into account values of precaution and informed consent, as well as the equality of access to treatments. As a last example, improving risk management and prevention related to accidents and incidents involving ionizing radiation can benefit from lessons learned in the broader field of health and environment (for example chemical accidents, or COVID-19 management).

The care for holism can hereby be understood as the care for governance that takes into account all relevant facts, values, interests, scientific developments, hopes, hypotheses, beliefs and concerns, with the aim to generate synergetic insights that have the potential to be trusted by those involved in, and affected by, ionising radiation exposure situations. Aspects of concern include, but are not limited to, (i) integration of scientific, technical, social and political aspects in the decision-making processes; and (ii) raising public awareness of these aspects and integrating them into knowledge building. A core emphasis here is on providing insights and guidance on multi-dimensional, multi-actor and multi-institutional decision-making and policy-making and on addressing emerging trade-offs in the governance of ionising radiation exposure situations.

Relevant cross-cutting topics include:

2.1. Ethics of governance and aspects of 'good' governance (holistic, participatory, deliberative, sustainability thinking, capacity building, sense for cooperation, transparency, reflexivity, accountability, robustness, adaptability, traceability, …).

2.2. Analysis of existing policy and regulation related to governance of ionising radiation exposure situations:

a. Public involvement in policies and decision making processes related to ionising radiation.

b. Knowledge management (incl. transparency) and decision-making mechanisms (incl. institutional recreancy, interests and power relationships).

c. Science as policy advice (role and working of scientific institutions and advisory councils, facilitation and mediation of the science-policy interface, uptake and implementation of advice into policy, research funding policies, etc.).

2.3. Facilitating a cooperation between institutional (formal) and non-institutional (social) actors.

2.4. Assessing values and expectations that come with the integration of SSH in ionising radiation research and policies.

Additional topics relevant to emergency preparedness, response and recovery

2.5. Holistic approaches to accident preparedness, management and recovery, taking into account multiple risks (with short and long-term consequences), social, economic and psychological factors and lessons learned from other types of emergencies. Specific emphasis should be given to:

a. Social, ethical and psychological issues related to preparedness and response to nuclear and radiological terrorism and other criminal behaviour.

b. Decision making in post-accident situations, with emphasis on local knowledge and values.

c. Socio-psychological and economic aspects of medical follow-up after accidental exposures or resulting from malevolent acts.

d. Ethical aspects of crisis management, particularly ethical questions around evacuation, post-accident management, and the transition from emergency to recovery in radiological exposure situations.

Additional topics relevant to the medical field

2.6. Analysis of the values and principles that inform radiological protection programmes and practices in the medical field with a view to develop tools and methods to elaborate such programmes.

2.7. Assessment of how various types of uncertainties (i.e. scientific, technical, social and ethical) are identified and managed in different professions, for instance general practitioners, surgeons, food scientists, environmental scientists, publics.

2.8. Exploration of the needs, possibilities and processes to engage patients in informed decision-making in a holistic approach perspective.

2.9. Analysis of the evolution of governance, practices, ethics, and recommendations for Radiation Protection in Medicine.

Additional topics relevant to waste management

2.10. The ethics of compensation for radiological risks and comparison of approaches in different countries.
2.11. Inclusion of intergenerational ethics in the governance of spent nuclear fuel final solution (e.g. nuclear back-end funds schemes, funds devoted for the so-called "added value approaches" and/or compensations and rules for their use for future generations).

Additional topics relevant to nuclear facilities

2.12. Integrating research of economic/financial aspects of nuclear facilities planning/ operation/ lifetime extension/ decommissioning. For example clarification of anticipated vs. real costs for the nuclear back-end.
2.13. The role of nuclear energy in broader problems such as security of electricity supply, climate change, sustainability.

Additional topics relevant to radon and NORM

2.14. Decision making processes related to radon and NORM.

RESEARCH LINE 3: RESPONSIBLE RESEARCH AND INNOVATION IN RADIOLOGICAL PROTECTION AND APPLICATIONS OF IONISING RADIATION

Research line 3 aims at assessing how the research, development and innovation related to the use or existence of ionising radiations as well as radiological protection are conducted, with the aim of inciting more socially responsive and ethically sound processes and outcomes. The design of transdisciplinary activities is emphasised in this research line, for example through co-creation agenda setting processes that engage scientists from various disciplines (sciences, engineering, medicine, social sciences and humanities, …) with concerned publics.

The topics addressed in this Research Line 3 investigate how a multi-dimensional governance concept like Responsible Research and Innovation (RRI) is or can be used in technical R&D concerning radiological protection and various applications of ionising radiation, and how these governance mechanisms structure interactions between different actors, as well as follow-up actions in this regard.

Relevant cross-cutting topics include:

3.1. Examining the social, cultural, economic, (geo)political and historical context of research in various fields of ionising radiations research and applications, with particular focus on the rationales, possibilities, and limitations of research approaches and methods, as well as the social relevance of research hypotheses.
3.2. Enhancing the reflexive awareness of actors involved in technical R&D about the societal implications of nuclear technology applications and radiological exposure situations.
3.3. Characterising, developing and operationalising principles such as transdisciplinarity, which sustain the integration of SSH with the research associated with various fields of application of ionising radiations, as well as in radiological protection research.
3.4. Ascertaining conflicts of interest in the research associated with various fields of application of ionising radiations as well as in radiological protection research, and finding ways to manage such conflicts.
3.5. Evaluating the institutional uptake of research projects and findings; and the position of transdisciplinary research therein.

3.6. Establishment of a collaborative framework for stakeholder engagement in research and development, policy and practice in ways that enhance responsiveness to societal needs and concerns (in connection with RL4)
   a. Developing methodologies and tools for the dynamic mapping of stakeholders' concerns, views and needs to identify R&D priorities in the development of ionising radiations uses and radiation radiological protection.
   b. Determining how to make SSH integration meaningful and effective for all stakeholders, for example by comparing expectations of various scientific disciplines and concerned publics with regard to SSH contributions on research in the fields of radiological protection and the use of ionising radiation.

RESEARCH LINE 4: STAKEHOLDER ENGAGEMENT PRACTICES IN RELATION TO RADIOLOGICAL PROTECTION AND APPLICATIONS OF IONISING RADIATION

Research line 4 aims at fostering stakeholder engagement in research, policy and practice related to radiological protection and applications of ionising radiation in ways that enhance responsiveness to societal needs and concerns. This research line looks at how (formal or informal) participation practices are enacted by various actors and in different contexts. These cover different socio-economic, political and cultural contexts, different exposure situations (planned, existing and emergency), different applications of ionising radiation, and the different stages in the cycle from knowledge generation to policy formulation and practical implementation.

The topics addressed in this Research Line 4 are generic to all exposure situations, applications of ionising radiations, and include various types of stakeholders. Therefore they should be developed taking into account the specificities of the contexts addressed in particular research projects. The topics listed have in common that they deal with either the assessment and development of stakeholder and public participation tools and methodologies for different exposure situations, or with the assessment of existing policies and practices.

In view of prioritizing research needs, below a number of exposure situations and/or target groups have been listed as particular foci of interest when addressing one or more of the following generic, **cross-cutting topics.**

4.1. Potential and limitations of citizens' involvement in the production of knowledge for the governance of various radiation exposure situations (e.g. citizen science, citizen journalism).
4.2. Development of approaches for involving directly affected stakeholders in facing the challenges related to ionising radiation exposure situations.
4.3. Motivations, roles and responsibilities of stakeholders in the engagement process, values underlying the engagement process and links between theory and practice.
4.4. Analysis, comparison and evaluation of formal practices for mediation and facilitation between authorities, scientists, publics and other stakeholders for different exposure situations and different applications of ionising radiation, with due attention to issues of representativeness.
4.5. Analysis of societal needs for public participation and access to information and justice, and evaluation of whether and how these are reflected in legal requirements and governance frameworks.
4.6. Empirical research on the relationship between stakeholder engagement and transparency

4.7. How stakeholder engagement shapes the development of knowledge, technologies and policies, institutional practices and relations between stakeholders.
4.8. Research on the institutional contexts enabling or hindering public participation in decision-making processes.
4.9. Challenges for maintaining participation over the long term. These include the development of participation cultures and the preservation of knowledge and experience with participation of local stakeholders (e.g. local community, schools, citizens) and other concerned actors.

Particular focus is needed in relation to:

- dismantling and decommissioning of reactors (e.g. stakeholder engagement related to recycling of materials, to the future of the site, …)
- management of radioactive waste (e.g. stakeholder engagement related to high level waste storage siting processes);
- radon risk management (with emphasis on stakeholders at the local level);
- preparedness for emergency response and recovery (with emphasis on local communities, local networks, and medical professionals);
- future of nuclear energy;
- medical exposures (with emphasis on patients, care-givers, and patients' representatives).

RESEARCH LINE 5: RISK AND HEALTH COMMUNICATION

Risk communication needs to be *"evidence-based (e.g., based on the qualitative and quantitative empirical data, surveys, experiments), theory-based (e.g., drawing from empirically-supported theories of health behaviour, information processing, risk perception and risk communication) and strategic (e.g., based on formats and methods that have been proven to reach its preconceived objectives)"*[13].

This area covers issues related to communication of risk, how exchange or sharing of risk-related data, information and knowledge between and among different parties (such as regulators, experts, consumers, media, general public) can be provided. It also covers studies and practices of communicating promotional health information such as public health campaigns related to ionising radiation exposure situations, e.g. related to radon and doctor-patient communication, in order to address personal choices for health related actions. Research line 5 aims at developing research to support communication about ionising radiation between different stakeholders and citizen-centred risk communication, in order to clarify choices and options in a variety of exposure situations. It also seeks to empower citizens and other stakeholders to make more informed decisions.

Relevant cross-cutting topics include:

5.1. Structured approaches to identify needs for information and develop timely and targeted communication.
5.2. Methodological research supporting the development of valid and reliable measurement scales for different latent constructs, questionnaires and health surveillance protocols for development of communication and evaluation of communication outcomes.

[13] Bouder, F., Perko, T., Lofstedt, R., Renn, O., Rossmann, C. et al. The Potsdam radon communication manifesto, *Journal of Risk Research*, DOI: 10.1080/13669877.2019.1691858

5.3. Media communication related to ionising radiation, e.g. inter-media agenda setting in different exposure situations, social amplification of risk, framing, new information technologies (social media, human computer interaction, etc.).
5.4. Role of different approaches in risk communication for improved radiation protection in different exposure situations (e.g. instrumental approach, risk message approach, risk governance approach, normative, dialogue, etc.).
5.5. Ethical basis and values underpinning risk and health communication about ionising radiation exposure situations (planned, existing, emergency).
5.6. Communication related to various trade-offs in decision-making, e.g. non-radiological considerations, and why some of them are more important in a particular country or context (e.g. protective measures in a radiological emergency situation, medical applications etc.)
5.7. Closing the gap between communication theory and practice related to the concept of trust as an important factor in risk and health communication.
5.8. Developing risk and health communication about low doses: Use of state of the art knowledge from socio-psychological research with focus on low doses of ionising radiation and related uncertainties.
5.9. Communication of uncertainties (including visualization) in different exposure situations and contexts, and how it influences perceptions, attitudes and behaviour. This includes investigation of potential causes for misinterpretation related to the presentation of information (e.g. format, design, data and uncertainty).
5.10. Use and perception of technical information (e.g. measured data), uncertainties and risk estimates in communication with various publics (e.g. citizens, experts, informed civil society), taking into account cultural aspects.
5.11. Influence of framing of different exposure situations on risk perception and (self)protective behaviour actions.

Additional topics concerning radiological protection:

5.12. Developing models and tools for communication in specific exposure situations, as for example communication in waiting rooms, decontamination rooms.
5.13. Perception and communication related to radiosensitivity and radio-susceptibility including mental maps, ethical aspects, for instance related to low dose or emergency exposures.

Additional topics concerning radiological or nuclear facilities and waste management:

5.14. Communication barriers between different actors in discussing issues related to projects in the nuclear sector (e.g. waste management, new nuclear installations, etc.).
5.15. Specifics of risk communication directly or indirectly related to potential exposure situations.
5.16. Communication about issues concerning ionising radiation related to extension of lifetime of radiological or nuclear facilities.
5.17. Communication of issues related to ionising radiation in the context of security of nuclear installations against malicious acts, e.g. terrorism, sabotage.
5.18. Communication culture and strategies for dealing with and communicating about institutional mistakes and unforeseen changes in risk management.
5.19. Balancing issues of confidentiality and transparency in communication, taking into account the Aarhus Convention.
5.20. Develop communication for memory preservation, for instance related to deep geological disposal.
5.21. How nuclear heritage mediates risk narratives and can be mobilised as an additional means of risk communication.

Additional topics relevant to the medical field:

5.22. Risk and health communication about radioactivity and radiological protection principles in medical applications of ionising radiation, and the impact of communication on the radiological protection behaviour.

5.23. Improving decision-making for medical procedures involving ionising radiation through better risk and health communication tailored to the needs of patients: informed consent, empowering patients in decision-making, information processing, ethical issues and communication about uncertainties. How can considerations related to emotions, sensitivities, religious, cultural aspects be included in risk communication?

Relevant topics for existing exposure situations:

5.24. Risk communication and stakeholder involvement in long-term exposure situations in order to improve Radiological Protection Culture and to support decision-making processes related to daily life and the improvement of public health (e.g. post-accident recovery, environmental remediation of NORM sites, radon). Identify which approaches are most effective for different audiences.

RESEARCH LINE 6: RADIOLOGICAL PROTECTION CULTURE

Research line 6 involves research concerning the assessment and development of a radiological protection culture among all concerned stakeholders, in the various exposure situations (planned, existing and emergency) and for the different categories of exposed individuals (workers, patients, general public).

Radiological protection culture is a still evolving concept. It is a concept of composite nature, characterized by a set of perceptions, values, attitudes, beliefs and expectations related to radiation risk; an assembly of knowledge, know-how, regulations, skills, experience, and practices related to radiological protection; and a dynamic building process based on multi-stakeholder interactions, including regulatory bodies and all concerned parties.

From a general point of view, the aims of radiological protection culture are manifold. First, it favours an understanding of radiological protection norms and standards. Second, it enables individuals to reflect on their own protection and/or that of others, consciously consider radiological protection aspects in their lives, and contribute to decision-making processes related to the management of radiological exposure situations. Thirdly, it enables professionals in radiological protection and other stakeholders to participate in a dialogue, to share a common language, with a view to enhance decision-making processes associated with the implementation of the radiological protection system and to better address the concerns of all stakeholders.

From a practical point of view, the specific elements characterizing radiological protection culture, the aim of radiological protection culture as well as the tools or methods of dissemination will depend on the exposure situations as well as on the stakeholders involved in the management of the situations.

The topics addressed in this Research Line 6 are generic to all exposure situations and stakeholders and should be developed taking into account the specificities of the contexts addressed in the research projects.

Relevant cross-cutting topics include:

6.1. Further analysis to characterize radiological protection culture

6.1.1. Analysis of organisational, social, political, economic, cultural and psychological aspects influencing radiological protection culture, in particular:

- How regulatory practices influence/shape/help to configure radiological protection culture;
- Relationships between radiological protection culture and a general safety or security culture;
- Interactions between the radiological protection culture at the level of an organisation or community, and at individual or sub-group level;
- Analysis of processes of radiological protection knowledge production, values and expectations.

6.1.2. Analysis of the impact of evolving technologies, knowledge, and communication technologies on radiological protection culture.

6.1.3. Identification of ethical frameworks and value judgments underlying radiological protection culture and its development.

6.2. Analysis of the role and benefits of building and enhancing radiological protection culture

6.2.1. For the implementation and improvement of the radiological protection system;

6.2.2. For the improvement of governance and stakeholder engagement processes related to radiological protection and/or management of situations associated with the use/existence of ionising radiation;

6.2.3. For the improvement of health and well-being of populations.

6.3. Developments associated with building, maintaining, enhancing and transmitting radiological protection culture

6.3.1. Development of specific strategies, according to the exposure situations and target stakeholders, including - among others:

- Identification of role and responsibilities of the various actors in the development of radiological protection culture;
- Development of multidisciplinary, multi-level, and multi-stakeholder participatory approaches to build, enhance and transmit radiological protection culture;
- Integration of radiological protection culture within the development of a broad safety culture to help stakeholders to consider risks in a holistic manner.

6.3.2. Identification of tools and processes allowing participation of stakeholders at the relevant level. Focus points are:

- Exploration of methods for the co-construction of radiological protection culture, relying on the contribution from radiological protection experts together with the stakeholders themselves for the development of skills, knowledge and practical measures combining science, expertise and practical experience;
- Collaborating with existing citizen science projects, to understand the motivations, concerns and needs of citizens engaging in such activities;
- Building frameworks to develop citizen science projects and other initiatives empowering target stakeholders to develop radiological protection culture.

6.3.3. Development of education and training schemes adapted to the target stakeholders.,

- E.g. through the development of open access sources of information on radiological protection in various fields and for various stakeholders.

6.3.4. Elaboration of guidelines on the development of radiological protection culture adapted to specific exposure situations and stakeholders.

6.4. Developments regarding the evaluation of the level of radiological protection culture

6.4.1. Development of methods and tools for the qualitative and/or quantitative evaluation of the degree of radiological protection culture, at group and or individual level

6.4.2. Development of evaluation strategies, with consideration of:

- Internal versus external evaluation;
- Role of audits;
- Role of various actors (authorities, professional associations, …) in the evaluation process.

Acknowledgements

SHARE would like to express its gratitude to everyone involved in the development of this Strategic Research Agenda, defining the respective research lines and topics, either within our SRA Working Group, or in the previous activities that set the stepping stones for building this SRA (cf. document mentioned in footnote 1).

This document is the collective work of SHARE members and experts representing other organisations and projects, whose input and advice allow this document to tackle all components of the SSH in ionising radiation research. The writing of this SRA was coordinated by our SRA working group, composed of: SRA WG leaders Catrinel Turcanu (SCK CEN) and Martin Durdovic (Czech Academy of Sciences), and the SRA WG members (in alphabetical order) Anne Bergmans (University of Antwerp), Gaston Meskens (SCK CEN), Peter Mihok (Matej Bel University), Susan Molyneux-Hodgson (University of Exeter, SHARE president), Tanja Perko (SCK CEN, SHARE vice-president), Christiane Pölzl-Viol (BfS), Caroline Schieber (CEPN), Benham Taebi (University of Delft) and Yevgeniya Tomkiv (NMBU).

We also owe a special mention to the following experts, whose input, comments and reviews represented a great value in the writing of this SRA: Thierry Schneider (CEPN, president of NERIS); Veronika Olšovcová (Institute of Physics of the Czech Academy of Sciences, on behalf of EURADOS); Sisko Salomaa (STUK, member of MELODI Executive Board) together with Karim Peltonen, Teemu Siiskonen, Maarit Muikku, Riikka Pastila (STUK); Jim Malone (Trinity College Dublin); Vilma Luoma-aho (Jyväskylä University); Liudmila Liutsko (ISGlobal) and Marika Hietala (SCK CEN).