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How to Communicate about Radiological Risks? A European Perspective

Tanja Perko Belgian Nuclear Research Centre; University Antwerp, Belgium

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This working paper series shares research produced as part of the Fukushima Global Communication (FGC) Programme, a research initiative of the United Nations University Institute for the Advanced Study of Sustainability (UNU-IAS). The FGC Programme applies a human security approach to examine impacts of the Great East Japan Earthquake, tsunami and nuclear accident of 11 March, 2011 on people and society, and the challenges of the recovery process in Fukushima. It also focuses on issues of risk and information provision, aiming to improve understanding of how the threat of radiation is perceived, and the specific challenges of risk communication related to nuclear energy.

This working paper is an output of the FGC research workshop "Understanding and Communicating Risks Post Fukushima", held in Tokyo on 12–13 November 2015. The workshop brought together international experts to explore the specific challenges of understanding and discussing risks related to nuclear accidents, and identify appropriate and effective forms of risk communication.

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ABSTRACT

In this manuscript we first explain, how people understand the concept of radiation, followed by risk perception, how people process the risk related information and we close it with a description of the nowadays common socio-centric approach to risk communication which empowers stakeholders to make an informed decisions. We focus on nuclear emergencies and recovery after a nuclear emergency with a special attention on differences between general population and affected population. We conclude that risk communication should be an arena for discussing the moral values and emotions associated with risks, it should be ethically justified and the communication should be adequately directed to obtain the desired effects. Risk communication should present various options for action with a list of pros and cons in a balanced and nuanced way to leave more room for the decisions of stakeholders. Some societal constraints related to stakeholder involvement process and some selected recommendations to overcome these constraints are presented as identified by the IAEA project CIDER.

抄録

本ペーパーでは、まず、人々がどの様に放射線という概念を理解しているか述べ、続いて、リスク認知、そして、どの様にリスクに関する情報を処理しているかを述べる。最後に、関係者の情報に基づく意思決定を可能にする、現在普及が進んでいる社会中心型のリスクコミュニケーションアプローチについて概説する。我々は、原子力事故と事故後の復興における一般市民と被災者の違いに特に注目し、リスクコミュニケーションは、モラル価値とリスクに関する感情を議論する場であるべきであり、倫理的に正当で、望ましい効果を充分に得るためのものでなければならないと結論付ける。リスクコミュニケーションにおいては、バランス良くきめ細やかな方法でさまざまな選択肢をそれぞれの長所、短所を添えて呈示し、関係者の意思決定の余地を残すべきである。関係者の参加プロセスを阻害している社会的要因、そして、国際原子力機関のCIDER (Constraints to Implementing Decommissioning and Environmental Remediation) プロジェクトの経験に基づき、阻害要因への対応策を提案する。

Introduction

The most important aims of risk communication after a radiological contamination of an environment should be i) to support the stakeholders to make informed decisions related to radiation risks, ii) to establish two-way communication and iii) joint problem solving. Communication related to radiological risks touches on multiple psycho- societal aspects. Communicators have to take into account not only health risks for the population and biological effects, but also social attitudes (e.g. stigma), psychological effects (e.g. distress, depression), values and economic threats (e.g. decrease of property value). The complexity of a risk communication starts already on an individual level (mental process) and continues at the societal level with an interaction of many views, values and motivations.

Many theories and concepts have been developed to explain the mental processes that lead formation of an opinion related to the communicated risk. In order to understand the processing of radiation risk related information and decision-making we discuss three levels; the first level is the individualistic one, which tries to define individual preferences based on the expected utility, or some combination of expectancies and values. The second, societal level emphasizes the structure and functioning of groups within stakeholder engagement process. The final level, called the institutional one, focuses on the establishments that are responsible for risk management. In general, the concept of radiation carries immediate associations with nuclear energy, accidents and elicits some degree of anxiety. Trust and transparency are important dimensions in the foreground of many issues. Communicating information and processing information are complex processes that directly implicate trust, transparency and empower affected people for decision making. Responsible communication requires a legitimate procedure, an ethically justified risk message and concern for and valuation of the effects of the message and procedure. Emotions point out moral aspects of risks such as justice, fairness and autonomy (Fahlquist & Roeser, 2014).

The manuscript highlights, how people understand the concept of radiation, how they perceive ionizing radiation risks, how people process the risk related information and describes the nowadays common socio-centric approach to risk communication which empowers stakeholders to make an informed decisions. A special focus is given to nuclear emergencies and recovery after a nuclear emergency. A special attention is given to differences between general population and affected population. We conclude that risk communication should be an arena for discussing the moral values and emotions associated with risks, it should be ethically justified and the communication should be adequately directed to obtain the desired effects. Risk communication should present various options for action with a list of pros and cons in a balanced and nuanced way to leave more room for the decisions of stakeholders.

Discussion

How Do People Understand the Concept of Radiation?

To identify how an individual understands the terms "radiation" and "radioactivity" is far more complicated than to measure the basic knowledge about ionizing radiation

a member of a lay public holds. In general, the level of knowledge has only a limited effect on risk communication affect. However, it has been recognized as a mediator between a person and the effect of communication. Tichenor et. all (1970) proved that that level of knowledge is relevant for an individual's communication skills. Those with a better reading ability, for example, should be able to comprehend information more easily. In addition, a positive direct relationship between knowledge and the perceived information-gathering capacity was evidenced by Griffin et al.(2008), Kahlor et al.(2006) and Huurne et al.(2009). Specific knowledge is the most powerful predictor for an attentiveness to the radiological risk information. People with a higher specific knowledge remember and recall more information information (Perko, Thijssen, C., & Van Gorp, 2014). In other words, people who are well informed about an issue are more exposed to information, comprehend more of the information provided and remember it and recall it more than people who are less knowledgeable. Although increasing public's knowledge often is set as a primary objective of risk communication efforts, it is in the nuclear field known that the public lacks knowledge and has only rarely (acknowledged) experiences with radioactivity (Kuklinski, Metlay, & Kay, 1982; Miller, 1998; Perko, Turcanu, Schröder, & B., 2010; Van Aeken, Turcanu, Bombaerts, Carlé, & Hardeman, 2007). For instance, in Belgium knowledge related to ionizing radiation is rather low, even after an intense nuclear emergency communication campaign organised by authorities and after an information campaign organised by nuclear industry. Table 1 presents some selected knowledge answers given by representative samples of a Belgian population in years 2009, 2011 and 2013.

Although the level of knowledge is important for risk information, many risk communicators mistakenly measure the success of risk communication by what the population knows about the risk, and whether it believes it knows enough to make a decision. Knowledge may not always play a role in determining people's behavior. Knowledge about radon, for example, is uncorrelated with actually doing a home radon test (Sandman & Eblen, 1994). People who take risks are not necessarily less knowledgeable than those who do not take risks (Sjöberg & Drottz-Sjöberg,

Table 1: *Knowledge about the nuclear domain in Belgian population, (Perko. T, Turcanu. C, Schröder. J, & Carlé. B, 2010; Turcanu & Perko, 2014; Turcanu, Perko, & Schröder, 2011)*

Knowledge questions	Answering categories	Year 2013 % correct answers	Year 2011 % Correct answers	Year 2009 % correct answers
What do you think about the following issues:				
Will exposure to radiation always lead to radioactive contamination?	*1. Yes 2. No 9. Don't know / no answer*	26% (No)	31%	26%
Is radioactive waste produced only by nuclear power plants?		65% (No)	61%	NA
Which of the following sectors makes use of nuclear technology?				
production of electricity	*1. Yes 2. No 9. Don't know / no answer*	95% (Yes)	97%	95%
medical sector		92% (Yes)	89%	87%
food industry		50% (Yes)	29%	25%
In your opinion, how is radioactive waste managed?				
Radioactive waste is collected and treated	*1. Separately from other wastes 2. Together with theother waste 9. Don't know/no answer*	87% ("Separately from other waste")	87%	NA
Radioactivity can be directly measured:	*1. With special equipment 2. It cannot be measured 9. Don't know/no answer*	88% ("With special equipment")	91%	NA
The measurement unit for radioactivity is:	*1. Becquerel 2. Hertz 3. Metres/ second 9. I don't know/ no answer*	52% (Bq)	53%	NA
Vegetables grown near a nuclear power plant are not good for consumption because of radioactivity	*1. Yes 2. No 9. Don't know/no answer*	33% (No)	NA	NA
Natural radioactivity is never dangerous because we are used and adapted to it		51% (No)	NA	NA
The human body is naturally radioactive		37% (Yes)	NA	NA
With time, every radioactive substance becomes more and more radioactive		47% (No)	NA	NA

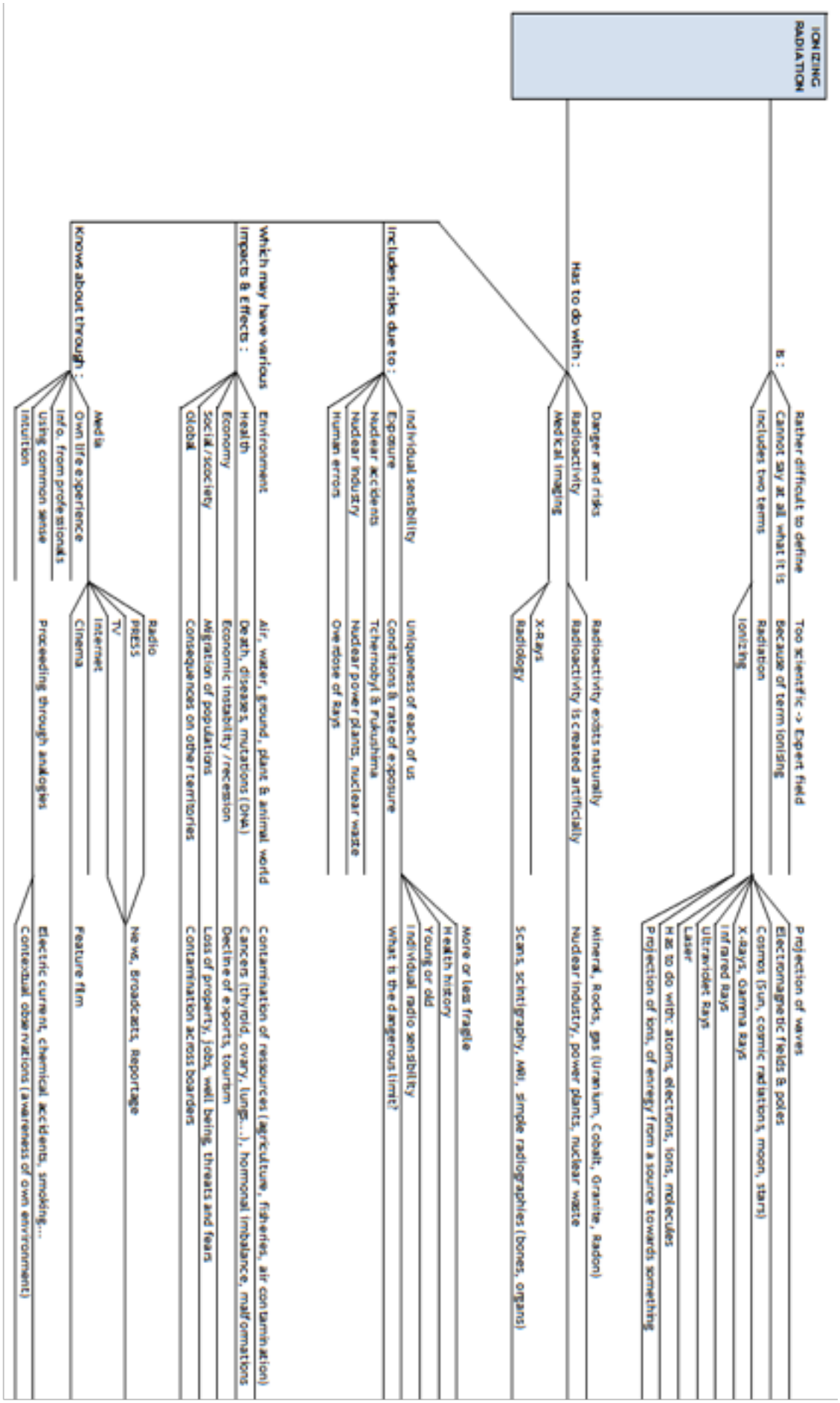

Figure 1: *General mental model of ionizing radiation among lay public developed in a context of the FP7 EAGLE project, Nina Schnider N. and Mays C. in zeleznik N. et al (2015)*

Table 2: *Some psychometric risk characteristics and comparable risks. Adapted and upgraded from literature (Covello, 1983), (Slovic, 1987), (Renn, 2003), (Havenaar, de Wilde, van den Bout, Drottz-Sjöberg, & van den Brink, 2003), (Knight & Warland, 2005), (Renn, 2003) and (Sjöberg, 2000)*

Some risk characteristics:	Explanation of influence	Explanatory scale	Some comparable risks
Personal control	Increases risk tolerance	controllable – not controllable	Driving car vs. flying in the airplane
Institutional control	Depends upon confidence in institutional performance	trust, confidence in institution	Accident in high trusted company vs. accident in low trust company
Number of exposed	Decreases risk tolerance	catastrophic – chronic	Plane accident – car accident
Voluntariness	Increases risk tolerance	voluntary – involuntary	Smoking vs. food poisoning
Mortality	Decreases risk tolerance	fatal – not fatal	Aids vs. angina
Knowledge	Increases risk tolerance	new technology – established technology	Genetically modified food vs. using pesticides
Familiarity	Increases risk tolerance	familiar – not familiar	Medical X rays vs. nuclear waste disposal
Dread / fear	Decreases risk tolerance	fear – no fear	Nuclear accident vs. Radiation from mobile phone
Artificiality of risk source	Amplifies attention to risk Often decreases risk tolerance	human – natural	Radon vs. nuclear installation
Blame	Increases quest for social and political responses	Degree of legal or social responsibility	Deliberate release vs. accidental release from nuclear installation
Benefit	Increase risk tolerance	Benefit to self-vs. unclear or inequitable	Worker exposure vs. public exposure
Effect on children	Decrease risk tolerance	Children specifically at risk	Higher cancer risk

1991). The research about how people understand ionizing radiation, what associations they have and how do they think about ionizing radiation (mental models) in selected European countries showed, "*that collectively, members of the lay public (independently of their education or background) possess a non-negligible amount of knowledge on the topic of ionizing radiation and its risks, and they hold strong views on related concepts. However, formal, organized knowledge about ionizing radiation is rather low*" (Zeleznik et al., 2015).

Figure1 below presents the mental model for ionizing radiation as measured in some selected European countries by Zeleznik et. al (2015). The researchers investigated how non-specialist population understand ionizing radiation by using structured, open-ended and minimally directive interviews, in which the focus was on gathering 'natural' vocabulary and implicit relationships among words, concepts and processes related to ionizing radiation. Figure 1 presents the findings, how people understand and think about ionizing radiation.

How Do People Perceive Radiation Risks?

In general, public understanding of nuclear risk-related information is hindered by the complexity of the risk. This concept includes not only the probability and consequences of a nuclear event, but also the specific risk characteristics, past hazard experiences, intuition, emotions, personal interest, involvement in the topic, existing widespread images related to risk, interpretations, (mis)understanding of scientific facts, educational background, access to and

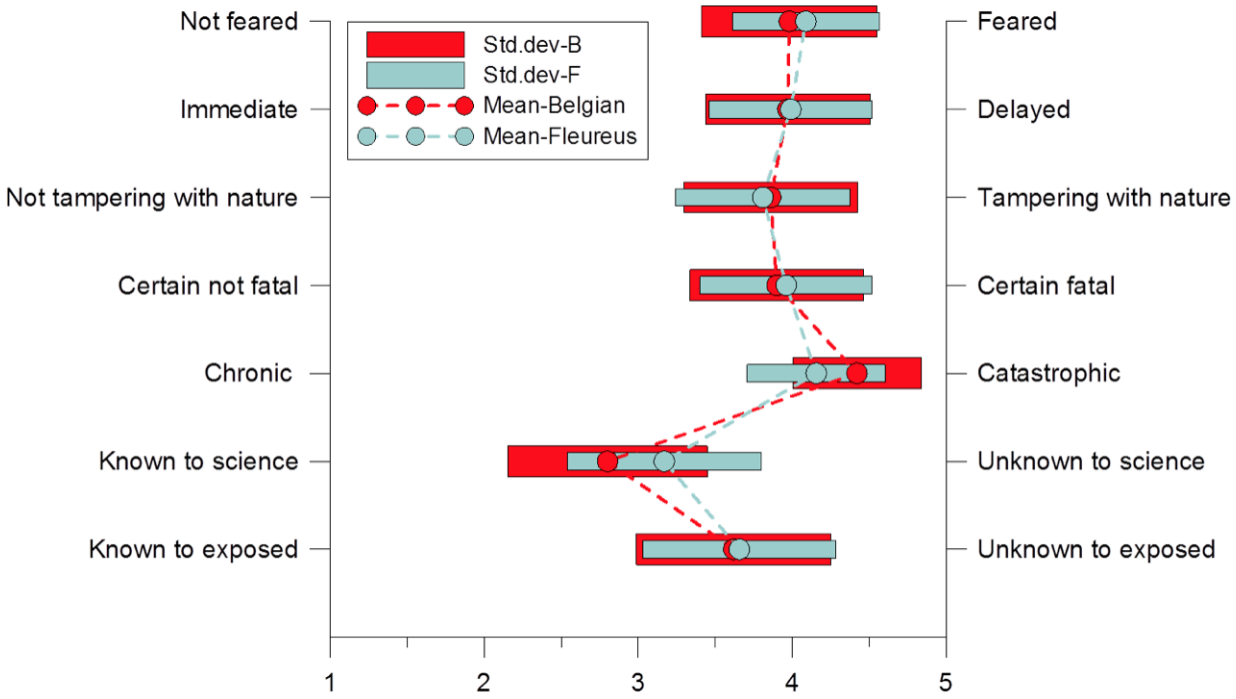

Figure 2: *Risk perception of an accident at a nuclear installation in Belgium; Differences between the general population (N=1035) and the affected population (N=104)*

understanding of information, credibility of information and communication processes, trust in information sources and communication partners, and more broadly, confidence in the governance of ionizing radiation risks. Since human behaviour is primarily driven by perception and not by facts (Renn, 2008), risk perception is a concept of great importance when developing sound and successful risk communication. Different approaches on risk perception have been developed over time. In one of these approaches is the psychometric paradigm (Fischhoff, Slovic, Lichtenstein, Read, & Combs, 1978; Renn, 2008; Sjöberg, 2000; Slovic, 1987).

Jaeger (2008, p. 106) listed the four characteristics of the psychometric paradigm:

1. *Establish risk as a subjective concept, not an objective entity;*

2. *Include technical, physical and social, psychological aspects in assessing risks;*

3. *Accept opinions of "the public" as a matter of academic and practical interest; and*

4. *Analyze the cognitive structure of risk judgment, usually employing multivariate statistical procedures such as factor analysis, multidimensional scaling or multiple regression.*

Risk characteristics measured by the psychometric approach go beyond the classic components of risk being harm and probability of occurrence. Hence it expands the realm of subjective judgment about the nature and magnitude of risk. Table 2 presents some selected psychometric risk characteristics.

For this proceedings, we were interested to identify how a nuclear accident is perceived in the Belgium population and in specific, if there are some differences in perception of an accident at a nuclear installation between the general population in Belgium (N=1035) and the population that was exposed to a nuclear accident (INES=3) in 2008 in Fleureus, Belgium (N= 104). Figure 2 shows that a nuclear accident is perceived as strongly feared event with fatal consequences, that a nuclear accident has delayed effects, is a result of a human tampering with nature, is perceived as rather unknown to science and unknown to exposed people. Interesting, we did not observe any strongly significant differences in risk perception of an accident between a general population and affected population, except for the *catastrophic potential* factor, where affected population perceived a nuclear accident as less catastrophic than general population and for *unknown to science* factor, where affected population perceived a nuclear accident as more unknown than general population.

With the increasing complexity of technological innovations, people find themselves in a position of not knowing much about highly complex and potentially dangerous

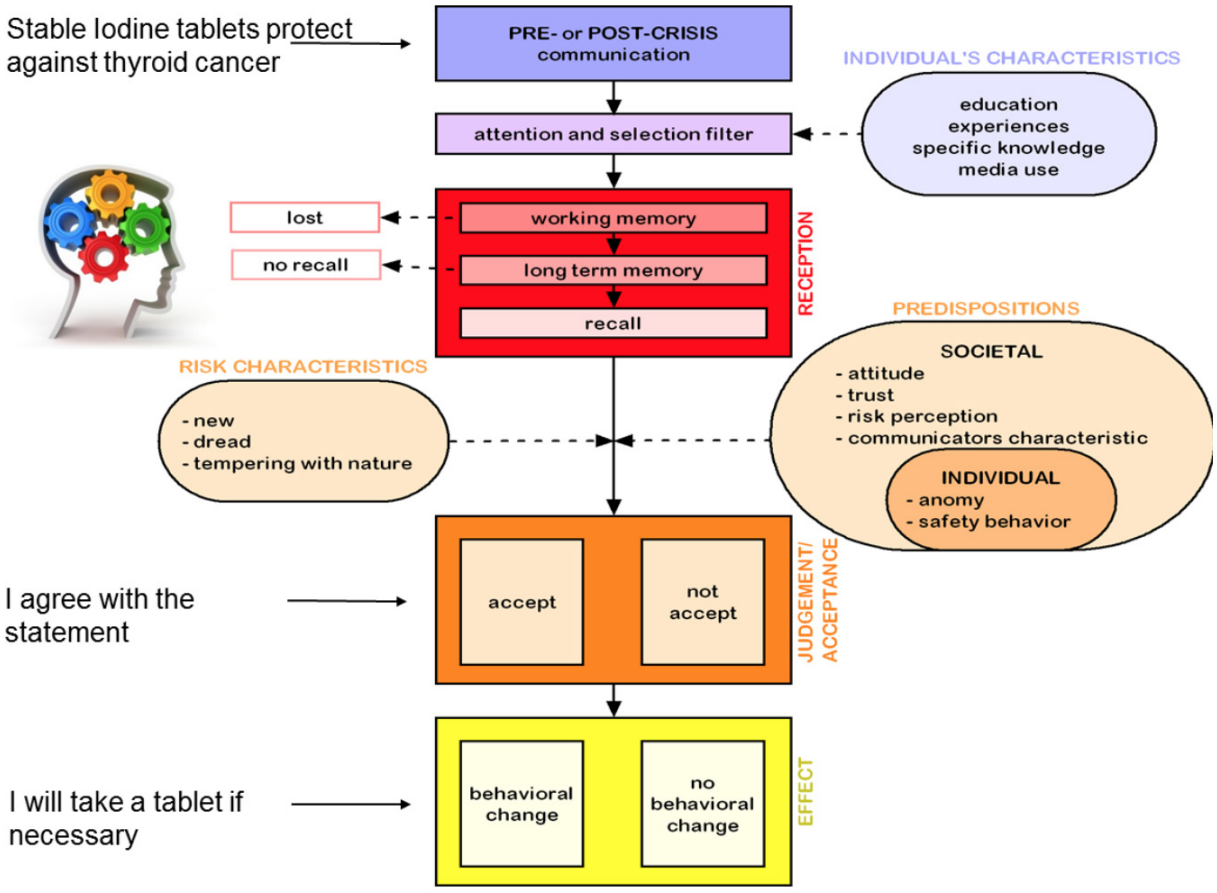

Figure 3: *Processing of information and its predictors; example related to the stable iodine tablets*

technologies and novelties. They therefore must rely upon their judgments about whom to trust (Gaskell et al., 2004). The meaning of trust in the field of risk perception and communication was examined in many studies on food-related risks (e.g. Frewer et al. (1996)), on opposition to a high-level radioactive-waste repository (e.g. Flynn et al. (1992)), study related to a nuclear power plant by Lofsted (1996), (Costa-Font, Rudisill, & Mossialos, 2008) and studies related to nuclear accidents (Greenberg & Truelove, 2011). These studies found that the perception of trust and credibility of a communicator is dependent on the perceptions of his/her knowledge and expertise, honesty and care (Peters, Covello, & McCallum, 1997). It was proven that effective communication requires respected and trustworthy sources (Fischhoff, 1991; Morgan, Fischhoff, Bostrom, Lave, & Atman, 1992). Conversely, not knowing whom or what to believe can make risk decisions intractable, and lack of credibility and trust can erode relations between experts (the communicator) and the public. In general, people will be more accepting of risks that are perceived to be generated by a trusted source, compared to a questionable one (Fischhoff, 1991). However, trust is not created by knowledge in itself. Rather, trusted sources are seemingly characterized by multiple positive attributes, since sources with moderate accountability are seen as the most trusted ones (Frewer et al., 1996). In the late 1990s, concerns were expressed about the quality of risk-related public discourse and communication that took place with regard to complex and controversial technologies. The question was raised whether society or individuals might be harmed by contentious, overly adversarial public debate about new technologies, including nuclear technologies. Some scholars, for instance Fischoff (1995), discussed the obligations of citizens and societal institutions to facilitate a well-reasoned discourse that is respectful of the opinions of others. Trust plays an important role in bridging the gap between experts and public and making risk communication effective. It is a moral emotion that requires trustworthiness and ethically responsible risk communication (care, empathy and respect) (Nihlén Fahlquista & Roesera, 2014).

How Do People Process Information and Make Decisions about Radiological Risks?

Efficient communication about nuclear risks requires thorough insight into the factors that influence people's attentiveness and recall of information or more generally speaking: how people process risk related information. People process information using two different modes: 1) heuristic and 2) systematic processing (Petty & Cacioppo, 1986).

Heuristic processing is characterized by low effort and reliance on existing knowledge and simple cues for instance trust. Systematic processing on the other hand is characterized by greater effort and the desire to evaluate information formally (Trumbo, 1999). The information processing models are seen as applicable for each individual, regardless of the societal or cultural bias (Chaiken & Stangor, 1987; Eagly, 1992; Eysenck, 2005; Lang, 2006; Lang, Bolls, Potter, & Kawahara, 1999; McGuire, 1973; Shiffrin & Schneider, 1984; Trumbo, 2002; Zaller, 2006), however, countries may differ in beliefs, cultural values, past social and risk experiences, the saliency of particular aspects of a policy issue, the socio-economic profile and trust in regulatory agencies.

At which stage of information processing do predictors such as risk perception, trust, knowledge and other predictors traditionally used in risk research, start to influence opinion formation? We tested these predictors in the context of crisis communication triggered by a radiological accident in Fleurus (Belgium, 2008, INES=3)(Perko et al., 2014). Our results confirmed that: i) specific knowledge is the dominant predictor for the reception of risk related information and ii) that knowledge is not significant at the level of agreement with these risk related message, but can act as a facilitating variable. For instance, people who were more knowledgeable about nuclear issues in general were more likely to know when and where did the accident happen and what kind of protective actions were taken by the authorities; however, they didn't necessarily agree with these actions (Perko et al., 2014). The level of agreement was influenced by heuristic predictors, for instance risk perception and trust.

Our findings suggest that indicators of systematic information processing have a stronger influence on the reception of information than the indicators of the heuristic mode also in a pre-crisis context, for instance in nuclear emergency preparedness campaign (Perko, van Gorp, Turcanu, Thijssen, & Carlé, 2013). More prior knowledge about the field relates to a higher reception of information and the indicators like risk perception, trust, attitudes are only to a minor extent involved in the reception of emergency preparedness information and mainly influence a level of agreement with communication. Our results have also confirmed the importance of engagement within communication process. Respondents that processed the communicate information, for instance the information related to iodine tablets more heuristically (they did not think about, did not discussed and they did not consider pro-and contra) seemed less inclined to agree with the communicated messages than respondents that processed the information more systematically. A higher level of agreement with communicated messages of the communication campaign for instance related to iodine tablets as whole seems to be mostly driven by systematic information processing and the trust in experts.

In addition, we investigated if and how did the predictors and the strength of these predictors vary among two population groups: the population that has been directly affected by a radiological accident, respectively the population that had neither been exposed to protective actions, nor has it been target population for risk communication. Several differences in information processing were identified between the general population and the affected population. For the affected population socio-demographic variables, as opposed to the general population revealed as unimportant for information processing. This could be due to the higher intensity of the communication campaign in the affected population and a higher saliency of the issue. Based on the findings, we can conclude that the more affected one is by an emergency, the less important socio-demographic characteristics are for the information processing. In addition, specific knowledge was revealed as more influential for the reception of information in the affected population than in the general population. At the same time, risk perception was revealed as the most significant predictor for information reception in the group of the general population that remembered the accident: respondents with higher risk perception were more likely to remember more details about the accident. Risk perception was however not significant for information reception in the affected population. Figure 3 presents information processing related to communicated message about stable iodine tablets applied in a nuclear emergency preparedness campaign.

Communication about Radiological Risk as a Stakeholder Engagement Process

Risk communication was in previous century seen as a form of a technical communication and education whereby the public should be informed about risk estimates. Later on, risk communication was seen as a marketing practice with the aim to persuade people to adopt a certain message. In nowadays societies, risk communication is seen as a socio-centric communication based on public participation with which the gaps between stakeholders can be bridged (Leiss. A & Powell. D, 2004). The participation of a wide range of stakeholders is the key to avoid possible exclusion of persons or groups who are key participants in the process, and the empowerment of inhabitants of the territories to understand the local situation and to have autonomy in the implementation of their personal actions to improve it. It is stressed that risk communication should not only be effective, but also ethical, which requires taking moral values into consideration. There are moral values at stake, which means that decisions have to be made in a democratic way, after serious debate about values and not merely about numbers. The procedure should be legitimate (requires legitimate procedure for discussing the moral values and emotions associated with risks), it should be ethically justified (ethical deliberation about the values and emotions involved in

Table 3: *Societal constraints for stakeholder involvement process and some recommendations to overcome these constraints (IAEA, project CIDER, in press)*

Societal constraints	Some selected recommendations to overcome societal constraints
Groups and individuals against the implementation of stakeholder involvement	• Identify possible opponents in advance • Establish contact with possible opponents and listen to their concerns and suggestions • Integrate their suggestions and solutions to the stakeholder involvement plan to the extent possible • Consider such groups separately from the other stakeholders and assess the extent to which specific communication and involvement actions may be effective in order to engage them in the process
Complexity of procedures for involvement	• Elaborate an involvement plan that consists of well- defined and short term goals • Develop indicators to measure progress achievement • Make clear from the beginning the different phases of the involvement process and the capacity that stakeholders may have to influence decisions in each of the phases • Provide possibilities for feedback and improvement
Changing opinions within one group	• Keep track of the opinions (e.g. record keeping) • Encourage the nomination of a spokesperson for each stakeholder group who represents a joint opinion • Encourage the stakeholder group to write and share with other groups their position so that any change in opinion needs to be well justified
Limited capacity to express opinions in public	• Employ trained and independent facilitators • Use different participatory tools to allow the stakeholders with limited capacity to express opinions (e.g. face-to-face interviews, anonymous voting, etc.) • Conduct targeted stakeholder group meetings • Organise public speaking courses for main communicators
Lack of funding sources to undertake involvement	• Make a financial plan for stakeholder involvement which requires low economic resources • Foresee cost for subcontractors (e.g. Communication companies, facilitators), • Provide resources or incentives to cover the costs of stakeholder participation (e.g. logistics, compensation for the loss of earnings) • Plan the budget for communication tools (e.g. print materials, Internet, TV, etc.) and use creative low cost tools
Limited access to information and communication	• Provide a wide range of tools to get access to information (e.g. Internet access, newspaper, radio) • Target information channels appropriately for the different stakeholders • Face to face communication with workers involved in the D&ER programme is effective and cost-free messengers.

Information overload	• Provide enough time for processing the information • Establish the information management system (e.g. Database, search engines) • Encourage the use of Executive summaries and visual aids in reports • Organise public speaking courses for main communicators • Prioritise and categorise issues, from most relevant to less prone to create impacts in the decision-making process.
Negative experience with stakeholder involvement	• Identify negative experiences with former D&ER projects at the local, regional, national and even international arena • Acknowledge and explain the motifs and pitfalls of experiences • Apply the lessons learned
Lack of use of independent facilitation	• Employ trained and independent facilitators • Get the neutrality of the facilitator recognized by all parties involved in the process
Lack of motivation to participate in the process	• Explain the advantages of participation in the achievement of a mutual satisfactory result and the potential consequences of the absence of effective involvement. • Clarify and guarantee in advance the participants' capacity to influence the decisions related to the D&ER programme • Increase general knowledge about the problem being faced • Organize events (e.g. meetings, interviews, etc.) in convenient time and venue
Unrealistic expectations	• Justify the choice of options • Show the consequences of different options • Share international practice and standards
Lack of continuous stakeholder involvement and communication	• Establish the mechanisms for record keeping and membership of the stakeholders group (e.g. Minutes of the Meetings to be issued and approved appropriately, encourage the nomination of the representatives of the stakeholders group) • Encourage the representatives of stakeholders groups to disseminate the information of the activities undertaken among the members of their group • Provide regular feedback regarding the improvements, modifications or compromises made to the process and which are the results of stakeholder involvement. • Always design the involvement events from "What is here for me" point of view.
Lack of balance between transparency and security	• Explain the principles of transparency and security • Establish and communicate the security and transparency policy • Establish a security committee to coordinate the requests for information disclosure • Develop commitment by all parties to share information in a transparent manner and to protect sensitive and confidential information (e.g. through an ethical charter or in case of commercial classified information which is protected from dissemination by law)

different messages) and the effects should be adequately addressed.

Stakeholder involvement is of paramount importance to develop effective environmental and health related policies, their implementations and to reach effective consensus around common goals with affected communities in a sustainable and cost-effective manner. Involvement may take the form of sharing information, consulting, conducting dialogues or deliberating on decisions. Through stakeholder involvement, public concerns can be addressed in an open and transparent manner and trust can be built between the different parties. Furthermore, stakeholders may end up developing a kind of ownership of the solutions to be implemented. It is effective if communication and stakeholder involvement are planned at an early stage.

Conflict between stakeholders is common when considering options for recovery after a radiological contamination. Such conflicts are often driven by differences in how the recovery activities' benefits and risks are distributed, valued and perceived. This may reflect differences between individuals, groups and authorities in their motivation, values, goals, level of knowledge, interests, their perceptions, beliefs about the objectivity and efficacy. In addition, arguments over the objectivity, validity, credibility and relevance of scientific findings are common in debates related to health effects of radiation, especially related to scientific uncertainty and effects of low doses. The participative process should lead to effective, democratic, ethical and transparent decisions.

There are many constraints that hinder progress in stakeholder involvement, however, there are also approaches to overcome these constraints (Monken-Fernandes et all. 2015) and (IAEA, project CIDER, in press). Table 3 presents selected societal constraints related to stakeholder involvement process and some selected recommendations to overcome these constraints.

Conclusions: Some Policy and Practical Recommendations

A general conclusion and recommendation is that risk communication in modern society should be seen as an important form of stakeholder engagement, and one that stresses dialogue and two-way communication rather than a simple provision of information. Knowledge-based society requires involvement of citizens at a large scale, including local communities, teachers, students, mothers, volunteers, etc. Early engagement of relevant stakeholders should be a formal part of the early planning of a recovery after a nuclear accident and/or contamination of an environment. Stakeholder engagement has to be an integral part of a decision-making. Mutual learning and transparency among all stakeholders, including scientists and lay people, is vital. A technocratic approach, where '*experts know best and can decide for the people who do not understand the technical issues*' should be switched to a socio-centric communication based on public participation with which the gaps between experts and stakeholders can be bridged. Citizen initiatives and engagement opportunities should be created. A transdisciplinary approach in risk communication (collaboration with natural science, social sciences and humanities) about a recovery phase of a nuclear emergency is important in order to develop appropriate, responsible and value based risk communication. The converging values and differences among the different groups of stakeholders should be identified.

These values and differences as well as local knowledge, practices and needs, must be respected.

The following specific recommendations are suggested in order to develop sound, transparent and successful risk communication:

- It is important to improve public knowledge by providing relevant and timely information in an understandable way. This process takes time and resources and should be continuous. (There is a need to identify the level of knowledge and understanding related to recovery activities to be implemented among the different stakeholders).

- The reasons for stakeholders' perception of radiological risks should be investigated (psychometric method analysis), and analysis of the psycho-social and economic environment of the area should be identified. The perceptions of risk could be different within different stakeholder groups and shall be addressed separately. (For these purposes the dialogue with small stakeholder groups, with a limited number of people, should be established.)

- An analysis of the opinion of the different stakeholder groups might help to reveal the differences regarding the concerns and demands coming from different segments. (Surveys, focus groups, interviews or other social science methods are useful to identify the values, demands and concerns of stakeholders and how these are prioritised.)

- The government should provide clear information at the beginning of the remediation programme to all stakeholders about the funds that can be made available to the implementation of the project. The extent to which demands from stakeholders will be taken into consideration should be clear beforehand. It is also important that during the implementation of the environment

remediation programme, regular information on the budget expenditures should be provided with the aim to acquaint the stakeholders with the current situation.

- The analyses of previous stakeholders' experiences and lessons learned related to an environmental contamination as well as health protection campaigns should be considered before developing the communication and stakeholder involvement activities.
- Governmental authorities should give a high priority to the implementation of remediation and "return to a normal life" programmes.
- In case that relevant administrative and/or legal frameworks related to environmental remediation programme changes during its implementation, it is important to clearly identify these changes and how they influence the implementation of the programme in a first place and then, what would be the consequences the changes will bring to the adopted strategy of stakeholder involvement.
- Integrating economic and social concerns into environmental decision making can be accomplished by forming partnerships with impacted communities and taking time to learn about community quality of life and environmental justice concerns.

Tanja Perko holds a PhD in Social sciences; risk perception and risk communication in nuclear emergency management (Universtiy of Antwerp, Belgium), MSc in political studies and bachelor in journalism, University of Ljubljana (Slovenia). She has 16 y of experiences in research and practice related to risk communication, risk perception, media analysis, stakeholder involvement and public opinion. She is a coordinator of the European project EAGLE (Enhancing education, training and communication processes for informed behaviors and decision-making related to ionizing radiation risks) and a task leader of the European project PREPARE (Evaluation and improvement of global communication for nuclear/radiological emergency). She acts as consultant and lecturer in different IAEA and EC projects on stakeholder involvement and communication for environmental remediation and communication in nuclear/radiological emergencies and risk communication about ionizing radiation in general. She participated in writing of IAEA guidelines "Communication with the public in a nuclear or radiological emergency" and "Communication and stakeholder involvement in environmental remediation processes"; author or co-author of more than 20 scientific papers in peer-reviewed journals, 12 in-proceedings papers more than 200 presentations at international events, reports and lectures. She is a member of some editorial boards in international journals and a member of Media, Movements and Politics (m2p) international research group initiated by the University of Antwerp (Belgium). She has been head of the Public Relation department at the Ministry of Defense in Slovenia and a journalist at the Slovenian national TV. She is also a semi-professional firefighter with a specialization and license for CBRN contamination management.

References

Chaiken, S., & Stangor, C. (1987). Attitudes and Attitude Change. *Annual Review of Psychology, 38*, 575-630.

Covello, V. T. (1983). The Perception of Technological Risks - A Literature Review. *Technological Forecasting and Social Change, 23*(4), 285-297.

Eagly, A. H. (1992). Uneven Progress - Social Psychology and the Study of Attitudes. *Journal of Personality and Social Psychology, 63*(5), 693-710.

Eysenck, M. W., Keane, M. T. . (2005). *Cognitive psychology* (5 ed.). London: Psychology Press.

Fahlquist, J. N., & Roeser, S. (2014). Nuclear energy, responsible risk communication and moral emotions: a three level framework. *Journal of Risk Research, 18*(3), 333-346.

Fischhoff, B., Slovic, P., Lichtenstein, S., Read, S., & Combs, B. (1978). How Safe is Safe Enough - Psychometric Study of Attitudes Towards Technological Risks and Benefits. *Policy Sciences, 9*(2), 127-152.

Griffin, R. J., Yang, J., & Huurne, E. (2008). After the Flood: Anger, Attribution, and the Seeking of Information. *Science Communication, 29*, 285-315.

Havenaar, J. M., de Wilde, E. J., van den Bout, J., Drottz-Sjöberg, B. M., & van den Brink, W. (2003). Perception of risk and subjective health among victims of the Chernobyl disaster. *Social Science & Medicine, 56*(3), 569-572.

Huurne, E., Griffin, R. J., & Gutteling, J. M. (2009). Risk Information Seeking Among U. S. and Dutch Residents: An Application of the Model of Risk Information Seeking and Processing. *Science Communication, 31*, 215-237.

Kahlor, L. A., Dunwoody, S., Griffin, R. J., & Neuwirth, K. (2006). Seeking and Processing Information About Impersonal risk. *Science Communication, 28*, 163-194.

Knight, A. J., & Warland, R. (2005). Determinants of food safety risks: A multi-disciplinary approach. *Rural Sociology, 70*(2), 253-275.

Kuklinski, J. H., Metlay, D. S., & Kay, W. D. (1982). Citizen Knowledge and Choices on the Complex Issue of Nuclear Energy. *American Journal of Political Science, 26*(4), 615-642.

Lang, A. (2006). Using the Limited Capacity Model of Motivated Mediated Message Processing to Design Effective Cancer Communication Messages. *Journal of Communication, 56*, S57-S80.

Lang, A., Bolls, P., Potter, R. F., & Kawahara, K. (1999). The Effects of Production Pacing and Arousing Content on the Information Processing of Television Messages. *Journal of Broadcasting & Electronic Media, 43*(4), 451-475.

Leiss. A, & Powell. D. (2004). *Mad Cows and Mother's Milk: The Perils of Poor Risk Communication:* . Montreal: McGill-Queen's University Press.

McGuire, W. J. (Ed.). (1973). *Persuasion, Resistance, and Attitude Change*. Chicago: IL:Rand McNally.

Miller, J. D. (1998). The Measurement of Civic Scientific Literacy. *Public understanding of science, 7*, 203 - 223.

Perko, T., Thijssen, P., C., T., & Van Gorp, B. (2014). Insights into the reception and acceptance of risk messages: nuclear emergency communication. *Journal of Risk Research, 17*(9), 1207-1232.

Perko, T., Turcanu, C., Schröder, J., & B., C. (2010). *Risk Perception of the Belgian Population; Results of the Public Opinion Survey in 2009* (Scientific report of the Belgian Nuclear Research Centre No. ISBN 978-90-76971-15-5). Mol: SCK CEN.

Perko, T., van Gorp, B., Turcanu, C., Thijssen, P., & Carlé, B. (2013). Communication in Nuclear Emergency Preparedness: A Closer Look at Information Reception. *Risk Analysis,* 10.1111/risa.12048.

Perko. T, Turcanu. C, Schröder. J, & Carlé. B. (2010). *Risk perception of the Belgian population, 2009.*

Petty, E. R., & Cacioppo, J. T. (1986). The Elaboration Likehood Model of Persuasion. In A. D. Berkowitz (Ed.), *Advances in Experimental Social Psychology* (Vol. 19, pp. 124-192). New York: Academic Press.

Renn, O. (2003, Sep 28-Oct 01). *Perception of risks.* Paper presented at the 41st Congress of the European-Societies-of-Toxicology, Florence, Italy.

Renn, O. (2008). R*isk Governance; Coping with Uncertainty in a Complex World.* London: Earthscan.

Sandman, P. M., & Eblen, R. A. (1994). Risk Communication In R. W. Eblen (Ed.), *Encyclopedia of the Environment* (pp. 620–623). Boston: Houghton Mifflin.

Shiffrin, R. M., & Schneider, W. (1984). Automatic and Controlled Processing Revisited. *Psychological Review, 91*(2), 269-276.

Sjöberg, L. (2000). Perceived risk and tampering with nature. *Journal of Risk Research, 3*(4), 353-367.

Sjöberg, L., & Drottz-Sjöberg, B. M. (1991). Knowledge and Risk Perception Among Nuclear Power Plant Employees. *Risk Analysis, 11*(4), 607 -618.

Slovic, P. (1987). Perception of Risk. *Science, 236*(4799), 280-285.

Tichenor, P. J., Donohue, G. A., & Olien, C. N. (1970). Tichenor, P. J., Donohue, G. A. & Olien, C. N. (1970). Mass media flow and differential growth in knowledge. *Public Opinion Quarterly, 34*, 159–170.

Trumbo, W. C. (1999). Heuristic-Systematic Information Processing and Risk Judgement. *Risk Analysis, 19*(3), 391-400.

Trumbo, W. C. (2002). Information Processing and Risk Perception: An Adaption of the Heuristic-Systematic Model. *Journal of Communication, 52*, 367-382.

Turcanu, C., & Perko, T. (2014). *The SCK•CEN Barometer 2013: Perceptions and attitudes towards nuclear technologies in the Belgian population.* Mol, Belgium: SCK•CEN.

Turcanu, C., Perko, T., & Schröder, J. (2011). *The SCK•CEN Barometer 2011 - Perception and attitudes towards nuclear technologies in the Belgian population.* Mol; Belgium: Belgian Nuclear Research Centre SCK•CEN.

Van Aeken, K., Turcanu, C. O., Bombaerts, G., Carlé, B., & Hardeman, F. (2007). *Risk perception of the Belgian population. Results of the public opinion survey in 2006.* Mol, Belgium: Belgian Nuclear Research Centre SCK•CEN BLG-1038.

Zaller, J. (2006). *The Nature and Origins of Mass Opinion.* New York: Cambridge university press

Zeleznik, N., Constantin, M., Schneider, N., Mays, C., Zakrzewska, G., & Diaconu, D. (2015). *Lay public mental models of ionizing radiation: Representations and risk perception in four European countries,* Brussels: European Commission.