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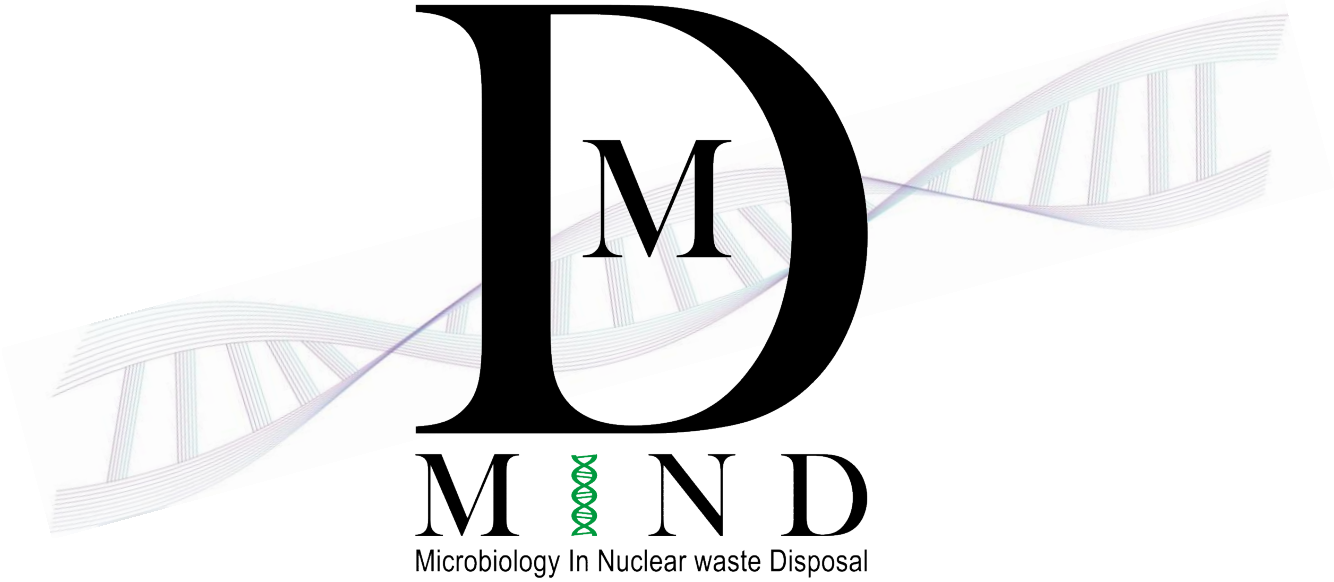

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DELIVERABLE D3.2-1

rmediate report on the methodology for the development of guidelines for risk communic

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Publishable Summary

This deliverable presents the methodological plan for the development of guidelines for risk communication in the context of microbiology research for nuclear waste disposal. The outcome of this study will support the design of communication guidelines for the project objectives and results during and after its implementation.

The document elaborates on the research plan for studying the impact of the inclusion of microbiology on expert conceptualization and public perception of geological disposal. This addresses two main research questions: *i)* how radioactive waste experts in the MIND project conceptualize nuclear waste disposal once the microbes have entered the network of nuclear waste 'actors' how radioactive waste disposal is (re)configured through the MIND project, i.e. through the inclusion/exclusion of microbial processes in the evaluation of safety for geological repositories and *ii)* how publics' perceptions of geological disposal changes depending on their knowledge about the host environment and microbial processes.

In addition, a plan for the study of risk communication with the general public and informed civil society is presented, taking into account scientific uncertainties, perceptions of risk and the specifics related to the biotic vs. abiotic environment of the repository. Based on the findings, good practice in public communication about complex issues will be suggested, designed for lay persons' understanding.

Contents

1 Integration of the task in the project

WP3, "Communication, Integration and Dissemination", evaluates and integrates microbial processes towards the conceptualization and performance assessment of geological repositories and in the respective state of the art knowledge base. The impact of the inclusion of microbiology on expert conceptualisation and public perception of geological disposal will be studied. The proper contextualization of results will be ensured and remaining key topics within and beyond the MIND project will be extracted by maintaining an active dialogue with stakeholders. The knowledge on general geomicrobiology and the outcome of the experimental work packages will be distributed to a broad audience, including students, professionals, the scientific community, stakeholders and the lay community.

Within WP3, task 3.2 evaluates the impact of the inclusion of microbiology on expert conceptualization and public perception of geological disposal. Geological disposal of radioactive waste is a challenging topic where social and technical aspects blend and where input from social sciences is required with regard to the design, implementation and post-construction management of the installation.

This deliverable outlines the methodology supporting the design of a communication strategy for project details during and after its implementation, specifically designed for the research theme addressed in the project: microbiology in geological disposals. The first communication guidelines will constitute the object of a subsequent deliverable and will be upgraded in subsequent steps throughout the project.

2 Introduction

Geological disposal is typically presented as a passive isolation strategy for long term radioactive waste management, while a microbial influenced environment can be considered as dynamic processes on a range of scales and time spans. This document outlines the plan for studying potential differences in the understanding and presentation of geological disposal, depending on the exclusion or inclusion of microbiology in the knowledge production and evaluation process. In addition it presents a research plan to study how people’s risk perception of geological disposal changes depending on their knowledge about the host environment and microbial processes. Finally, it outlines a research plan for the study of risk communication with the general public and the informed civil society, taking into account scientific uncertainties, risk perceptions and the specifics related to the biotic vs. abiotic environment of the repository. In other words, the design of the methodology is drafted. Later, the field work and analysis will be carried out. Based on the findings, good practice in public communication will be suggested, designed for a lay person's understanding. The outcome of this study will support the design of a common communication strategy for project details during and after implementation.

3 The method breakdown structure

The task 3.2 is divided into two parts (A and B). In addition, part B is divided in three research lines and builds on parts A.

A. Expert conceptualization

- Aim: Ascertain how experts in radioactive waste, interacting throughout the MIND project (i.e. MIND researchers, non-microbiologist experts, members of the MIND Implementer Review Board) conceptualize nuclear waste disposal now that microbes have entered the network of nuclear waste 'actors'
- Approach: Science and Technology Studies (STS), specifically Actor-Network Theory and Sociology of Translation
- Methods: Semi-structured interviews, participant observation, documentary analysis

B. Risk perception and communication

B1:

- Aim: Assess how experts and non-experts (informed civil society and lay public) perceive, and make sense, of nuclear waste disposal when confronted with mutual inputs; and suggest ways of integrating public values and considerations into ongoing research and development (R&D) processes in the field of nuclear waste disposal
- Approach: Technology Assessment (TA), Social Learning Theory
- Methods: Public Value Mapping (PVM)

B2:

- Aim: To identify risk perception characteristics of microbiological organisms that could be found in a geological disposal and differences in risk perception by experts, informed civil society and lay publics.
- Approach: Risk Perception Theory (Psychometric paradigm and cultural theory)
- Methods: Online questionnaire with the MIND consortium partners, local community members and students.

B3:

- Aim: To develop a communication approach in order to support the stakeholders to make informed decisions
- Approach: Risk communication model
- Method: Analysis of the collected results and deliberative workshop with experts and communication practitioners

4 PART A: Expert conceptualization

In this subtask, we will follow **how microbes, microbiologists, and microbiology are enrolled into the MIND research project and nuclear waste management** more generally.

Our approach is grounded in science and technology studies (STS), which identifies the study of the mobilization of resources as a key area in revealing how scientific practice operates. As Bruno Latour (1991 p. 41) argues, we must study the links between actors and their networks, as it is by observing what occurs "inside the links" that we can better grasp how science, technology, and "the social" shape the world. To understand how a network operates, the links that connect its constituent parts must be followed in as many directions as time and energy allow. It is argued that the network is in a constant state of change, temporarily stabilizing when multiple points of view are aligned toward a particular outcome.

As the mobilization of microbiology in nuclear waste management is a fairly new phenomenon, we adopt a grounded, inductive approach that observes how actors process new data and insights, and resolve challenges.[1] Drawing on semi-structured interviews with actors in the MIND project (MIND researchers, researchers, non-microbiologist experts, members of the MIND Implementer Review Board), on techniques of participant observation, and documentary analysis, we will ascertain how the integration of microbiology in nuclear waste management elicits or affects: *(i)* new topics and processes, *(ii)* knowledge gaps and uncertainties; *(iii)* priorities and opportunities; *(iv)* future outlooks. Examples of pending or new debates may pertain to the safety and (ir)retrievability of radioactive waste, the requirement for post-closure monitoring, anticipation of possible sociotechnical scenarios, new ways of managing risks, etc.

The semi-structured interviews with experts (see appended interview protocol) and our notes from participatory observation will allow us to identify the abovementioned issues (*i-iv*) and the strategies actors deploy to discuss and manage these issues (e.g. the development of intermediary languages using models, scenarios, calculation cases). We will also draw on relevant public statements, authorizing statutes, MIND documents, etc. to facilitate interviewing and draw out responses from experts. Data of the communicative interactions (interviews, group meetings, conference presentations) will be collected using a digital audio recorder and subsequently transcribed and analyzed using NVIVO software. All data will be fully anonymized to ensure research subjects' privacy.

Findings from this subtask will be fed back to research respondents, i.e. the MIND expert community, to enhance reflexive awareness of how experts conceptualize and negotiate the role of microbiology/microbiologists in nuclear waste management, and to initiate debate among them on outstanding issues, challenges, and problem areas within their research field. **Given the specific attention accorded in the project to managing risk, safety, and uncertainty, we will single out these particular issues for further discussion with broader publics (see below).**

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[1] We use the Actor-Network Theory (ANT) concept of a "translation process" as a guiding concept. This process comprises: 1) A stage of *problematization* in which actors define a problem in such a way that other implicated actors can recognize it as a problem too. 2) A stage of *interessement* in which the researchers acquire the commitment of others to a set of goals and a course of action. 3) A phase of *enrollment,* in which proposed courses of action are carried out consolidating the roles and activities which the researchers originally suggested. 4) A phase involving the *mobilization* of the allies, during which primary actors assume a spokesperson role for passive network actors (agents) and seek to mobilize them to action. Translation involves negotiations among human actors and representatives of material actants. Negotiations establish common sets of definitions and meanings for understanding the phenomena with which the network is concerned (Callon 1986).

5 PART B: Risk perception and communication

The findings from part A will be compared and contrasted with findings from the "perception" subtask (part B). The study will thus **shed light on overlaps and differences in how experts and non-experts understand and present the integration of microbiology into nuclear waste management, and trace how experts and non-experts alike change their conceptions of the issues at hand. The results will be used as a foundation for the development of a communication approach to be used in order to support informed decision-making of stakeholders.** Two lines of a research will be conducted in parallel and the results will be used as an input for the final design of the communication approach.

The first line (B1) draws on technology assessment (TA) methods and interactive/social learning theory. Following Lave (1993), social learning is stimulated when experts engage with perspectives voiced outside their professional environment (e.g. laboratories, working environment, research networks). We therefore seek to bring together the MIND actors mentioned in part A with (a) informed civil society and (b) lay publics in an interactive workshop. Whereas group (a) is already knowledgeable of radioactive waste management, group (b) consists of individuals who have little to no knowledge of the field. For (a) we will retrieve participants from the MONA and STORA networks[2]; for (b) we will mobilize students at Belgian universities. The aim is not to draw a representative sample of society but to create a rich, interactive learning dynamic that enables participants to learn from one another. This dynamic should elicit:

- An enhanced reflexive awareness among scientists and non-scientists about the opportunities and pitfalls of integrating microbiology into nuclear waste management;
- A joint assessment of the possible value conflicts, risks, safety issues, and uncertainties inherent in designing and implementing nuclear waste management strategies and technologies for the future.

To enhance interaction between participants in ways that draw open these questions, we take inspiration from public value mapping (PVM). This approach assumes that it is possible to identify public values, including ones not well captured by technological and economic constructs; and that innovation can be characterized not only in terms of contributions to technological or economic growth and productivity but also in terms of public values achieved. At the very least, PVM should incite experts to redefine and articulate values with publics; it can also alter R&D and science policymaking by clearly articulating public interests (Valdivia and Guston 2006).

[2] Mols Overleg Nucleair Afval (http://www.monavzw.be) and Studie- en Overleggroep Radioactief Afval in Dessel (http://www.stora.org/nl).

With these intentions in mind, the interactive workshop will be structured as follows:

1. Introduction stage (plenary): Workshop moderator introduces aim and method of workshop and provides participants with information material about MIND and the role of microbiology in nuclear waste disposal[3]

2. Presentation stage (plenary): MIND experts present their research work to participants; social scientists present findings from part A

3. Discussion stage (subgroups of 4-6 participants[4]): Workshop participants jointly consider and debate the following questions:

    a. Which public values and considerations do experts presently take into account when designing and conducting research on microbiology in nuclear waste disposal?

    b. Which public values and considerations are left out and why?

    c. Which public values and considerations deserve more attention and should be taken into account in research programs like MIND?[5]

4. Reporting stage (plenary): Subgroup moderators and/or rapporteurs report main threads of discussions

The outcomes will be drafted in a report, designed to incite further reflection among scientists and experts on which considerations and values demand to be given more attention in the R&D process within and outside MIND, and which sociotechnical futures are worthwhile developing and which ones are undesirable. The report will be disseminated within and beyond the MIND research project, notably to research participants, experts and decision makers not directly implicated in MIND, and education and training professionals. Building on TA and PVM approaches, it will suggest ways of taking into account public values in R&D, notably by targeting strategic research agendas and modulating technology trajectories in real time.

The second line (B2) draws on the psychometric paradigm and cultural theory. These two theories argue that people use cognitive heuristics in sorting and simplifying information, leading to biases in the comprehension of risk. The psychometric paradigm was created by Fischoff, Slovic and Lichtenstein (1978) and later became a leading model in the field of risk perception. The psyhometric paradigm scholars, e.g. literature (Slovic 1987), (Renn 2003), (Havenaar et al. 2003), (Knight and Warland 2005), and (Sjöberg 2000) identified numerous factors responsible for influencing the individual perceptions of risk, including dread, newness, stigma and other factors. In this approach, the patterns of risk perception are measured by using a numerical scaling technique. The measurement expands the factors that influence risk perception beyond the classic components of

[3] This material will be drafted with MIND researchers before the start of the workshop. It contains information about the aim of the project, expected outcomes, and who is involved, as well as information about MIND task 3.2. It will also briefly explain the rationale for the interactive workshop and how its outputs will be disseminated.

[4] If opportune, groups will be categorized along overarching themes, such as responsibility, uncertainty, risk.

[5] In the process, social scientists will observe and assess the interactions between participants. They will pay due attention to additional issues: Which values do participants subject to discussion? Which values and considerations do they take as essential (non-negotiable)? Do participants discern new values and considerations? If so, which ones? One could think for instance of the delegation of agency to non-human actants like microbes.

harm and probabilities of their occurrence and hence it expands the realm of subjective judgment about the nature and magnitude of risk. 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;*
4. *Analyze the cognitive structure of risk judgment, usually employing multivariate statistical procedures such as factor analysis, multidimensional scaling or multiple regression.*

Since the psychometric paradigm appears to be an effective tool for the prediction of risk perception, it has been widely tested empirically and it is still being developed in order to identify the risk attributes or dimensions supposedly underlying people's preferences. This model has been used as a basis for extensive work on risk communication by many scholars for instance, (Fischhoff et al. 1978, Slovic 1987, Sjöberg 2000, Renn 2008). The model is based on a number of explanatory scales corresponding to various risk characteristics, which are an empirically driven explanation of contextual characteristics that individual decision-makers use when assessing and evaluating risks. Some of these scales involve whether the hazard was involuntary or not, whether it was catastrophic, delayed or immediate, whether it was already known to science, and other factors. The psychometric model was shown to explain up to 60% of the variance of perceived risk - very high correlations between the basic scales and risk perception or risk acceptance were reported in different papers.

As a challenge to the psychometric paradigm, "cultural theory" arose. The theory was developed by Douglas and Wildavsky (1982) and was later on integrated into quantitative studies (Wildavsky and Dake 1990, Dake 1992). In this theory, the individual approach to risk evaluation is replaced by a societal approach. The emphasis lies on the structure and functioning of groups in societies, and risk evaluation is placed on the meaningful relationships of either individuals or populations with understanding of the contextual and cultural structures of individuals within social groups. Cultural theory explains why people come to accept or reject environmentalism and why they choose which potential hazards to fear and which to ignore. It proposes that differences in risk perception between groups within society, such as experts and lay people, arise from different social characteristics and patterns of social relations, rather than because one group is inherently more logical or rational than the other. The theory is based on anthropological research and holds that patterns of social relationships are dependent on an individual’s worldview. It refers to the extent to which individuals are bound by feelings of belonging or solidarity. The tighter the bonds, the less individual choice can personally be controlled.

The main criticism against cultural theory is that the model has not been able to explain more than 5% - 10% of the variance of perceived risk (Sjöberg 1999, Sjöberg 2000). However, in a study by Buss and Craik (1983), cultural theory explained 16% of variances in risk perception of nuclear power. In addition, the explained variance of the perceived risk can increase if the elements of cultural theory are integrated into more extensive models.

With these two theories and already validated scales to measure different latent constructs (worldviews and characteristics of a risk) we are going to develop a new scale applicable for the measurement of risk perception of microbiology in geological disposals.

This research line (B2) is empirical and will be conducted by way of an internet survey. The expert population participating in the survey will be the MIND project partners, the representatives of an informed civil society will be members of two local communities with nuclear waste disposal and the participants from the lay public will be students of unrelated studies.

A third line (B3) will analyze all collected results and develop a communication approach to support the stakeholders to make informed decisions related to microbiological aspects of nuclear waste disposal, to establish two-way communication and joint problem solving.

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 considered as a socio-centric communication based on public participation with which the gaps between stakeholders can be bridged (Leiss. A and 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 stakeholders to understand the 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 values into consideration. There are 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 values and emotions associated with risks), it should be ethically justified (ethical deliberation about the values and emotions involved in 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 a shared problem understanding 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 of the program.

Conflict between stakeholders is common when considering options for nuclear waste management, due for instance to diverging risk perceptions (Slovic 1996). Such conflicts are often driven by differences in how the 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. The participative process should lead to effective, democratic, ethical and transparent decisions.

The analysis of the collected results in this task will give an idea of how to develop appropriate communication. A deliberative workshop with experts and communication practitioners will serve as a final stage of the research, where proposed solutions for communication will be discussed and validated.

6 Conclusions

In order to study **the impact of the inclusion of microbiology on expert conceptualization and public perception of geological disposal** SCK•CEN (Society and Policy Support Expert Group) will follow the social science methodology presented in this document. In this respect, MIND partners (researchers actively contributing in MIND, as well as other colleagues within the participating institutes), members of the MIND Implementer Review Board and related institutes and entities outside the MIND consortium, will contribute as interviewees to evaluate expert conceptualization subtleties and risk perception. In addition, MIND partners, through Task 3.1 of this WP, will provide an outline of existing knowledge on microbiology in geological disposal. Other stakeholders (e.g. informed civi society and lay people) will be invited to participate in the research. As a last stage, communication material for microbiology in nuclear waste disposals will be developed and validated by a multidisciplinary group in a special deliberative workshop.

7 Acknowledgments

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9 Appendix 1: Interview protocol

(Guiding questions, subject to change)

Please provide a brief account of your background, training, and expertise.
Please describe your role in the MIND project.
Why is it important to study microbial processes in relation to nuclear waste disposal?
How can microbiology make a contribution to treating radioactive waste?
How will microbes affect the evolution of a repository?
Does taking microbiology into account contribute to a more complete and realistic safety case, as the MIND website suggests? In which ways? Why is this important?
Can the same organisms be applied to other toxic metals? If so, which ones?
What are the biggest challenges you and your colleagues face in this research field?
What is needed to make the MIND project a success?
How will microbes and microbiology change the management of nuclear waste disposal in the years ahead?

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