Deliverable 10.13: UMAN - Understanding of uncertainty management by the various stakeholders

Work Package 10

Uncertainty Management multi-Actor Network (UMAN)

This project has received funding from the European Union's Horizon 2020 research and innovation programme 2014-2018 under grant agreement N°847593.

http://www.ejp-eurad.eu/

Document information

Project Acronym	**EURAD**
Project Title	**European Joint Programme on Radioactive Waste Management**
Project Type	**European Joint Programme (EJP)**
EC grant agreement No.	**847593**
Project starting / end date	**1st June 2019 – 30 May 2024**
Work Package No.	**10**
Work Package Title	**Uncertainty Management multi-Actor Network**
Work Package Acronym	**UMAN**
Deliverable No.	**10.13**
Deliverable Title	**UMAN - Understanding of uncertainty management by the various stakeholders**
Lead Beneficiary	**KIT (TU Clausthal)**
Contractual Delivery Date	**Month 40 (September 2022)**
Actual Delivery Date	**Month 54 (November 2023)**
Type	**Report**
Dissemination level	**PU**
Authors	**Klaus-Jürgen Röhlig (TU Clausthal)**

To be cited as:

Röhlig K-J. (2023): UMAN - Understanding of uncertainty management by the various stakeholders. Final version as of 24.10.2023 of deliverable D10.13 of the HORIZON 2020 project EURAD. EC Grant agreement no: 847593.

Disclaimer

Acknowledgement

This document is a deliverable of the European Joint Programme on Radioactive Waste Management (EURAD). EURAD has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 847593.

Status of deliverable		
	By	Date
Delivered (Lead Beneficiary)	**Klaus-Jürgen Röhlig KIT (TU Clausthal)**	30 May 2021
First review (Task 5 leader)	**Julien Dewoghelaere IRSN (Mutadis)**	28 July 2022
Review by Task 5 participants	**Jean-Noel Dumont (Andra), Valery Detilleux (Bel V), Agnieszka Strusinska-Correia (BGE), Ari Ikonen Posiva (Envirocase), Dirk-Alexander Becker (GRS), Muriel Rocher (IRSN), Niels Henrik Hooge IRSN (NTW), Gabriele Mraz IRSN (NTW), Colin Wales IRSN** (NTW), **Alexander Carter (RWM), Oleksandr Soloviov** (**SSTC-NRS), Ivan Ivanov (TU-Sofia)**	31 October 2022
Second review (Task 5 leader)	**Julien Dewoghelaere IRSN (NTW)**	28 June 2023
Verified (WP Leader)	**Daniela Diaconu (RATEN)**	9 July 2023 / 31 October 2023
Approved (PMO)	**Elisabeth SALAT (IRSN)**	15 September 2023 / 02 November 2023
Submitted to EC (Coordinator)	Andra	02 November 2023

What is UMAN project about?

Decisions associated with Radioactive Waste Management (RWM) programmes are made in the presence of irreducible and reducible uncertainties. Responsibilities and role of each stakeholder, the nature of the RW disposal programme and the stage of its implementation influence the preferences of each category of actors in approaching uncertainty management. EURAD WP UMAN carries out a strategic study about the management of these uncertainties. This study is based on extended exchanges of the experience accumulated in the national RWM programmes by a broad range of stakeholders representing WMOs, TSOs, REs and Civil Society, as well as on a review of knowledge generated by past and on-going R&D projects, and findings of international organisations (such as IAEA, NEA, etc.).

UMAN discusses the classification schemes and approaches applied to the uncertainties management and identifies possible actions to be considered in the treatment of uncertainties. The relevance for safety of the uncertainties associated with site and geosphere, human aspects, spent fuel, waste inventory, spent fuel and near-field, as perceived by each type of the above mentioned stakeholders, and approaches used by these stakeholders to manage these uncertainties are explored via questionnaires, workshops and seminars, with the aim to reach either a common understanding on how uncertainties relate to risk and safety and how to deal with them along a RWM programme implementation, or, when agreement is not achieved, a mutual understanding of each individual view. As result of these activities, UMAN identifies uncertainties assessed as highly significant for safety and associated R&D issues that should be further investigated.

This Work Package (WP) of EURAD includes the following tasks:

- Task 1 - Coordination, interactions with Knowledge Management (KM) WP & integration
- Task 2 - Strategies, approaches, and tools
- Task 3 - Characterization and significance of uncertainties for different categories of actors
- Task 4 - Uncertainty management options and preferences of different actors across the various programme phases
- Task 5 - Interactions between all categories of actors including Civil Society

Interactions between the different tasks and types of actors including civil society are central to this WP. These interactions take place notably through workshops (Task 4) and seminars (Task 5) where the significance of identified uncertainties (Task 3) as well as possible strategies and options to manage them (Tasks 2 and 4) are discussed.

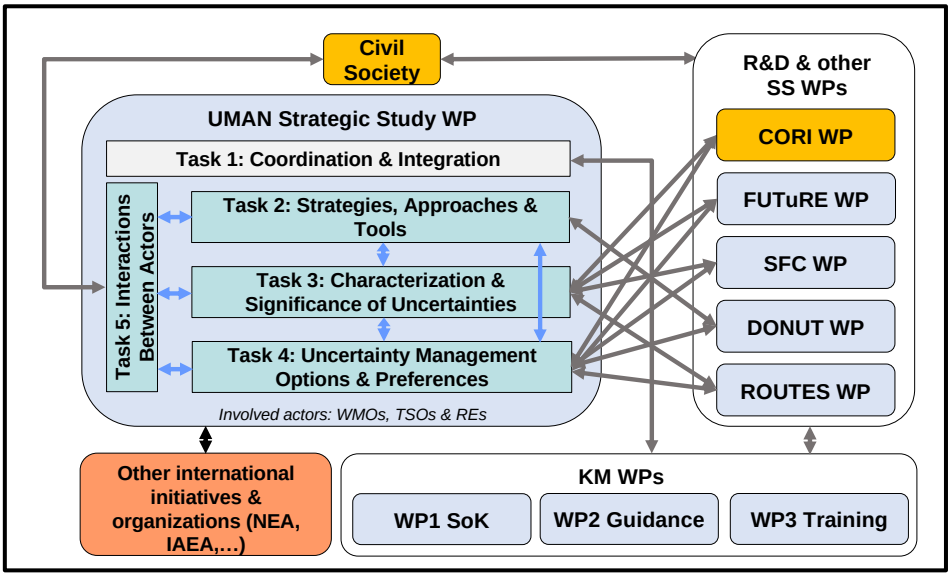


Figure 1 – UMAN WP structure and interactions

Executive Summary

This report provides information about the work carried out in UMAN Task n°5 - Interactions between all categories of actors, including Civil Society in the frame of Subtask 5. 1 – Preparation, support and reporting of pluralistic analyses, topic 1: Meaning for different actors of uncertainty management and of its relationships with risk, safety and the safety case. Various inputs were used for Topic 1 but the central instrument was a seminar held on 26-27 October 2020 ("UMAN seminar 1. What does uncertainty management mean for different types of actors and how is it related to risk, safety and the safety case?"). The report provides a description and interpretation of the seminar.

The general views of WMOs, TSOs, REs, CS representatives, and regulators about **uncertainty types** are rather similar. There are differences, though, with respect to priorities and focus:

Safety relevance is an important aspect for all actors. However, WMOs, regulators, and TSOs are in a position to produce or to review the Safety Case (SC) and therefore to classify particularly technical uncertainties with a holistic view on the repository system, while REs remain rather focused on their area of expertise. To overcome this, long-term engagement of REs in the programme is needed.

More generally, uncertainties related to staff and knowledge management at large are recognised as a challenge. Also, political, financing, security (including cyber security), environmental, and logistical uncertainties require more attention. CS representatives are particularly concerned about these and other "non-technical" uncertainties, including intentional and unintentional Human Intrusion as well as the "unknown unknowns".

In regards with the views of the actors on **uncertainty management,** it was generally agreed that regulatory and TSO research is essential for independent SC reviews. More attention should be paid to managing "unknown knows" (a better term for which might be "ignored knowns"), e.g., by means of establishing appropriate management systems and developing a safety culture. CS representatives stressed that the most important uncertainty is the societal understanding of the system, and that technical and political uncertainties are related and hence should not be separated and see their involvement in an open dialogue discussing uncertainties as a contribution to safety. In the view of CS representatives, reversibility, recoverability, and approaches of rolling stewardship are potential means to manage uncertainties.

The concept of a "safety envelope" as introduced into IAEA's GEOSAF project was discussed in relation to the **evolution of uncertainties**. Addressing issues inside the envelope was seen as a minimal requirement, but the scope, and thus the envelope, will evolve over time, with the aim that finally (e. g. at the licensing stage) the envelope will embrace the real situation and converge with views by different actors.

Generally, it can be concluded that the need for "mitigation" of differences in actors' views on uncertainty management, types, and evolution is seen as rather limited, but an open discourse is essential for each programme. Transparency is paramount, for which appropriate communication tools are needed.

With respect to **CS** interaction, effective implementation of the Aarhus Convention is seen as a key element guaranteeing access to information and participation in the process. An essential question is how to present information to the CS so that it is well perceived and understood. This concerns the level of technical detail provided and the ability of experts to explain the information.

Contents

List of figures

List of Tables

Acronyms

ASN	Autorité de sûreté nucléaire (Nuclear Safety Authority, France)
BASE	Bundesamt für die Sicherheit der nuklearen Entsorgung (Federal Office for the Safety of Nuclear Waste Management, Germany)
BfE	Bundesamt für kerntechnische Entsorgungssicherheit (Federal Office for Nuclear Disposal, Germany, now renamed to Federal Office for the Safety of Nuclear Waste Management BASE)
CS	Civil Society
EURAD	European Joint Programme on Radioactive Waste management
FANC	Federaal Agentschap voor Nucleaire Controle (Federal Agency for Nuclear Control, Belgium. In French : Agence fédérale de Contrôle nucléaire AFCN)
FEP	Features, Events, Processes
FSC	Forum of Stakeholder Confidence
IGSC	Integration Group for the Safety Case
InSOTEC	(International) Socio-Technical Challenges for implementing geological disposal
MS	Milestone
NEA	Nuclear Energy Agency
NGO	Non-governmental organisation(s)
OECD	Organisation for Economic Co-operation and Development
PEP	Pathway Evaluation Process
R&D	Research and development
RE	Research Entity
RWM	Radioactive Waste Management
SA	Safety Assessment
SC	Safety Case
STUK	Säteilyturvakeskus (Radiation and Nuclear Safety Authority, Finland)
TSO	Technical Safety Organisation
UMAN	Uncertainty Management multi-Actor Network
WMO	Waste Management Organisation
WP	Work Package

1. Introduction

This report provides information about the work carried out in UMAN Task n°5 - Interactions between all categories of actors, including Civil Society. According to UMAN's Work Package (WP) description, the objectives of Task n°5 are:

- To develop a common understanding or understanding of the different viewpoints among the different categories of actors on:
  - uncertainty management and how it relates to risk & safety,
  - whether and why a safety case is robust vis-à-vis uncertainties.
- To share knowledge/know-how and discuss common methodological/strategical challenging issues on uncertainty management among a broader group of actors.

More specifically, the report is addressing Subtask 5. 1 – Preparation, support and reporting of pluralistic analyses, Topic 1:

Meaning for different actors of uncertainty management and of its relationships with risk, safety, and the safety case

As foreseen in the WP description, various inputs were used for Topic 1 and, thus, for this report, but the central instrument was a seminar held on 26-27 October 2020 ("UMAN seminar 1. What does uncertainty management mean for different types of actors and how is it related to risk, safety, and the safety case?"). Other inputs were used in the preparation and introductory talks of the seminar. Consequently, the report consists of a description and interpretation of the seminar.

2. Conception and preparation of the seminar

The central idea of the seminar was to bring together and to juxtapose the views of EURAD's four actors' groups, namely:

- Waste Management Organisations (WMO),
- Technical Support Organisations (TSO),
- Research Entities (RE), and
- Civil Society (CS) Representatives.

Early in the preparation phase, it was agreed by the Task 5 team that also regulators should take part in the seminar. This was important when preparing Milestone MS25: Composition of the pluralistic stakeholder group for Seminar 1. "For seminar 1, a participation of around 40 people is envisioned. It includes UMAN Task 5 members, other EURAD members (including CS experts), around 5 members of the CS larger group, some representatives of the regulatory authorities (STUK from Finland, FANC from Belgium, ASN from France, BfE from Germany, a representative from an authority of an Eastern country to be determined)." (Excerpt from the meeting notes of the Task 5 kick-off meeting held on October 10-11, 2019, note that BfE in the meantime has been renamed to BASE).

Initially it was planned to initialise and to facilitate the discussion at the seminar by means of a serious game (an interactive activity combining a "serious" intention - pedagogical, informative, communicative - and playful mechanisms) "Pathway Evaluation Process" (PEP), which consists in an exercise of pluralistic and comparative assessment of alternative scenarios on long-term management of radioactive waste. The approach had been successfully tested at the Task 5 kick-off meeting but later fell victim to the COVID-19 pandemic: The seminar had to be held online and carrying out an online version of PEP was not considered feasible.

A set of inputs for the seminar were identified, namely various UMAN deliverables or draft deliverables (D10.2, D10.5, D10.10) as well as information from relevant recent and ongoing activities: InSOTEC, Modern2020, an ongoing OECD/NEA initiative on safety case communication and uncertainty carried out by the Working Parties IGSC and FSC, various German interdisciplinary / transdisciplinary projects as well as personal experience of the Task 5 participants.

1. Further, representatives of the aforementioned actors' groups were to prepare keynotes as inputs for the seminar. These were later to be reviewed by other UMAN task 5 participants (by categories of actors). At the 2nd Task 5 meeting (31 January 2020) four main topics were agreed upon, after further revisions, they were rearranged into the three topics below: Meaning of Uncertainty Management & Types of Uncertainty,
2. Evolution of uncertainties, and
3. Interactions with Civil Society

The keynotes were then further discussed in working group (breakout) sessions the results of which were finally presented and synthesised. The agenda of the seminar is attached as Appendix A of this document, the Terms of Reference as Appendix B.

3. UMAN seminar 1

3.1 Introductory session

The objectives and methodology of the seminar as outlined in section 2 above were presented by the Task leader. Furthermore, especially for the benefit of the participants coming from outside UMAN, the context, objectives and working methods of the whole UMAN WP were presented. Then, the UMAN WP leader gave an overview of views on uncertainty-related issues in the context of the Safety Case.

3.2 Keynotes

3.2.1 Uncertainty management and types

In the **WMO** presentation on "Uncertainty management and types" a technical view on the disposal system was given by taking the perspective of the overall protection objectives of disposal with a focus on post-closure safety. Inter alia, the following points were stressed:

- The safety case includes all underlying documentation, research, waste records etc. so that all claims around safety can be audited and tested.
- Uncertainty management describes the approach by which a WMO handles this lack of knowledge.
- Uncertainty management is a key aspect in the production of a safety case.

It was stressed that there will always be remaining uncertainties, which is not a problem in itself. However, it is important that the claims made in a safety case are true in the presence of such uncertainties. Therefore, their significance has to be evaluated e. g. by means of "performance metrics" as e. g. risk. As uncertainty types important for WMOs

- Programme uncertainties,
- Societal uncertainties, and
- Safety case uncertainties

were mentioned.

In the **TSO** presentation, the following uncertainty types were named:

- uncertainties associated with the national RW disposal programme & other «prevailing circumstances»,
- uncertainties associated with the quality of input data,
- uncertainties on the future evolution of the disposal system,
- uncertainties associated with the completeness of the FEPs,
- uncertainties associated with the quality of the Safety Assessment (SA).

These categories were juxtaposed with those identified by other international projects and documents. It was stressed that uncertainty management falls in the responsibility of the implementer (i. e. the WMO) but that TSOs must be brought into a position enabling informed reviews. This requires the need for own capacities and capabilities, which might be developed by means of own research and development

(R&D), own assessments and own management systems. In the reviews, TSOs have to follow the requirements made by authorities.

In the **RE** presentation, the distinction of uncertainty types as typical for SA (epistemic versus aleatory, scenario, model, and parameter uncertainties, cf. *Figure 1*) was presented, followed by the recognition that such categorisation is always a question of framing. Taking a wider perspective,

- uncertainties concerning technical feasibility,
- human factors when
  - planning a repository,
  - compiling a Safety Case,
  - constructing, operating, and closing a repository, as well as
- uncertainties concerning organisation and management, e. g.
  - funding uncertainty, staff fluctuation

also need to be considered. Also, distinguishing the availability of information and the question whether the level of available information is used (or otherwise), one can distinguish known unknowns, unknown knowns (i. e. issues in principle known but not taken into account due to lack of awareness or ignorance), and unknown unknowns.

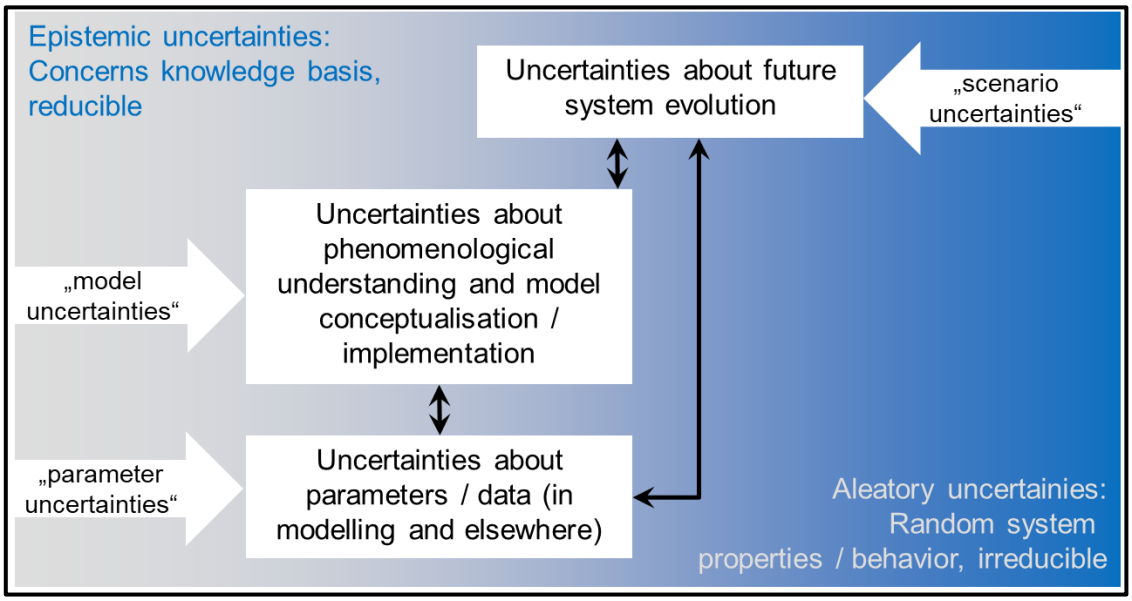


Figure 2 – Uncertainty categorisation typically made in SA, inspired by Galson & Kursheed 2006 [1]

The categorisation was then juxtaposed with the one developed for UMAN Milestone 21 “UMAN Draft D10.5 Views of actors on uncertainties in the safety case” [2] namely:

- Programme uncertainties
- Uncertainties associated with the initial characteristics of the waste, site and engineered components.
- Uncertainties in the evolution of the disposal system and its environment, including the effects of events and processes that may affect the initial characteristics of the disposal facility (e.g., hazards that may occur during construction and operation).
- Uncertainties associated with the data, tools and methods used in the safety case.
- Uncertainties associated with the completeness of the FEPs considered in the safety case.

It was concluded that “scenario”, “model” and “parameter” uncertainties as well as “organisation and management” uncertainties are well covered while uncertainties related to technical feasibility, “unknown (ignored) knowns”, “unknown unknowns”, and human factor are less visible.

Similarly, as in the TSO presentation, it was stressed that uncertainty management is primarily a WMO responsibility. The approach taken by Vigfusson et al. (2007) [3] was reiterated: "Uncertainties need to be carefully identified and tracked and it is recommended that a register of significant uncertainties is required as part of the safety analysis for a disposal system. Once uncertainties have been identified, the question of their further management arises. It is thus also recommended that the developer of the disposal facility should present a clear forward strategy for managing uncertainties.

Developing such a strategy involves asking at least the three following questions for each uncertainty:

- Is the uncertainty important?
- Can the uncertainty be avoided, mitigated, or reduced?
- Can the uncertainty be quantified?"

It was concluded that this approach, however, is focussed on "known unknowns". Unknown (or more precisely: ignored) knowns can be addressed (i.e., taken into account rather than being ignored) by means of appropriate safety culture. For "unknown unknowns", robustness can be a means to address them, but the question arises to what extent it is optimally and cost-effectively appropriate. The question of guiding principles was also asked. E. g. the minimax principle (i. e. optimising for the least favourable case / scenario) leads to the question of how much speculation is appropriate when deriving such a scenario or case. In the **CS** presentation, first the role of CS organisations in EURAD was clarified. Despite not being "active" researchers, they are interested in reaching safe RWM solutions and in contributing.

Parts of the CS presentation take advantage from replies to a questionnaire sent to the CS larger group in May 2020. In response to the question "What important uncertainties do you see in each phase of the RW backend management?" uncertainties were identified in relationship to the programme phase (*Table 1*) as well as to the areas concerned (*Figure 2*). The answers to this question were compiled in an Excel sheet for a later analysis, as described in the document "Uncertainties in Nuclear Waste Management – Views of the Civil Society's Group" presenting preliminary elements for deliverable D10.17 [4].

Table 1 – Summary of replies to Question 1: What important uncertainties do you see in each phase of the RW backend management?

Phase		***Total uncertainties named: 679***
Phase 0	*Policy, framework and program establishment*	*137*
Phase 1	*Site evaluation and site selection*	*133*
Phase 2	*Site characterization*	*109*
Phase 3	*Facility construction*	*94*
Phase 4	*Facility operation and closure*	*104*
Phase 5	*Post closure*	*102*

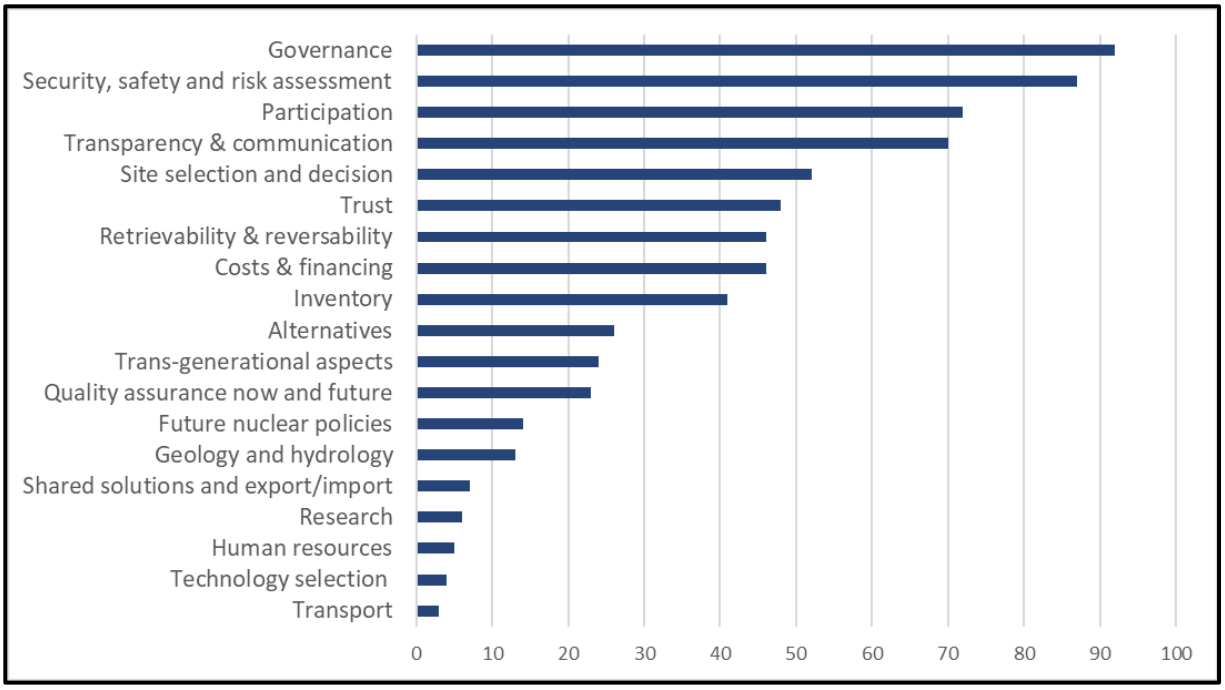


Figure 3 –Distribution of CS answers per types of uncertainties (Questionnaire replies- total answers over all phases)

It was further stressed that possible evolutions of the political and societal context require particular attention. Unknown unknowns should get particular attention but also pose a conceptual problem. Also, residual risks should be accounted for, irrespectively of their perhaps low probability. Lack of Public information and transparency was identified as a cause of uncertainty. Long implementation times were considered an asset for managing uncertainties. Concerns were raised that achieving solutions for waste management might give raise to further nuclear energy use.

Concerning governance issues, it was stressed that independence of the authority and governing bodies is essential. Scepticism was expressed concerning compensation policies as they might decrease awareness concerning safety issues. Evolution over time might require a flexible interpretation of safety standards. Concerns were raised about the impact of political and other non-technical uncertainties.

3.2.2 Evolution of uncertainties

In the **WMO** presentation, strategy options for handling uncertainties over time were mentioned, e. g.

- for programme uncertainties:
  - early full-scale programme experiments, technology transfer from other WMO's,
  - contingency planning,
  - regular two-way engagement with local government, national government, and regulators to gain an early understanding of potential changes and to feedback implications,
  - providing an underpinned range for estimates of the programme cost with the 'uncertainty funnel' linked to key milestones.
- for societal uncertainties:
  - regular two-way engagement with local communities and civil society with mutual respect and trust,
  - metadata policies, knowledge management activities, training plans, investment in younger staff.

It was stressed that programme and societal uncertainties reduce with time as the point of facility closure nears. For managing "Safety Case uncertainties" the following approaches were named:

- demonstrate that the uncertainty is irrelevant (i.e. the uncertainty in a particular process is not important to the safety outcome because it is controlled by other processes),
- look to mitigate or remove the uncertainty (e.g. where a design or concept may be changed),
- address the uncertainty explicitly using probabilistic techniques,
- bound the uncertainty and show that even in the bounding case the safety outcome is acceptable,
- rule out the uncertain process or event, usually on the grounds of very low probability of occurrence, or because other consequences, if the uncertain event would happen, would far outweigh concerns over the facility's performance,
- agree a stylised approach for handling an uncertainty (e.g. the use of internationally agreed reference biosphere models).

In the **TSO**s' presentation, it was stressed that uncertainties evolve in very different ways, dependent on the type they belong to. The approach to manage uncertainties has to be adapted accordingly to the different programme phases and the decisions to be taken. TSO's expectations at the steps at hand are summarised in the European Pilot Study, EPS (2016) [5], while a generalising view on the relationship of uncertainties, safety, licensing decisions and R&D is given by Lemy & Bernier (2013) [6]. Measures for dealing with new uncertainties include:

- the defence in depth principle,
- the implementation of a stepwise and flexible decision-making process where the validity of assumptions made at one phase is verified during subsequent phases through RD&D, characterisation, monitoring and inspection activities,
- the implementation of an experience feedback programme based on construction and operational feedback as well as international experience, and
- the systematic implementation of management system principles.

For science and research, and thus for **REs**, addressing uncertainty and "producing knowledge" can be considered a "core business". Attitudes to their contextualisation in terms of safety relevance vary dependent on the role an RE takes in a disposal programme – REs might be working within the programme either for the implementer (WMO) or for the authority but might also be working outside this implementer-regulator relationship either by performing programme-related and thus application-orientated but "independent", or more general (basic) research. With the proximity to the programme, the focus on safety-relevant issues increases but the scope of research widens when it is performed "farther away" from the programme. Motivations other than safety such as general research interest, science policy, but also funding issues come into play. There might even be cases in which alleged programme relevance is claimed without knowledge about the existing safety or feasibility problems at hand, perhaps in order to increase motivations for funding. This observation goes along with the finding from UMAN's milestone MS 24[1] [7]:

"Overall understanding of this very complex repository system is at hand only for very few experts if any."

"*Too often in national programmes, research entities are only involved in developing of process understanding while process coupling in the overall analysis of a repository site and in scenario development is left to engineers of WMOs or TSOs. A stronger involvement of RE in scenario development and safety analysis would allow to identify overlooked interdependencies and other shortcomings. This requires of course that RE are willing to commit in long term engagement."*

[1] This document is a draft version of the UMAN deliverable 10.10 which has been delivered during the redaction of this document. In the References appendix, the deliverable 10.10 will thus replace the milestone MS 24.

In the RE presentation, these observations were complemented by stating that they might sometimes be true even for specialists working for WMOs and TSOs. As mentioned above, such "lack of inclusion" sometimes might lead scientists to address issues not so relevant for disposal, (while claiming that they are relevant), and asking for funding. Another important issue is that such inclusion (or lack thereof) is not only a question of "willing", but also of "being able to". The latter needs sustainable funding.

In the **CS** presentation, the questionnaire results (cf. above) were mapped to both phase of programme evolution and area concerned (*Figure 3*).

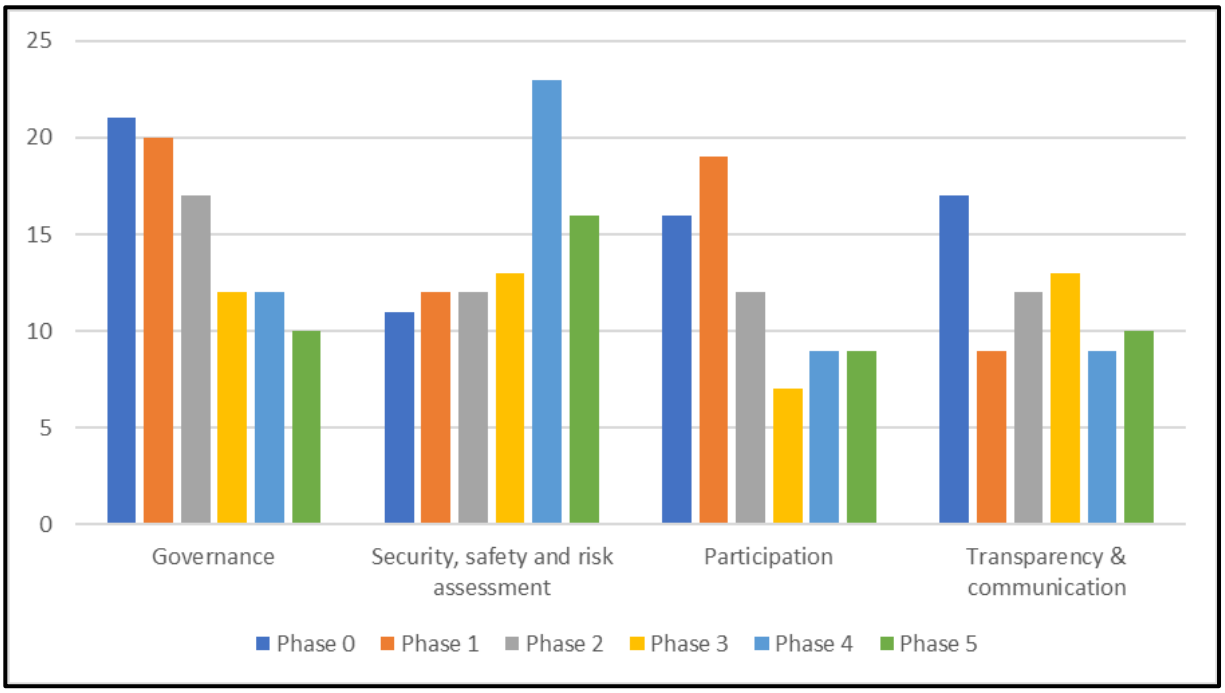


Figure 4 – Questionnaire replies: Uncertainties mapped to programme phases and areas concerned

In the presentation concerns were raised particularly

- with respect to the investigation of programme alternatives in order to address uncertainties in the process itself,
- with respect to retrievability, recoverability and related knowledge transfer.

Given that apparently the next EURAD phase will not focus on the post-closure phase, it was stated: "It is uncertain if taking the post-closure phase out of the main EURAD focus will ensure the necessary research on questions like how to reach a common understanding if future generations should be warned about the DGR and, if yes, how they can be informed."

Furthermore, the precautionary principle as guidance for decision-making and the idea of rolling stewardship for RWM were advocated.

3.2.3 Interactions with CS

For **WMO**s, CS is a key stakeholder to RWMOs as they implement geological disposal, including:

- Local communities near to the disposal facility,
- Communities on waste shipping or transport routes,
- Special interest groups (e.g., environmental groups, energy groups, nuclear groups, unions), and
- Learned societies.

Regular discussion and information exchange as well as addressing potential community benefits are crucial. Stakeholders might provide input on technical and infrastructure issues. Potential difficulties in the interaction are seen in:

- the common interpretation that 'uncertainty (incomplete knowledge)' necessarily equals 'insufficient knowledge',
- the difference between 'demonstrating future safety' and 'predicting the future',
- lack of trust (due to perceived lack of transparency, secrecy, past nuclear incidents),
- the complexity of the science of the overall system,
- the magnitude of the pre-closure timescales being considered (communication across multiple generations),
- the magnitude of the post-closure timescales being considered, and
- views about the possibility that future science will deliver an alternate solution ('why now?').

The presentation concluded with considerations about the potential impact of the pandemic on risk perception and on the need to act given the existence of the waste.

In the **TSO** presentation, various issues affecting credibility of, and trust in, actors were identified including the general lack of trust in institutions and negative experiences, which can be addressed by strengthening the dialogue with CS.

A further complicating issue is the complexity of the Safety Case and the Safety Assessment. Concerns expressed by CS actors include fears about disruptive alternative evolution scenarios, the significance of which is hard to assess. A more concrete definition of uncertainties e.g. based on their nature rather than on the way they are treated in the SC might be helpful for communication in that respect. This should become part of a continuous dialogue, if possible in the context of local partnerships, about the objectives of the SC at hand, the key uncertainties and strategies for their management. Involvement of pluralistic expert groups in SC review and a thorough documentation are considered important. More international exchange of knowledge and experience about CS involvement should be aimed at.

According to the **RE** presentation, trust of CS actors in RE or in scientists in general depends on their role in the programme: Vicinity to actors, especially implementers, might decrease trust, perceived or real "independence" of scientists is seen as an asset, although the concept of independence is not well-defined.

Often, concerns expressed by CS actors relate to "unknown unknowns", including those related to human intrusion issues and to uncertainties about phenomenological understanding and model conceptualisation and implementation. Sometimes, such concerns amount to serious doubts about the validity of the SC as such. Probably, this relates to the (mis-)conception that a SC aims at predicting the future. Risk aversion seems common amongst SC actors. All these points are related to post-closure safety, but especially local stakeholders might also be concerned about issues such as transport, conditioning, operation, and environmental impact.

For **CS** representatives, the request for transparency in the governance on decision-making in RWM is not only an aim in itself but is seen as a way to improve safety. Transparency and public participation are essential elements of environment-related decision-making according to the Aarhus Convention, the Espoo Convention on Environmental Impact Assessment in a Transboundary Context, the Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment, and the Directive 2014/52/EU on the assessment of the effects of certain public and private projects on the environment.

In UMAN draft deliverable D10.5, it was observed: *"No principal differences were observed comparing the point of views of TSO, WMO and RE both on key uncertainties and on their evolution in the various phases of the repository program. In the same way, actors from less advanced and more advanced national programmes share rather similar views on the uncertainties of the safety case. Coherent and complementary views were as well observed when interpreting the discrepancy between the rather*

promising results of quantitative safety analyses and the sentiment of uncertainty prevailing in the larger public." In the CS presentation, this view was described as "binary" and a change of perspective was suggested: *"Our suggestion is to shift the focus on this binary categorization of the public versus the scientific community to a broad and inclusive discussion on transparency and public participation."*

Further, the institutionalised model for transparency and public participation in the decision-making on RWM in Denmark as well as the approach taken in Sweden with the NGO Office for Nuclear Waste Review were described as examples for a possible way forward.

Finally, it was stated in the draft deliverable D10.5 that uncertainties also lie in the issue of transparency and public participation in itself. *"A guidance for providing better quality information on uncertainties in the EIA- and SEA-reports would be a helpful result of the EURAD project. There is a need to broaden up the scope of EURAD: Transparency of uncertainties is strongly linked to uncertainties of transparency - you cannot have one without the other. […] Different countries have different transparency regimes. Especially difficult is the situation in Eastern European countries. Focus should also be put on missing transparency from private companies engaged in RWM – they should also be subject to the relevant legislation and international Conventions. EURAD may recommend standards for a transparency regime as one outcome of the project."*

3.3 Working group results

Working groups discussed the issues addressed in the keynotes in consecutive sessions. For each of the issues, a set of questions was prepared in advance for consideration by the working groups. Since no written summaries of the working group sessions were produced, the summary slides of each working group as presented at the seminar are provided in Appendix C.. Some of the groups discussed and presented the issues question by question, in these cases empty slides indicate that a question was not addressed.

4. Summary: Main lessons and messages

Hereinafter, a synthesis of the points made in the keynotes and in the working group sessions compiled by the topic leader and author of this report in collaboration with the leader of UMAN task 5 is given.

The general views of WMOs, TSOs, REs, CS representatives, and regulators about **uncertainty types** are rather similar. There are differences, though, with respect to priorities and focus:

Safety relevance is an issue for all actors. However, WMOs, regulators, and TSOs are in a position to produce or to review the Safety Case (SC) and therefore to classify particularly technical uncertainties with a holistic view on the repository system. They acknowledge the existence of other, e. g. programme-related, uncertainties but seem to see them as "outside the SC scope". A notable exception is an example from Belgium in which programme uncertainties are addressed in the SC using a specific approach.

As already recognised in EURAD MS 24[2], specialists e. g. at REs do not always take a holistic view on the repository system but remain focused on their area of expertise. To overcome this, long-term engagement of REs in the programme is needed. This, in turn, requires continuous funding. More generally, uncertainties related to staff and knowledge management at large are recognised as a challenge. Also, political, financing, security (including cyber security), environmental, and logistical uncertainties require more attention.

CS representatives are particularly concerned about these and other "non-technical" uncertainties, including intentional and unintentional Human Intrusion as well as about "unknown unknowns".

[2] This document is a draft version of the UMAN deliverable 10.10 which has been delivered during the redaction of this document. In the References appendix, the deliverable 10.10 will thus replace the milestone MS 24.

According to their roles, and perhaps linked to biases caused by these roles, different actors take different views on **uncertainty management** and develop different degrees of "risk appetite". It was generally agreed that regulatory and TSO research (to be carried out independently from the one performed on behalf of WMOs) is essential for independent SC reviews.

More attention should be paid to managing "unknowns knows" (a better term for which might be "ignored knowns"), e.g. by means of establishing appropriate management systems and developing a safety culture. Also, given that there are ways and methods of addressing technical uncertainties, other uncertainties require more attention. CS representatives in particular stressed that the most important uncertainty is the societal understanding of the system, and that technical and political uncertainties are related and hence should not be separated. CS representatives see their involvement in an open dialogue on these and other matters as a contribution to safety.

It appears that there are shared views about uncertainties on knowledge management, on storage and transfer of data over generation, as a part of societal uncertainties.

In the view of CS representatives, reversibility, recoverability, and approaches of rolling stewardship are potential means to manage uncertainties. The precautionary principle is seen as an important approach for managing uncertainties. However, this might lead to aiming at a minimax principle of optimising against the worst possible scenario(s), which was considered problematic by some participants, as it is not clear how such scenarios can be defined and to which extent such definition is open to speculation.

The concept of a "safety envelope" as introduced into IAEA's GEOSAF project (https://www.iaea.org/topics/disposal/international-project-on-demonstrating-the-safety-of-geological-disposal) was discussed in relation to the **evolution of uncertainties**. Addressing issues inside the envelope was seen as a minimal requirement, but the scope, and thus the envelope, will evolve over time, with the aim that finally (e. g. at the licensing stage) the envelope will embrace the real situation and converge with views by different actors (*Figure 4*).

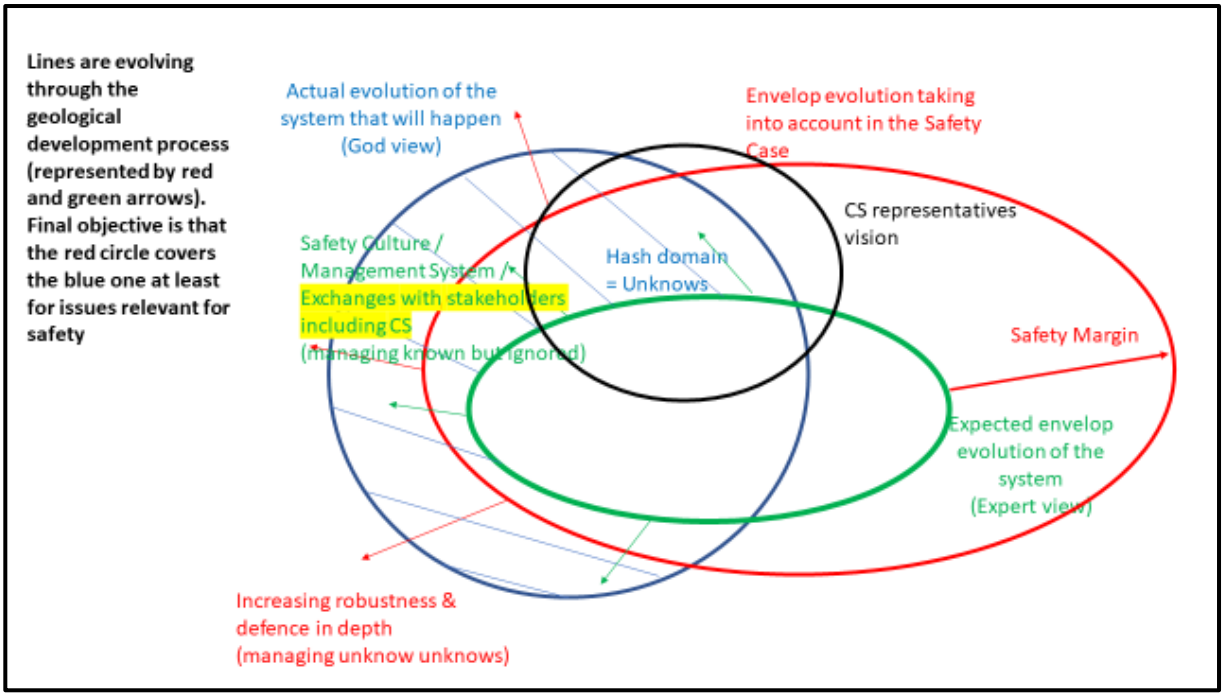


Figure 5 – Vision on the evolution of the safety envelope in relationship to actors' views and issues at stake as discussed at the seminar

Generally, it can be concluded that the need for "mitigation" of differences in actors' views on uncertainty management, types, and evolution is seen as rather limited, but an open discourse is essential for each programme. Transparency is paramount, for which appropriate communication tools are needed. In the seminar, the Visualization of System Information (VISI) as developed by the UK WMO was discussed as a potential means for ensuring traceability of the SC content.

With respect to **CS** interaction, effective implementation of the Aarhus Convention is seen as a key element guaranteeing access to information and participation in the process. An essential question is how to present information to the CS so that it is well perceived and understood. This concerns the level of technical detail provided and the ability of experts to explain the information. Three questions potentially guiding the approach were identified:

1. Are the presented facts well-based?
2. What is the social and normative context behind the statement?
3. What is the agenda of the actor making it?

Funding for independent expertise, including for the CS, is needed, but the limited availability of experts is a concern.

It is the responsibility of the CS to challenge other actors, not necessarily in order to reach a consensus. Debates in themselves have a value to improve the safety level. For such debates, there is a need for institutionalised ways of communication and for establishing boundary roles for the actors. It is however not always straight-forward to identify the "appropriate" CS representatives to interact with. The concept of "independence" of expertise was questioned in the seminar, it is probably better to aim at a "plurality" of expertise. Transdisciplinary research can be valuable to bring different types of expertise together to better achieve a holistic view and to ensure that important aspects are taken into account.

References

1. Galson D.A. & Khursheed A. (2006) The Treatment of Uncertainty in Performance Assessment and Safety Case Development: State-Of-The-Art Overview. PAMINA Milestone M1.2.1, http://www.ip-pamina.eu/downloads/pamina.m1.2.1.pdf
2. Grambow B. (2023): UMAN - Uncertainties relevant to the safety case. Deliverable D10.5 of the HORIZON 2020 project EURAD. EC Grant agreement no: 847593
3. Vigfusson J., Maudoux J., Raimbault P., Röhlig K.-J., Smith R.E. (2007) European Pilot Study on The Regulatory Review of the Safety Case for Geological Disposal of Radioactive Waste Case. Study: Uncertainties and their Management
4. Dewoghélaëre J., Hériard-Dubreuil G., Hooge N-H, Mraz G., Rey H. (2020) Preliminary elements for deliverable D10.17 – Synthetic mapping of the stakes related to WP UMAN outcomes from a civil society point of view. (available in the appendix of D10.17)
5. EPS (2016) Report on the European Pilot Study on the Regulatory Review of a Safety Case for Geological Disposal of Radioactive Waste. Final version 16/08/2016, http://www.belv.be/images/pdf/Report_on_the_European_Pilot_Study_on_the_Regulatory_Review_of_a_Safety_Case_for_Geological_Disposal_of_Radioactive_Waste.pdf
6. Lemy F. & Bernier F. (2013) Regulatory expectations regarding the safety case: moving from conceptualisation to implementation. In: Proceedings of EURADWASTE 2013, 8th EC Conference on the Management of Radioactive Waste Community Policy and Research on Disposal; 2013. p. 167-170, https://op.europa.eu/de/publication-detail/-/publication/2331f509-eee6-4051-849a-ea6463b38ccc/language-en
7. Göbel A., Wengler W., Strusińska-Correia A., Müller-Hoeppe N., Mikšová J., Vojtechová H. (2020): Analysis and description of groups of different actors. Final version as of 07.03.2022 of deliverable D10.10 of the HORIZON 2020 project EURAD. EC Grant agreement no: 847593.

Appendix A. UMAN Seminar 1: Agenda

WP 10-UMAN

UMAN seminar 1

What does uncertainty management means for different types of actors and how it is related to risk, safety and the safety case?

Agenda

26-27 October 2020
ZOOM meeting : https://us02web.zoom.us/j/8384914149

This Seminar is organized by Mutadis with the support of a team of experts from the task 5 of the UMAN WP

The seminar 1 will address the meaning for different actors of uncertainty management and of its relationships with risk, safety and the safety case. It will be the opportunity to discuss the results of the different UMAN tasks (Task 2.1 and Task 3.1).

First Day - 26 October 2020

Introductory session

13:00 **Welcome of participants, presentation of the seminar n°1 team and rules of the remote meeting** – Julien Dewoghelaere (UMAN Task 5 leader), Mutadis, France & Frank Lemy (UMAN WP leader), Bel V, Belgium

13:10 **UMAN pluralistic seminars: objectives and methodology** – Julien Dewoghelaere (UMAN Task 5 leader)

13:25 **Uncertainty, safety case and strategies for managing uncertainty** – Frank Lemy (UMAN WP leader)

13:45 Discussion

14:00 10 minutes break

Plenary session: presentation of views of actors

14:10 **Meaning of Uncertainty Management & Types of Uncertainty (15 minutes per actor)**

- for Waste Management Organisations: Alexander Carter, RWM, United Kingdom
- for Technical Support Organisations: Muriel Rocher, IRSN, France
- for Research Entities: Klaus Röhlig, TU Clausthal, Germany
- for Civil Society: Gilles Hériard-Dubreuil, Mutadis, CS experts' team, France

1

15:10 Questions and answers (elements of clarification)

15:25 10 minutes break

15:35 **Evolution of uncertainties (10 minutes per actor)**

- for Waste Management Organisations: Alexander Carter, RWM, United Kingdom
- for Technical Support Organisations: Muriel Rocher, IRSN, France
- for Research Entities: Klaus Röhlig, TU Clausthal, Germany
- for Civil Society: Gabriele Mraz, NTW, CS experts' team, Austria

16:15 Questions and answers (elements of clarification)

16:30 **Interactions with Civil Society (10 minutes per actor)**

- for Waste Management Organisations: Alexander Carter, RWM, United Kingdom
- for Technical Support Organisations: Muriel Rocher, IRSN, France
- for Research Entities: Klaus Röhlig, TU Clausthal, Germany
- for Civil Society: Niels Henrik Hooge, NTW, CS experts' team, Denmark

17:10 Questions and answers (elements of clarification)

17:25 **Conclusive remarks** – Frank Lemy (UMAN WP leader), Bel V, Belgium

17:30 End of the first day

2

Second Day - 27 October 2020

Working Groups sessions

During this session, the participants will be split in 4 Working Groups with a moderator and a rapporteur coming from the UMAN team. Each working group will be composed pluralistically (representatives of different types of actors).

WG n°1:
Moderator: Klaus Röhlig, TU Clausthal (Research Entities)
Rapporteur: Nadja Železnik, EIMV (Technical Support Organisation)

WG n°2:
Moderator: Muriel Rocher, IRSN (Technical Support Organisation),
Rapporteur: Gilles Heriard-Dubreuil, Mutadis (Civil Society expert)

WG n°3:
Moderator: Alexander Carter, RWM (Waste Management Organisation),
Rapporteur: Frank Lemy, Bel V (Technical Support Organisation)

WG n°4:
Moderator: Julien Dewoghelaere, Mutadis (Civil Society expert)
Rapporteur: Valery Detilleux, Bel V (Technical Support Organisation)

4 working group sessions will be held in parallel to discuss the different views of actors presented during the First Day. The results of the discussions will be used to develop the deliverable of UMAN task 5 *D10.13: UMAN - Understanding of uncertainty management by the various stakeholders.*

9:00 **Welcome of participants and description of the working group sessions** – Julien Dewoghelaere (UMAN task 5 leader)

Parallel working group sessions – 4 working groups

9:10 **Working group session on meaning of Uncertainty Management (topic 1)**

9:55 **Working group session on types of uncertainty (topic 2)**

10:40 05 minutes Break

10:45 **Working group session on Evolution of uncertainties (topic 3)**

11:30 **Working group session on Interaction with Civil Society (topic 4)**

12:15' Lunch Break

3

Plenary session

14:00 Working groups results presentations (15 minutes per group)

The rapporteurs of each working group will present a synthesis of the results of the discussions to be held during the parallel working group sessions.

15:00 15 minutes Break

15:15 Synthesis Discussion

All the participants will have the opportunity to comment and discuss the results of the discussions.

16:00 **Conclusive remarks** – Frank Lemy (UMAN WP leader), Bel V, Belgium

16:10 End of the Second Day

4

Appendix B. UMAN Seminar 1: Terms of Reference

Terms of reference
UMAN Seminars

In order to ensure fruitful discussions in mutual respect, it was suggested to elaborate terms of reference that will be agreed by all the participants in the UMAN Task 5 seminars. These terms of reference establish a set of prerequisites to attend the seminar, notably based on elements of the procedure for establishing the group of CS representatives involved in EURAD that have been validated by the EURAD PMO and Bureau.

1- The participants in the UMAN seminar will have to support the EURAD vision hereunder and commit to contribute constructively to the exchanges that will take place in EURAD, respecting the goals of EURAD described hereunder:

EURAD vision:

"A step change in European collaboration towards safe radioactive waste management (RWM), including disposal, through the development of a robust and sustained science, technology and knowledge management programme that supports timely implementation of RWM activities and serves to foster mutual understanding and trust between Joint Programme participants"

EURAD goals:

- "Support Member-States in developing and implementing their national RD&D programmes for the safe long-term management of their full range of different types of radioactive waste through participation in the RWM Joint Programme;
- Develop and consolidate existing knowledge for the safe start of operation of the first geological disposal facilities for spent fuel, high-level waste, and other long-lived radioactive waste, and supporting optimization linked with the stepwise implementation of geological disposal;
- Enhance knowledge management and transfer between organisations, Member States and generations."

2- The participants in the UMAN seminar recognize that the objective of the seminar is to foster a common understanding or understanding of the different viewpoints among the different categories of actors on the management of uncertainties associated with the management of radioactive waste and how it relates to safety.

3- It is not intended to reach a consensus. Rather, the discussions during the seminar will seek to allow for a nuanced understanding of the issues at stake and a better understanding of the arguments of the various participants, without prejudice to their position with regard to a particular option.

4- The seminar will promote the clarification of the implicit elements leading each actor to establish his choices and preferences, while creating a climate of mutual listening and respect for the views of each participant. The discussion will be based on a freedom of expression of views. The plurality of categories of participants, or at least a plurality of views, experiences and professional profiles, is therefore desirable to foster an in-depth discussion that takes into account a wide range of issues.

5- The animation of the seminar will require pluralistic and transparent governance, i.e the organisation of the seminar and the facilitation of the discussions will be done by a pluralistic team gathering representatives of different categories of actors (WMO, TSO, RE and CS).

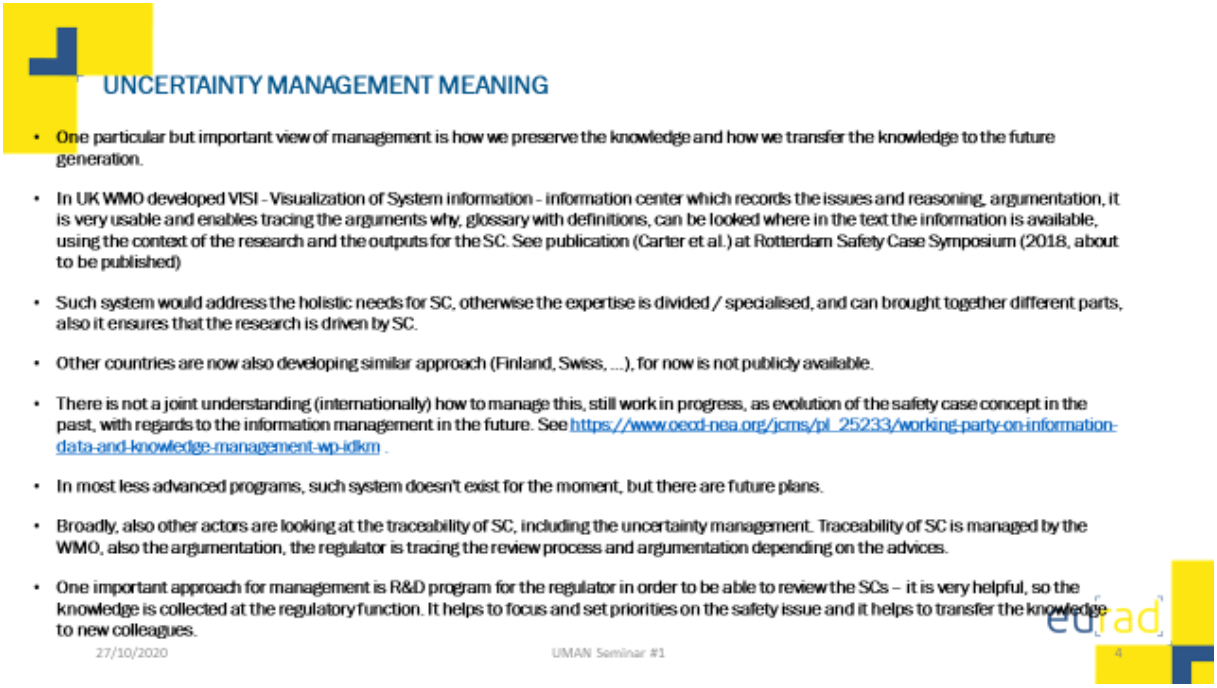
Appendix C. Working Group Results

1. Uncertainty management

1.1 Questions

1. Regarding uncertainty management and based on your own views and experiences, what are the main elements important for you as WMO, TSO, RE, CS or Regulators?
2. Based on the presentations and your personal views and experiences, what are the commonalities between the different types of actors? What are the differences?
3. Do you see a need, and, if so, ways to mitigate these differences?

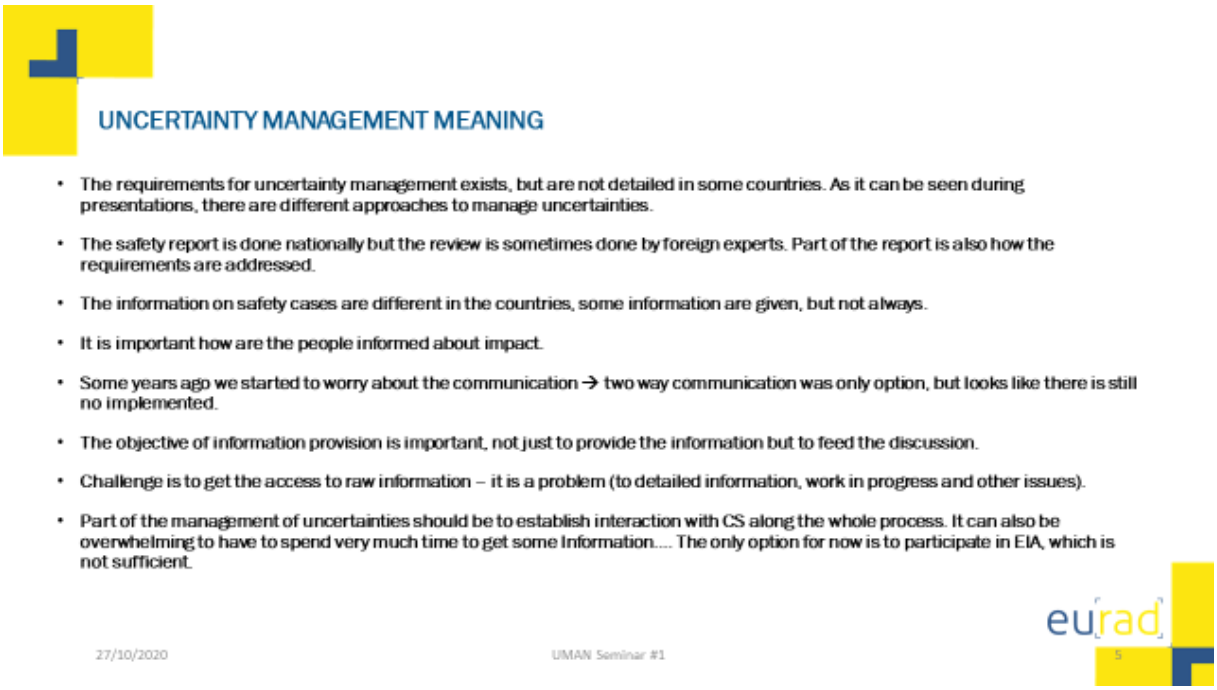
1.2 Working Group 1



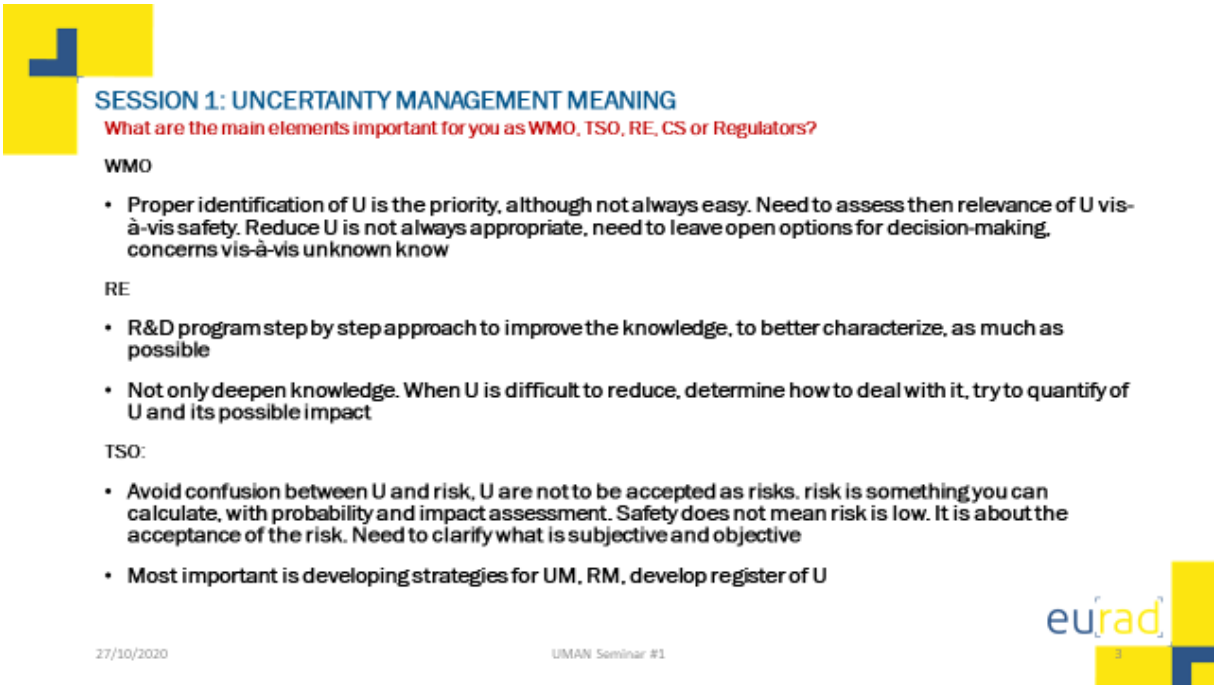
UNCERTAINTY MANAGEMENT MEANING

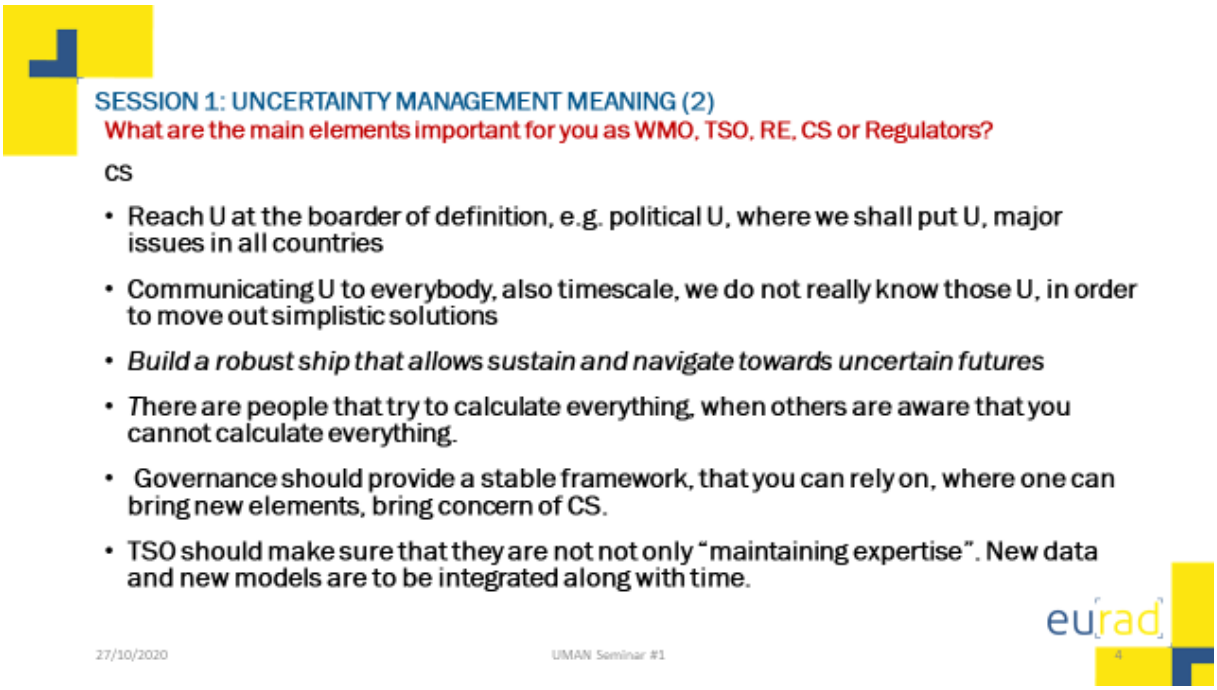
- One particular but important view of management is how we preserve the knowledge and how we transfer the knowledge to the future generation.
- In UK WMO developed VISI - Visualization of System information - information center which records the issues and reasoning, argumentation, it is very usable and enables tracing the arguments why, glossary with definitions, can be looked where in the text the information is available, using the context of the research and the outputs for the SC. See publication (Carter et al.) at Rotterdam Safety Case Symposium (2018, about to be published)
- Such system would address the holistic needs for SC, otherwise the expertise is divided / specialised, and can brought together different parts, also it ensures that the research is driven by SC.
- Other countries are now also developing similar approach (Finland, Swiss, ...), for now is not publicly available.
- There is not a joint understanding (internationally) how to manage this, still work in progress, as evolution of the safety case concept in the past, with regards to the information management in the future. See https://www.oecd-nea.org/jcms/pl_25233/working-party-on-information-data-and-knowledge-management-wp-idkm .
- In most less advanced programs, such system doesn't exist for the moment, but there are future plans.
- Broadly, also other actors are looking at the traceability of SC, including the uncertainty management. Traceability of SC is managed by the WMO, also the argumentation, the regulator is tracing the review process and argumentation depending on the advices.
- One important approach for management is R&D program for the regulator in order to be able to review the SCs – it is very helpful, so the knowledge is collected at the regulatory function. It helps to focus and set priorities on the safety issue and it helps to transfer the knowledge to new colleagues.

27/10/2020 UMAN Seminar #1 4



1.3 Working Group 2





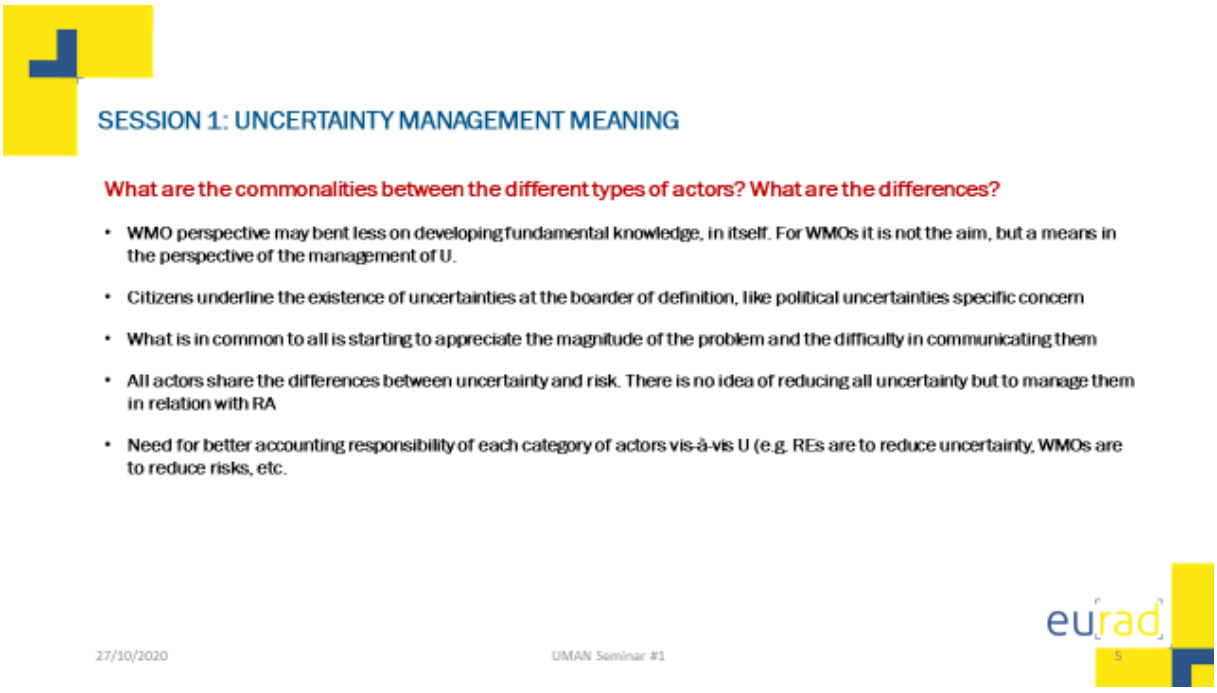
SESSION 1: UNCERTAINTY MANAGEMENT MEANING (2)

What are the main elements important for you as WMO, TSO, RE, CS or Regulators?

CS

- Reach U at the boarder of definition, e.g. political U, where we shall put U, major issues in all countries
- Communicating U to everybody, also timescale, we do not really know those U, in order to move out simplistic solutions
- *Build a robust ship that allows sustain and navigate towards uncertain futures*
- There are people that try to calculate everything, when others are aware that you cannot calculate everything.
- Governance should provide a stable framework, that you can rely on, where one can bring new elements, bring concern of CS.
- TSO should make sure that they are not not only "maintaining expertise". New data and new models are to be integrated along with time.

27/10/2020 UMAN Seminar #1 4

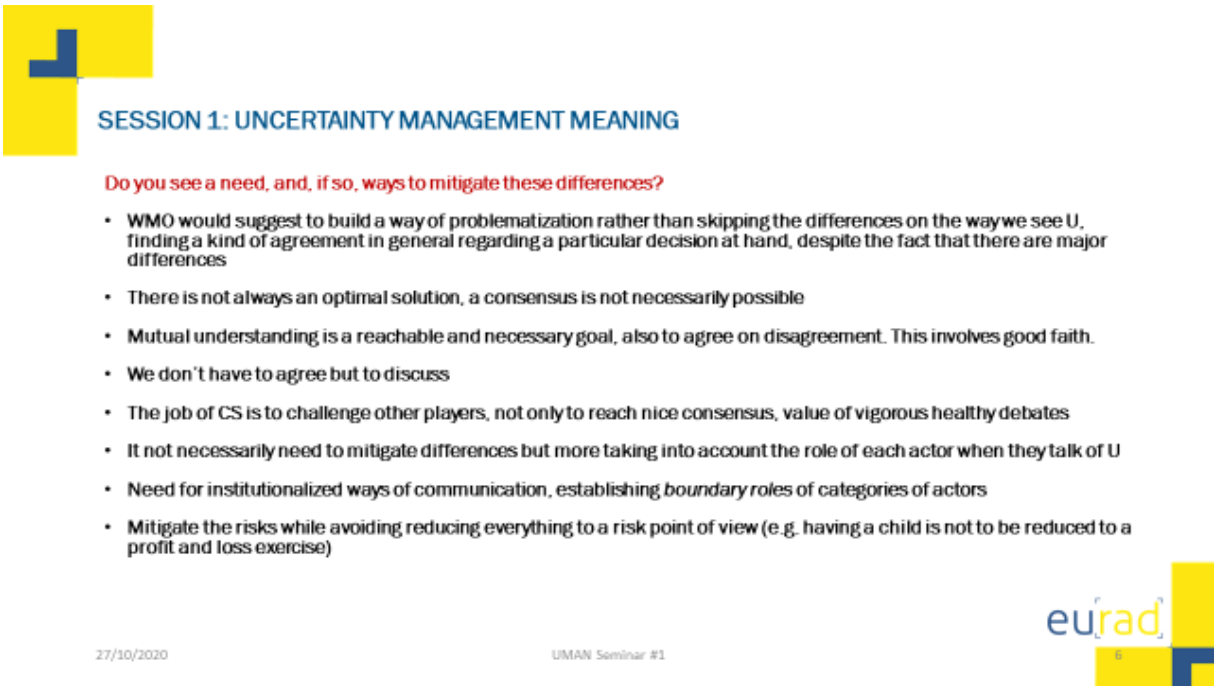


SESSION 1: UNCERTAINTY MANAGEMENT MEANING

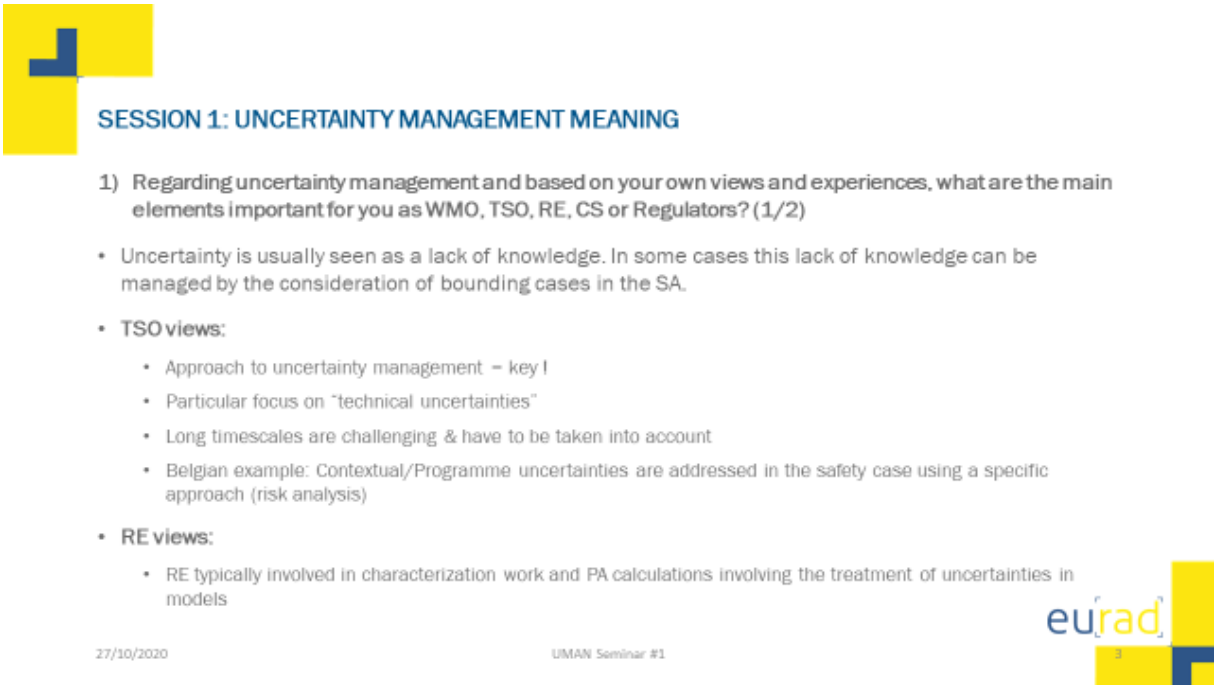
What are the commonalities between the different types of actors? What are the differences?

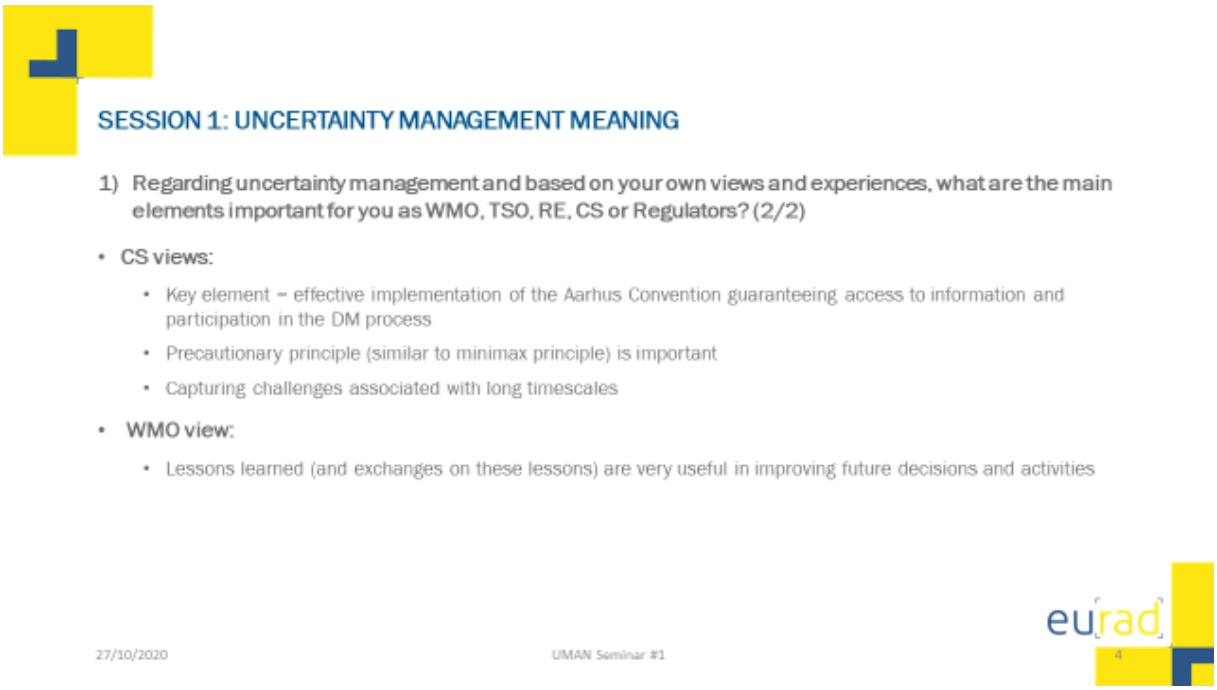
- WMO perspective may bent less on developing fundamental knowledge, in itself. For WMOs it is not the aim, but a means in the perspective of the management of U.
- Citizens underline the existence of uncertainties at the boarder of definition, like political uncertainties specific concern
- What is in common to all is starting to appreciate the magnitude of the problem and the difficulty in communicating them
- All actors share the differences between uncertainty and risk. There is no idea of reducing all uncertainty but to manage them in relation with RA
- Need for better accounting responsibility of each category of actors vis-à-vis U (e.g. REs are to reduce uncertainty, WMOs are to reduce risks, etc.

27/10/2020 UMAN Seminar #1 5



1.4 Working Group 3



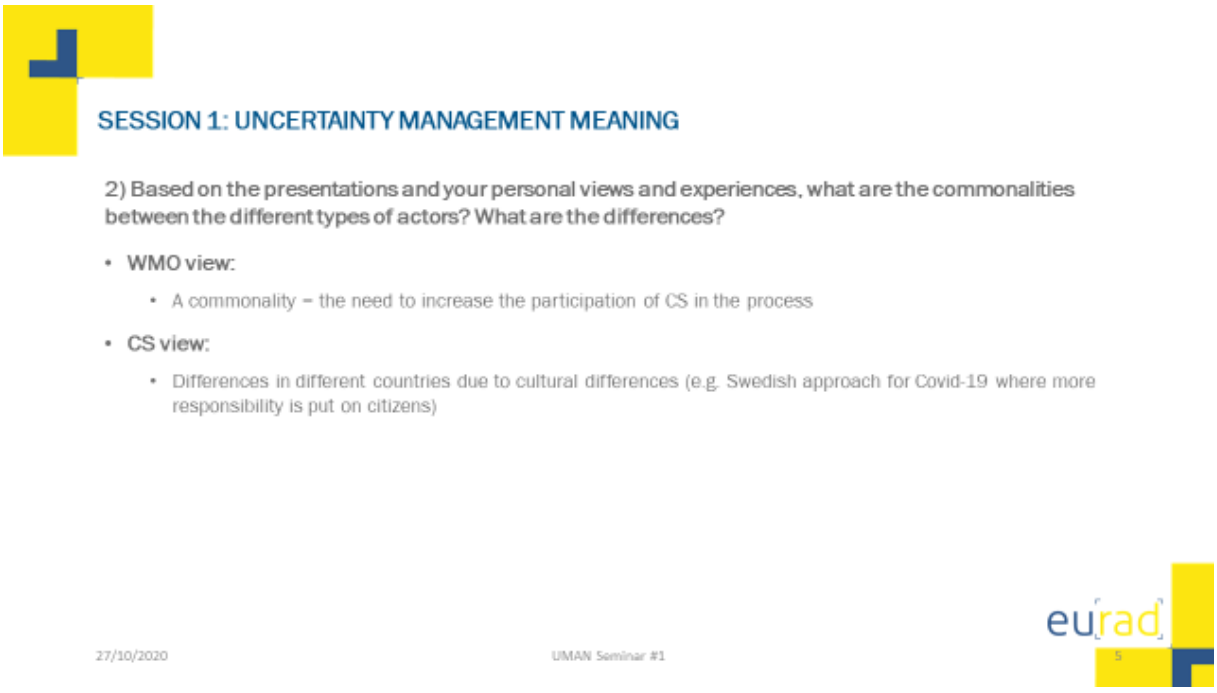


SESSION 1: UNCERTAINTY MANAGEMENT MEANING

1) Regarding uncertainty management and based on your own views and experiences, what are the main elements important for you as WMO, TSO, RE, CS or Regulators? (2/2)

- CS views:
  - Key element – effective implementation of the Aarhus Convention guaranteeing access to information and participation in the DM process
  - Precautionary principle (similar to minimax principle) is important
  - Capturing challenges associated with long timescales
- WMO view:
  - Lessons learned (and exchanges on these lessons) are very useful in improving future decisions and activities

27/10/2020 UMAN Seminar #1 4

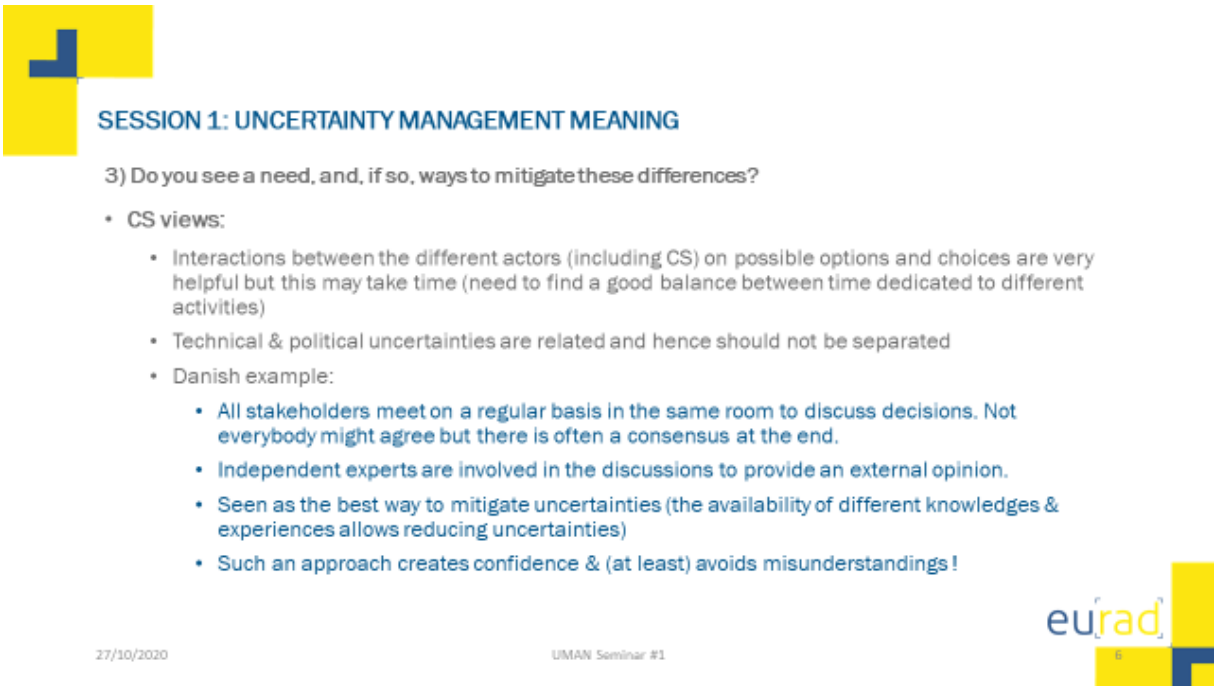


SESSION 1: UNCERTAINTY MANAGEMENT MEANING

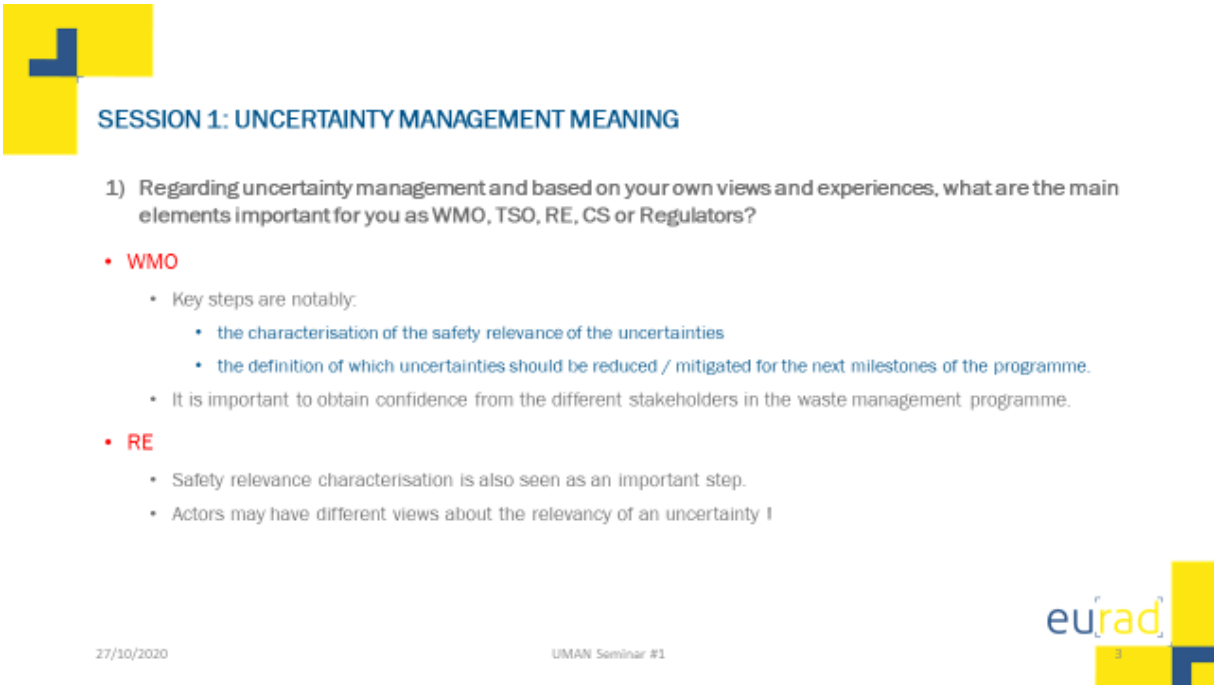
2) Based on the presentations and your personal views and experiences, what are the commonalities between the different types of actors? What are the differences?

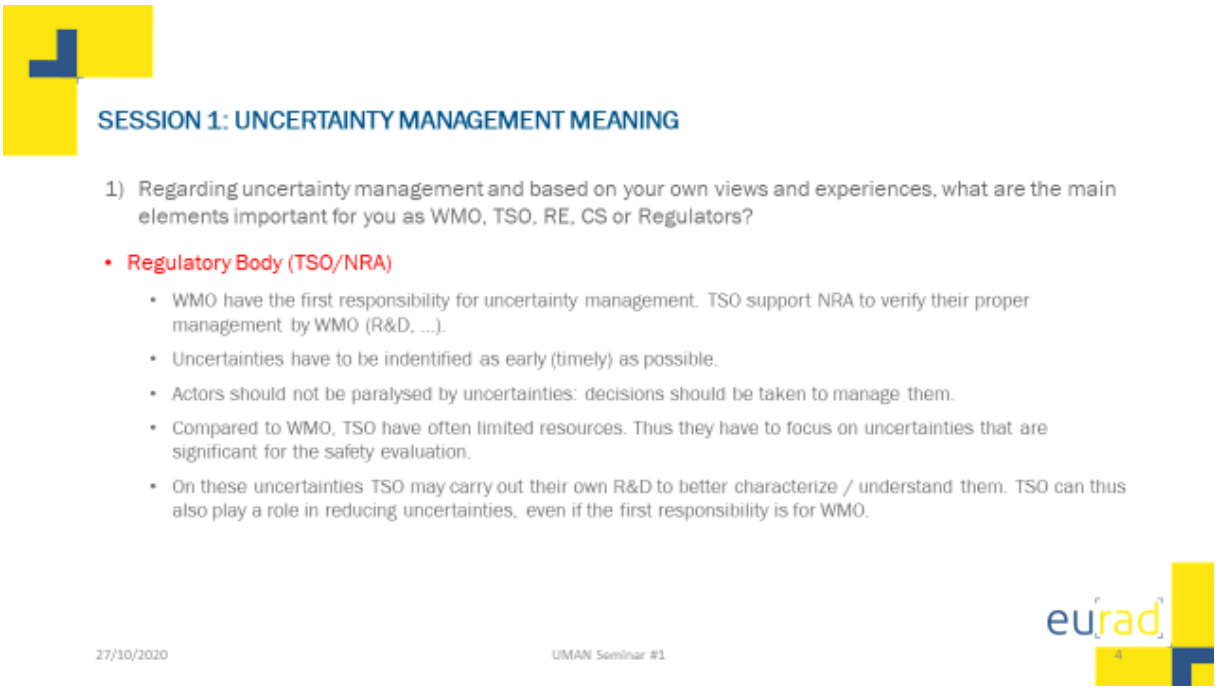
- WMO view:
  - A commonality – the need to increase the participation of CS in the process
- CS view:
  - Differences in different countries due to cultural differences (e.g. Swedish approach for Covid-19 where more responsibility is put on citizens)

27/10/2020 UMAN Seminar #1 5



1.5 Working Group 4



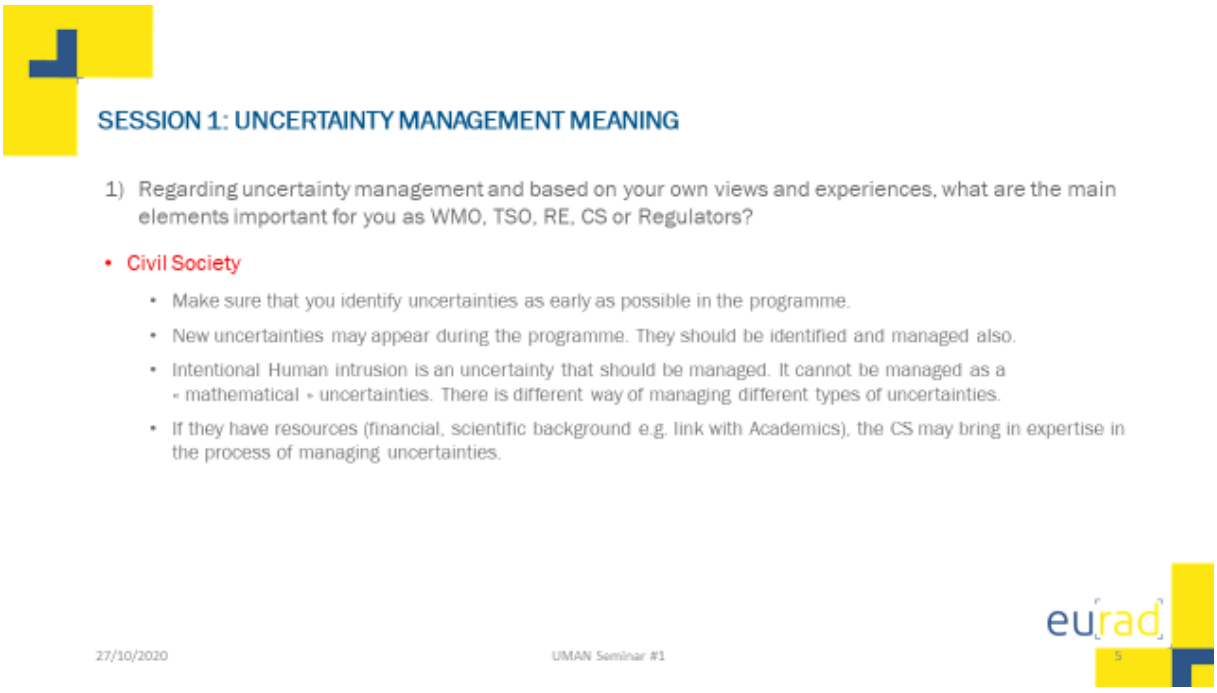


SESSION 1: UNCERTAINTY MANAGEMENT MEANING

1) Regarding uncertainty management and based on your own views and experiences, what are the main elements important for you as WMO, TSO, RE, CS or Regulators?

- Regulatory Body (TSO/NRA)
  - WMO have the first responsibility for uncertainty management. TSO support NRA to verify their proper management by WMO (R&D, ...).
  - Uncertainties have to be indentified as early (timely) as possible.
  - Actors should not be paralysed by uncertainties: decisions should be taken to manage them.
  - Compared to WMO, TSO have often limited resources. Thus they have to focus on uncertainties that are significant for the safety evaluation.
  - On these uncertainties TSO may carry out their own R&D to better characterize / understand them. TSO can thus also play a role in reducing uncertainties, even if the first responsibility is for WMO.

27/10/2020 UMAN Seminar #1 4

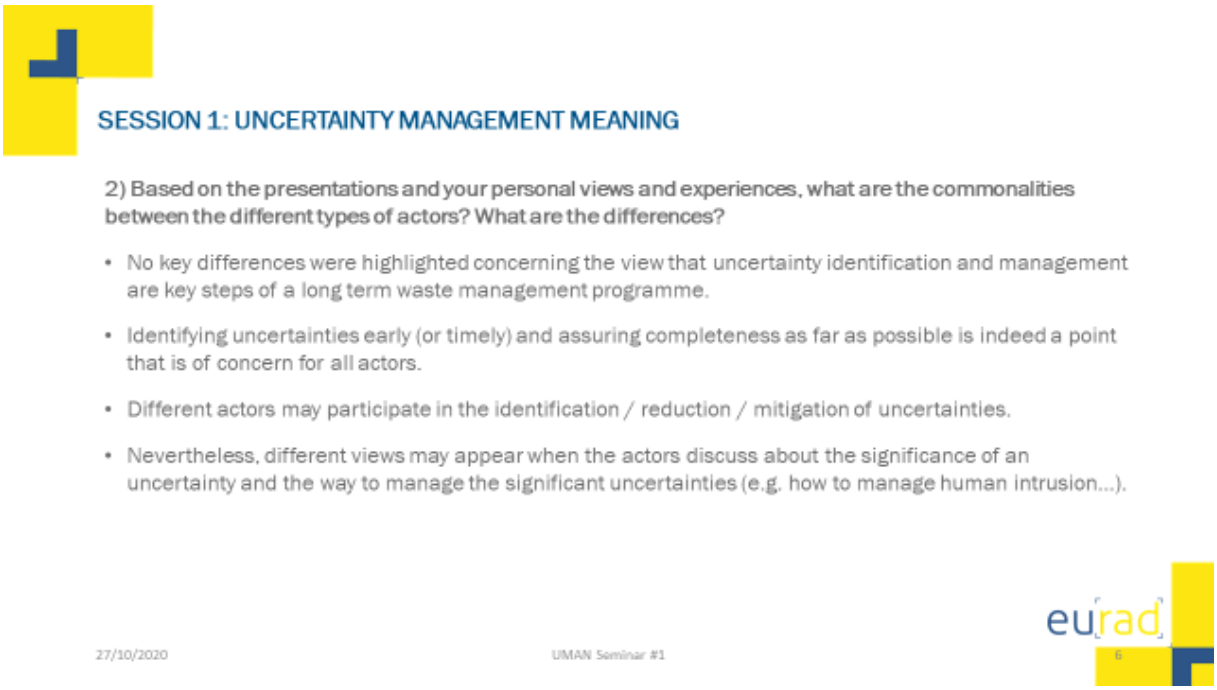


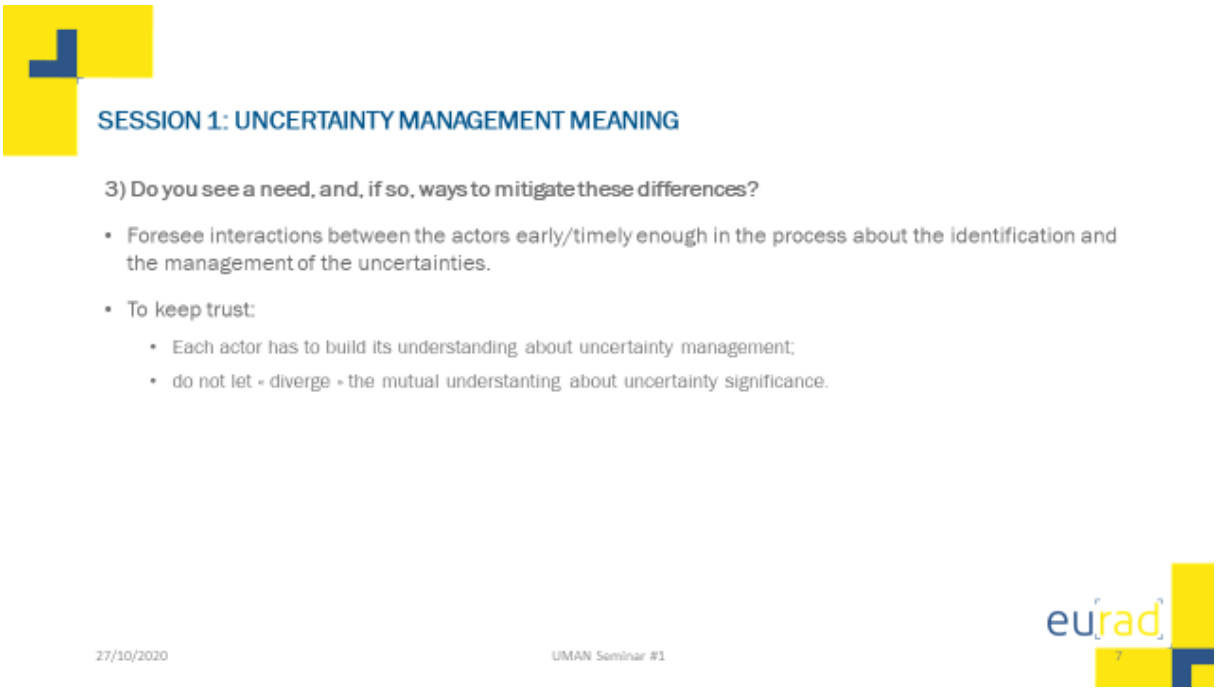
SESSION 1: UNCERTAINTY MANAGEMENT MEANING

1) Regarding uncertainty management and based on your own views and experiences, what are the main elements important for you as WMO, TSO, RE, CS or Regulators?

- Civil Society
  - Make sure that you identify uncertainties as early as possible in the programme.
  - New uncertainties may appear during the programme. They should be identified and managed also.
  - Intentional Human intrusion is an uncertainty that should be managed. It cannot be managed as a « mathematical » uncertainties. There is different way of managing different types of uncertainties.
  - If they have resources (financial, scientific background e.g. link with Academics), the CS may bring in expertise in the process of managing uncertainties.

27/10/2020 UMAN Seminar #1 5



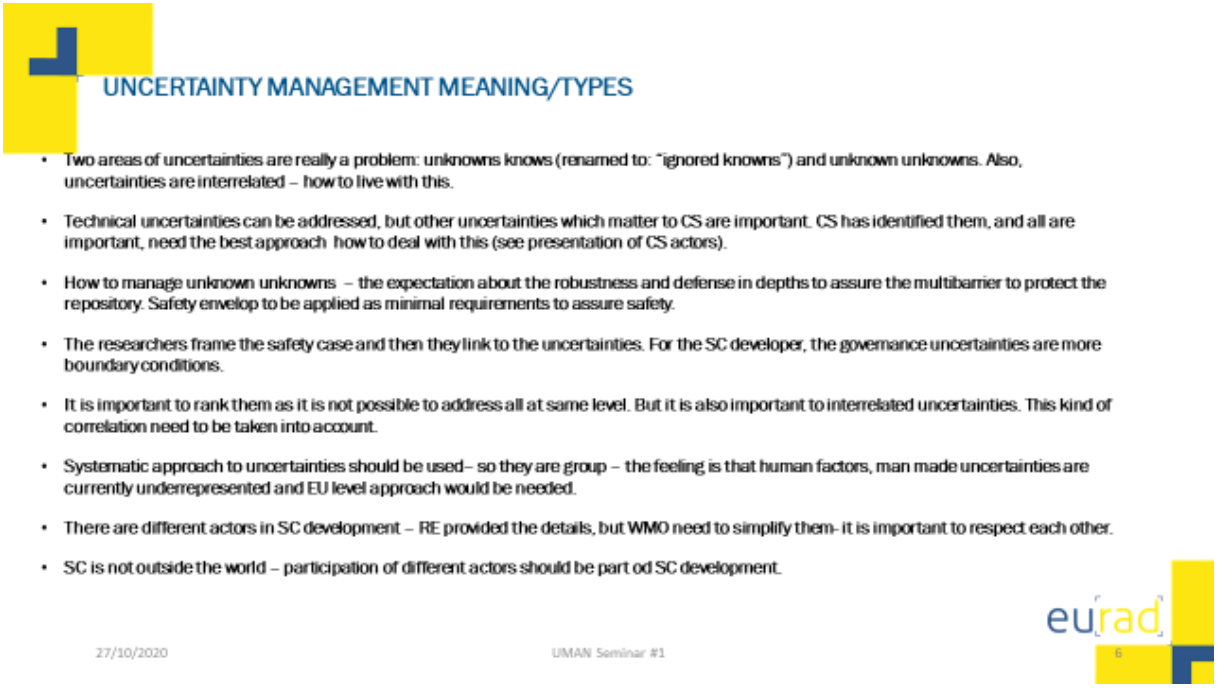


2. Types of uncertainty

2.1 Questions

1. Regarding types of uncertainty and based on your own views and experiences, what are the main elements important for you as WMO, TSO, RE, CS or Regulators? In particular: Which types of uncertainties are most important for you?
2. Based on the presentations and your personal views and experiences, what are the commonalities between the different types of actors? What are the differences?
3. Do you see a need, and, if so, ways to mitigate these differences?

2.2 Working Group 1

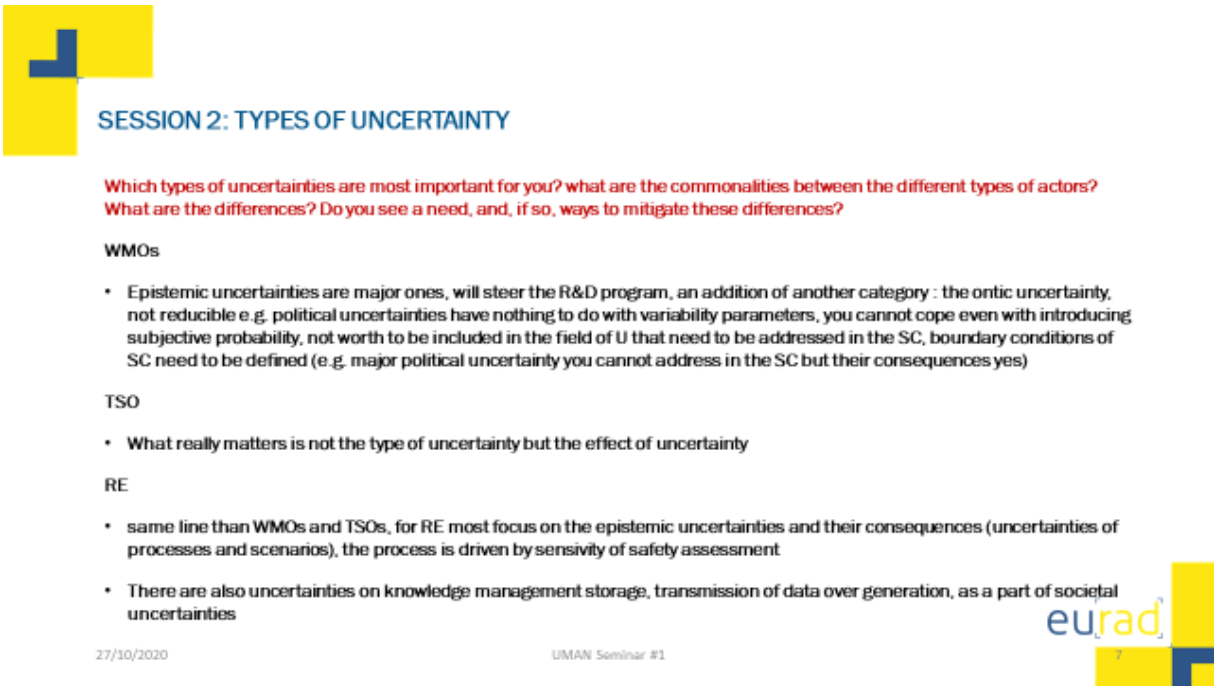


UNCERTAINTY MANAGEMENT MEANING/TYPES

- Two areas of uncertainties are really a problem: unknowns knows (renamed to: "ignored knowns") and unknown unknowns. Also, uncertainties are interrelated – how to live with this.
- Technical uncertainties can be addressed, but other uncertainties which matter to CS are important. CS has identified them, and all are important, need the best approach how to deal with this (see presentation of CS actors).
- How to manage unknown unknowns – the expectation about the robustness and defense in depths to assure the multibarrier to protect the repository. Safety envelop to be applied as minimal requirements to assure safety.
- The researchers frame the safety case and then they link to the uncertainties. For the SC developer, the governance uncertainties are more boundary conditions.
- It is important to rank them as it is not possible to address all at same level. But it is also important to interrelated uncertainties. This kind of correlation need to be taken into account.
- Systematic approach to uncertainties should be used– so they are group – the feeling is that human factors, man made uncertainties are currently underrepresented and EU level approach would be needed.
- There are different actors in SC development – RE provided the details, but WMO need to simplify them- it is important to respect each other.
- SC is not outside the world – participation of different actors should be part od SC development.

27/10/2020 UMAN Seminar #1 6

2.3 Working Group 2



SESSION 2: TYPES OF UNCERTAINTY

Which types of uncertainties are most important for you? what are the commonalities between the different types of actors? What are the differences? Do you see a need, and, if so, ways to mitigate these differences?

WMOs

- Epistemic uncertainties are major ones, will steer the R&D program, an addition of another category : the ontic uncertainty, not reducible e.g. political uncertainties have nothing to do with variability parameters, you cannot cope even with introducing subjective probability, not worth to be included in the field of U that need to be addressed in the SC, boundary conditions of SC need to be defined (e.g. major political uncertainty you cannot address in the SC but their consequences yes)

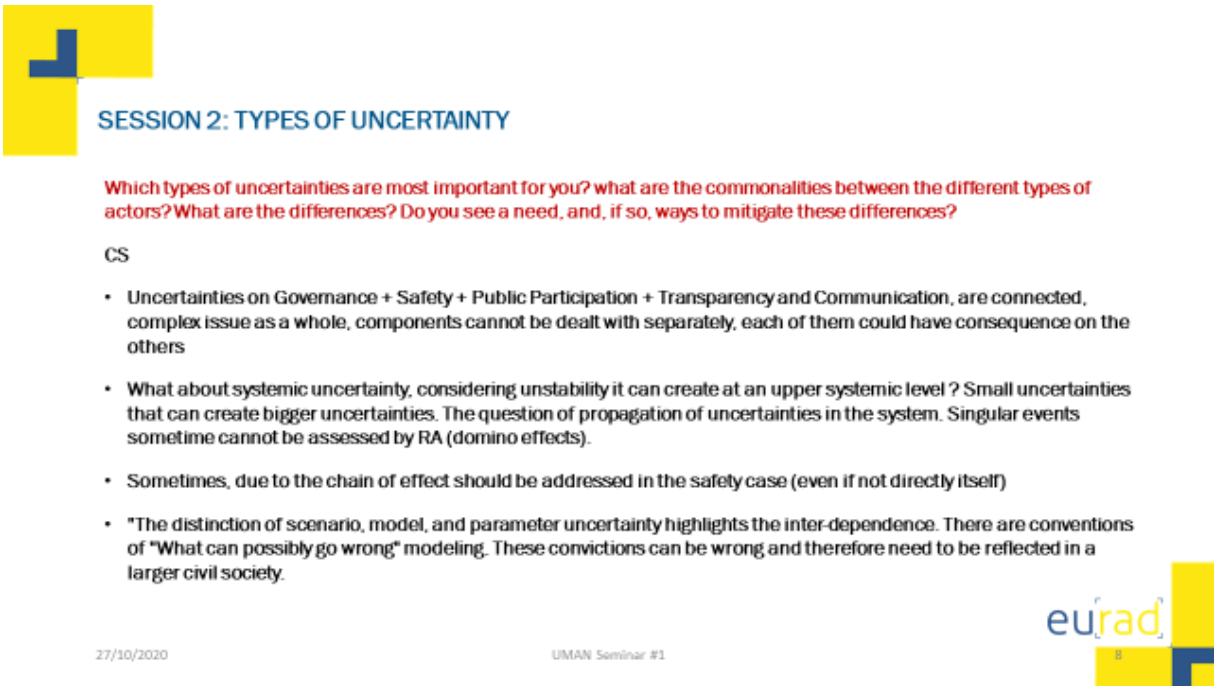
TSO

- What really matters is not the type of uncertainty but the effect of uncertainty

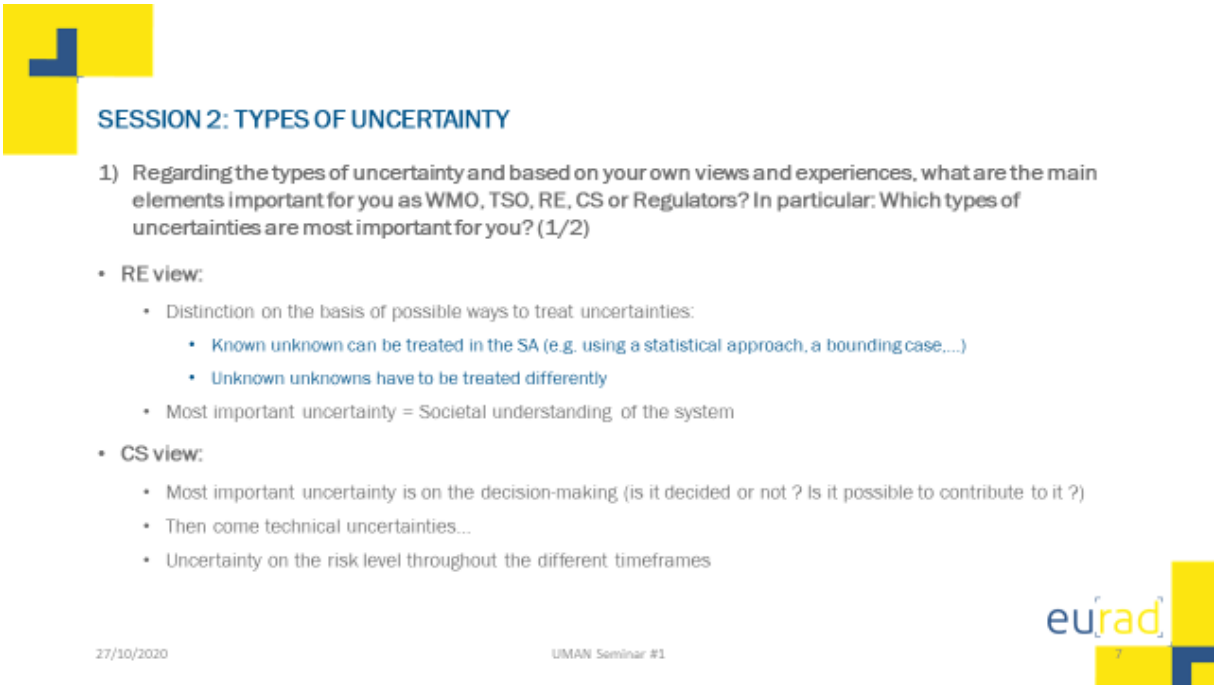
RE

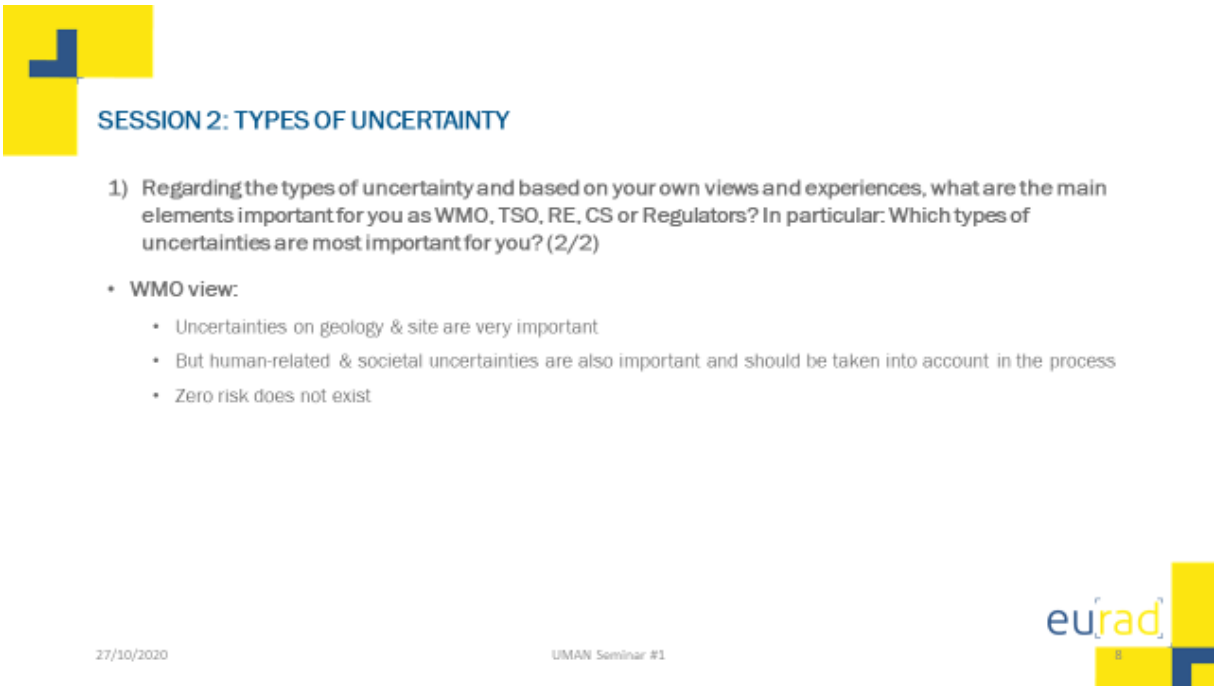
- same line than WMOs and TSOs, for RE most focus on the epistemic uncertainties and their consequences (uncertainties of processes and scenarios), the process is driven by sensivity of safety assessment
- There are also uncertainties on knowledge management storage, transmission of data over generation, as a part of societal uncertainties

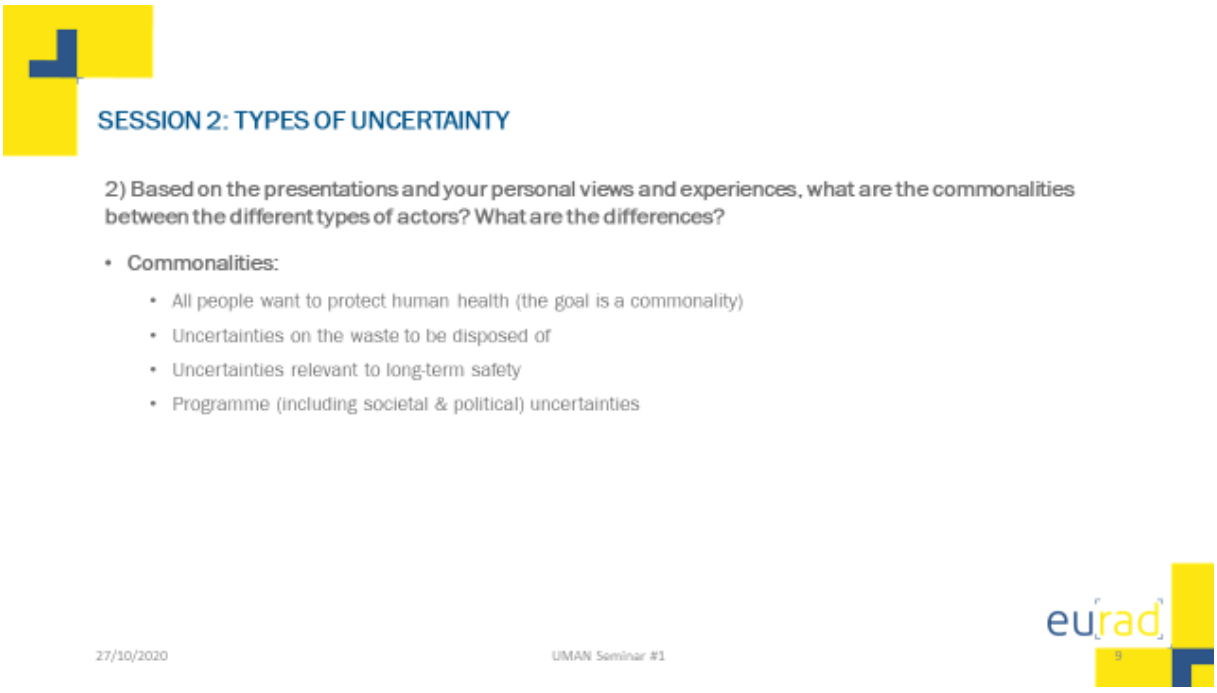
27/10/2020 UMAN Seminar #1 7

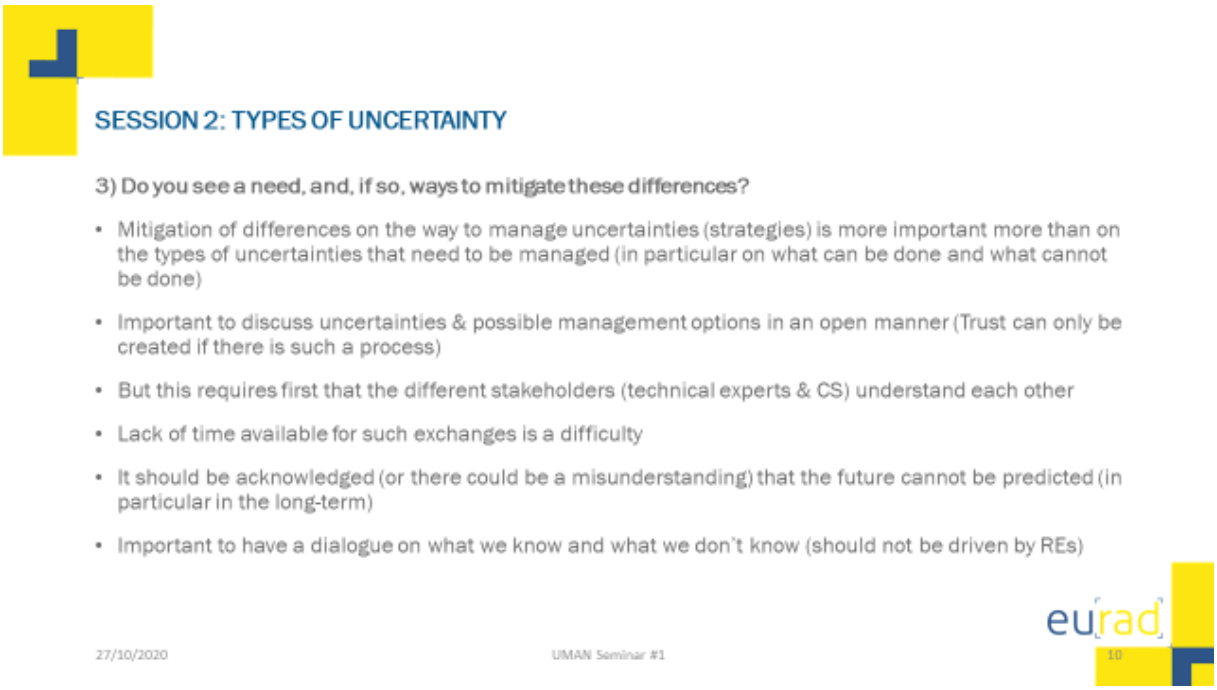


2.4 Working Group 3

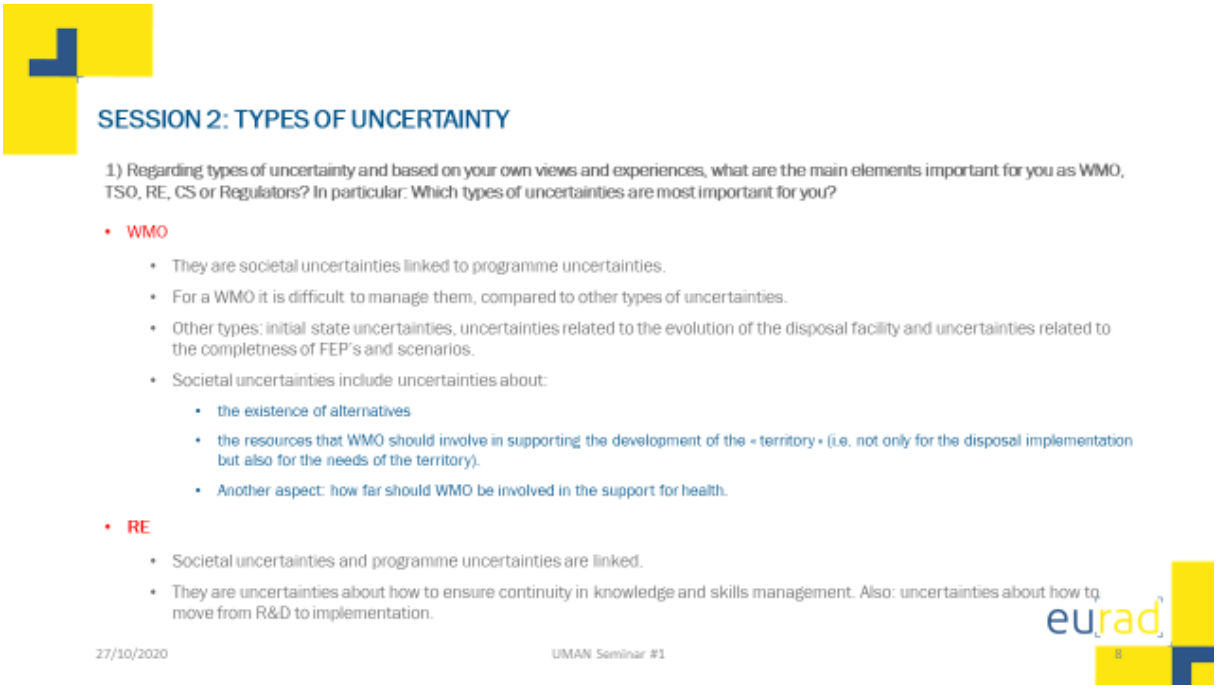


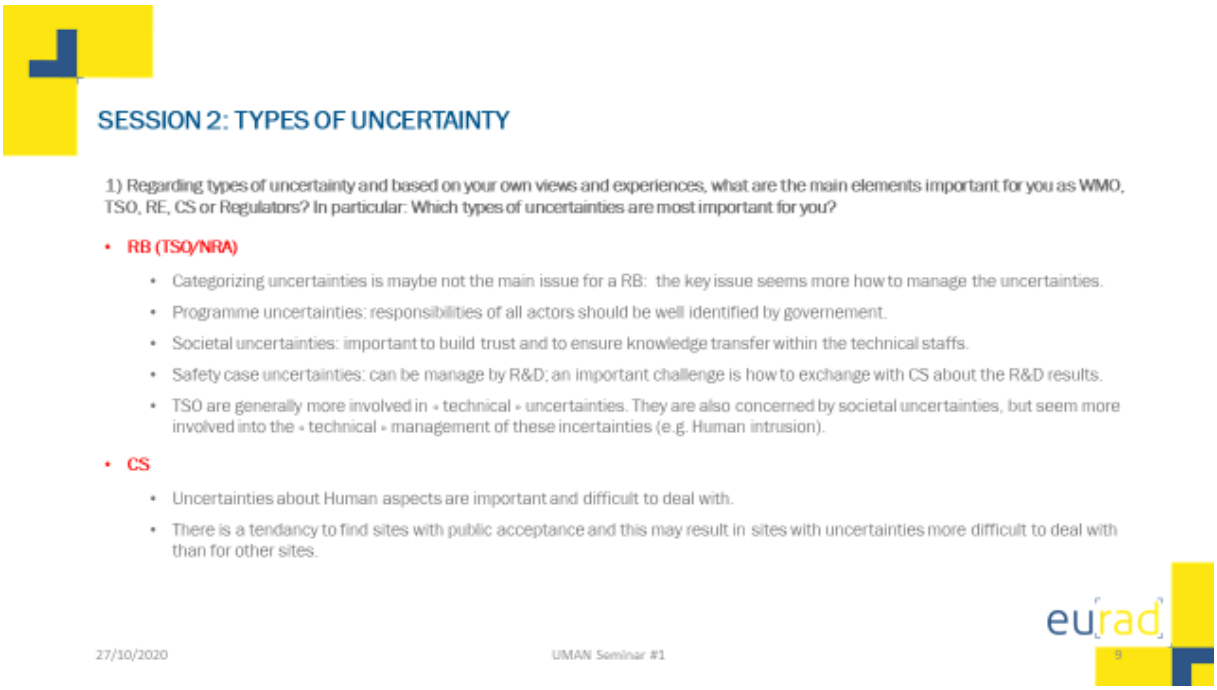

SESSION 2: TYPES OF UNCERTAINTY
1) Regarding the types of uncertainty and based on your own views and experiences, what are the main elements important for you as WMO, TSO, RE, CS or Regulators? In particular: Which types of uncertainties are most important for you? (2/2)
• WMO view:
• Uncertainties on geology & site are very important
• But human-related & societal uncertainties are also important and should be taken into account in the process
• Zero risk does not exist
27/10/2020
UMAN Seminar #1
eurad
8


SESSION 2: TYPES OF UNCERTAINTY
2) Based on the presentations and your personal views and experiences, what are the commonalities between the different types of actors? What are the differences?
• Commonalities:
• All people want to protect human health (the goal is a commonality)
• Uncertainties on the waste to be disposed of
• Uncertainties relevant to long-term safety
• Programme (including societal & political) uncertainties
27/10/2020
UMAN Seminar #1
eurad
9



2.5 Working Group 4



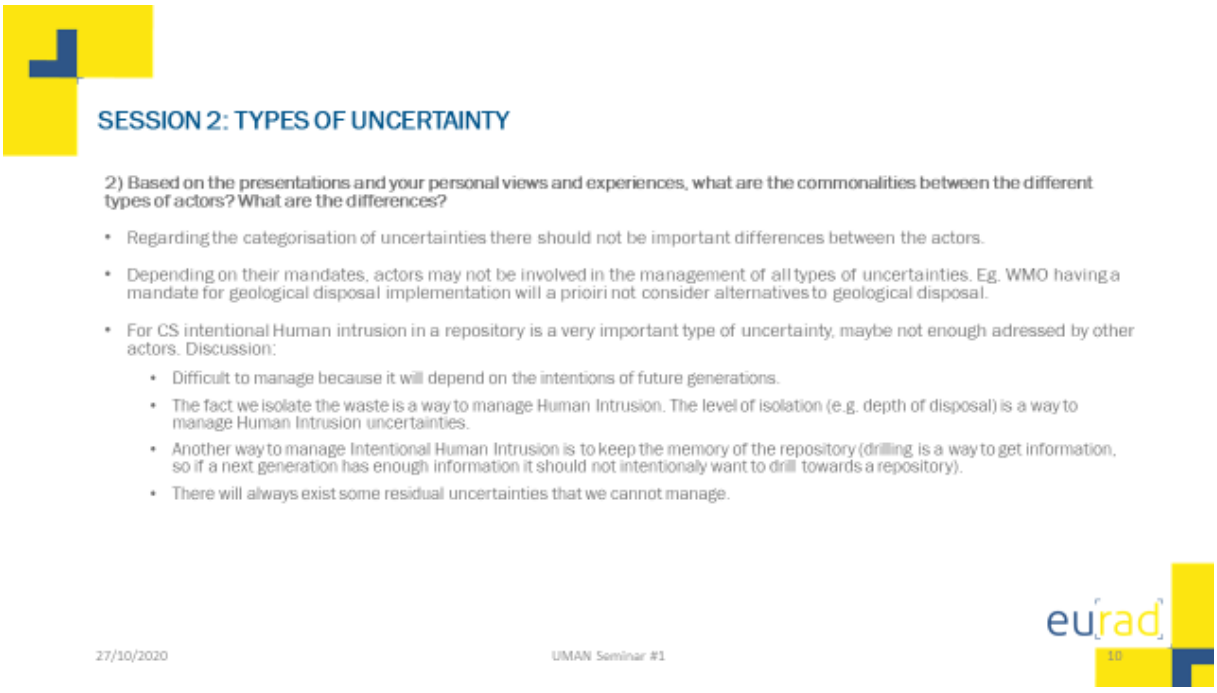


SESSION 2: TYPES OF UNCERTAINTY

1) Regarding types of uncertainty and based on your own views and experiences, what are the main elements important for you as WMO, TSO, RE, CS or Regulators? In particular: Which types of uncertainties are most important for you?

- RB (TSO/NRA)
  - Categorizing uncertainties is maybe not the main issue for a RB: the key issue seems more how to manage the uncertainties.
  - Programme uncertainties: responsibilities of all actors should be well identified by governement.
  - Societal uncertainties: important to build trust and to ensure knowledge transfer within the technical staffs.
  - Safety case uncertainties: can be manage by R&D; an important challenge is how to exchange with CS about the R&D results.
  - TSO are generally more involved in « technical » uncertainties. They are also concerned by societal uncertainties, but seem more involved into the « technical » management of these incertainties (e.g. Human intrusion).
- CS
  - Uncertainties about Human aspects are important and difficult to deal with.
  - There is a tendancy to find sites with public acceptance and this may result in sites with uncertainties more difficult to deal with than for other sites.

27/10/2020 UMAN Seminar #1 9

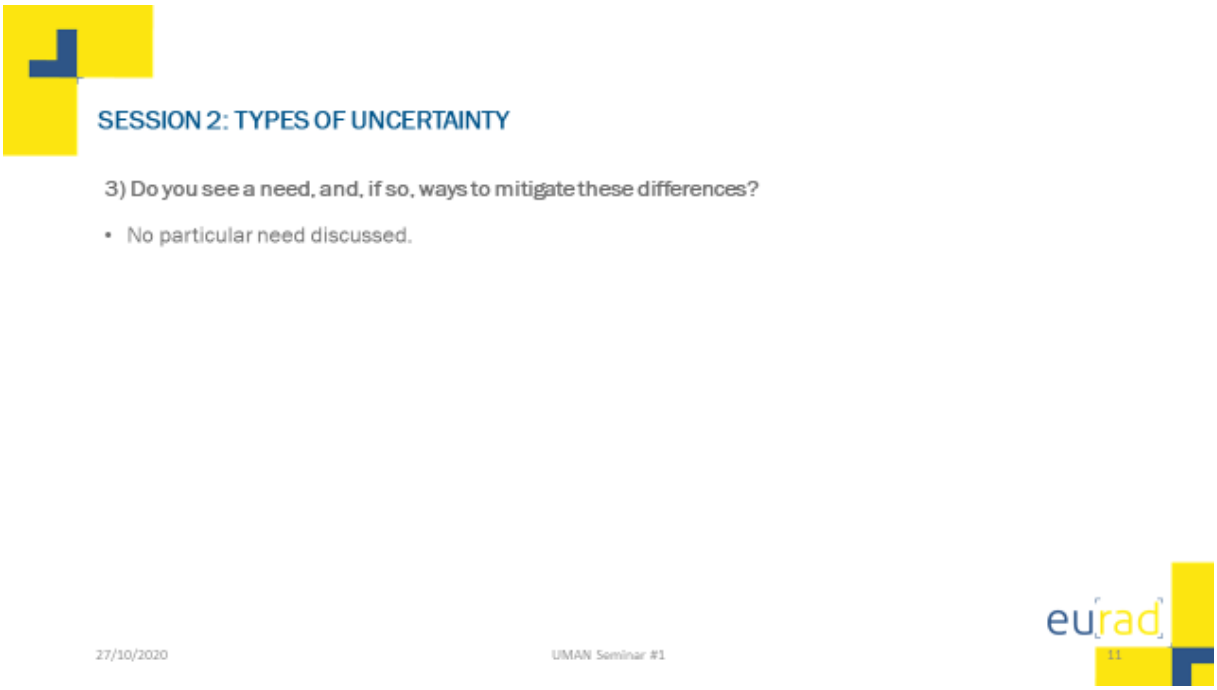


SESSION 2: TYPES OF UNCERTAINTY

2) Based on the presentations and your personal views and experiences, what are the commonalities between the different types of actors? What are the differences?

- Regarding the categorisation of uncertainties there should not be important differences between the actors.
- Depending on their mandates, actors may not be involved in the management of all types of uncertainties. Eg. WMO having a mandate for geological disposal implementation will a prioiri not consider alternatives to geological disposal.
- For CS intentional Human intrusion in a repository is a very important type of uncertainty, maybe not enough adressed by other actors. Discussion:
  - Difficult to manage because it will depend on the intentions of future generations.
  - The fact we isolate the waste is a way to manage Human Intrusion. The level of isolation (e.g. depth of disposal) is a way to manage Human Intrusion uncertainties.
  - Another way to manage Intentional Human Intrusion is to keep the memory of the repository (drilling is a way to get information, so if a next generation has enough information it should not intentionaly want to drill towards a repository).
  - There will always exist some residual uncertainties that we cannot manage.

27/10/2020 UMAN Seminar #1 10



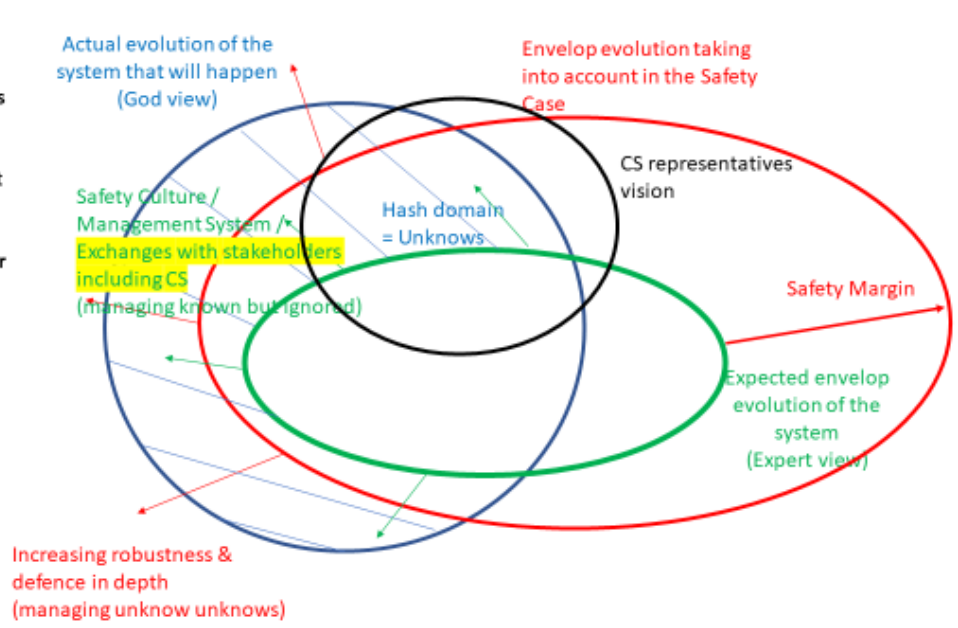
3. Evolution of uncertainties

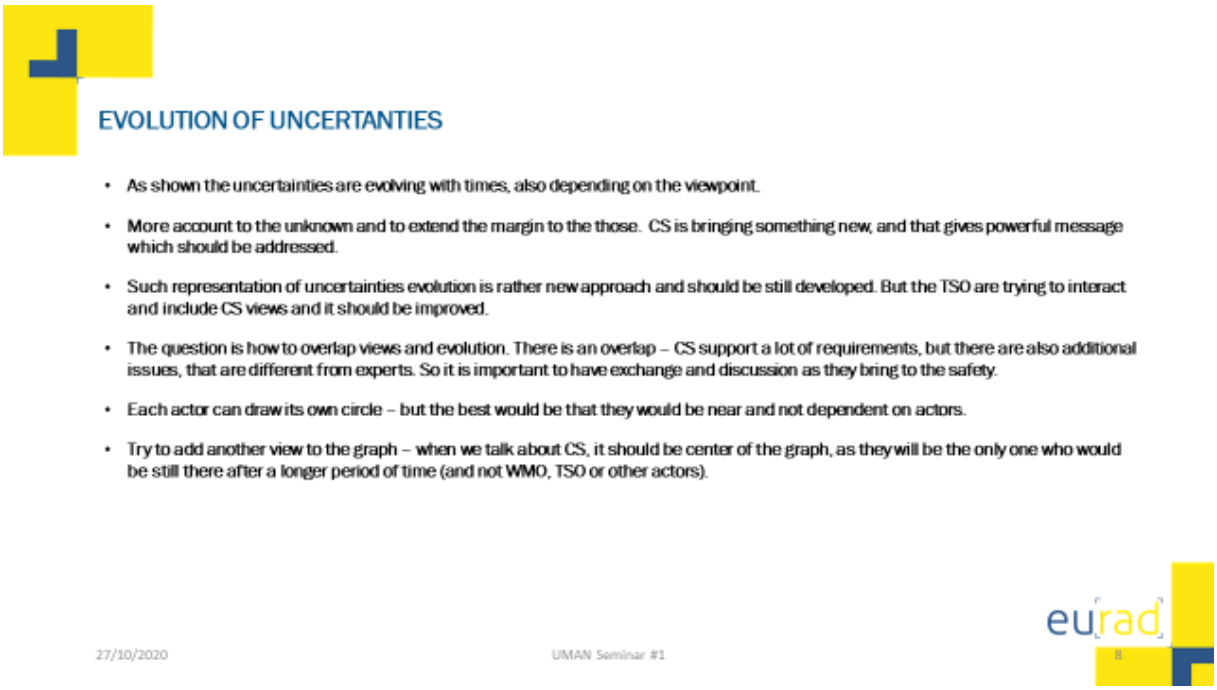
3.1 Questions

1. Regarding evolution of uncertainty and based on your own views and experiences, what are the main elements important for you as WMO, TSO, RE, CS or Regulators? In particular: what can be or is being done to address the main uncertainty for you?
2. Based on the presentations and your personal views and experiences, what are the commonalities between the different types of actors? What are the differences?
3. Do you see a need, and, if so, ways to mitigate these differences?

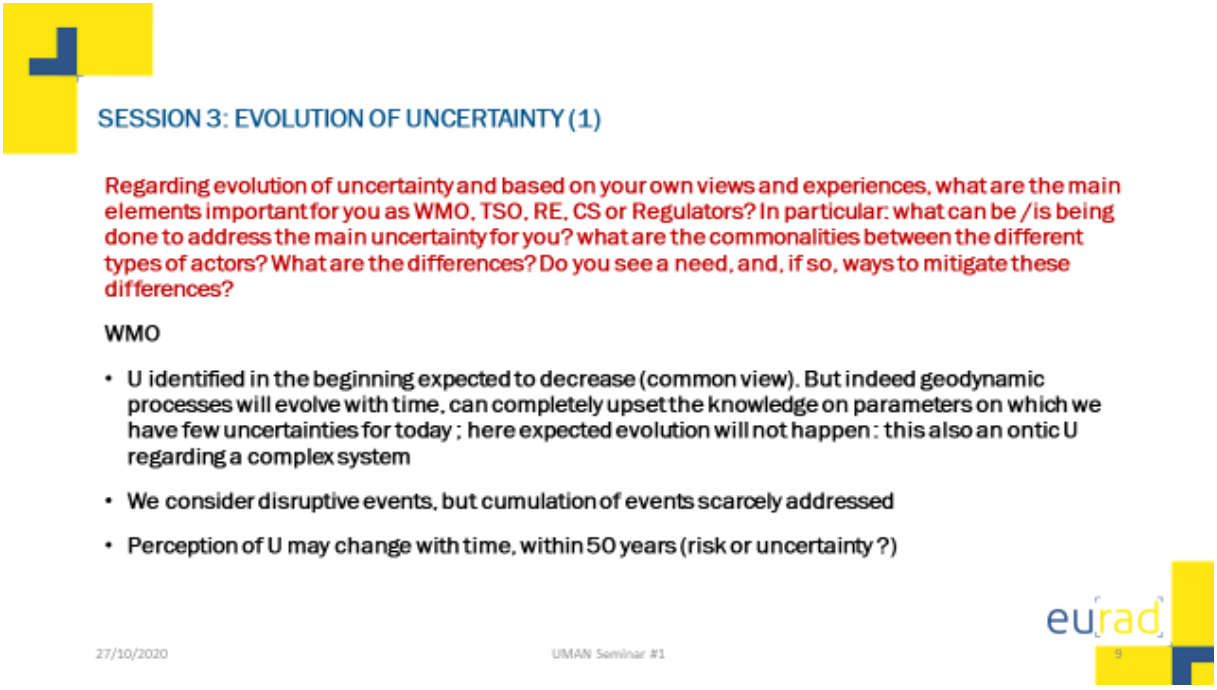
3.2 Working Group 1

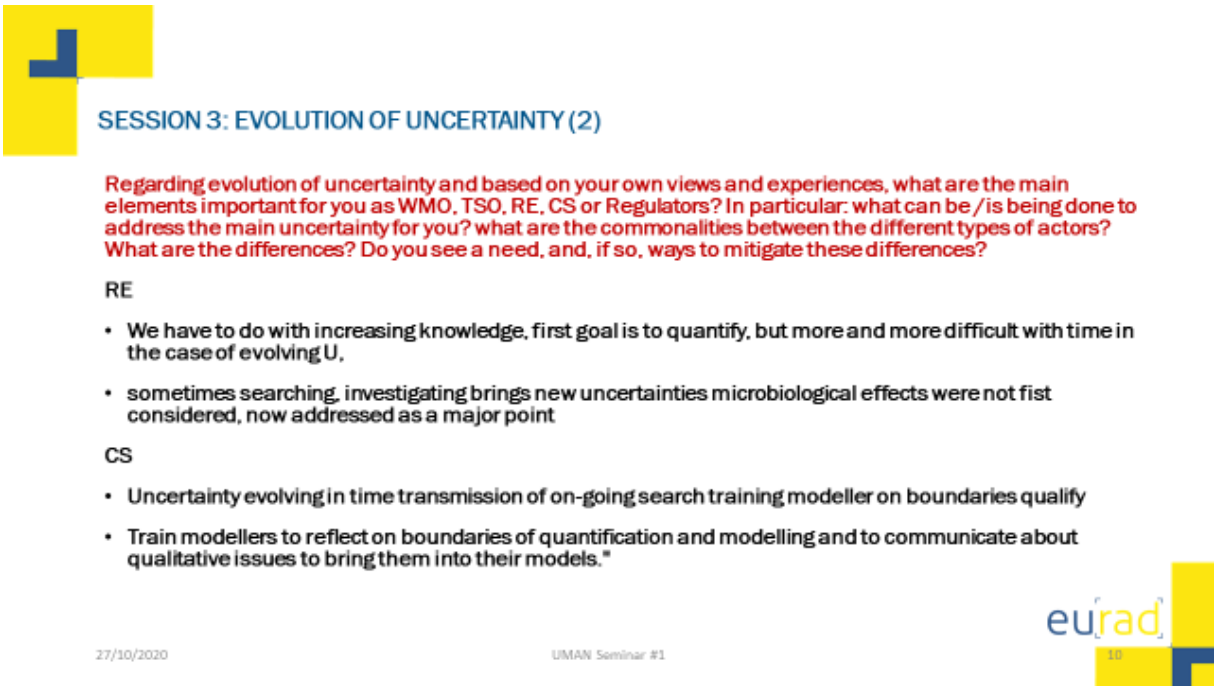
Lines are evolving through the geological development process (represented by red and green arrows). Final objective is that the red circle covers the blue one at least for issues relevant for safety



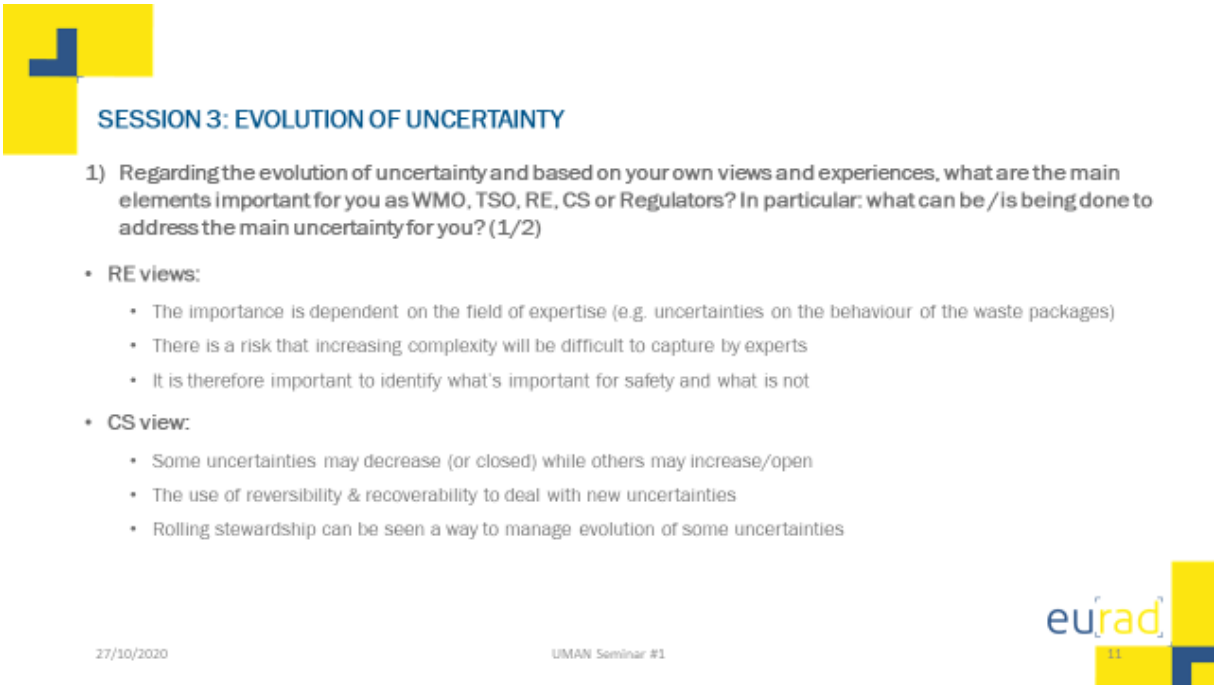


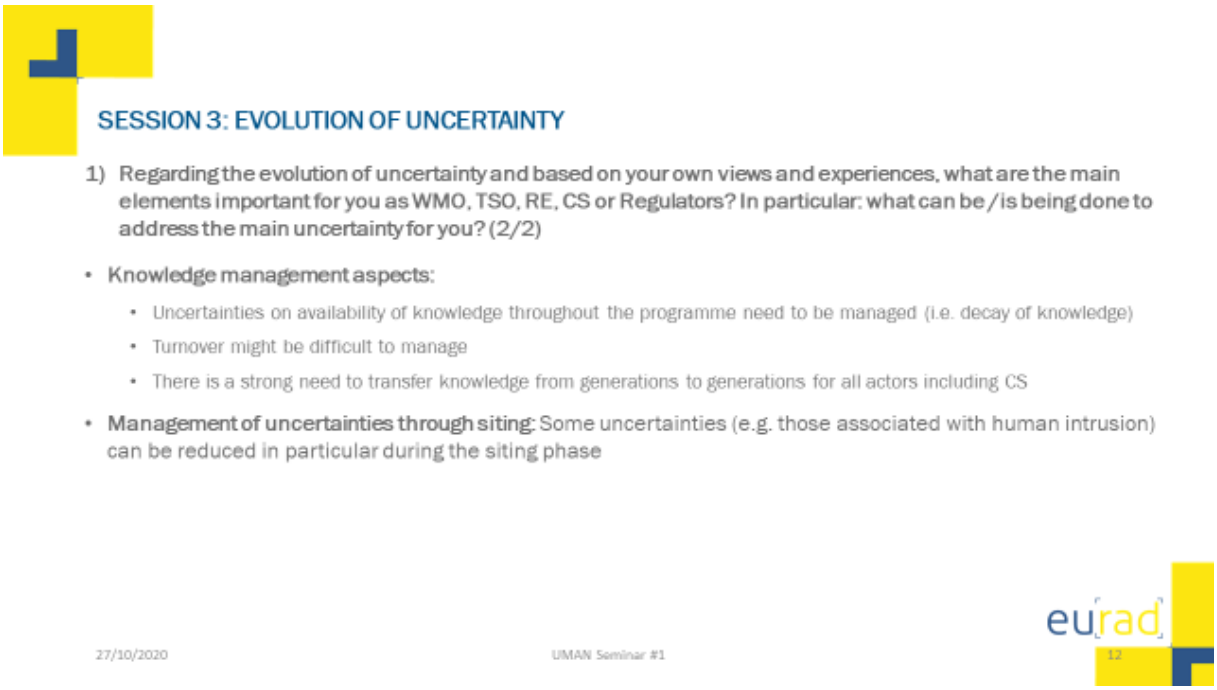
3.3 Working Group 2





3.4 Working Group 3



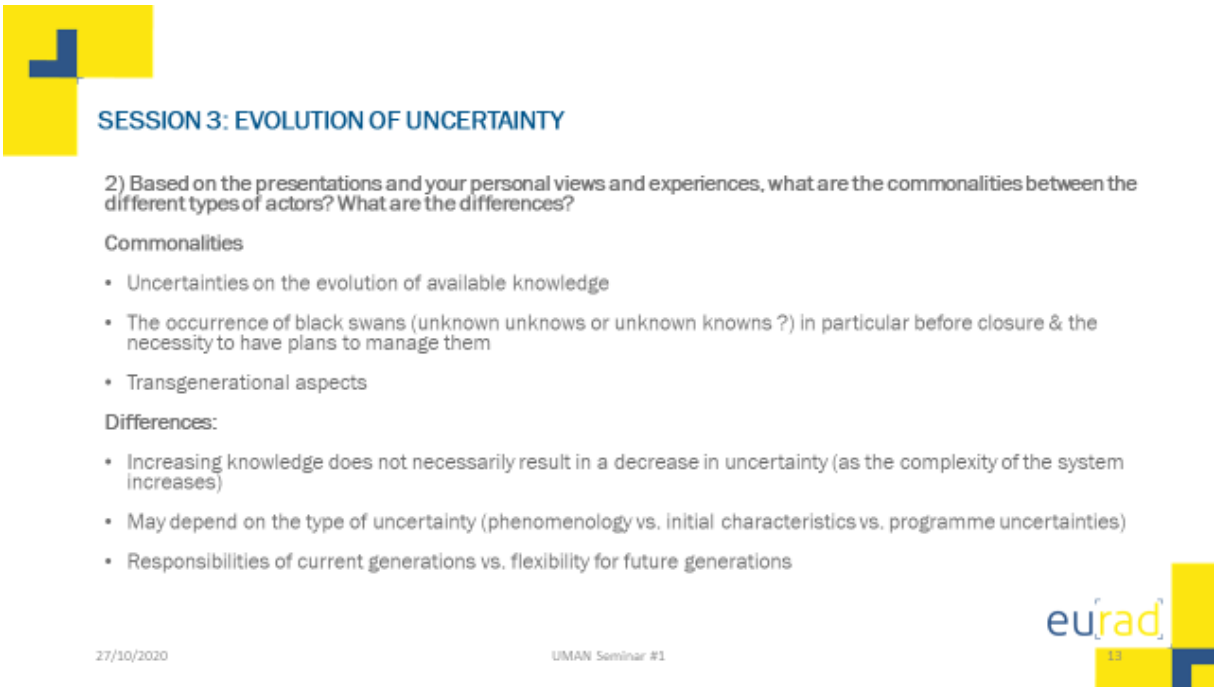


SESSION 3: EVOLUTION OF UNCERTAINTY

1) Regarding the evolution of uncertainty and based on your own views and experiences, what are the main elements important for you as WMO, TSO, RE, CS or Regulators? In particular: what can be / is being done to address the main uncertainty for you? (2/2)

- Knowledge management aspects:
  - Uncertainties on availability of knowledge throughout the programme need to be managed (i.e. decay of knowledge)
  - Turnover might be difficult to manage
  - There is a strong need to transfer knowledge from generations to generations for all actors including CS
- **Management of uncertainties through siting**: Some uncertainties (e.g. those associated with human intrusion) can be reduced in particular during the siting phase

27/10/2020 UMAN Seminar #1 12



SESSION 3: EVOLUTION OF UNCERTAINTY

2) Based on the presentations and your personal views and experiences, what are the commonalities between the different types of actors? What are the differences?

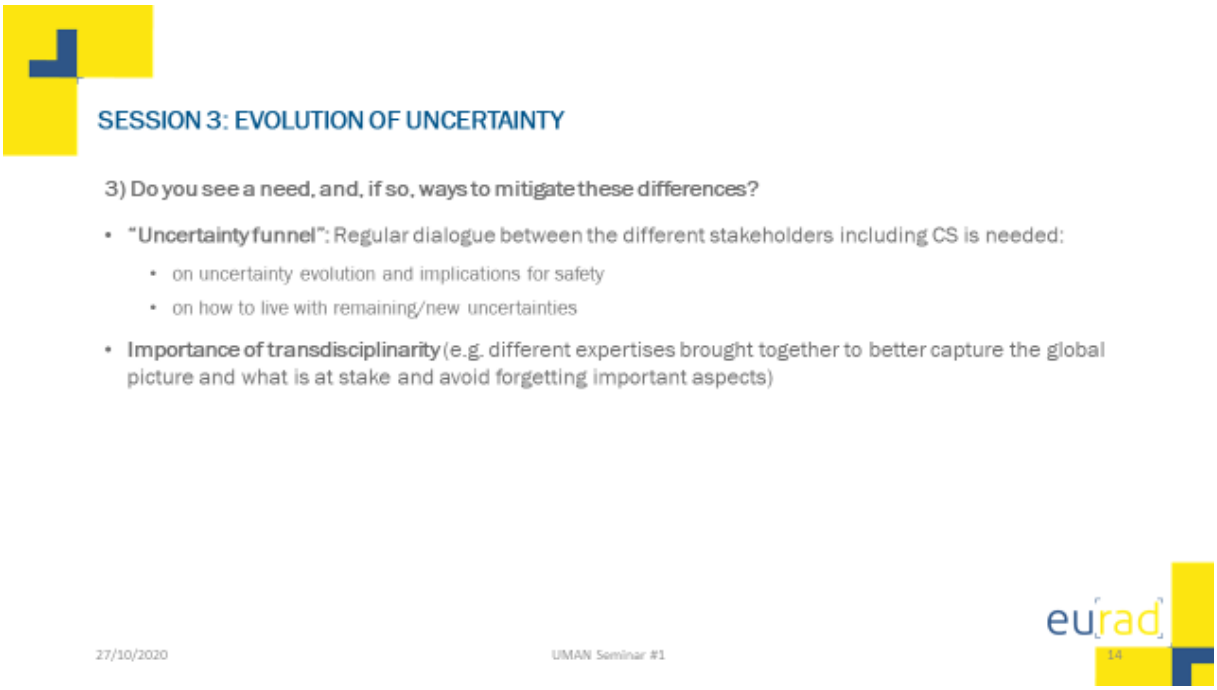
Commonalities

- Uncertainties on the evolution of available knowledge
- The occurrence of black swans (unknown unknows or unknown knowns ?) in particular before closure & the necessity to have plans to manage them
- Transgenerational aspects

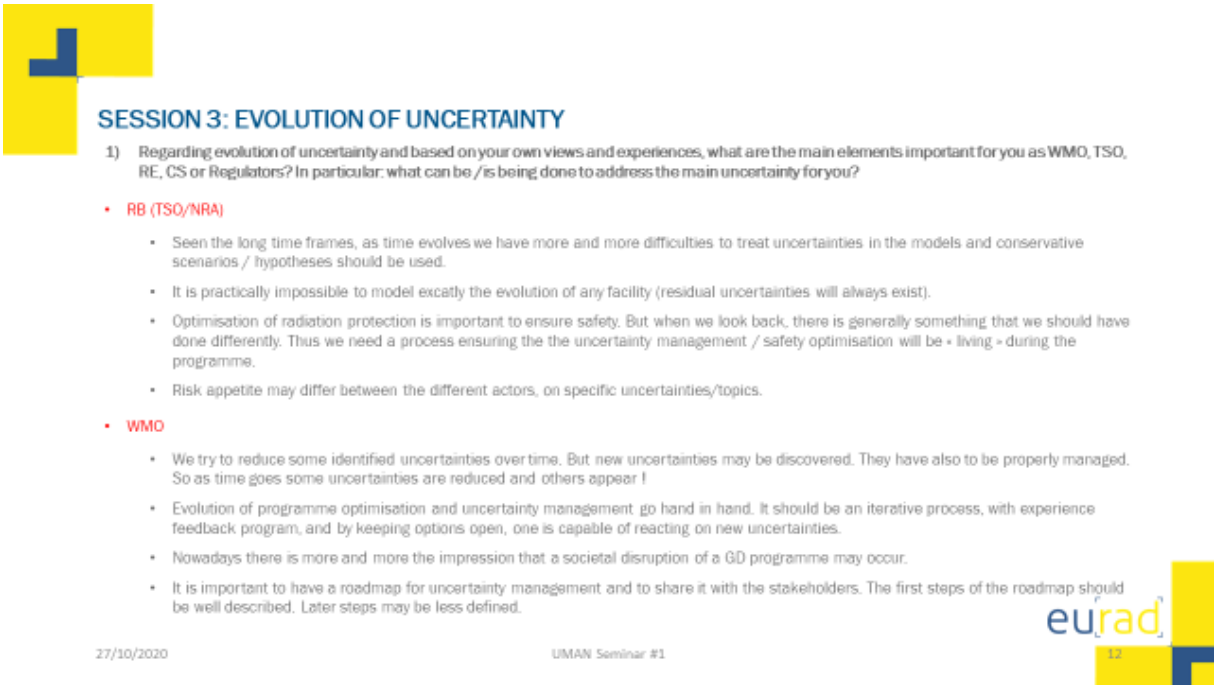
Differences:

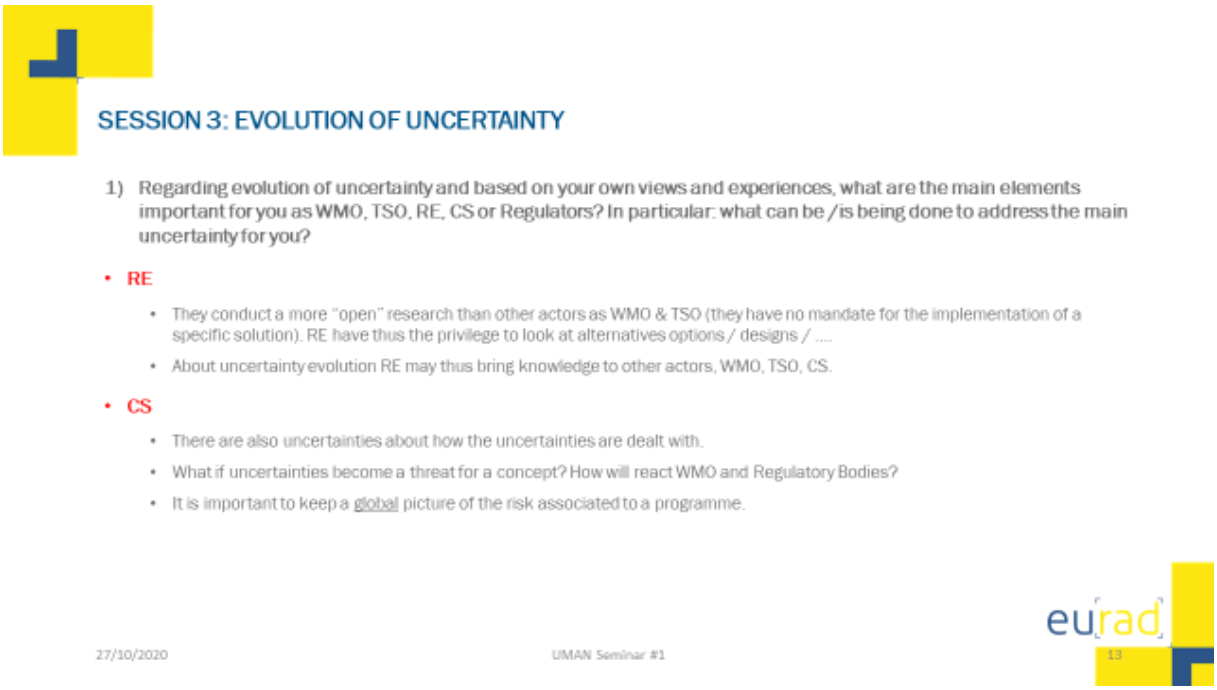
- Increasing knowledge does not necessarily result in a decrease in uncertainty (as the complexity of the system increases)
- May depend on the type of uncertainty (phenomenology vs. initial characteristics vs. programme uncertainties)
- Responsibilities of current generations vs. flexibility for future generations

27/10/2020 UMAN Seminar #1 13



3.5 Working Group 4



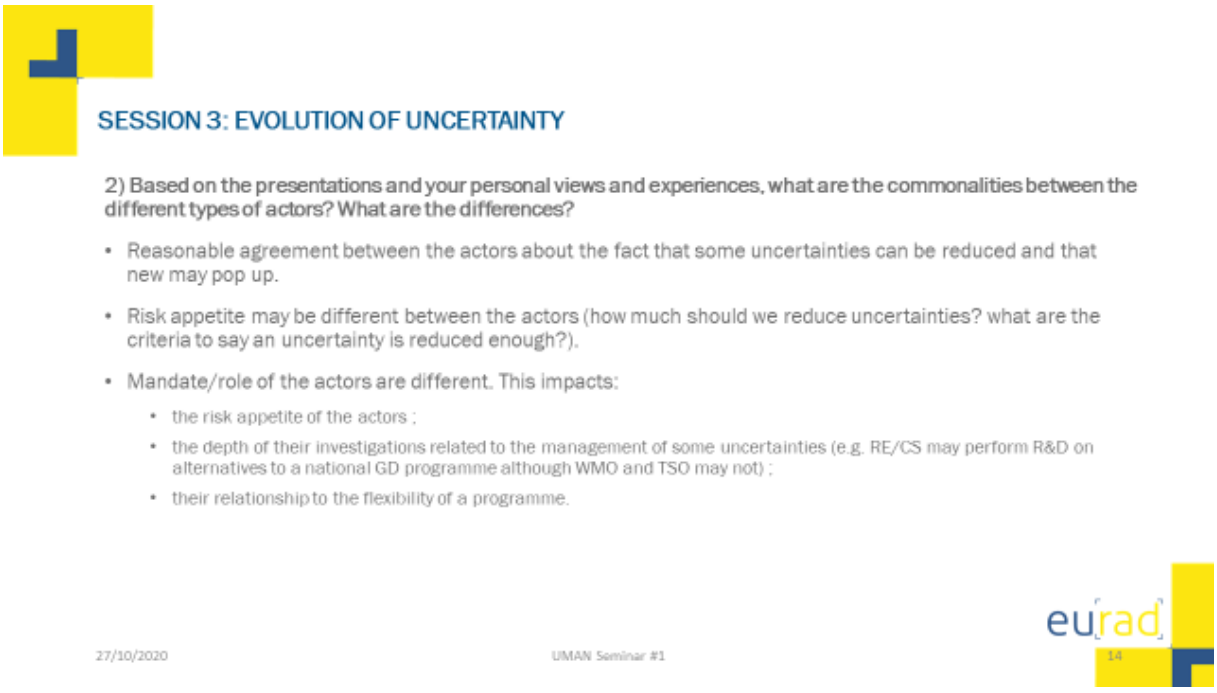


SESSION 3: EVOLUTION OF UNCERTAINTY

1) Regarding evolution of uncertainty and based on your own views and experiences, what are the main elements important for you as WMO, TSO, RE, CS or Regulators? In particular: what can be /is being done to address the main uncertainty for you?

- RE
  - They conduct a more "open" research than other actors as WMO & TSO (they have no mandate for the implementation of a specific solution). RE have thus the privilege to look at alternatives options / designs / ....
  - About uncertainty evolution RE may thus bring knowledge to other actors, WMO, TSO, CS.
- CS
  - There are also uncertainties about how the uncertainties are dealt with.
  - What if uncertainties become a threat for a concept? How will react WMO and Regulatory Bodies?
  - It is important to keep a global picture of the risk associated to a programme.

27/10/2020 UMAN Seminar #1 13

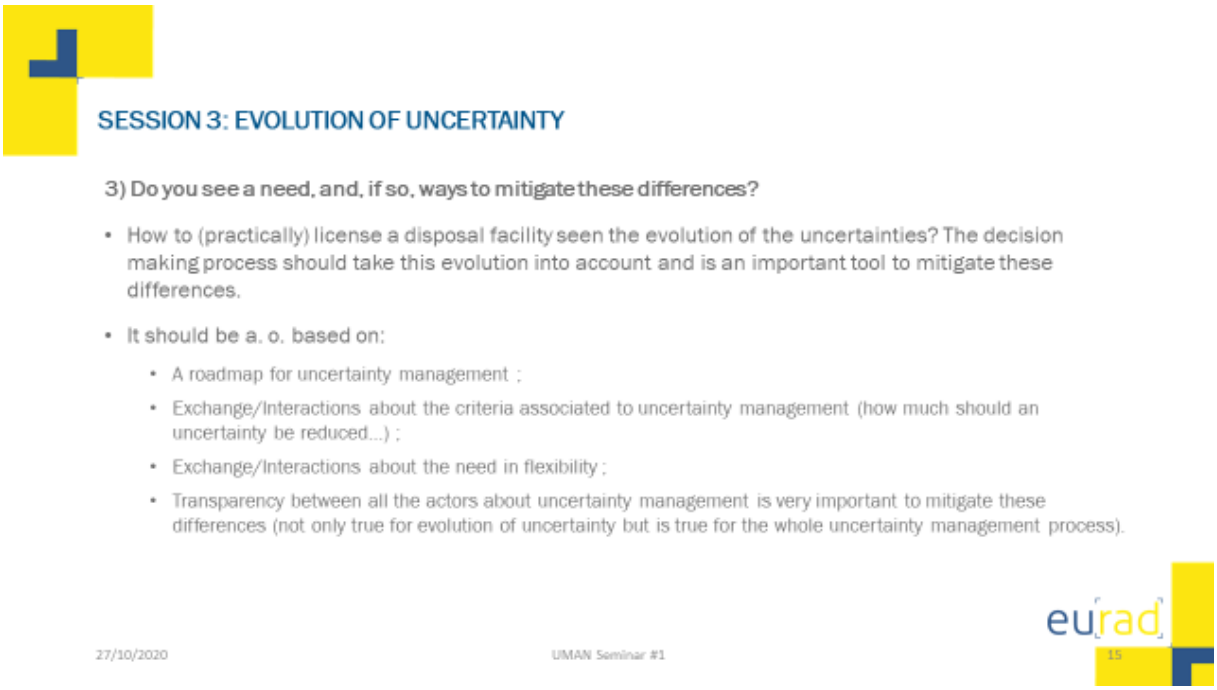


SESSION 3: EVOLUTION OF UNCERTAINTY

2) Based on the presentations and your personal views and experiences, what are the commonalities between the different types of actors? What are the differences?

- Reasonable agreement between the actors about the fact that some uncertainties can be reduced and that new may pop up.
- Risk appetite may be different between the actors (how much should we reduce uncertainties? what are the criteria to say an uncertainty is reduced enough?).
- Mandate/role of the actors are different. This impacts:
  - the risk appetite of the actors ;
  - the depth of their investigations related to the management of some uncertainties (e.g. RE/CS may perform R&D on alternatives to a national GD programme although WMO and TSO may not) ;
  - their relationship to the flexibility of a programme.

27/10/2020 UMAN Seminar #1 14

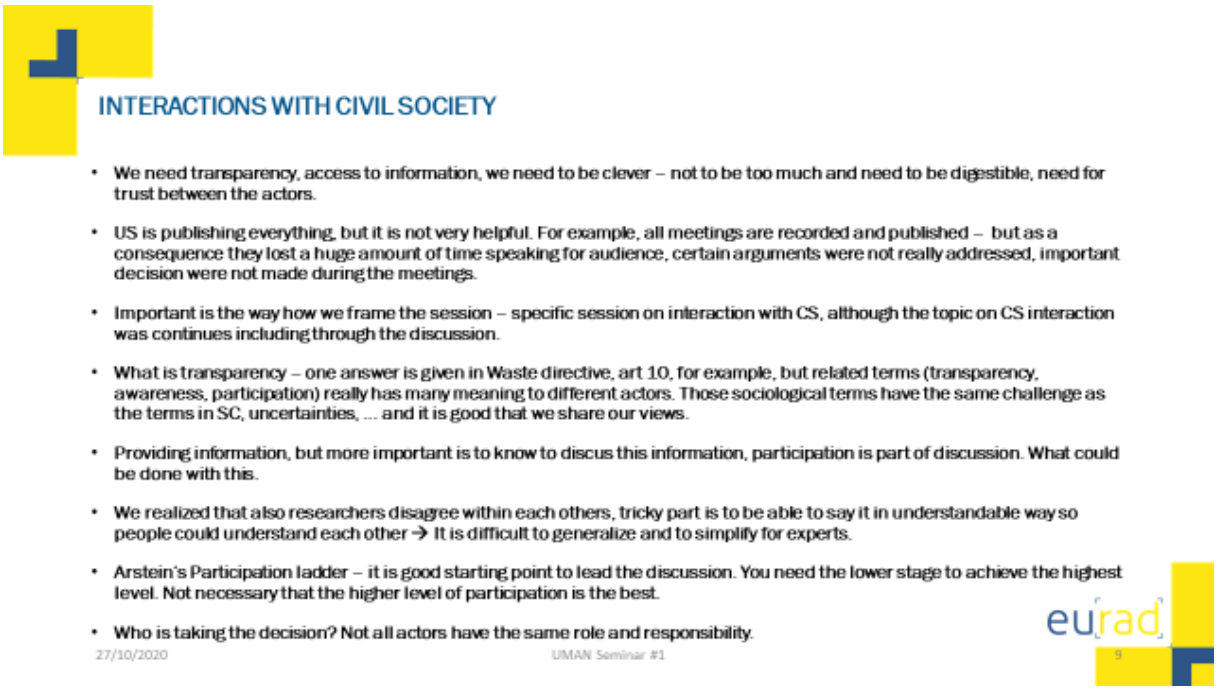


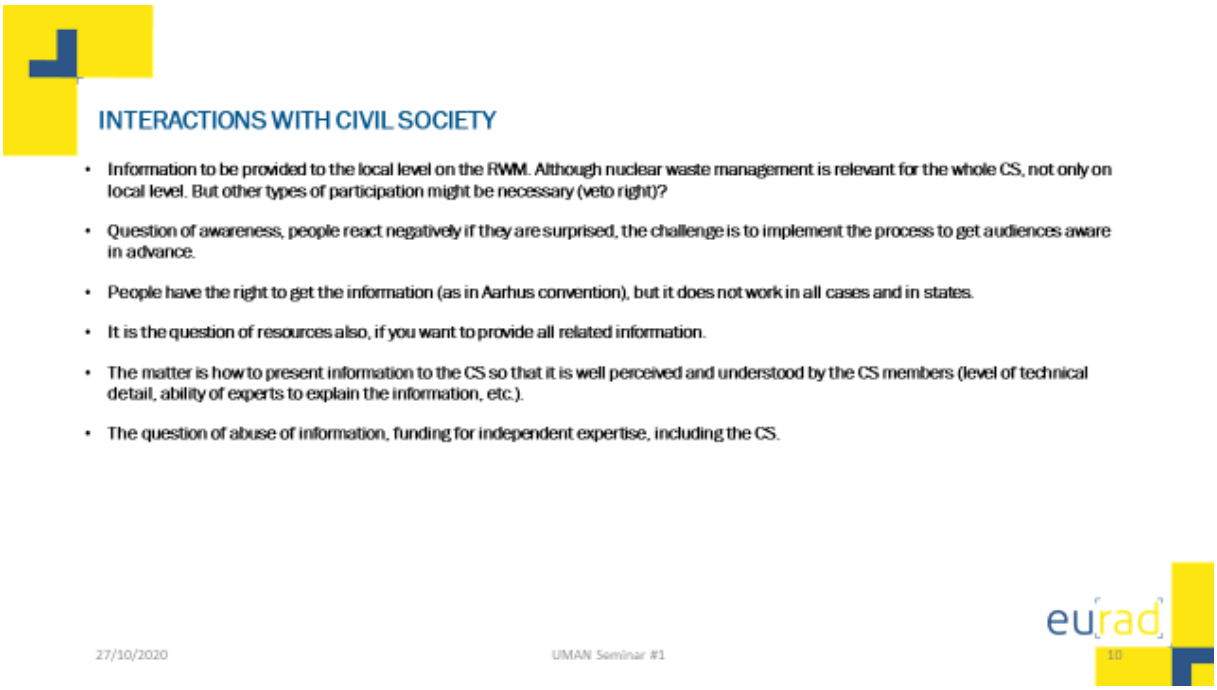
4. Interactions with CS

4.1 Questions

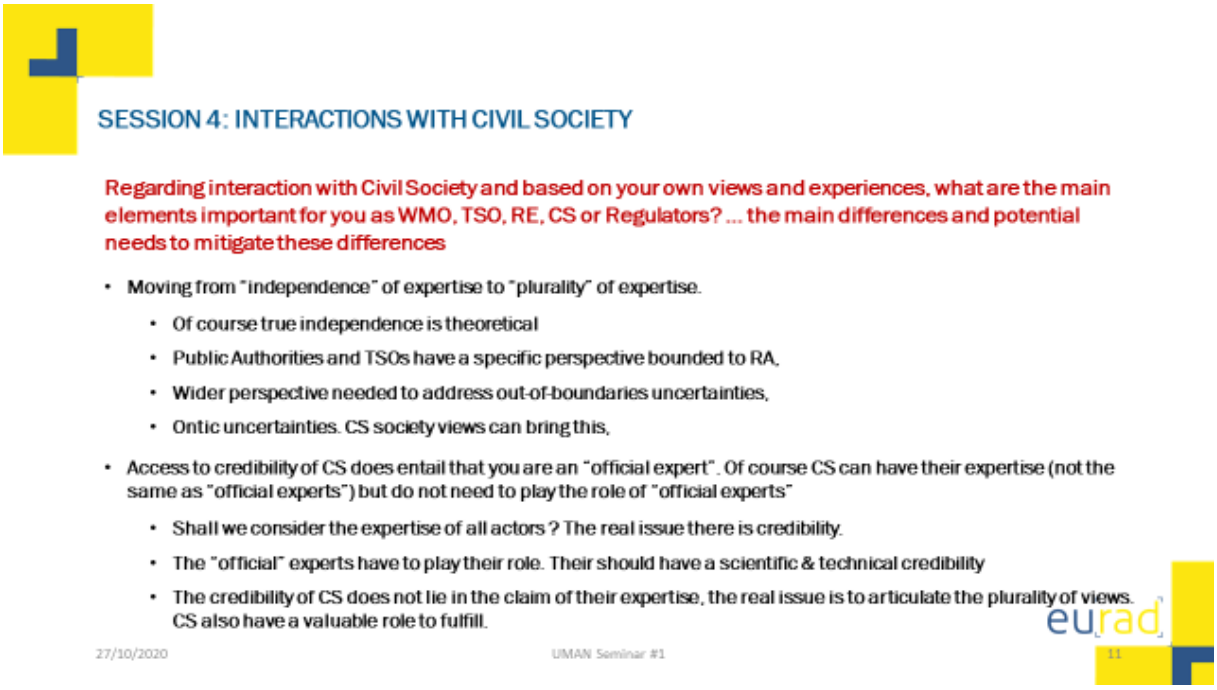
1. Regarding interaction with Civil Society and based on your own views and experiences, what are the main elements important for you as WMO, TSO, RE, CS or Regulators?
2. Based on the presentations and your personal views and experiences, what are the commonalities between the different types of actors? What are the differences?
3. Do you see a need, and, if so, ways to mitigate these differences?

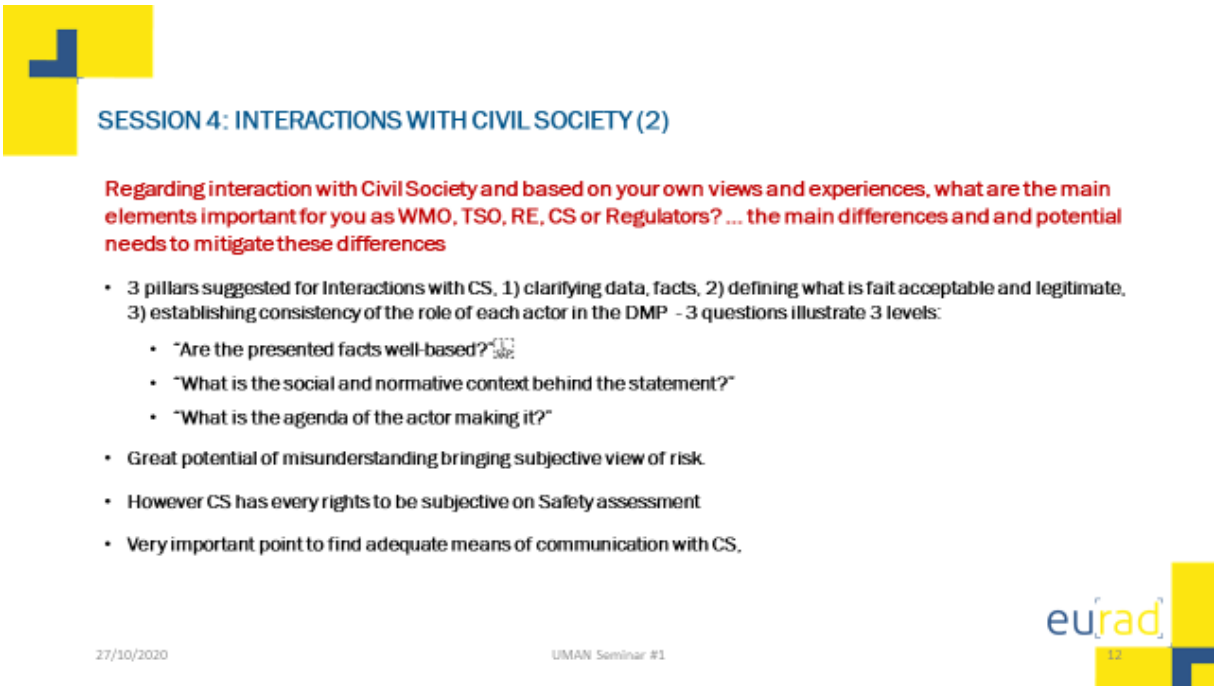
4.2 Working Group 1



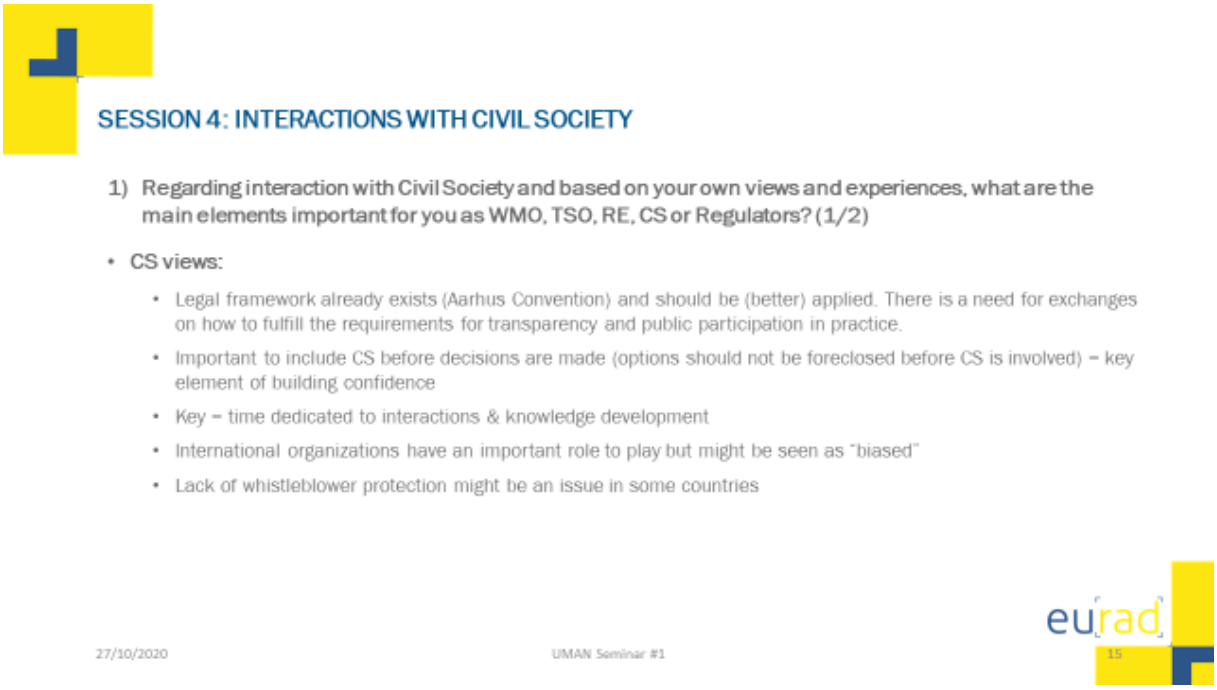


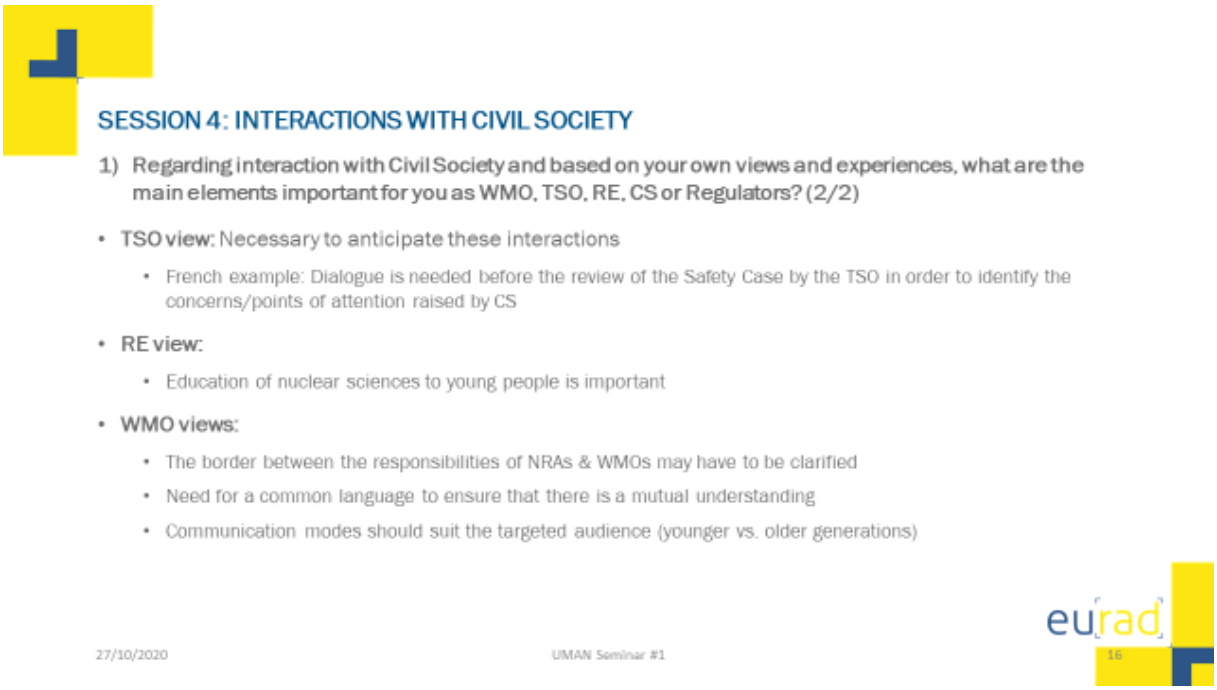
4.3 Working Group 2





4.4 Working Group 3



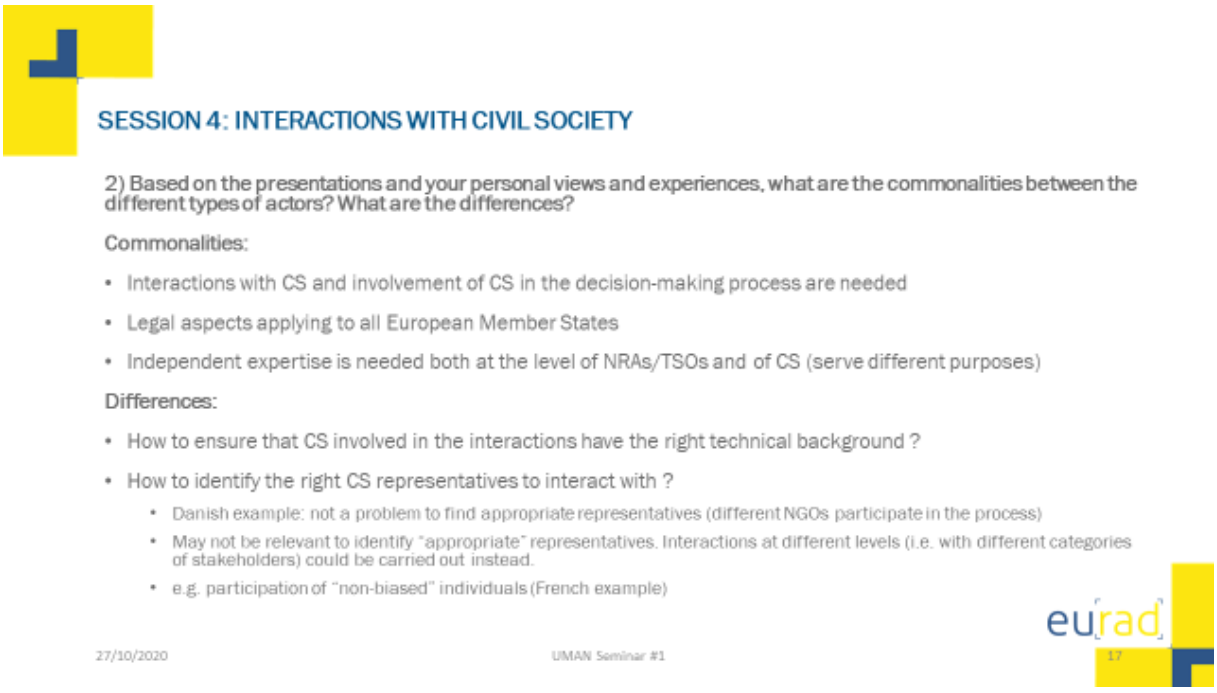


SESSION 4: INTERACTIONS WITH CIVIL SOCIETY

1) Regarding interaction with Civil Society and based on your own views and experiences, what are the main elements important for you as WMO, TSO, RE, CS or Regulators? (2/2)

- **TSO view:** Necessary to anticipate these interactions
  - French example: Dialogue is needed before the review of the Safety Case by the TSO in order to identify the concerns/points of attention raised by CS
- **RE view:**
  - Education of nuclear sciences to young people is important
- **WMO views:**
  - The border between the responsibilities of NRAs & WMOs may have to be clarified
  - Need for a common language to ensure that there is a mutual understanding
  - Communication modes should suit the targeted audience (younger vs. older generations)

27/10/2020 UMAN Seminar #1



SESSION 4: INTERACTIONS WITH CIVIL SOCIETY

2) Based on the presentations and your personal views and experiences, what are the commonalities between the different types of actors? What are the differences?

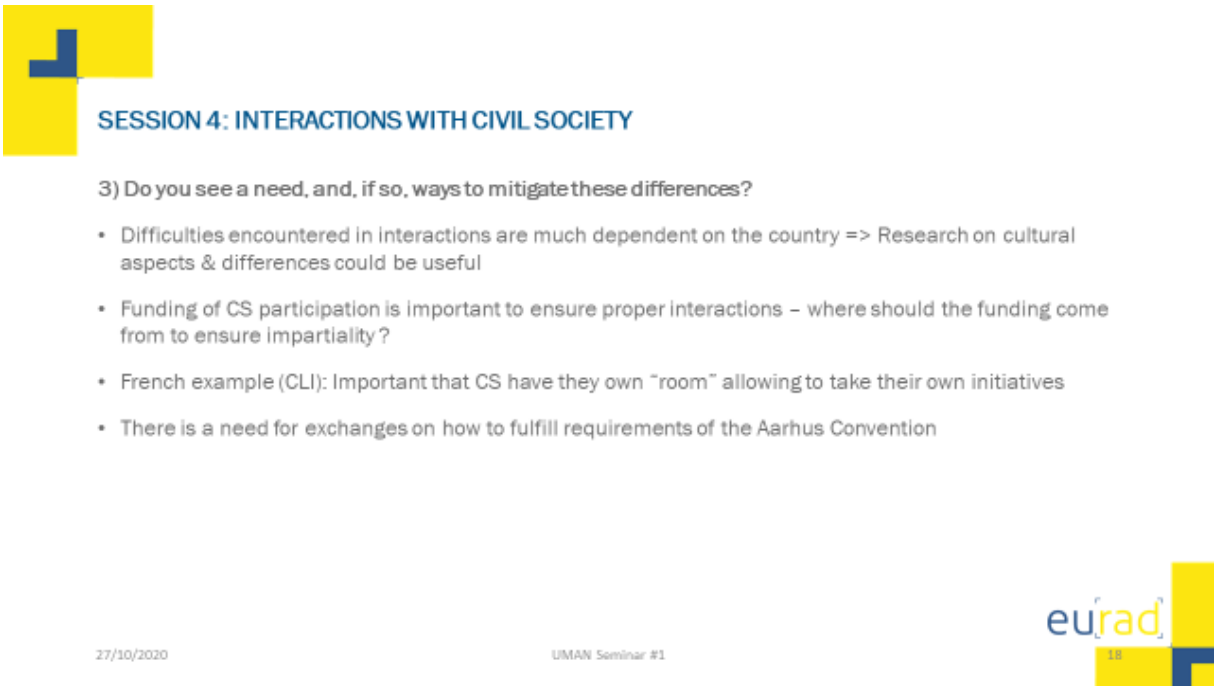
Commonalities:

- Interactions with CS and involvement of CS in the decision-making process are needed
- Legal aspects applying to all European Member States
- Independent expertise is needed both at the level of NRAs/TSOs and of CS (serve different purposes)

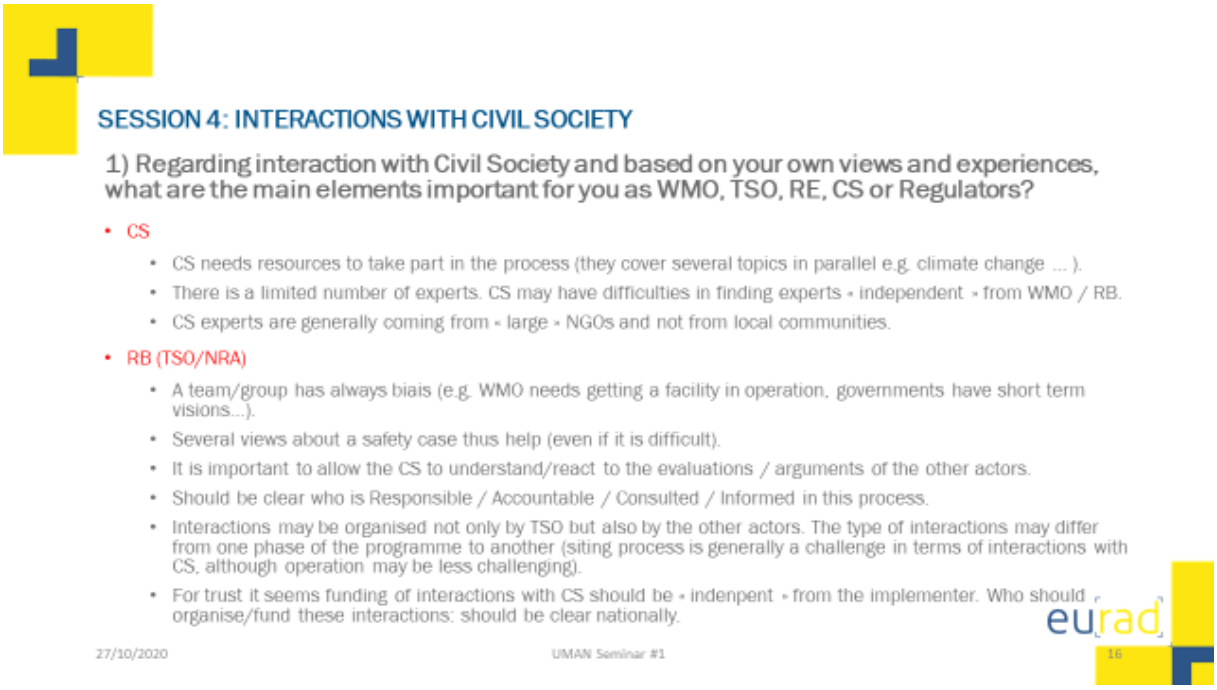
Differences:

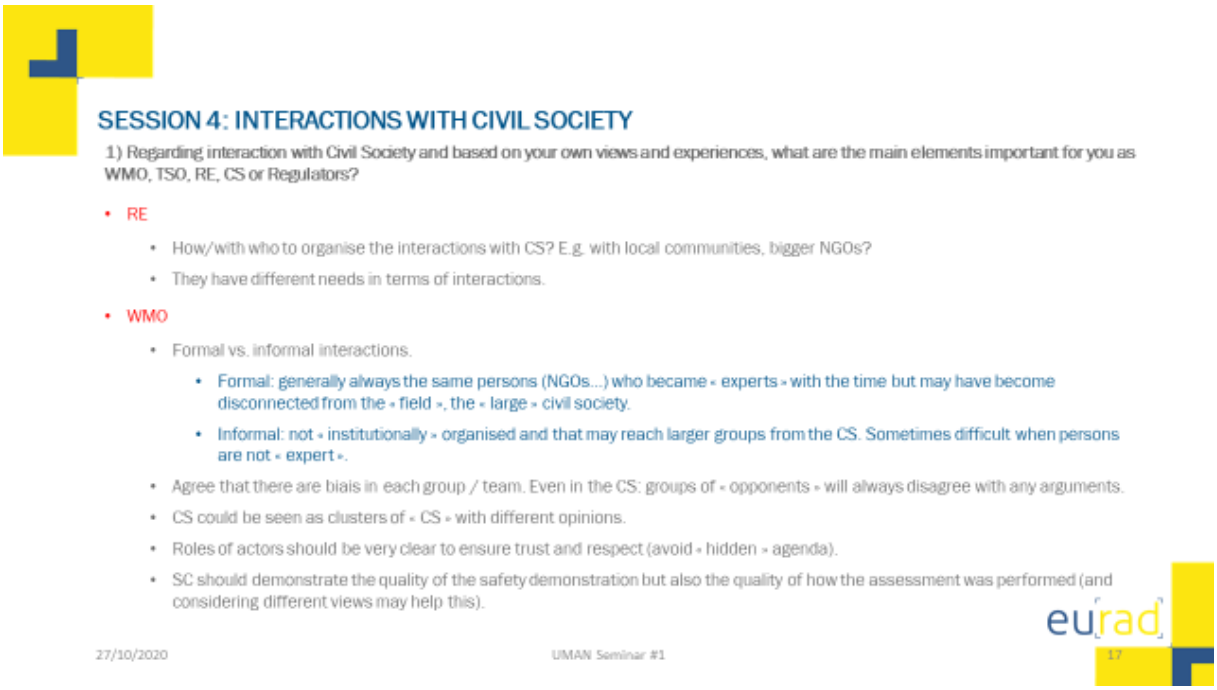
- How to ensure that CS involved in the interactions have the right technical background ?
- How to identify the right CS representatives to interact with ?
  - Danish example: not a problem to find appropriate representatives (different NGOs participate in the process)
  - May not be relevant to identify "appropriate" representatives. Interactions at different levels (i.e. with different categories of stakeholders) could be carried out instead.
  - e.g. participation of "non-biased" individuals (French example)

27/10/2020 UMAN Seminar #1



4.5 Working Group 4



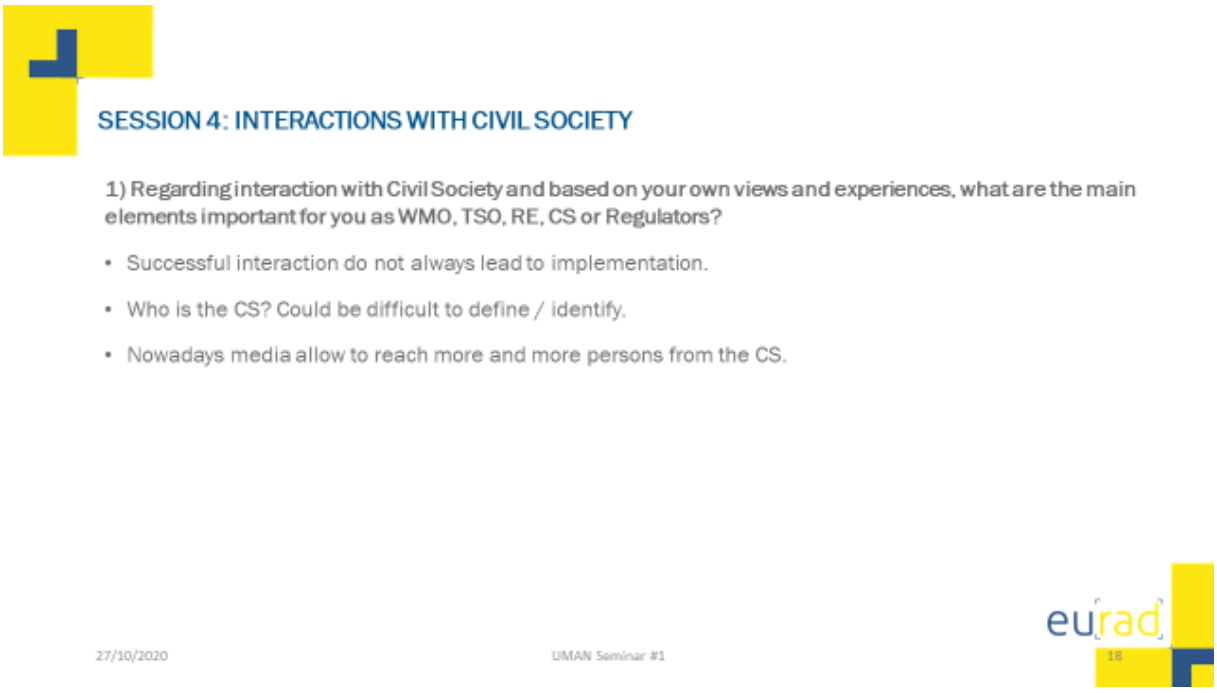


SESSION 4: INTERACTIONS WITH CIVIL SOCIETY

1) Regarding interaction with Civil Society and based on your own views and experiences, what are the main elements important for you as WMO, TSO, RE, CS or Regulators?

- RE
  - How/with who to organise the interactions with CS? E.g. with local communities, bigger NGOs?
  - They have different needs in terms of interactions.
- WMO
  - Formal vs. informal interactions.
    - Formal: generally always the same persons (NGOs…) who became « experts » with the time but may have become disconnected from the « field », the « large » civil society.
    - Informal: not « institutionally » organised and that may reach larger groups from the CS. Sometimes difficult when persons are not « expert ».
  - Agree that there are biais in each group / team. Even in the CS: groups of « opponents » will always disagree with any arguments.
  - CS could be seen as clusters of « CS » with different opinions.
  - Roles of actors should be very clear to ensure trust and respect (avoid « hidden » agenda).
  - SC should demonstrate the quality of the safety demonstration but also the quality of how the assessment was performed (and considering different views may help this).

27/10/2020 UMAN Seminar #1 17

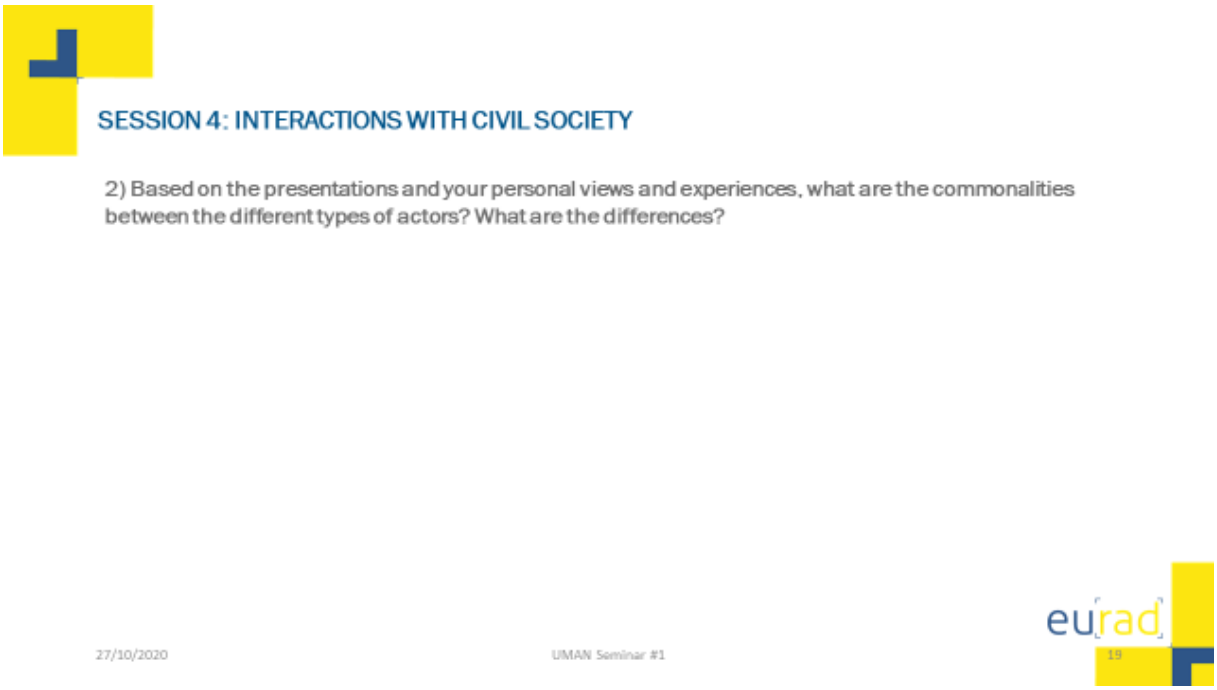


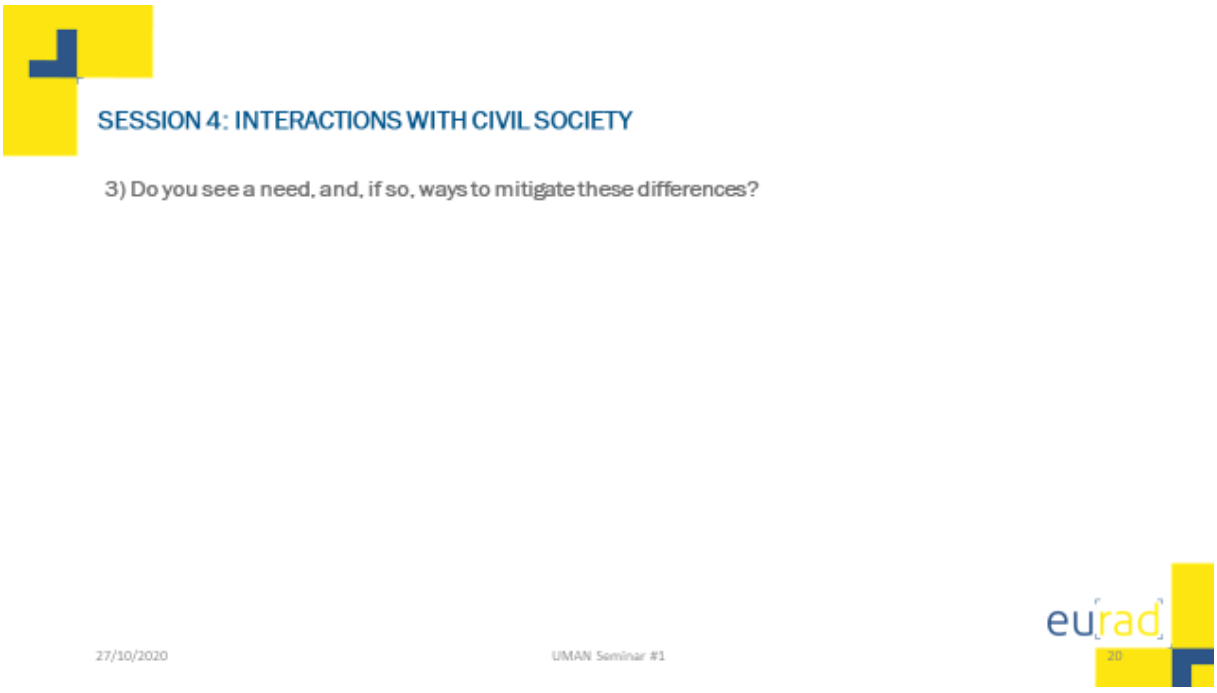
SESSION 4: INTERACTIONS WITH CIVIL SOCIETY

1) Regarding interaction with Civil Society and based on your own views and experiences, what are the main elements important for you as WMO, TSO, RE, CS or Regulators?

- Successful interaction do not always lead to implementation.
- Who is the CS? Could be difficult to define / identify.
- Nowadays media allow to reach more and more persons from the CS.

27/10/2020 UMAN Seminar #1 18


SESSION 4: INTERACTIONS WITH CIVIL SOCIETY
2) Based on the presentations and your personal views and experiences, what are the commonalities between the different types of actors? What are the differences?
27/10/2020
UMAN Seminar #1
19


SESSION 4: INTERACTIONS WITH CIVIL SOCIETY
3) Do you see a need, and, if so, ways to mitigate these differences?
27/10/2020
UMAN Seminar #1
20