



TU Clausthal



ENSURE

Endlagersicherheit: Ungewissheiten und
Regulatorische Aspekte

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Outline

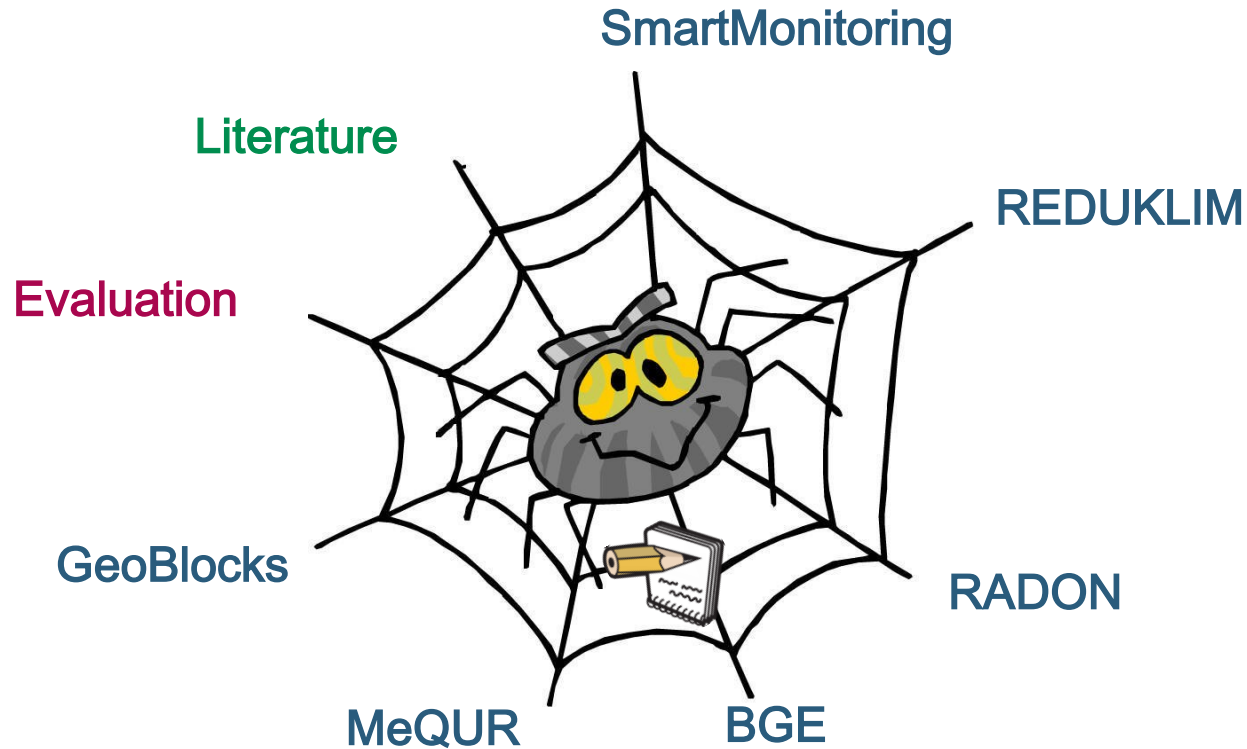
TU Clausthal:

- ENSURE – Outputs and Partner Involvement
- WP 1 Regulatory Requirements → Gap Analysis
- WP 3 Methods and Recommendations → Recommendations (similar to guidelines)

Uni Kassel:

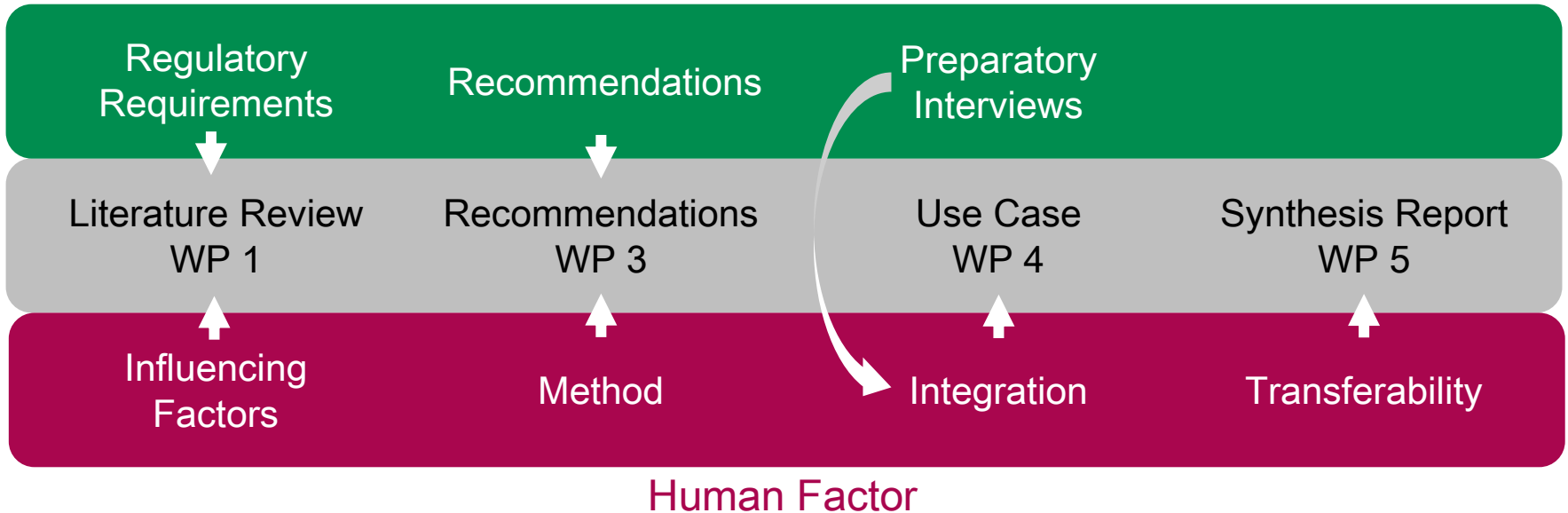
- WP 1 Human Factors
- WP 3 Method and Recommendations
- WP 2 + 4 Use Case
- WP 5 Transferability
- Summary

ENSURE: Our Self-Image

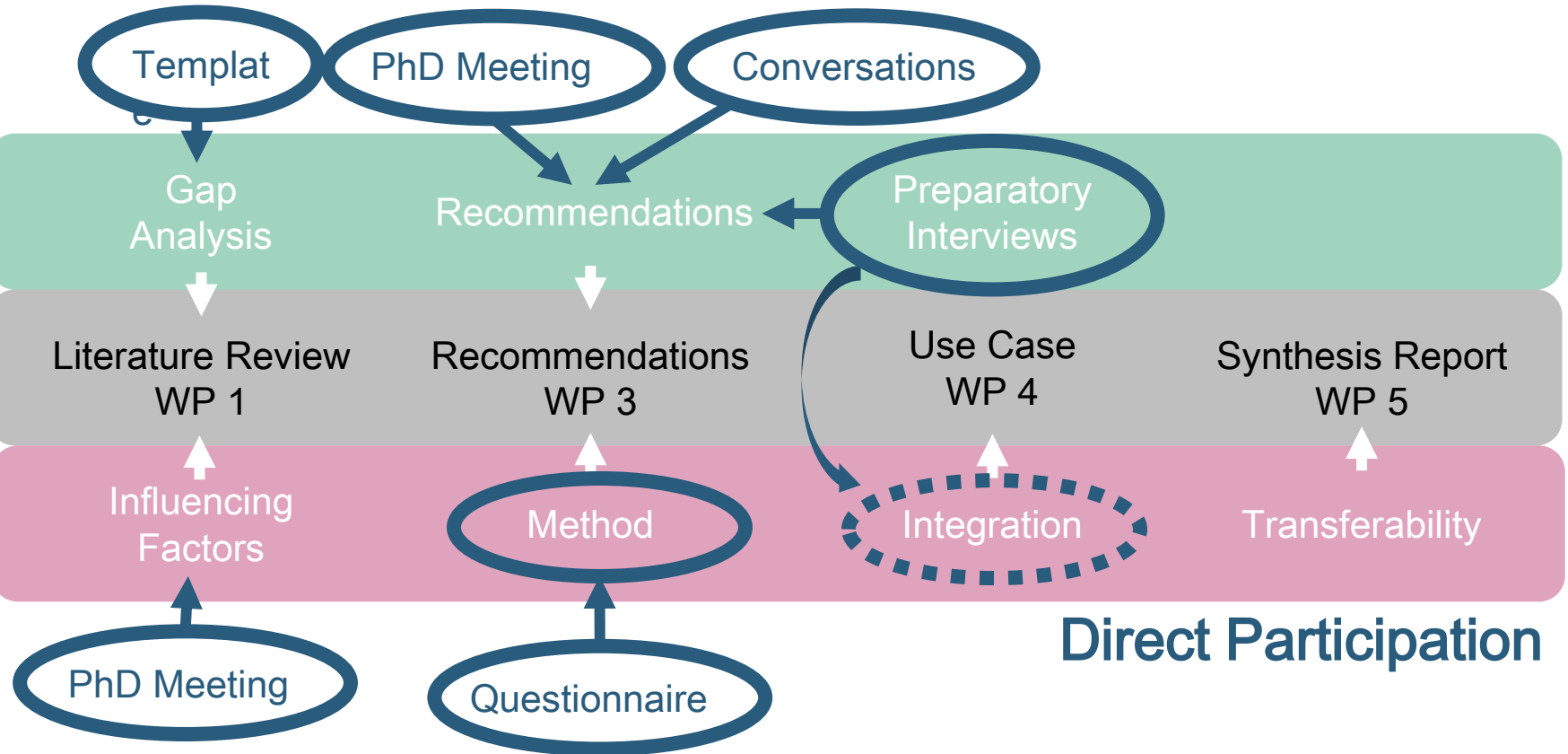


ENSURE: Main WP and Outputs

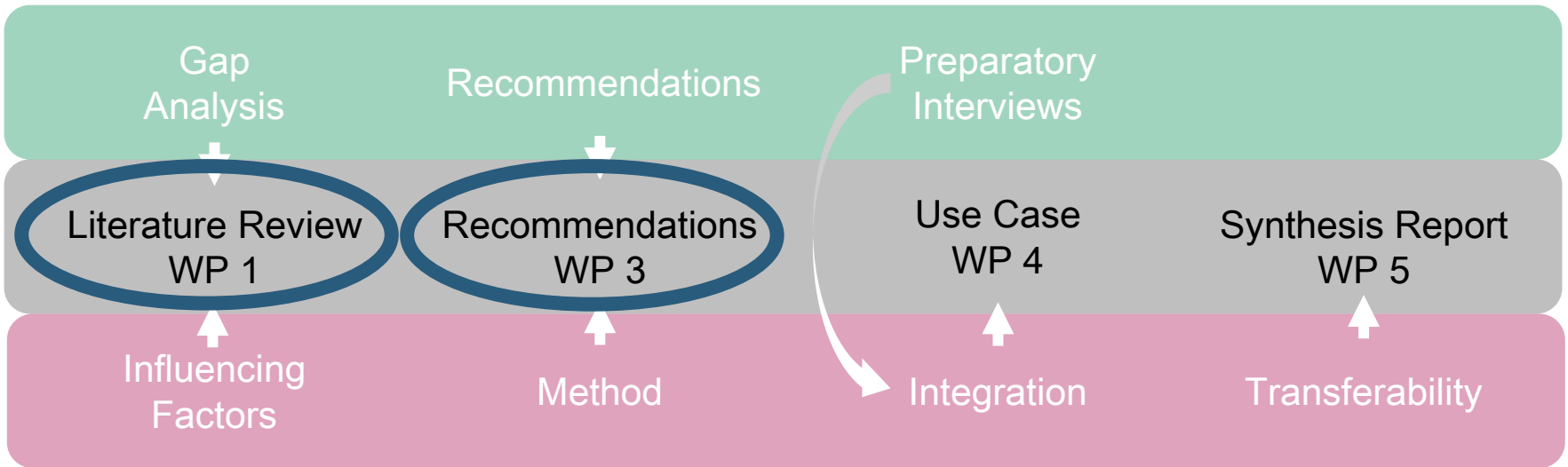
Scientific and Technical Uncertainties



ENSURE: Partner Involvement



ENSURE: Partner Involvement



Feedback on Written Outputs

WP 1 Regulatory Requirements

Literature Research: Scientific and Technical Uncertainties

- Screening of regulations (D, CH, F, SE, UK, CA, FI) for relevant
 - Laws
 - Decrees
 - Guidelines & policies
- Examination of international recommendations (IAEA, WENRA)
- Analysis of approx. 125 documents
- Citavi-Database with approx. 200 text snippets
- “Best of” – compilation of existing regulations and recommendations
- Comparison of German regulations with state of the art / practice

WP 1 Findings

- Regulations *must* be flexible in order to
 - allow adaptation to the state of the art
 - avoid changes in legislation
 - Accordingly: Very little mention of uncertainties in laws or decrees
 - Laws define targets, paradigms and responsibilities
 - Decrees define limits, reference values, broad methodologies
 - Guidelines and recommendations usually quite generic
 - Exceptions: BeGru (D), Guidance on Rqmts. for Authorization (UK)
- Germany is pretty specific compared to the other countries we examined!

WP 1 Findings (cont.)

Flip side of flexible legislation:

- Wording often leaves room for interpretation, e.g.:
 - When do we need quantification of uncertainties, when are qualitative assessments sufficient?
 - What can be addressed with parameter variations within a scenario, what needs to be addressed with a separate scenario?
- Methods are mentioned, but there are no recommendations regarding their application to specific problems
- Incompleteness – certain aspects are not addressed at all

WP 1 Findings (cont.)

Maybe too much wiggle room?!

- Example: Model uncertainties in German regulations
 - No recommendations for dealing with uncertainties originating in algorithms, code, or machine precision
 - International peer review, benchmarking, alternative conceptual models and other measures are not mentioned
 - No source for minimum requirements (e.g. ISO Standard) for code QC (validation, verification) – only a reference to the state of the art

WP 1 Findings (cont.)

Maybe too much wiggle room?!

- Some topics are not addressed at all
 - Site comparison
 - Communicating uncertainties to the public
 - Human errors and biases as sources of uncertainties
- Missing, but in the works (BGE): Overall concept for uncertainty management

WP 3 Recommendations

- Starting points:
 - State of the Art
 - WP1 “Best of” – compilation of regulations
 - Input from URS-Partners, e.g.:
 - Uncertainty quantification
 - Uncertainties related to surrogate modelling
 - Climate scenarios
 - Addressing spatial variability
 - Confidence in models
 - Interdisciplinary communication
 - Strategic issues when comparing sites or regions

Thank you!

WP 3 Recommendations

- Short document (~10 pages)
- German language only
- Recommendations on
 - Uncertainty management strategy and documentation of uncertainties
 - Scenario uncertainties
 - Model uncertainties
 - Parameter uncertainties
 - Human factor
 - Site comparison
 - Public communication

WP 3 Recommendations: Examples

- **Uncertainty management**
 - Minimum requirements for documentation (i.e. uncertainty database)
- **Scenario uncertainties**
 - Scenario development to follow structured, systematic and well-documented approach
 - Consistency across different sites
 - Documentation of physico-chemical phenomena in conjunction with their safety implications (e.g. safety functions)
 - Transparent documentation of the management of subjective factors, i.e. expert judgement, decision-making
- **Model uncertainties**
 - Recommendations w.r.t. model qualification
 - Handling of surrogate models
 - Preferential utilization of open-source software

WP 3 Recommendations: Examples

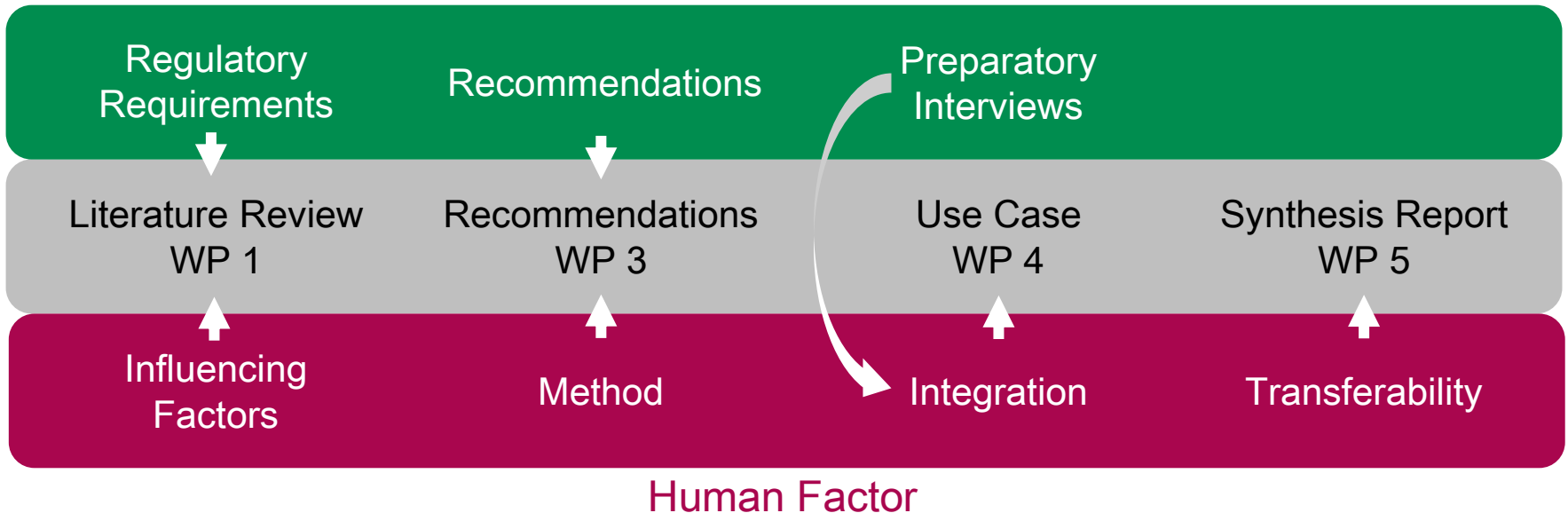
- Site comparison
 - Dose estimates not suitable for site comparisons
 - Indicators according to §§ 4-6 EndlSiAnfV only suitable for comparisons between sites with the same host rock and repository concept
 - Qualitative argumentation as basis for site comparison
 - Consideration of the potential for avoidance, reduction or mitigation of uncertainties and their impacts
- Public communication
 - Multilevel-documentation (target-group oriented)
 - Transparent communication, in particular concerning results of safety evaluation
 - Explain assumptions and their impacts

WP 3 Recommendations: Examples

- Human factors
 - Consideration and documentation of psychological aspects of decision-making, e.g. during
 - development of uncertainty management strategy,
 - scenario development,
 - qualitative/quantitative description of uncertainties.
 - Need to be considered during all phases and activities
 - no preferential treatment of particular decision paths / options,
 - deliberative decision-making,
 - potential future impact of human error / bias on the different options.
 - Detailed consideration of human factors by UK A&O

ENSURE: Main WP and Outputs

Scientific and Technical Uncertainties





WP 1 Human Factors

- Literature Research: uncertainties due to human factors
- Analysis of possible influences of psychological aspects
 - at the level of individuals (cognition)
 - at the level of groups (communication and coordination)
 - at the level of the system (external influences)
- Human beings act in the site selection as a...planner
 - ...designer
 - ...constructor
 - ...evaluator

WP 1 Human Factors - Background

- Human information processing...
- ...is based on cognitive concepts (individual experiences)
- ...has limits regarding perception, processing
 - Perception, e.g. Interest and dissonance (reduction)
 - Processing, e.g. short-term memory
- Leads to the use of simplifications and heuristics (mental shortcuts)
 - Devaluation of conflicting information
 - Practical search for solutions with the risk of biases



[1]

WP 1 Human Factors - Examples

■ *Confirmation Bias*

- The tendency to search for, interpret and remember information in a way that confirms preexisting beliefs while ignoring conflicting information.
 - Targeted search for literature that supports the model assumptions
 - Contradictory literature is devalued, contradictory data is classified as outliers



■ *Groupthink*

- The desire for conformity and agreement takes primacy over critical thinking and correct evaluation.
- Alternative actions are not (realistically) evaluated.
 - In order to avoid a controversial discussion, the correctness of the selected parameters is not questioned
 - Silence is interpreted as agreement



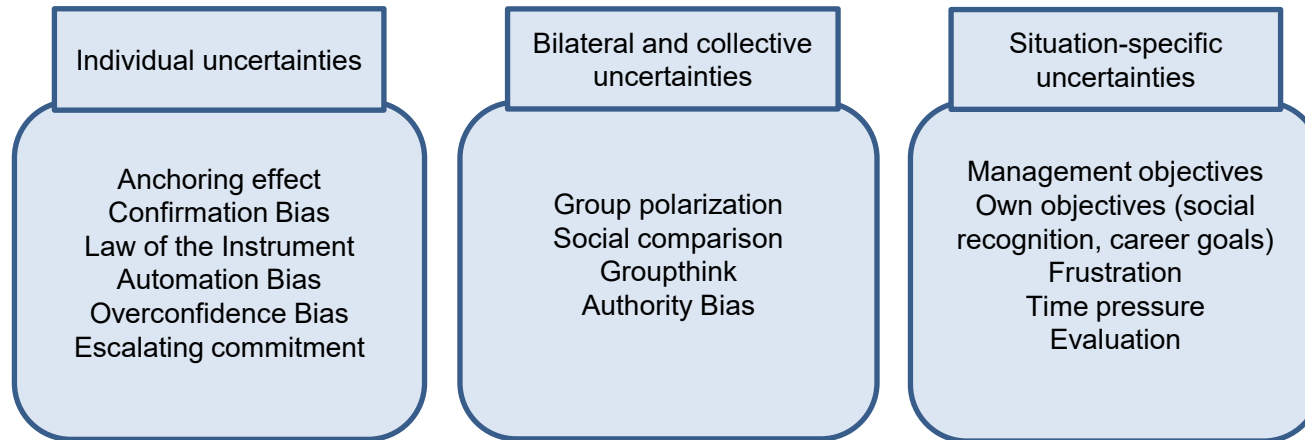


WP 3 Method and Recommendations

- Requirements:
 - Structured method to collect quantitative data
 - Measure uncertainties due to human factors
 - Improving human reliability with recommendations
 - Evaluate processes of individuals and groups
 - Economical and easy to use
- ➔ Development of an assessment tool (questionnaire)

WP 3 Method and Recommendations

- Assessment of Human Reliability In Concept phases (AHRIC)
- Self-rating statements as self-monitoring
- Overview:



WP 3 Method and Recommendations

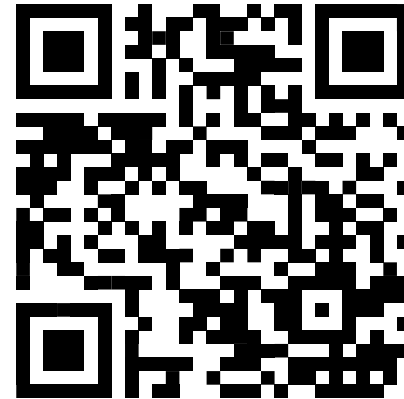
- Some examples:

Scale	Item	completely agree	mostly agree	agree to some extent	disagree to some extent	mostly disagree	completely disagree
Confirmation Bias	It was clear to me early on what the results of my modeling (research project) would be. (inverted)						
	I avoided nonapplicable information when working on my modeling (research project). (inverted)						
Groupthink	The leader in my modeling (research project) has clear project ideas and usually implements them. (inverted)						
	In my research group/working group, very different views or opinions are sometimes discussed due to the heterogeneous composition of the members.						



WP 3 Method and Recommendations

- Available versions of the questionnaire:
 - AHRIC – L (Long Version with 102 Items)
 - AHRIC – M (Medium Version with 24 Items)
 - AHRIC – S (Short/Screening Version with 9 Items)





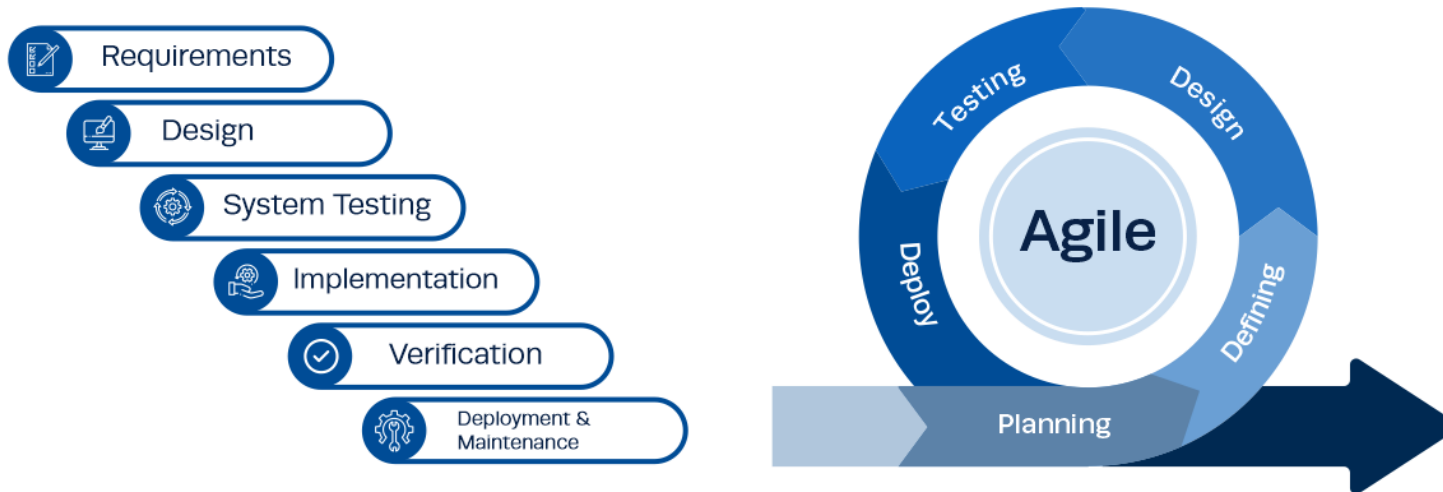
WP 3 Method and Recommendations

- Improving human reliability with recommendations
- Formulation of automated recommendations for action
- Generic formulation intended to stimulate further thinking and reflection

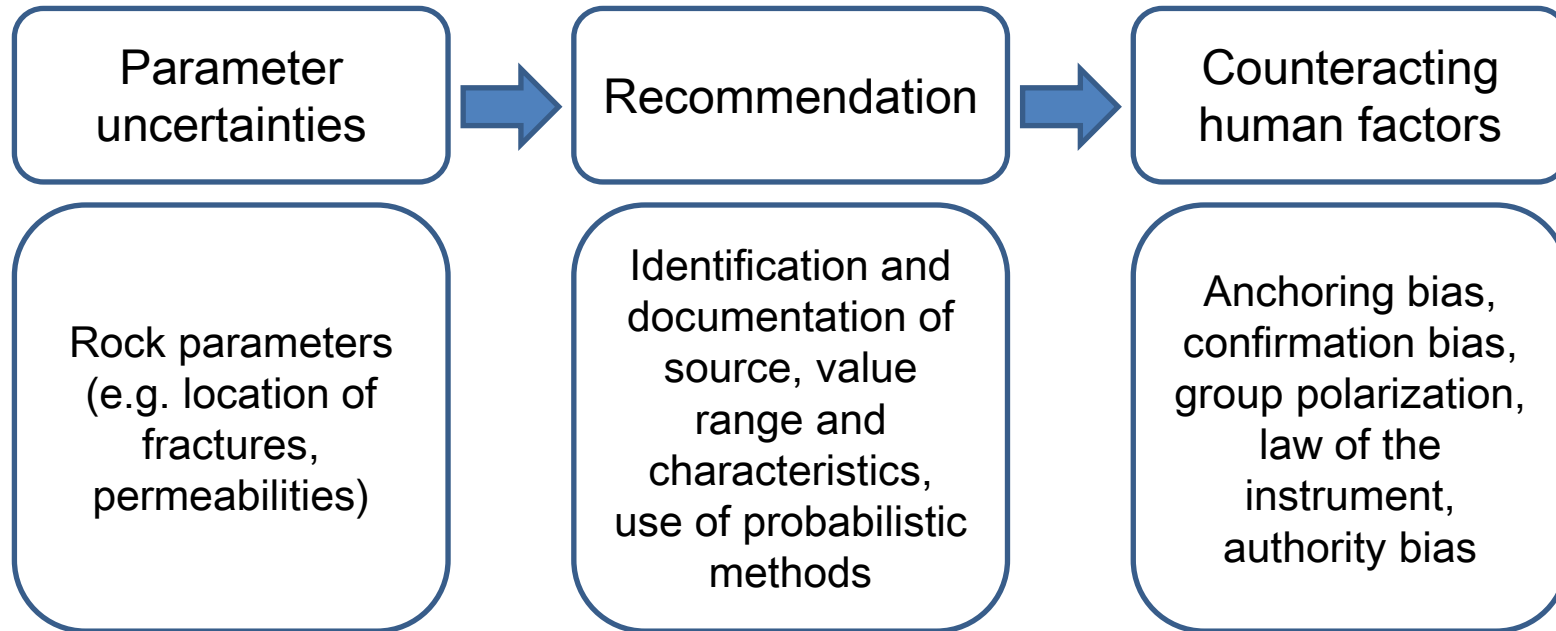
- *Confirmation bias*
 - “Identify the steps in your project where you had specific ideas about scenarios or outcomes. Actively search for information that contradicts these ideas. This may allow you to develop a new perspective on scenarios or results that enables you to make different statements.”

WP 2+4 Use Case in URS projects

Waterfall vs Agile Approach

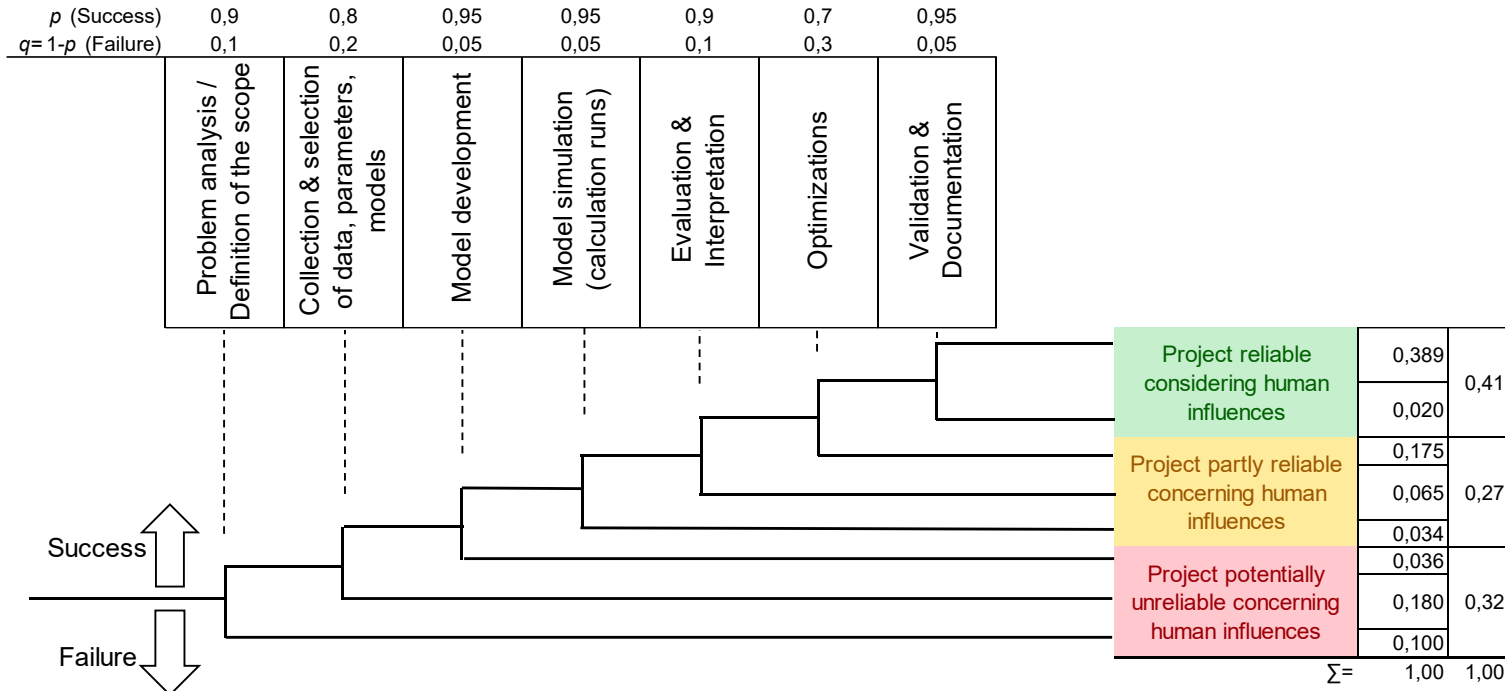


WP 2+4 Use Case - Example



WP 5 Transferability

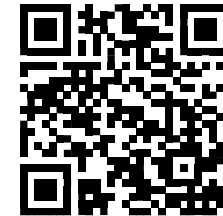
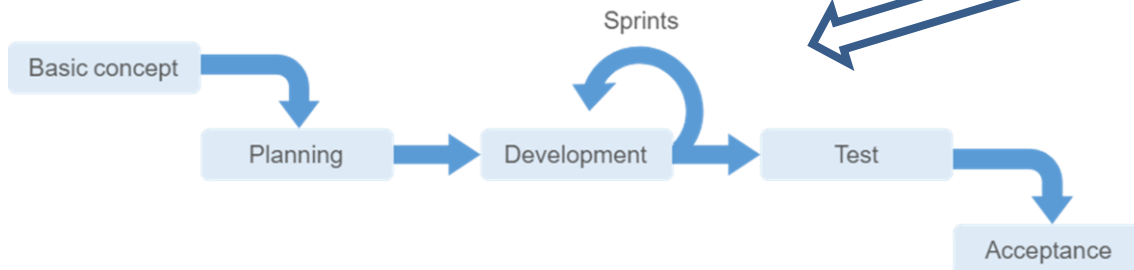
Quantification based on hypothetical assumptions



WP 5 Transferability

- Integration into classic (and agile) project management of site selection process
- Ensuring uncertainties due to human factors (bias) in project milestones and meetings

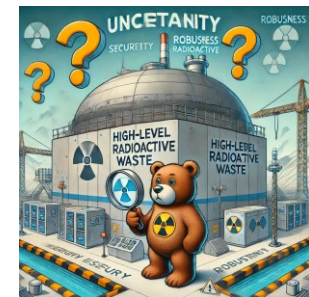
Hybrid project management
(e.g. Water-Scrum)



AHRIC – S
(Screening
Version with 9
Items)

Summary of contributions

- Recommendations for the consideration of uncertainties and their interaction for the further process of the vSU
- Self-Resilience Monitoring (*AHRIC – M*)
 - Questionnaire intended for self-assessment (confidence, biases, self-rating)
 - Aim: increasing confidence in one's own work (e.g. modeling actions)
- Group-Resilience Monitoring (*AHRIC – S*)
 - Questionnaire for group resilience (confidence, biases, group-think)
 - Aim: increasing confidence in decisions



AI-generated by OpenAI (DALL·E)

Thank you for your attention!

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**BUNDESGESELLSCHAFT
FÜR ENDLAGERUNG**



References

- [1]: <https://www.bestmastersinpsychology.com/wp-content/uploads/2015/02/cognitive-psychology-289x300.jpg>
- [2]: <https://projectmanagement.ie/blog/waterfall-methodology/>
- [3]: <https://www.teamspace.com/hybrid-project-management/>