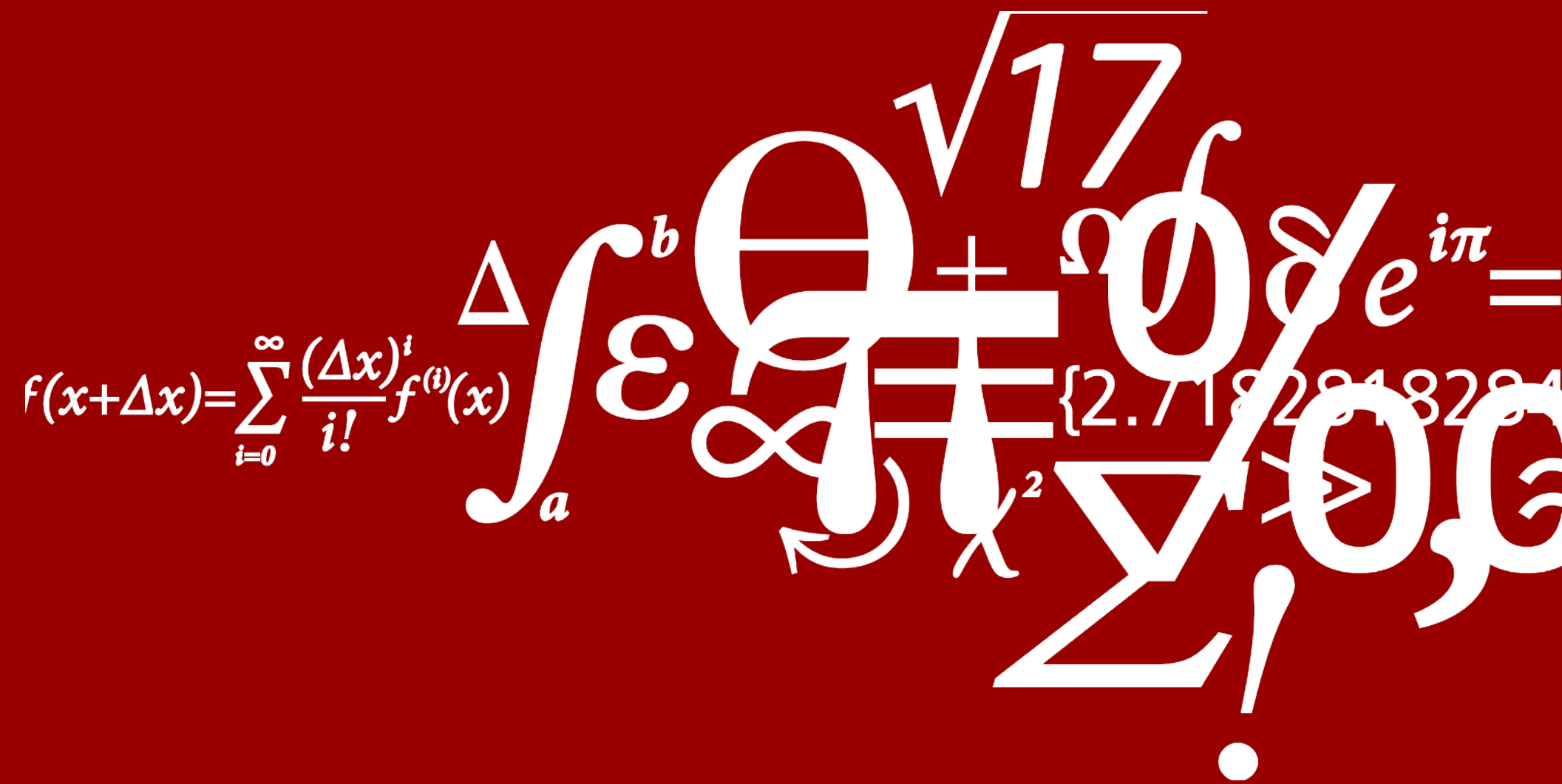


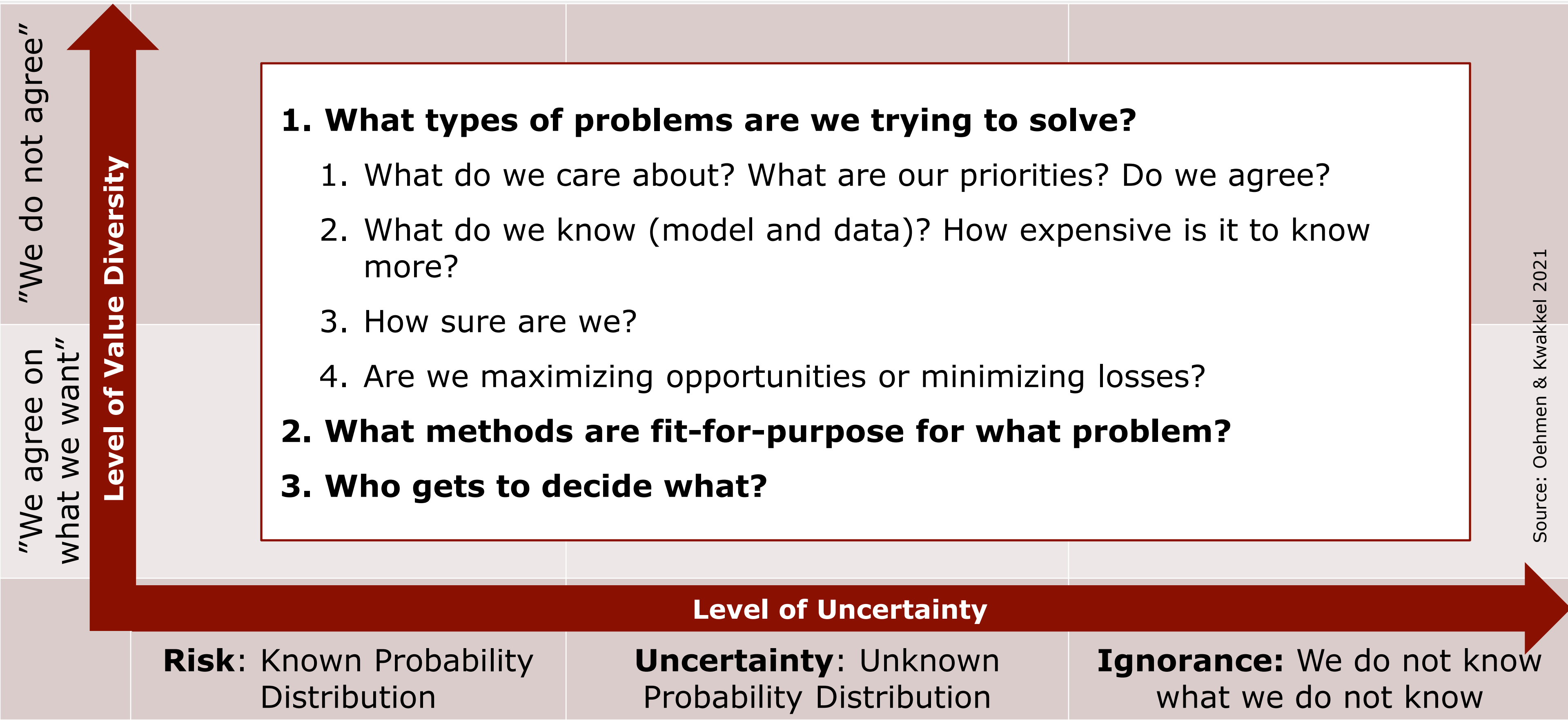
Managing Risk, Uncertainty and Ignorance

Prof. Dr. Josef Oehmen

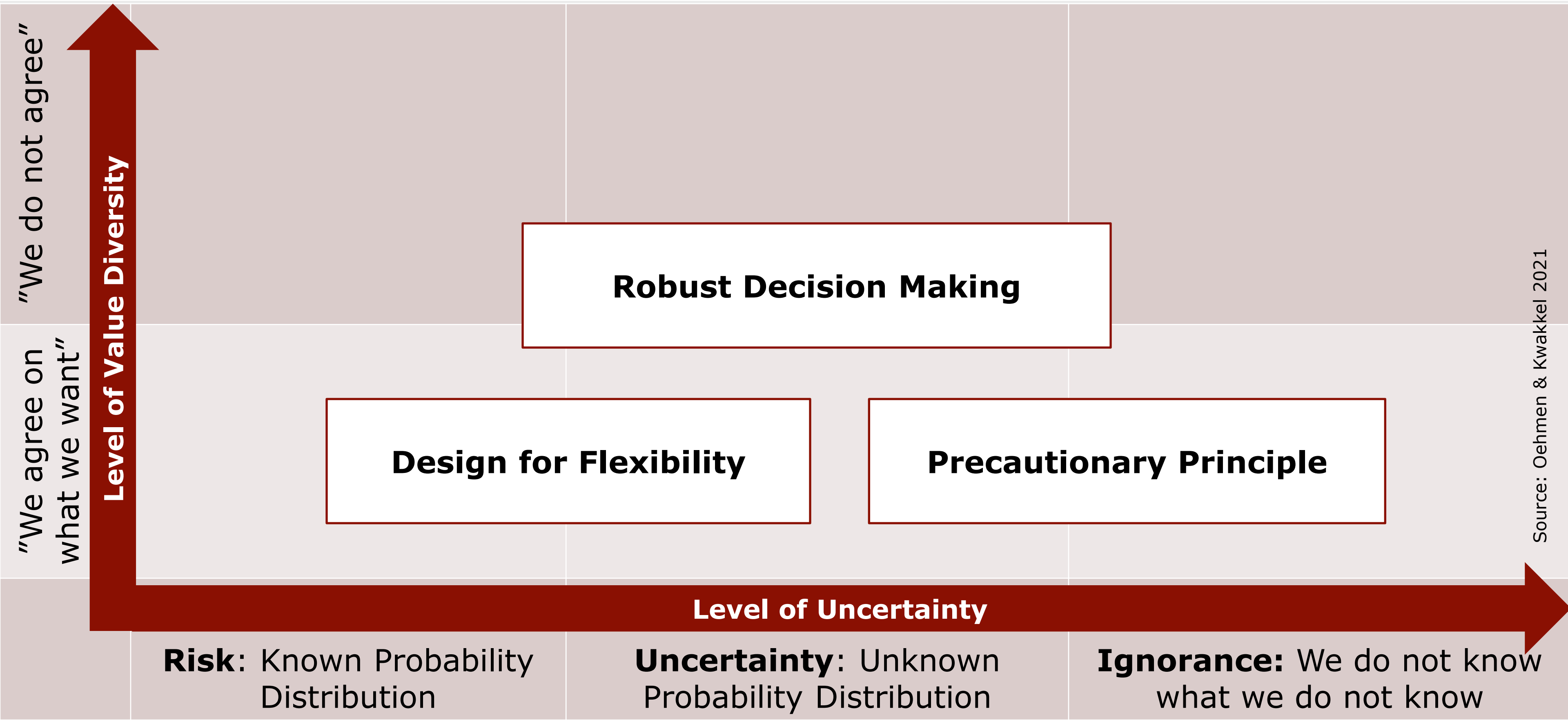
Technical University of Denmark



Why there is no one-size-fits-all solution: From “Risk Management” to “Risk Governance”



Why there is no one-size-fits-all solution: From “Risk Management” to “Risk Governance”



Robust Decision Making: Good decisions without predictions.

First: Minimize regret. Then: Maximize value.



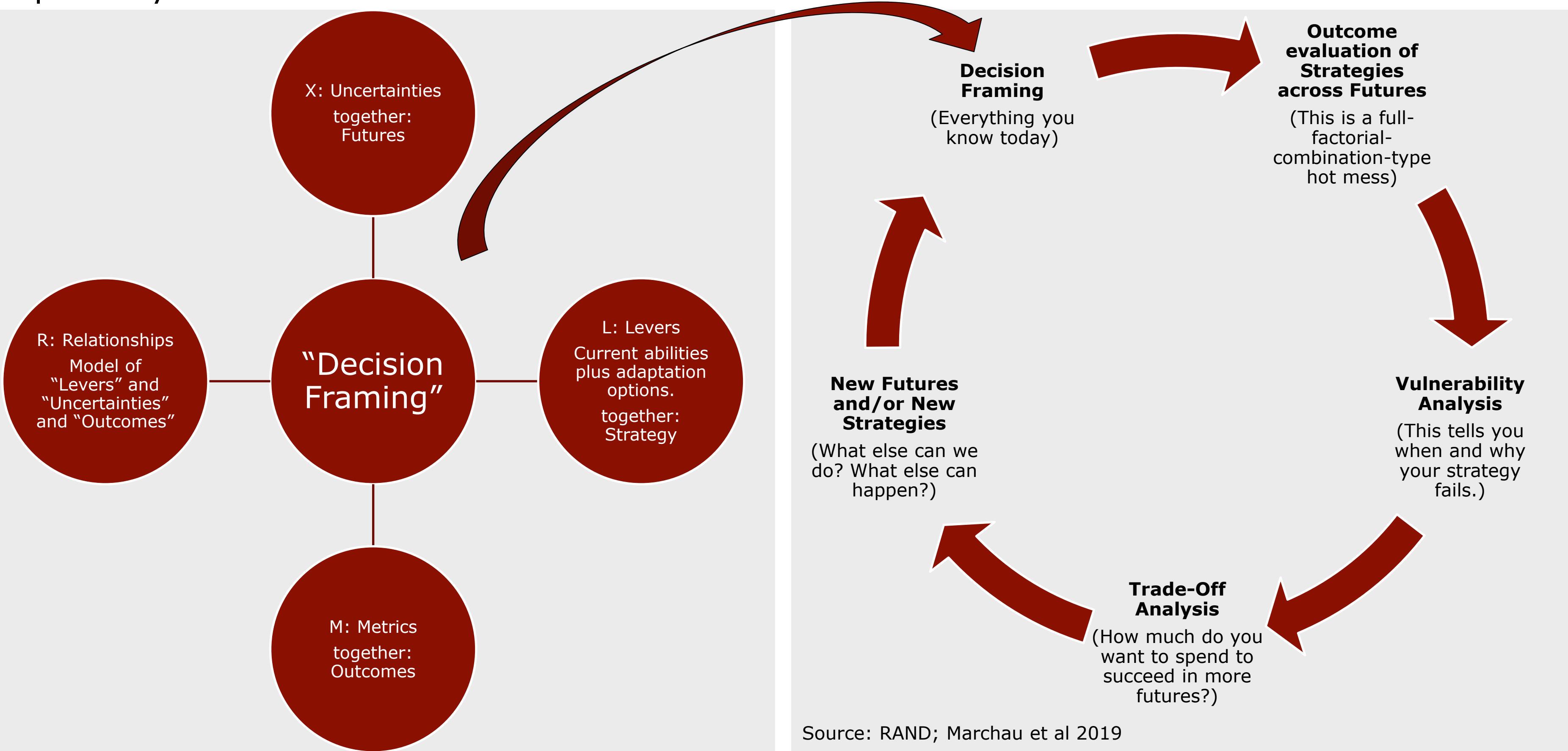
What do we care about? Do we agree?	We know – in principle. Different stakeholders have different priorities. We are not sure about the trade-offs.
What do we know (model and data)?	We know what failure and success look like. We have some ideas about causal structures. We have no or poor statistical data.
How sure are we?	We are not sure about and/or cannot agree on either data or causal structure. We know we are working with assumptions. We know we will learn more and want to take advantage of new knowledge
Are we preventing loss, or enabling gain?	We want “robust”, not “optimal (but brittle)” – good enough under a wide range of plausible futures. We must avoid catastrophic outcomes. We want to understand vulnerabilities and trade-offs.



RDM helps you discover more options to not fail, at minimum cost (and then take it from there)



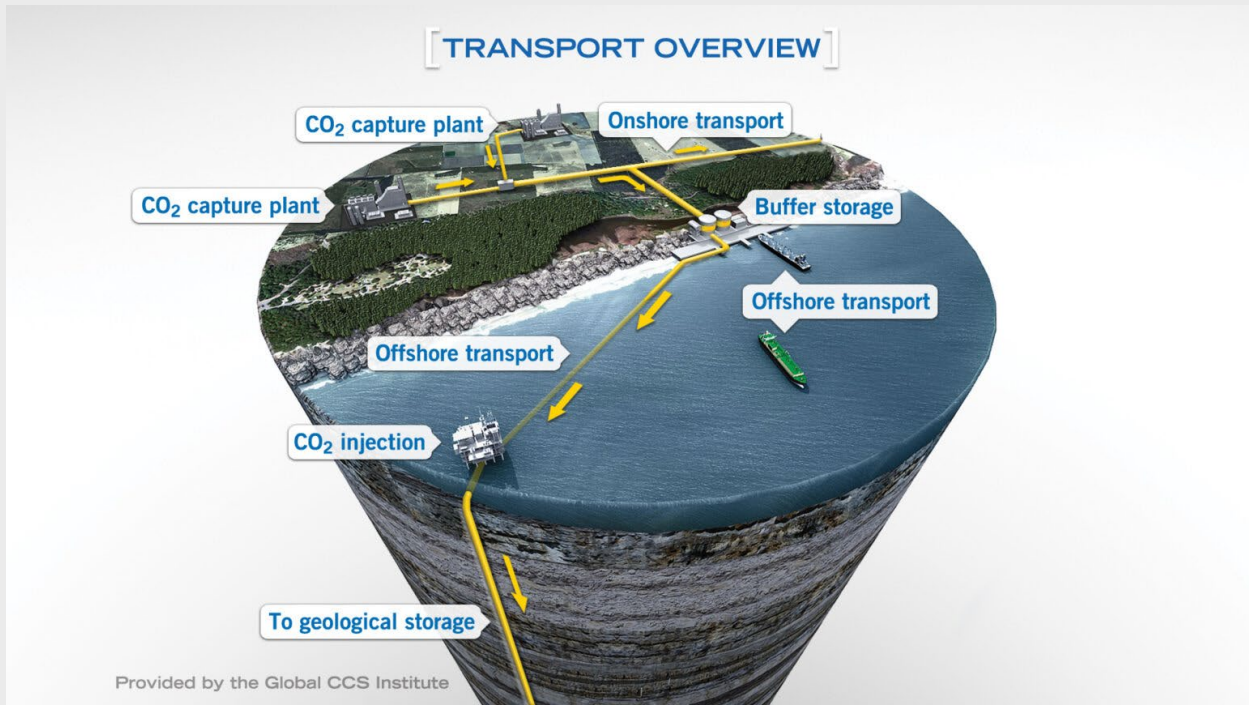
From: “Whose prediction is correct” to “deliberation with analysis” to “adaptive pathways”



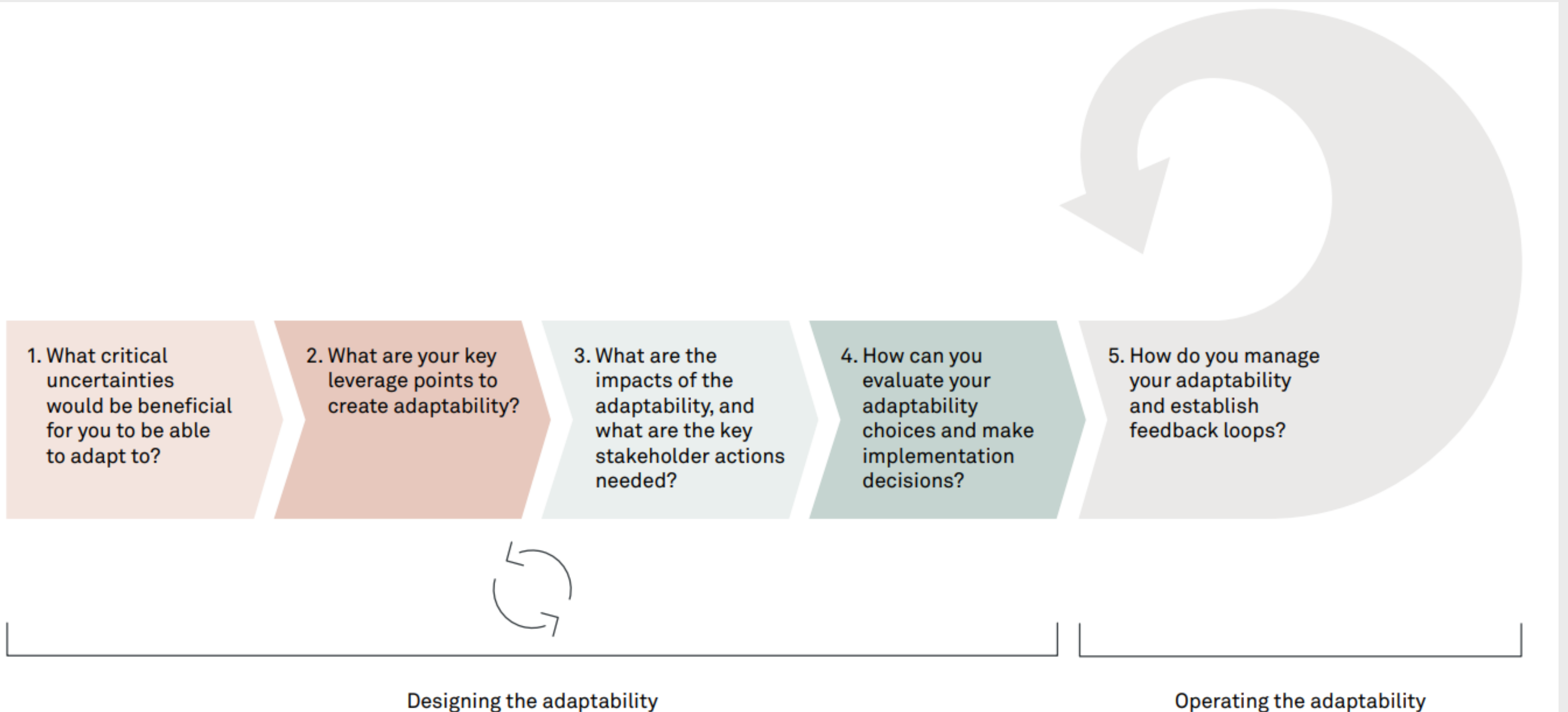
Design for Flexibility: Large CAPEX infrastructure with build-in smart options



What do we care about? Do we agree?	We agree.
What do we know (model and data)?	We know our causal structure We have some statistical data (at least plausible upper and lower bounds).
How sure are we?	We are sure about our causal structure and statistical data. We do not know if or when adverse or positive events or developments will happen.
Are we preventing loss, or enabling gain?	We want to maximize our objective function (usually expected NPV) under a range of scenarios, while limiting worst-case outcomes to acceptable levels.



Designing for *Scalability* and *Functional Flexibility*: Give yourself a chance to make smart choices later



Precautionary Principle: When the worst case is not acceptable

Or: We cannot detonate a thermonuclear device until we are reasonably sure that we will not set the atmosphere on fire.



What do we care about? Do we agree?	We carry the burden of proof to show what we do is safe. It is NOT someone else’s responsibility to proof that it is dangerous. Uncertainty is NOT a justification for regulatory inaction.
What do we know (model and data)?	We do not sufficiently understand causal structures, nor do we have reliable data to feed our model. Our knowledge does not satisfy any scientific standard of “proof of harm”.
How sure are we?	We are sure we do not know what we need to know to proof that what we do is safe.
Are we preventing loss, or enabling gain?	Better safe than sorry. We are not concerned about opportunities. We are clearly focused on catastrophic risk, i.e. morally unacceptable or irreversible harm.

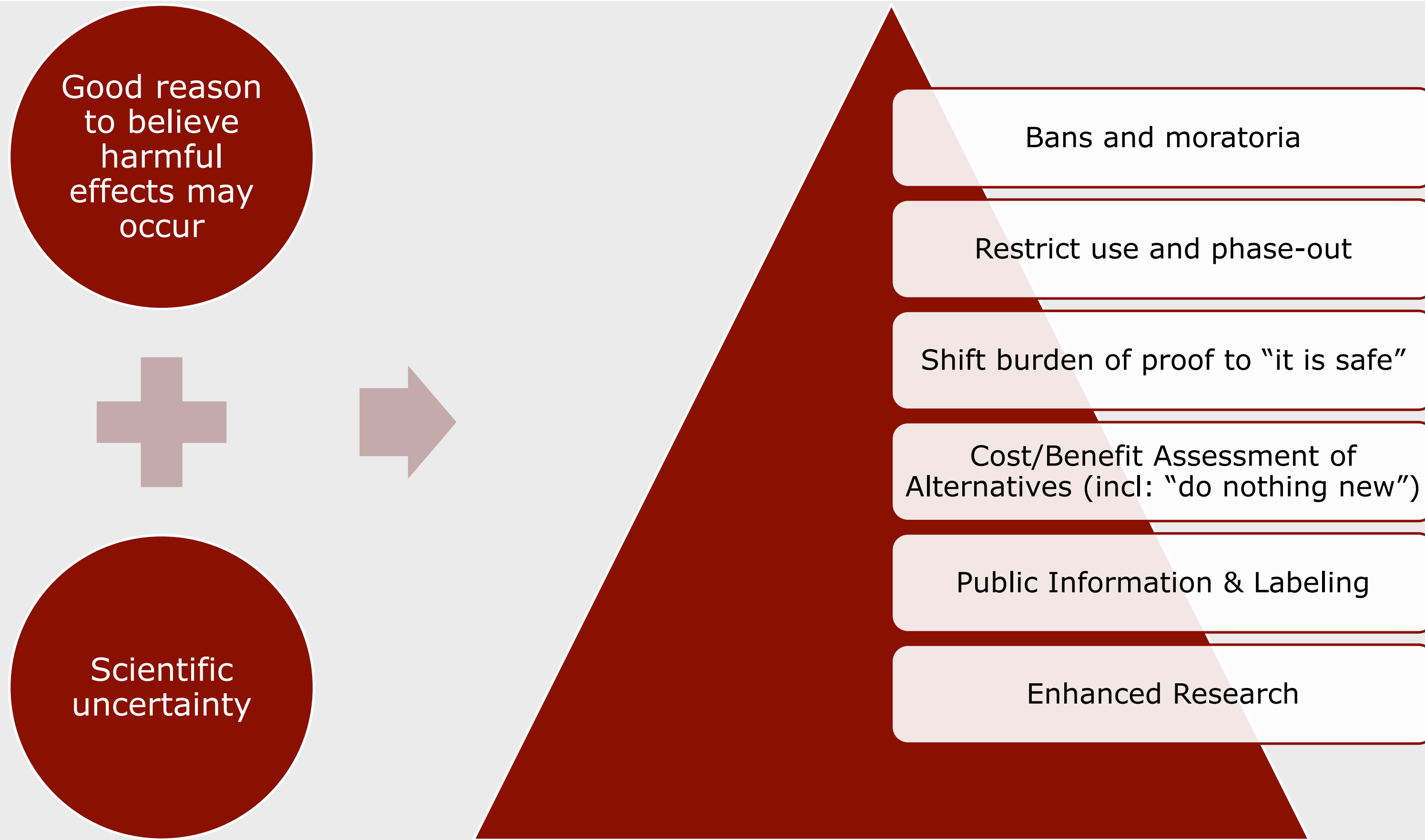


European Union

“Directive 2001/18/EC - Deliberate Release of GMO”

The Precautionary Principle offers a range of options

(contrary to public opinion, not all a bad for innovation)



Introductory Literature

Each of these domains has many professors and even more consultants vying for your approval (and funding). These are my personal recommendations to get started.



Some of my work

- Oehmen & Kwakkel (2021): **Risk, Uncertainty and Ignorance in Engineering Systems Design**. https://link.springer.com/rwe/10.1007/978-3-030-46054-9_10-1
- Wied, Oehmen, Welo (2019): **Conceptualizing Resilience**. <https://incose.onlinelibrary.wiley.com/doi/full/10.1002/sys.21491>
- Willumsen, Oehmen et al (2024): **Adaptability by Design** (Report): <https://orbit.dtu.dk/en/publications/making-the-green-transition-resilient-adaptability-by-design>

On Robust Decision Making

- Marchau et al. (2019): **Decision Making under Deep Uncertainty**. <https://link.springer.com/book/10.1007/978-3-030-05252-2>

On Designing for Flexibility

- De Neufville, Scholtes (2011): **Flexibility in Engineering Design**. <https://direct.mit.edu/books/monograph/2955/Flexibility-in-Engineering-Design>

On the Precautionary Principle

- ERPS (2015): **The precautionary principle**. [https://www.europarl.europa.eu/RegData/etudes/IDAN/2015/573876/EPRS_IDA\(2015\)573876_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/IDAN/2015/573876/EPRS_IDA(2015)573876_EN.pdf)
- A critical discussion: Foster et al (2000): **Science and Precautionary Principle**. <https://www.science.org/doi/10.1126/science.288.5468.979>
- Policy example: **EU Directive 2001/18/EC** <https://eur-lex.europa.eu/eli/dir/2001/18/oj/eng>

Thank you!

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