



**Black Swans in the Arctic:
How to cope with Complexity, Uncertainty and
Ambiguity in Risk Governance**



Seminar

Potsdam, July 1, 2014

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Interdisciplinary Understanding of Risk

- *Risk = possibility of experiencing harm*
- *Key Terms*
 - Hazard: potential to cause harm
 - Hazards: energy, material, pathogens, information
 - Risk agent: hazard carrier
 - Risk absorbing system: endpoint or target for harm
 - Exposure: target affected by the agent
 - Vulnerability: affect to which risk absorbing system is affected by risk agent
- *Different concepts of risks in different disciplines*

Three Challenges of Knowledge about Risk

- *Complexity* in assessing causal and temporal relationships
- *Uncertainty*
 - variation among individual targets
 - measurement and inferential errors
 - genuine stochastic relationships
 - system boundaries and ignorance
- *Ambiguity* in interpreting results

Risk and Uncertainty: Conceptual Note I

■ *Linear relationships*

- Plausible connection between cause and effect
- Symmetry between explanation and prediction
- Lack of intervening variables
- Stable context conditions
- Normal distribution of aleatory elements in prediction

■ *Complexity*

- Cause-effect chain requires modeling (not obvious)
- Many intervening variables and changing context conditions
- Explanation ex post possible, prediction often fuzzy
- Resolution by scientific investigations and scrutiny

Risk and Uncertainty: Conceptual Note II

■ *Uncertainty (first order)*

- Complexity cannot be fully resolved
- Combination of aleatory and epistemic uncertainty
- Caused by data imprecision, model limits, and extrapolation methods (confidence intervals)
- Quantitative estimates possible but not fully reliable

■ *Uncertainty (second order)*

- Cause-effect likely but neither proven nor quantifiable
- Genuine stochastic relationships (do they exist?)
- System boundaries (observation limits)
- Non-knowledge (surprises, outliers, idiosyncracies)

Risk and Uncertainty: Conceptual Note III

■ *Implication for uncertainty (first order)*

- Tradeoffs between risk and benefits impossible to calculate, but numerical estimates are helpful
- Need for advanced methods of uncertainty characterization
- Need for **robust** risk management

■ *Implication for uncertainty (second order)*

- Concept of tradeoffs may be misleading
- Need for qualitative characterization of knowledge boundaries
- Focus on vulnerability of risk absorbing systems
- Need for **resilient** risk management

Risk and Ambiguity: Conceptual Note IV

■ *Interpretative ambiguity*

- Not related to factual statements but to interpretation with respect to a value dimension (such as “adverse effect” or “safety”)
- Variation due to different values or priorities on values
- Need for discourse-based management (goal of common understanding)

■ *Normative ambiguity*

- Related to judgment about tolerability or acceptability
- Variation due to legal context, level of aspired safety, security and quality of life, related to value clusters
- Need for discourse-based management (goal of legitimate agreements)

Special Challenge: Systemic Risks

■ Characteristics

- Highly complex
- Second order uncertainty (non-knowledge)
- High interpretative and normative ambiguity
- Open system boundaries (ripple effect)

■ Problems

- Limits of quantification
- Plurality of risk assessment results and uncertainty characterization
- System breakdown possible
- Potential for high social mobilization

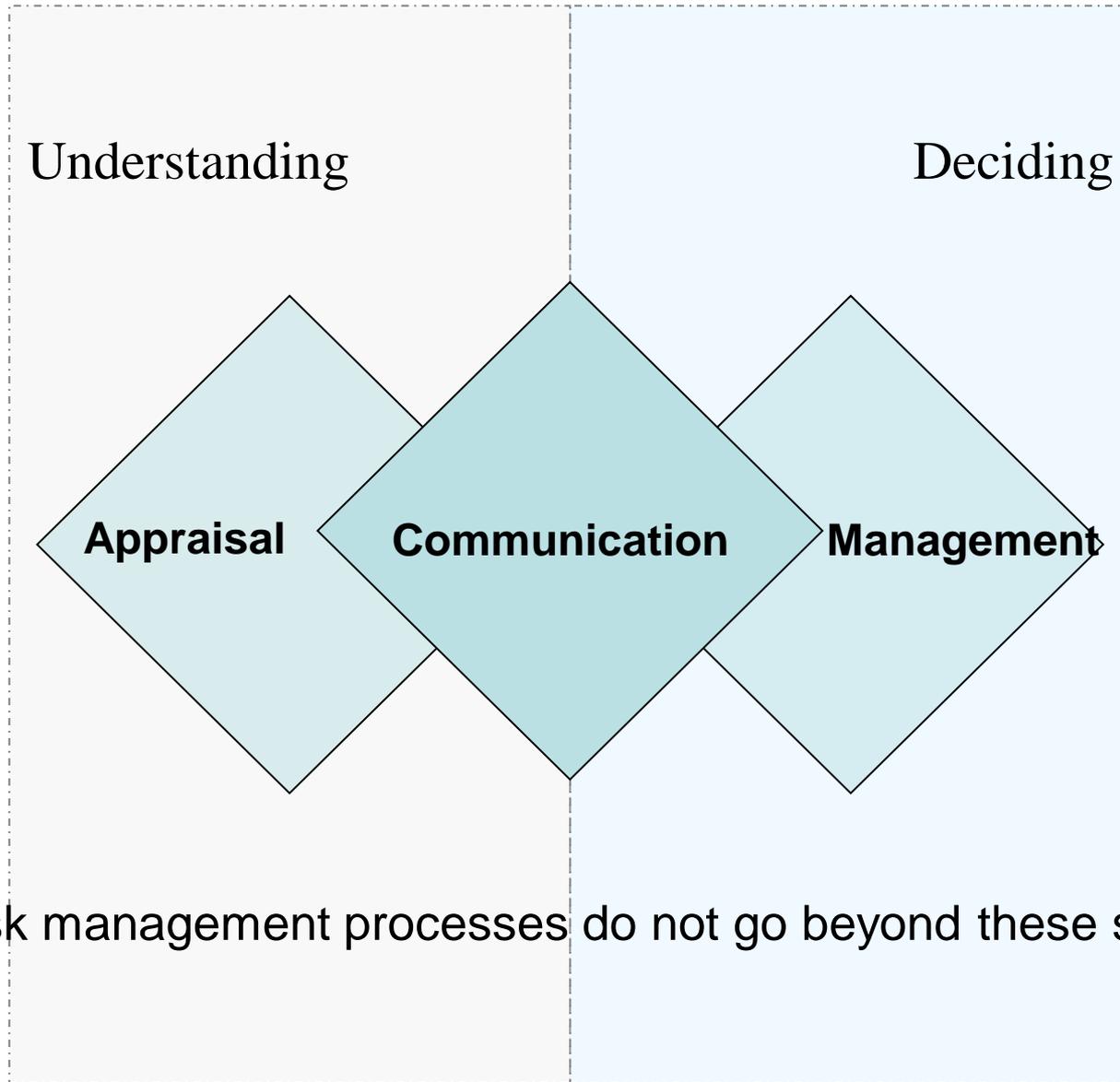
Part 2:

The Basic Fabrics of Risk Governance

**Complexity, Uncertainty and
Ambiguity in:**

Risk Governance

CONVENTIONAL RISK MANAGEMENT



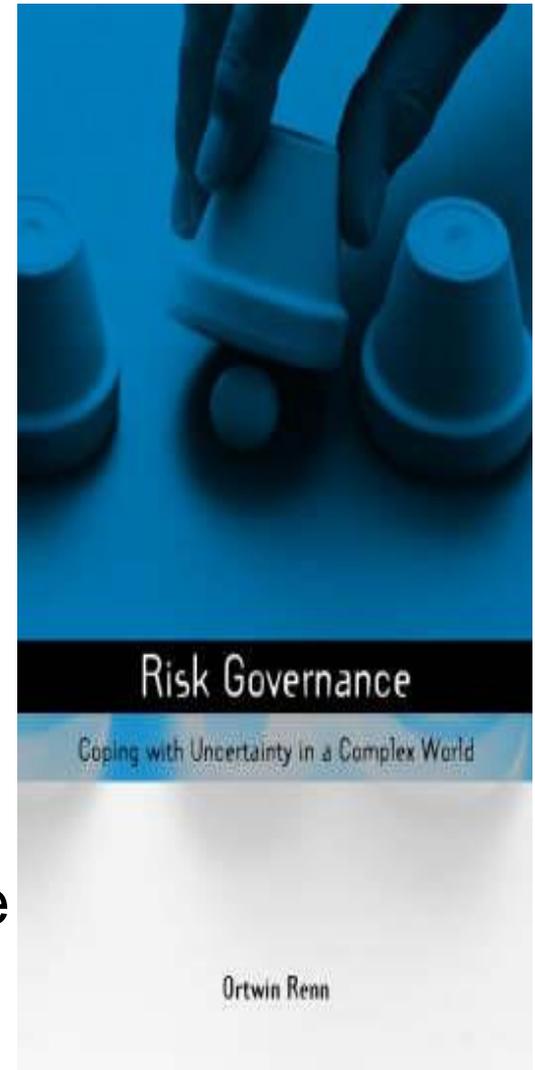
Most risk management processes do not go beyond these steps

Need for integration

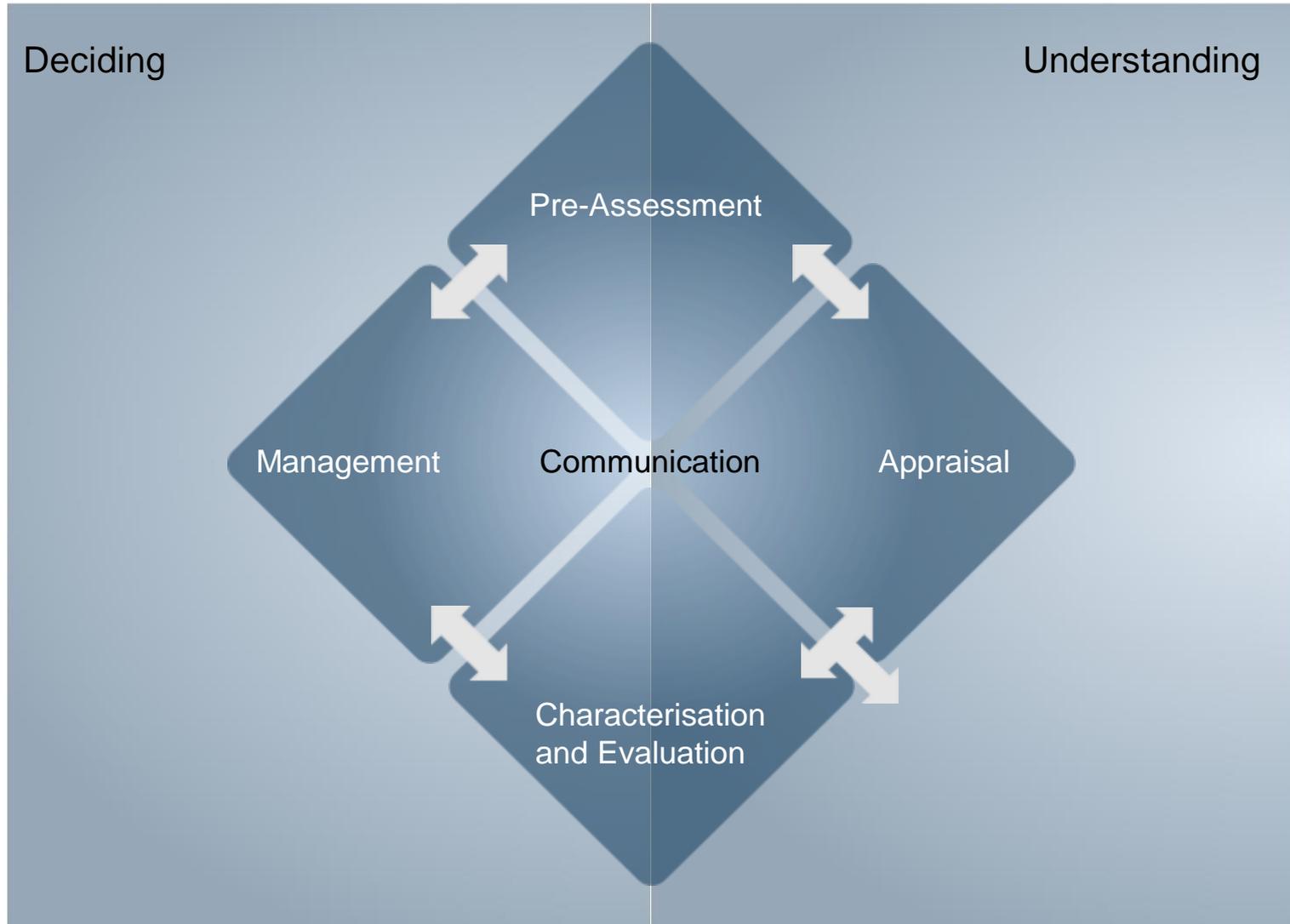
- Concept that links risk assessment with risk perception and social processing of risk
 - Avoiding relativist view of knowledge
 - Including social constructions of risks;
- Concept that links physical and environmental risk analysis with financial, economic and social risk;
 - Explore social amplification pathways
 - Look for cross-fertilization
- Concept that addresses complexity, uncertainty and ambiguity
 - Different guidelines for dealing with mixtures of CUA
 - Emphasis on inclusive governance models capable of providing adequate input to deal with CUA

Premises of Risk Governance

1. Both “real” and perceived dimensions of risk are important.
2. All stakeholders should be meaningfully involved as equals.
3. Be process-focused and principled
 - transparent, equitable, effective, efficient and accountable
4. It is based on an inclusive model of integrating governments, private sector, civil society and experts
5. It should be based on best available science and reliable and fair judgment procedures



Risk Governance Process



Part 3:

The Unique Features of Risk Governance

**How are complexity,
uncertainty and ambiguity
considered in each phase of
governance?**

Phase 1



IMPORTANCE OF FRAMING

- *Frames represent social, economic and cultural perspectives*
 - Challenge or problem
 - Opportunity or risk
 - Innovation or intervention
- *Frames determine boundaries of what is included and excluded*
 - Time and duration (future generations, sustainability)
 - Location and space (the universe, all nations, Potsdam)
 - Social class and stratus (vulnerable groups, poor, immigrants)
 - Types of adverse effects (physical, mental, social, cultural)
 - Primary or secondary impacts (ripple effects)
 - Criteria taken into account (risk reduction, cost, benefit, equity, environmental justice, value violations...)

Addressing complexity, uncertainty, ambiguity

- *Emphasis here is on ambiguity*
 - Different perspectives on the problem
 - Different perspective on institutional responses to problem
 - Different concepts about route of risk handling
- *Complexity and uncertainty are also included:*
 - Need for risk classification (complex, uncertainty of first order and second order, ambiguity)
 - Need for investigating system boundaries and potential for surprises
 - Need for stakeholder involvement for collecting and interpreting different frames

Phase 2

APPRAISAL

RISK APPRAISAL

■ Risk Assessment

- Hazard identification and estimation
- Exposure assessment
- Risk estimation

■ Concern Assessment

- Socio-economic impacts
- Economic benefits
- Public concerns (stakeholders and individuals)

Addressing Complexity, Uncertainty, Ambiguity

■ Risk Assessment

- First distinction; simple versus complex
- Second distinction: uncertainty of first order
- Third distinction: uncertainty of second order
- Final step: Risk profile

■ Concern Assessment

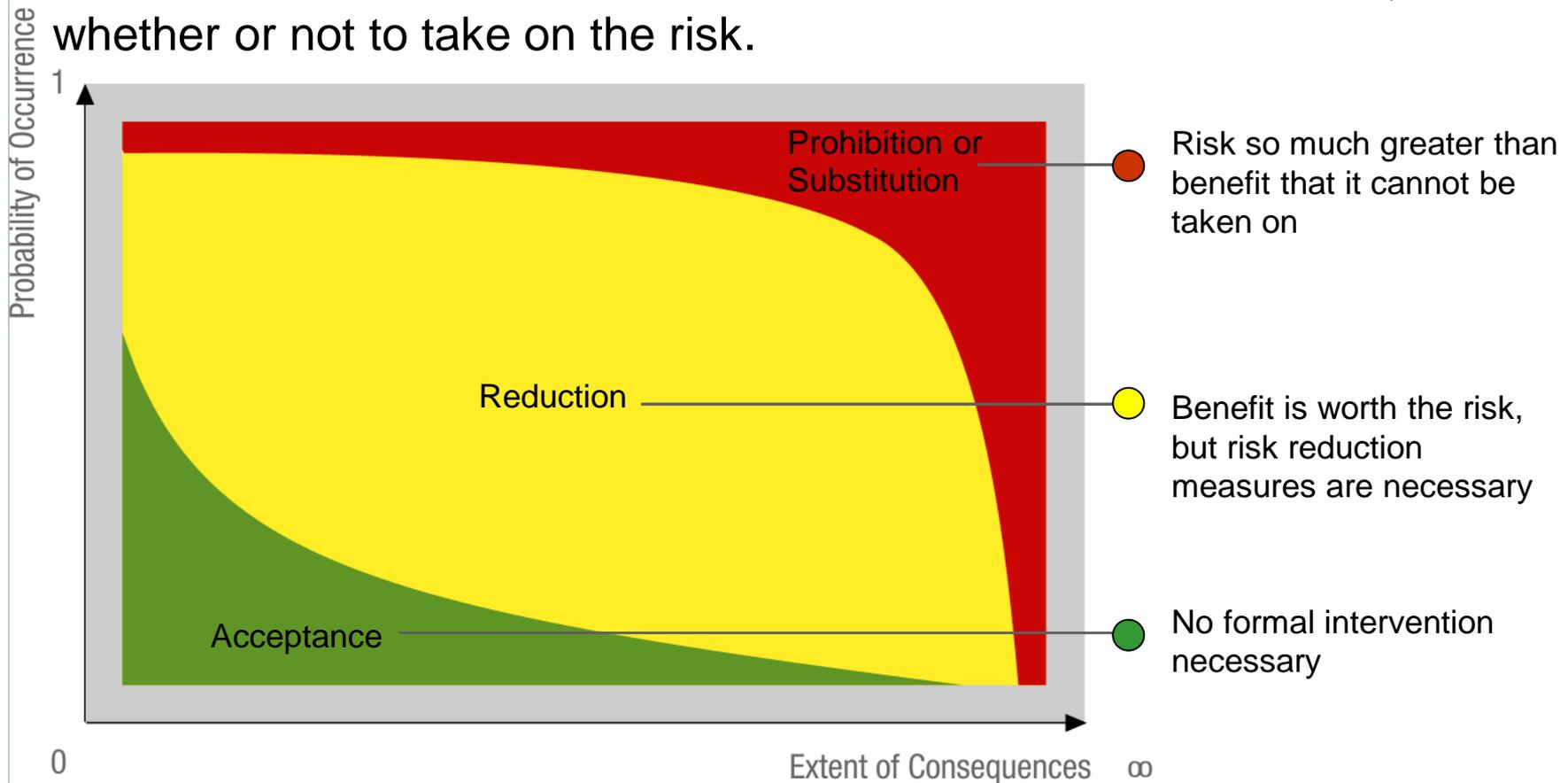
- First distinction: Likelihood of social concerns and negative perceptions
- Second distinction: Low or high amplification potential
- Final step: Concern profile

Phase 3

Tolerability and Acceptability Judgment

EVALUATION – IS THE RISK ACCEPTABLE, TOLERABLE OR INTOLERABLE / NOT-ACCEPTABLE (TRAFFIC LIGHT MODEL)

Based on **both the evidence from the risk appraisal and evaluation of broader value-based choices and the trade-offs involved**, decide whether or not to take on the risk.



Acceptable Risk Tolerable Risk Intolerable Risk Not defined

Addressing complexity, uncertainty, ambiguity

■ Characterization:

- How complex are benefits and risks? Can they be modelled with a high degree of validity and reliability?
- How can we characterize the uncertainties of the first order (confidence intervals, ranges) and the uncertainties of the second order (limits of knowledge)
- How can we characterize social and individual concerns

■ Evaluation:

- How can we assign trade-offs between different risk categories and between risks and benefits (or opportunities) in case of complex and uncertain (first order) risks?
- How can we make prudent judgments facing uncertainty of the second order?
- What are the societal values and norms for making judgements about tolerability and acceptability?

Phase 4

RISK MANAGEMENT

NEED FOR DIFFERENT RISK MANAGEMENT STRATEGIES

- dealing with routine, linear risks
- dealing with *complex* and moderately *uncertain* risks (*first* order uncertainty)
- dealing with highly *uncertain* risks (high degree of *second* order uncertainty)
- dealing with highly *ambiguous* risks (high degree of controversy)
- dealing with imminent dangers or crisis (need for fast responses)

RISK MANAGEMENT STRATEGIES (I): ROUTINE AND COMPLEXITY

■ Linear Risk Management

- Sufficient knowledge of key parameters
- Little complexity, clear causal knowledge
- Standard Assessment sufficient
- Risk-benefit analysis and risk-risk comparisons as basic tool for evaluation

■ Risk-Informed Management

- High complexity of causal risk models
- Low uncertainty or only first order uncertainty
- Expanded risk assessment / need for knowledge management tools
- Emphasis on robust risk management strategies, i.e. risk standards including safety factors and dealing with ranges of impacts
- Emphasis on close monitoring of outcomes

RISK MANAGEMENT STRATEGIES (II): COPING WITH UNCERTAINTY

■ Precaution-Based Management

- High second order uncertainty
- Adverse effects plausible but quantification not reliable
- Limits of knowledge are recognizable
- Characterization of uncertainty by non-statistical means
- Goal of risk management: avoidance of irreversible effects
- Instruments:
 - Negotiation between too little and too much precaution
 - classic: ALARA etc.
 - new: containment, diversification, monitoring; substitution

RISK MANAGEMENT STRATEGIES (III): COPING WITH AMBIGUITY

■ Discourse-Based Management

- High ambiguity
- Goal of risk management:
 - to find common understanding among all stakeholders (interpretative ambiguity)
 - to find legitimate procedures of making collectively binding decisions on acceptability and tolerability (normative ambiguity)
- Instruments:
 - stakeholder involvement
 - public debate
 - risk communication

Complementary Phase

Implications for Risk Communication and Stakeholder Involvement

RISK COMMUNICATION

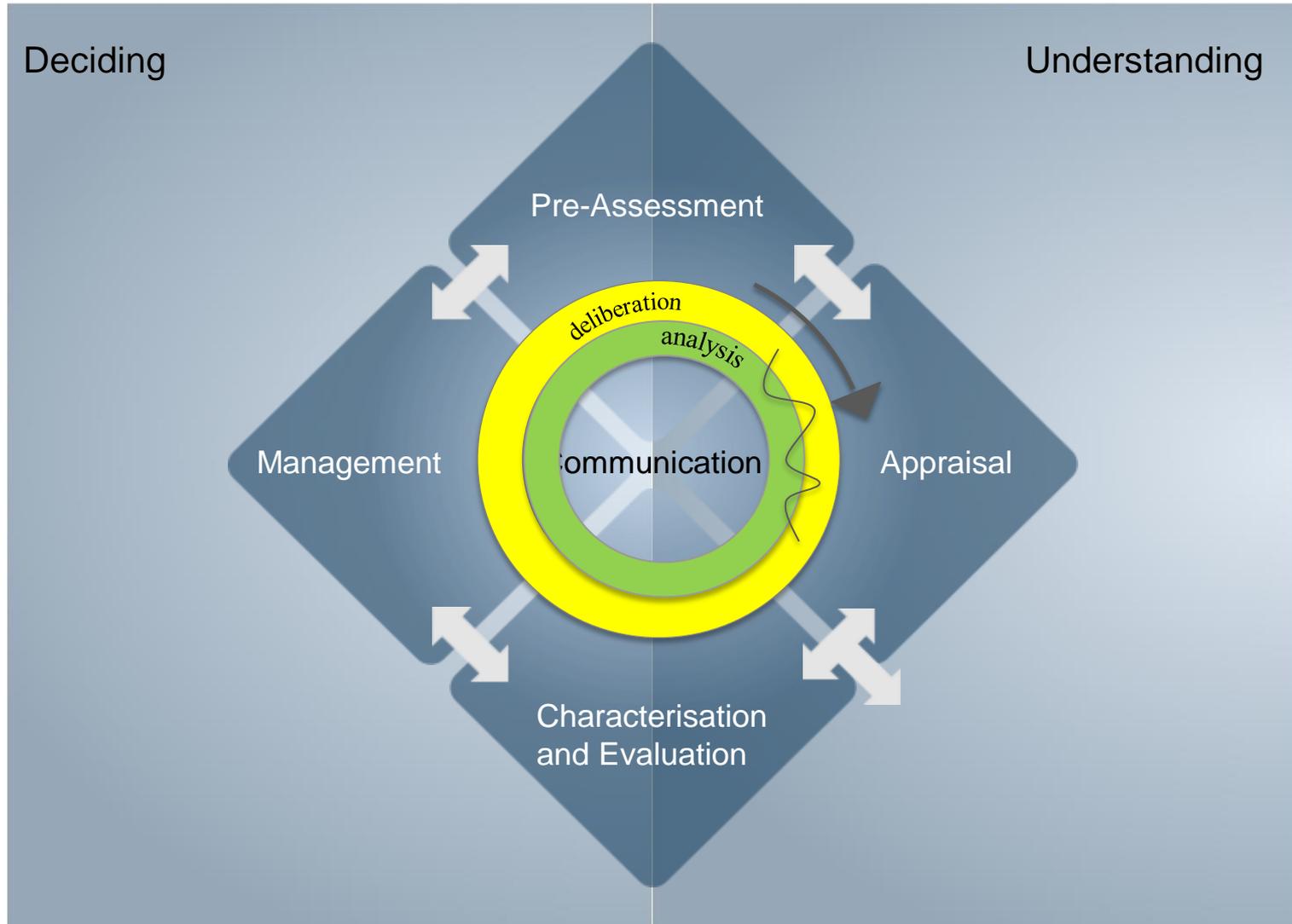
Risk Communication takes place in all 4 Governance phases

- **Internally (other agencies, regulatory bodies)**
- **Externally (stakeholders, media, public)**

Risk Communication should match risk characteristics

- **Complexity, uncertainty, ambiguity**

Risk Governance Process



Crucial Questions for Involvement

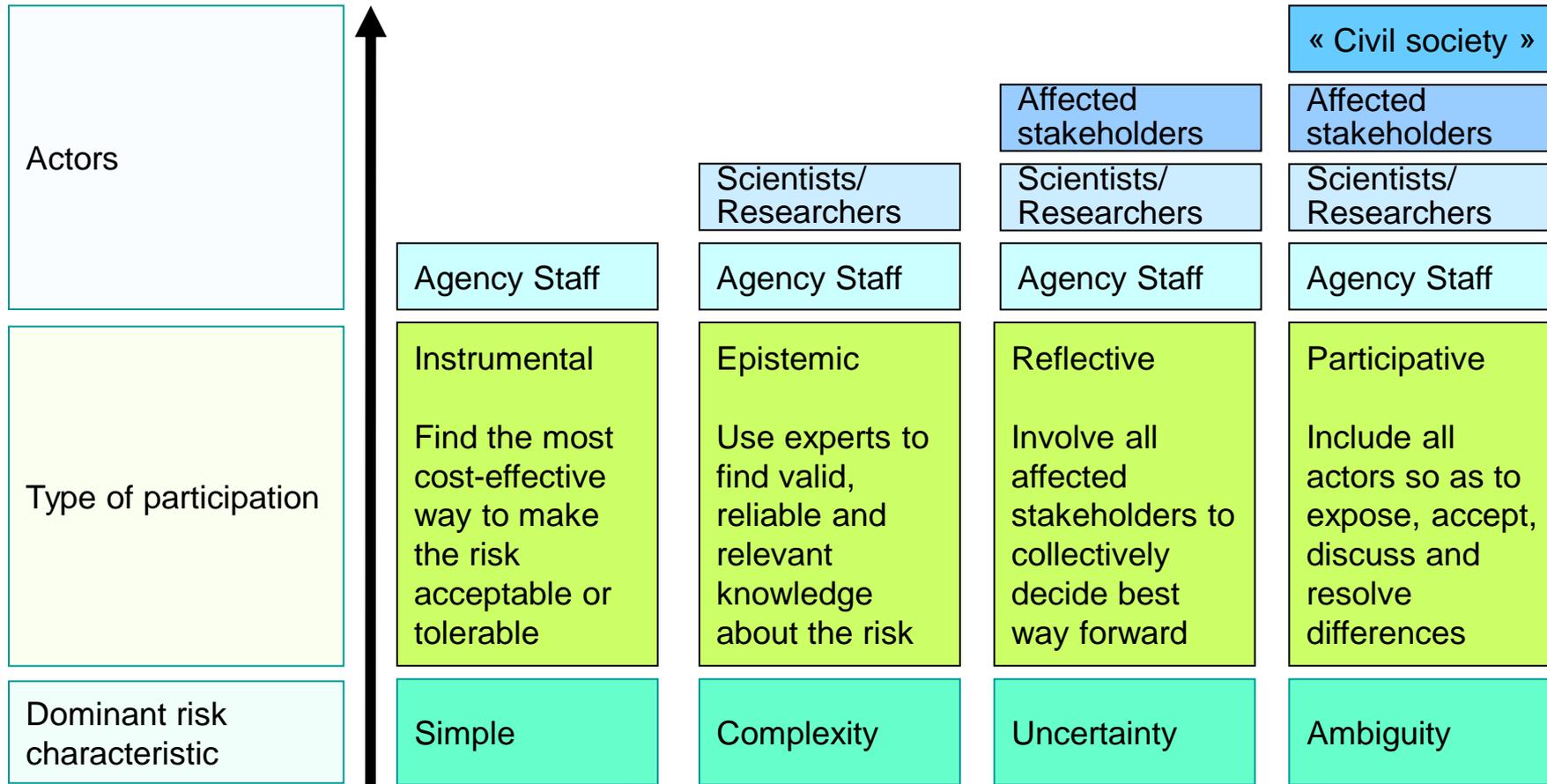
■ ***Inclusion***

- *Who*: stakeholders, scientists, public(s)
- *What*: options, policies, scenarios, frames, preferences
- *Scope*: multi-level governance (vertical and horizontal)
- *Scale*: space, time period, future generations

■ ***Closure***

- *What counts*: acceptable evidence
- *What is more convincing*: competition of arguments
- *What option is selected*: decision making rule (consensus, compromise, voting)

STAKEHOLDER INVOLVEMENT



As the level of knowledge changes, so also will the type of participation need to change

Part IV
Conclusions

**Lessons for Risk
Governance**

Conclusions I

- **Problems in handling risk and uncertainty:**
 - Plural values and knowledge claims
 - Oscillation between relativist and positivist perspectives on risk and knowledge
 - Expert dissent on degree of complexity, uncertainty and ambiguity
 - Low degree of distinction between complexity, uncertainty (first and second order) and ambiguity
 - Social amplification and attenuation are attached to handling of complexity, uncertainty and ambiguity
 - Inadequate methods to deal with different clusters of complexity, uncertainty and ambiguity
- Emergence of systemic risk that load high on CUA cross national and sectoral boundaries (ripple effects)
- Need for an integrated risk governance approach

Conclusions II

- Four risk management regimes should be used to deal with these new risk challenges:
 - linear risk management: standard risk assessments
 - *risk-informed management*: expanded risk assessments; seeking expert consensus and epistemic clarification
 - *precaution-resilience-based management*: negotiated safety level under uncertainty; seeking stakeholder consensus and relying on containment and resilience
 - *discourse-based management*: value-based orientation; seeking more public input and stakeholder involvement for interpretative variability and normative controversy

QUOTE

- “What man desires is not knowledge but certainty.”

Bertrand Russell

- Policy makers cannot produce certainty but can help people to develop coping mechanisms to deal prudently with the necessary uncertainty that is required for societies to progress