


# Risk and uncertainty communication

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# Engaging in the science-policy dialogue

## 4 Risk and uncertainty communication

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# Authors and chapters

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Christoph Beuttler and Melanie Paschke

**Risk and uncertainty communication**

## **TOOLS**

Christoph Beuttler and Melanie Paschke

**Citizen jury**

**Consensus conference**

**Focus group**

**Future workshop**

## **EXAMPLE**

Christoph Beuttler

**Engaging the public on geothermal energy**

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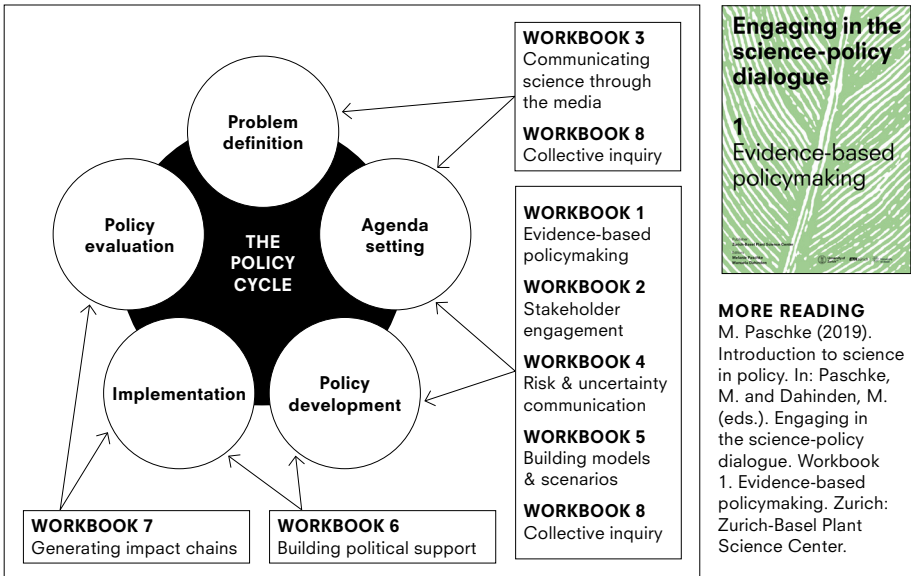
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# Editorial

Communication of uncertainty is an important component of the broader practise of risk communication. Risk and uncertainty communication has a long tradition. Previous attempts focused on increasing the public understanding through more information and education about risk and uncertainties. Current practise emphasizes the importance of building trust through a two-way dialogue and deliberative formats while integrating stakeholders and the public in the processes of risk and uncertainty judgement and the decision how to manage a risk.

This workbook is the fourth in a series of eight workbooks exploring the role of scientists in the science-policy dialogue. In workbook 4 we discuss risk and uncertainty communication and the use of different deliberative formats to generate a high level of responsiveness and accountability of scientists toward the needs, values and expectations of the public and policymakers.

**FIGURE 1 — The policy cycle.**



# Guide to workbook 4

## The aim

Workbook 4 introduces on the concepts of uncertainty, ignorance and risk in science. It explains risk perception. It offers guidelines for scientists to communicate risk and uncertainties to policymakers and to the public. It explains the theory of deliberation at the science-society interface and explains the design of a public engagement process.

## Competencies

- You will understand definitions and concepts of uncertainty, ignorance and risk.
- You will develop effective strategies for communicating risk and uncertainty.
- You will become aware of biases in risk perception, including your own.
- You will understand how deliberative systems can help to structure risk and uncertainty dialogue with the public.
- You will know the phases and deliberative formats for a public engagement process.

# How to read this workbook

## THEORY

### **Setting the scene**

We will introduce you to definitions and concepts of uncertainty, ignorance and risk and sources of uncertainty in scientific data and models.

### **Understanding your own and society's risk perception**

We introduce you to the factors that influence individual risk perceptions.

### **Key principles for risk and uncertainty communication**

We introduce you to examples and to guidelines for effective risk and uncertainty communication.

### **Design of a public engagement process**

We will introduce you to the practice of public engagement for issues where uncertainties and decision stakes are high. In cases of uncertainty and risk, deliberative systems can help to build consensus and legitimate decisions.

## TOOLS

In this section we introduce methods of public engagement. This includes the controversy matrix for assessing concerns at the beginning of a public dialogue, citizen jury, consensus conference, focus group and future workshop.

## EXAMPLE

We will introduce you to one example of a successful public engagement process.



# 1. THEORY of risk & uncertainty communication

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# 1.1. Definition of uncertainty, ignorance and risk

Science is accompanied by uncertainties about measurements, models, data analysis and interpretations but also about future outcomes, predictions and the unknown. Uncertainty has different dimensions, some of which can be lessened by improved knowledge, methodologies or techniques. These are **epistemic uncertainties**. Others are irreducible due to environmental variability or human behavior. They are **aleatory uncertainties** (see figure 2).

Communication of scientific evidence can also include **linguistic uncertainty**:

**Vagueness** – words allow borderline cases: ‘low’, ‘remote’ and ‘endangered’ are vague expressions.

**Underspecificity** – definitions include unwanted generality, e.g., the expression ‘there is a 70% chance of rain’ misses important information (time horizon, location, etc.).

**Ambiguity** – words have two or more meanings and it is not clear which is meant. With ambiguity, it might be difficult to define the system states even though their probability distributions are known.

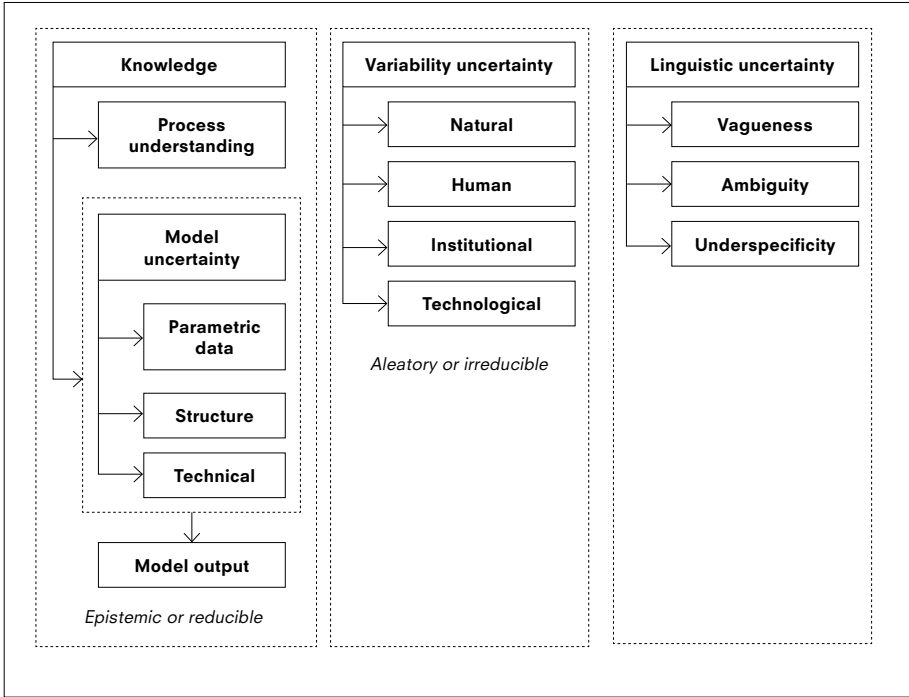
In policy studies, there is a profound difference between uncertainty and ambiguity:

- Uncertainty describes a lack of knowledge or a worrying lack of confidence in one’s knowledge.
- Ambiguity describes the ability to entertain more than one interpretation of a policy problem.

— Paul Cairney, 2018.

In policymaking, ambiguity can also arise from contrary beliefs and values, see EXAMPLE 1. This will result in different interpretations.

**FIGURE 2 — Uncertainty typology.** Adapted from Ascough et al., 2008.



## EXAMPLE 1 — Nuclear waste

Nuclear waste is a problem that includes components of uncertainty as well as ambiguity.

Uncertainty	Ambiguity
What to do with nuclear waste?  Where to store nuclear waste in a safe way?  How vulnerable is the technology toward earthquakes, terrorism, climate warming?  Are old nuclear plants still safe?	Could it be accepted as a CO <sub>2</sub> -neutral technology?  Could the vulnerability and accidents be accepted?  Could we accept the costs of nuclear waste in the next generation?

**Ignorance** is lack of knowledge or information. In science, lack of knowledge can have two dimensions: known unknowns and unknown unknowns.

**Known unknowns.** In many cases, scientific knowledge is not complete but researchers know that they still need to do research.

Reports that say that something hasn't happened are always interesting to me, because as we know, there are known knowns; there are things we know we know. We also know there are known unknowns, that is to say we know there are some things we do not know. But there are also unknown unknowns the ones we don't know we don't know.

— Donald Rumsfeld, 2002.

**Unknown unknowns** are questions we have not asked yet, and information we haven't realized is missing. These are the insecurities related to future developments. For example, predictive climate change models. Scientists know that elevated CO<sub>2</sub> emissions and CO<sub>2</sub> concentrations result in an overall temperature rise. Predictive modeling and climate scenarios for the next 10–100 years include uncertainty: By how many degrees will global and local temperatures rise? Will temperatures in summer in Switzerland continue to increase by 2 or even 4 °C under the 2 °C scenario or to 4 to 8 °C under unchecked climate change (NCCS, 2018)? Modeling and scenario building includes uncertainty due to incomplete knowledge about the climate system (known unknowns) and due to natural variability in the climate system that can hide predictive patterns (unknown unknowns). Nevertheless, the predictive power of the models and scenarios and the observational data is strong enough to allow decision-making.

**Risk** as a term is often understood as the quantitatively measured risk of a certain event taking place, i.e., as a measure for probabilities. However, there is also another connotation existing:

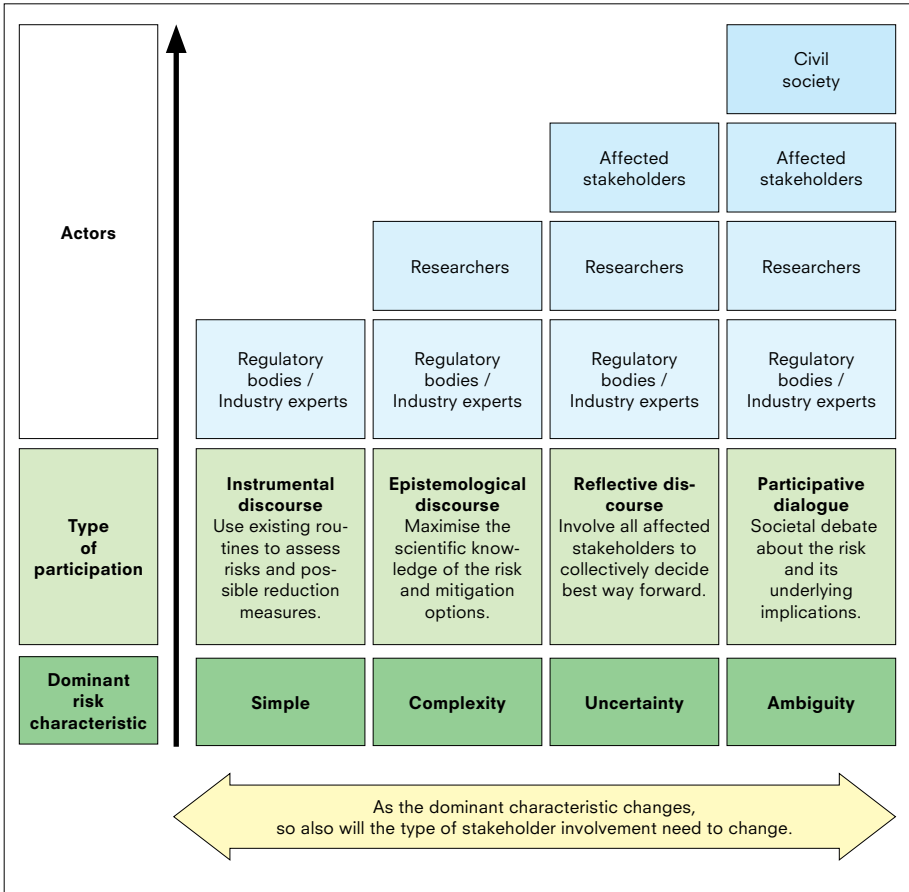
Risk is uncertainty about the severity of the consequences of an activity with respect to **something that humans value.**

— International Risk Governance Council, 2017: 5.

The risks of any given situation, technology or circumstance are perceived and assessed differently by different people. For the same risk there may be as many different risk perceptions and descriptions as there are people involved.

**Risk situations** can be anything from simple to complex, uncertain to ambiguous. Different levels of participation and dialogue are necessary (see figure 3). In an ambiguous situation, the risk will be perceived as higher and societal debate about the risk and its underlying implications and expected outcomes might be controversial. In this case risk governance and communication needs to include deliberative mechanisms. See 'Section 1.4.' in this workbook.

**FIGURE 3 — Risk perception can evolve from simple to complex to uncertain to ambiguous.**  
 Adapted and reproduced with permission from *International Risk Governance Center (IRGC)*, 2017: 29.



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## EXAMPLE 2 — The uncertainty framework of the IPCC

The *Intergovernmental Panel on Climate Change (IPCC)* has set up a calibrated language to allow its authors to link their statements and predictions about climate change and related uncertainties in a unified way. (Mastrandrea et al., 2010).

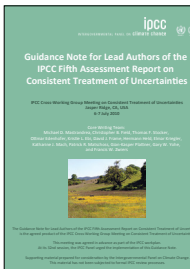
**Evidence.** How likely or unlikely it is that a piece of evidence is true or not true? The type, amount, quality, and consistency of evidence can be described with summary terms as *limited*, *medium* or *robust*. These terms are linked to the confidence intervals of:

- Virtually certain (probability of the occurrence of the outcome is 99–100%), very likely (90%–100%) (= **robust evidence**);
- Likely (66–100%) (= **medium evidence**); and
- About as likely as not (33–66%), unlikely (0–33%), very unlikely (0–10%), and exceptionally unlikely (0–1%) (= **low evidence**).

Evidence is related to probabilistic uncertainty and is epistemic.

**Agreement** deals with the extent to which the validity and interpretation of a scientific finding is agreed between experts. The degree of agreement can be described with summary terms as *low*, *medium* or *high*. See table 2.

**Confidence** is used as a term combining evidence and agreement. It should not be interpreted probabilistically and is distinct from statistical confidence.



### MORE READING

Mastrandrea, M. D., Field, C. B., Stocker, T. F., Edenhofer, O., Ebi, K. L., Frame, D. J., Held, H., Kriegler, E., Mach, K. J., Matschoss, P. R., Plattner, G.-K., Yohe, G. W., Zwers, F. (2010). Guidance note for lead authors of the IPCC fifth assessment report on consistent treatment of uncertainties. Intergovernmental Panel on Climate Change.

Retrieved from: [www.ipcc.ch/pdf/supporting-material/uncertainty-guidance-note.pdf](http://www.ipcc.ch/pdf/supporting-material/uncertainty-guidance-note.pdf)

**TABLE 2 — Levels of evidence (limited to robust) and agreement (high to low) between experts result in different levels of confidence in the IPCC reports.**

		Evidence		
		Limited	Medium	Robust
<b>Agreement</b>	<i>High</i>	Medium confidence.	<b>High confidence</b> “Estimated global GHG emissions levels in 2020 based on the Cancún Pledges are not consistent with cost-effective long-term mitigation trajectories that are at least about as likely as not to limit temperature change to 2 °C relative to pre-industrial levels [...] (high confidence).” — IPCC, 2014:12.	Very high confidence.
	<i>Medium</i>	<b>Low confidence</b> “The costs of achieving nearly universal access to electricity and clean fuels for cooking and heating are projected to be between 72 and 95 billion USD per year until 2030 with minimal effects on GHG emissions (limited evidence, medium agreement).” — IPCC, 2014: 29.	Medium to low confidence.	High confidence.
	<i>Low</i>	Low confidence.	Low confidence.	Medium to low confidence.

**How does the public understand the IPCC reports?**

The re-phrasing of likelihoods as done by the IPCC to standardize their expressions of uncertainty resulted in large variation in interpretation of the verbal terms by the lay public (Budescu et al., 2014). The authors recommended that the verbal presentation of the uncertainties is accompanied by their numerical values as the IPCC correctly does.

## 1.2. Risk perception factors

Our ability to assess risk is limited to those that our senses perceive and which we have been exposed to over the course of evolution. Most risks (or what we think of as risks) we are exposed to are of a technological nature and of relatively recent development (e.g., genetic engineering / driverless cars), or are risks we can only experience through technology (e.g., many forms of radiation, viruses) rather than directly. They are purely abstract and intellectual. Our built-in risk assessment has not yet had the chance to evolve perceptive strategies to cope with this type of risk.

The risks in question can be grouped into four categories:

- Estimated probability of occurrence.
- Individual and psychological factors.
- Risk specific and situational factors.
- Synthetic risk bias.

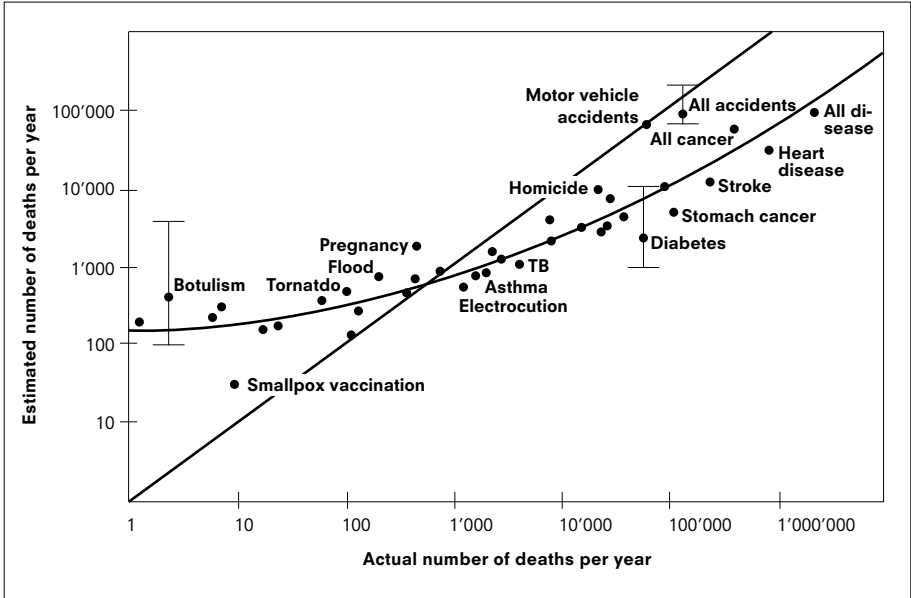
### 1.2.1. Estimated probability of occurrence

Let us assume the following case. You toss a coin 20 times and if, let's say heads comes up 20 times, you will be put to a fast and painless death. How much money would you want to accept for such a challenge? From our experience with participants, most will hesitate to take up the challenge at all, or would want rather large sums of money in order to accept it. However, the coin-toss experiment has a probability of very close to 1 in a million.<sup>1</sup>

You enter this level of probability of risk of your own death several times a day. For example, for every 1.4 cigarettes smoked (equals an increased risk of death from cancer or heart disease of 1 in a million or 1 micromort); for every 0.5 liters of wine that you drink (1 micromort increased risk of cirrhosis of the liver); driving 370 km by car (1 micromort increased risk of accident); flying 1609 km by plane (1 micromort increased risk of a plane crash).

**In conclusion:** we tend to overestimate very small probabilities like the risk of death from botulism or the risk outlined in the experiment above. Yet we underestimate the risk of very large probabilities like the risk of dying from cancer, heart disease or stroke (Slovic et al., 1982).

FIGURE 4 — Estimated and actual risk for different events in USA. Adapted from Slovic et al., 1982.



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<sup>1</sup> We prefer the term 'close to 1' because a number of theoretical statisticians/mathematicians have shown that the probability of a coin toss is not exactly 1/2.

## 1.2.2. Individual and psychological factors

A number of psychological factors affect how we assess various risks. Tversky and Kahneman (1974) have demonstrated, for example, that an unrelated number seen immediately before a question (or risk assessment) heavily influences the answer. They conducted the following experiment. A wheel of fortune is spun and points randomly to 65 or 10. Subjects are then asked the following question: What do you think is the percentage of African countries in the UN? The median estimate of subjects who saw the wheel show 65 was 45%; the median estimate of subjects who saw 10 was 25%.

Furthermore, heuristics, emotions, as well as demographics (such as age, gender, socioeconomic status or education), personal values, political orientation and willingness to take risks (risk affinity vs. risk aversion) affect how we perceive certain risks. Perhaps unsurprisingly, **expectations of personal benefit** (monetary, reputation, status, etc.) alter our risk perception substantially.

### Heuristics

Broadly speaking human beings have two main systems of risk assessment. Risks can be assessed by **analysis**. This requires the ability to master the context, needs comprehensive information and takes time, money and energy. Or they can be assessed in a semi-automatic, quasi-instinctive **heuristic**: a mental shortcut for split-second decisions with only incomplete information.

This latter system has different types, e.g., the **availability heuristic**. Events that can be more easily brought to mind are judged to be more likely – prominent examples are floods, tornados, nuclear accidents, etc. Another type is the **anchoring** and the **adjustment heuristic**. People often start with one piece of known information and then adjust it to create an estimate of an unknown risk.

A strong media or other communicative focus on uncertainty or risk will enhance the perception of risk, even if the occurrence of the event in question is improbable (Wardekker et al., 2013).

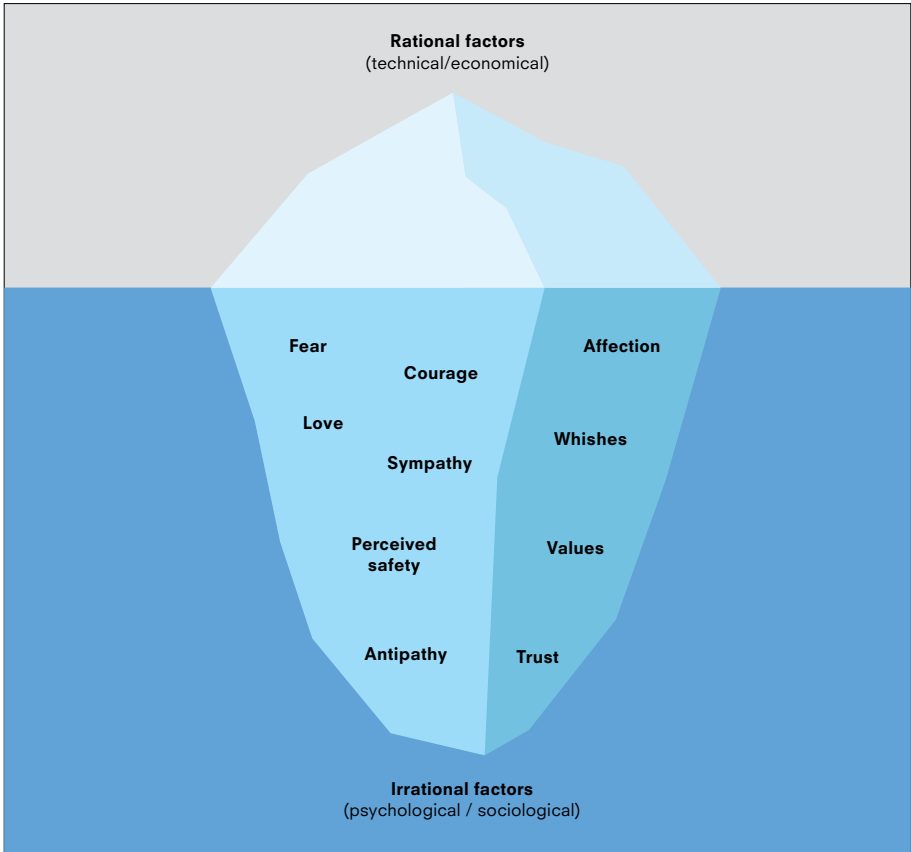
## EXERCISE 1

Think about five availability heuristics and five anchoring and adjustment heuristics in your field of study.

### Emotions

Emotions play a major role in risk perception, guiding risk perception more powerfully than rational factors. We often do not realize how much our concerns or risk perceptions are guided by emotions as figure 5 shows. Often arguments based on the rational factors are used in discussions but they don't convince the participants. Deliberation has to make the hidden factors transparent and accept them as necessary factors in the decision-making process.

**FIGURE 5 — The emotion iceberg of risk perception.** Courtesy of Risk Dialogue Foundation St.Gallen.



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## 1.2.3. Risk specific and situational factors

A number of factors influence whether we over- or underestimate a risk, based on the type of risk and the situation or circumstance in which it occurs.

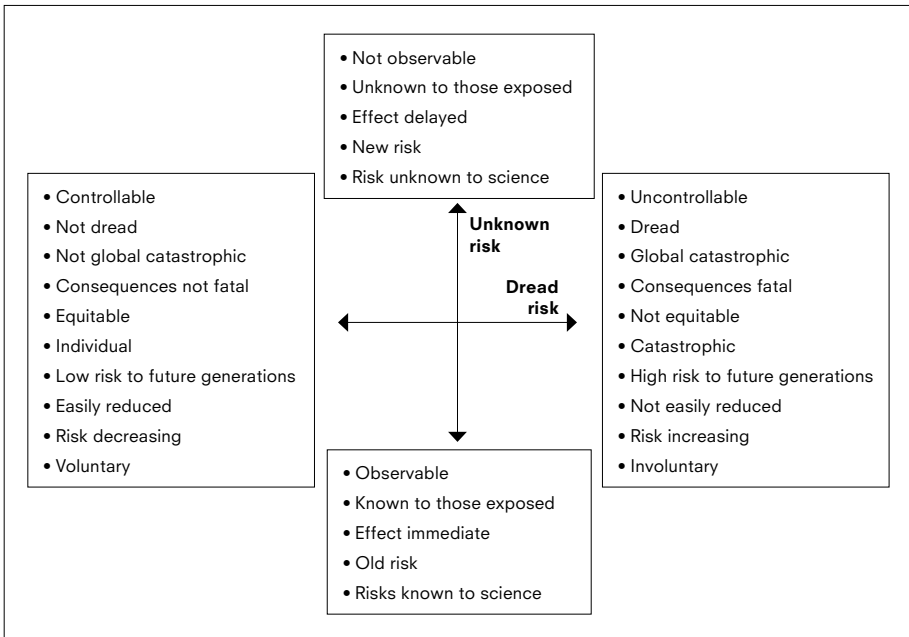
People feel most at risk when/ if...

- They know little.
- The risk is unfamiliar and unexplored.
- They may be personally affected.
- They fear a high potential for a disaster.
- They involuntarily have to take the risk.
- They have no way to control the situation.
- The risk mobilizes a lot of people.
- They have no perceived benefit.
- The outcomes are unfairly distributed.
- The outcomes are expected to be irreversible.
- They don't trust you.

— adapted from Covello, 2008.

The psychometric paradigm in figure 6 illustrates situational factors influencing risk perception. Risks that fall within the top right quadrant are typically overestimated, whilst risks that fall within the bottom left quadrant are typically underestimated.

**FIGURE 6 — Psychometric paradigm.** Courtesy of Risk Dialogue Foundation St.Gallen.



## EXERCISE 2

Think about where you would for example place these situations:

- (1) A medical doctor is talking to his patient about reducing his smoking. Where will the patient place the risk? Where will the doctor place the risk? How should the doctor communicate?
- (2) In a public hearing participants and experts discuss the opportunities and risks of xenotransplantation. Where will the participants place the risk?
- (3) Where would you place topics within your own research field?

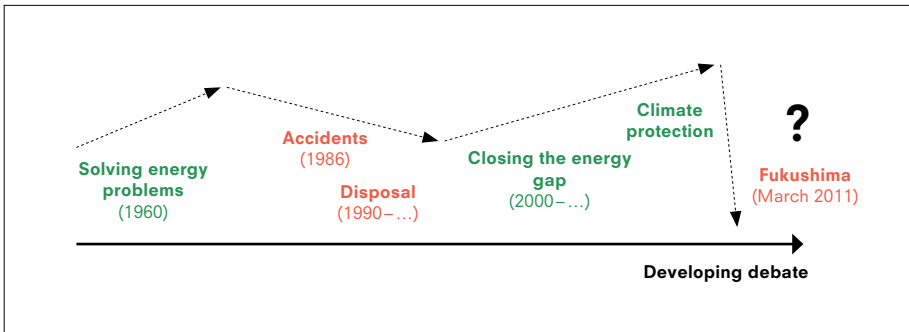
## 1.2.4. Synthetic risk bias

Synthetic or man-made risks are considered worse or more dangerous than risks that occur naturally. For example natural medicine is generally perceived to be less dangerous than pharmaceutical products. Naturally occurring radioactivity for example in mountainous areas is generally not given as much thought as radiation from atomic energy. And genetic modification from natural breeding is seen as far safer than artificially induced genetic modification. Sunstein (2003) calls this **moral heuristics**, for example the credo 'do not tamper with nature'. Also, while until the 1970s (western) society had a far more favorable view of technology in general – sometimes referred to as 'technological optimism' – people are now more cautious about the ecological and societal benefits of technology. This may have been influenced by some major industrial accidents such as Bhopal (1984) or Tschernobyl (1986). With a view to this, Ulrich Beck (1986) coined the term **risk society** in the mid-1980s. The idea has taken hold that society is inherently at risk from technologies we have invented and cannot escape. This plays into the last factor – in our experience by far the biggest source of bias – **if participation in risk is involuntary**, we tend to massively overestimate it.

## 1.2.5. Societal or social context

Risk perception is embedded in a social context. The culture we live in engrains certain behavioral norms in us. Every society trusts certain actors or institutions and distrusts others. The top concerns of the Swiss, for example, are listed annually in a *Sorgenbarometer* (Golder et al., 2017) compiled by *Credit Suisse*. Topics develop, and the social perception of most topics changes over time. For example trust in banks diminished for a few years during the financial crisis. However, it has now recovered and is higher than ever. Another example would be nuclear power that was seen in society under positive and negative connotations between 1960 to 2011 (see figure 7).

**FIGURE 7 — Examples of social debates unfolding around nuclear power.**  
 Figure is courtesy of Risk Dialogue Foundation St.Gallen.



You cannot conclude that one concept of risk perception or acceptance has more value than another. It is often equally hard for laypersons to give up their instinctively (heuristically) determined viewpoint / perception on a given risk. Any risk dialogue or participative approach aiming at **convincing** or **educating laypersons by experts** will likely be unsuccessful, as they will feel that the aim is to convince them rather than listen to them.

**TABLE 3 — Differences in risk perception and acceptance between experts and laypersons.**

Expert	Layperson
<ul style="list-style-type: none"> <li>• Scientific method.</li> <li>• Probabilistic concepts.</li> <li>• Risk comparisons.</li> <li>• Lay person.</li> <li>• Acceptance of remaining risk.</li> </ul>	<ul style="list-style-type: none"> <li>• Intuitive method.</li> <li>• Belief system.</li> <li>• Yes / No decision.</li> <li>• Personal involvement.</li> <li>• (Complete) safety.</li> </ul>

## 1.3. Risk and uncertainty communication

Risk communication is a broad term that can have different dimensions:

- **Information-based:** informing about the epistemic uncertainties.
- **Process-oriented:** informing about the process to deal with a risk and uncertainty.
- **Concern-based:** linking to the concerns and values of those affected.

Situations in which risk communication is practiced range from: routine, easily foreseeable situations to unforeseeable crises. The aim, type and content of communication depend on the type of risk, phase of conflict, stakeholders and target group involved.

In different situations the communication needs to change from increasing the emotional engagement of the public to communicating to lower the outrage level (see table 4):

- **Target group specific communication** aims to convey information about risks and their handling. It could include transparent exchange of risk and uncertainty assessments.
- **Risk prevention and disaster communication** seeks prevention measures for under-estimated risks and actual disasters, to foster adequate behavior in a crisis situation.
- **Conflict resolution and risk dialogue** aims to foster competent, broadly accepted decisions with stakeholder participation and public dialogue. The discussion is about concerns and often related to values.

Uncertainty communication is an important component of the broader term of risk communication. Especially uncertainty communication will be necessary if the outcomes are very uncertain and have a great impact on policy advice:

- The outcomes come close to a policy target.
- An incorrect estimate in one direction may have entirely different consequences for policy advice than one in another direction.
- There is a possibility of morally unacceptable damage or of catastrophic events.
- There is social controversy about the topic.
- There are value-laden choices/assumptions in the study that are in conflict with the views and interests of stakeholders or the public.

— Wardekker et al., 2013:10.

**TABLE 4 — Different communication strategies and their main messages.**  
 Adapted and reproduced with permission from World Health Organization, 2015.

Communication strategy	Examples of risks	How to communicate?	Main message	Required action
<b>Risk prevention through precautionary advocacy</b>	Smoking. Climate change mitigation.	Raise outrage level to your level of concern.	Beware! Something bad could happen!	Increase emotional engagement of public.
<b>Disaster communication</b>	Nuclear plant meltdown. Heat summer 2018. Coronavirus, covid-19 crisis.	Keep outrage high to maintain vigilance and the motivation to act. Increase the resilience level of the community.	We are in this together.	Communicate proactively and early. Explain what is happening. Make clear what you know and what you don't know.
<b>Conflict resolution through risk dialogue and outrage management</b>	Suspicion of autism from vaccination.	Try to lower outrage level.	I understand your concern. Here are the facts as I know them.	Listen and acknowledge the concern. Engage in public engagement.
<b>Stakeholder relations</b>	Micronutrient deficiency.	No action.	Be watchful.	Identify potential causes of concern early on.

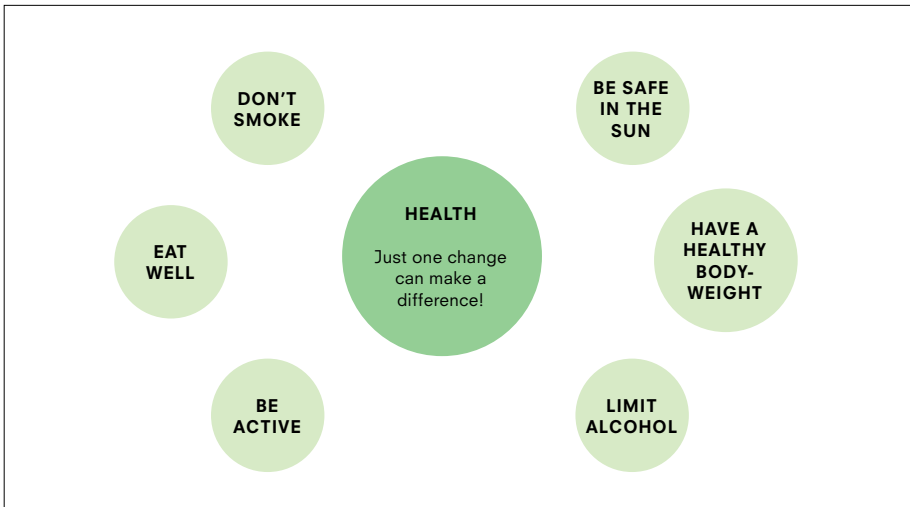
What you will be shown in the following: We start with examples for precautionary advocacy in health communication (EXAMPLE 3) and for climate change mitigation (EXAMPLES 4, 5 and 6). Referring to the ongoing cases of coronavirus, Covid-19 we include also an example of formulating of advice in disaster communication (EXAMPLE 7). As should be expected, there is no 'one size fits all' rulebook for effective risk and uncertainty communication; however, some approaches can improve the quality of such an endeavor.

In the last years several guidelines have been developed for effective communication about climate change mitigation and adaptation with different target audiences. The aim should be to send a positive message – communication should focus on the possibilities of positive change rather than on the risk itself. Communication should increase the potential for self-efficacy – they should trigger in a large proportion of the target audience the belief and motivation that the proposed changes can be achieved and risks overcome.

## EXAMPLE 3 — Keep the message simple in health communication

Communication should aim at the appropriate level of complexity – almost always means reducing complexity if your audience consists of non-experts (figure 8).

FIGURE 8 — Example of simplification in risk communication.



# EXAMPLE 4 — Communication within a promotion or preventing frame

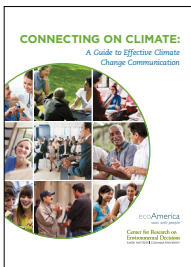
The *Center for Research on Environmental Decisions (CREC)* published its *Guide to effective climate change communication*. Their guidance is to formulate empowering and target-group specific risk messages to enable:

**Promotion or preventing orientation.** People either act to change a situation or to prevent it from changing. If messages are targeted to these preferences for prevention or promotion, the response to the climate change messages will increase. *CREC guidelines* offer examples of useful wording for promotional or preventative messages in the climate change context.

**Personal and collective efficacy.** Messages should empower people to take action. Messages should scale from local to global solutions and should scale from short-term (economic benefits) to long-term view (social improvement).

**TABLE 5 — Messages within a promotion vs. a prevention frame.** CREC and ecoAmerica, 2014.

Promotion	Preventing
...advance towards maximized or increased gains.	...maintain status quo to prevent, decrease or minimize losses.
Words to be used: avoid missed opportunities, hope, promote, support, nurture.	Words to be used: defend, safety, security, protect.
<i>Example</i> New data gives hope for meeting the Paris climate targets. Global carbon pollution appears to be close to peaking.	<i>Example</i> We must reach peak carbon emissions by 2020, says former UN climate chief. Three years prevent a climate disaster.



## MORE READING

Center for Research on Environmental Decisions and ecoAmerica. (2014). *Connecting on Climate: A Guide to Effective Climate Change Communication*. New York and Washington, D.C.

Retrieved from:  
<http://ecoamerica.org/wp-content/uploads/2014/12/ecoAmerica-CREC-2014-Connecting-on-Climate.pdf>

## EXAMPLE 5 — Guidelines for uncertainty communication in climate change

Corner et al. (2015) have provided an uncertainty handbook that distils the most important research findings and expert advice into practical, easy-to-apply techniques providing scientists, policy-makers and campaigners with the tools they need to communicate more effectively around climate change. Their most important advices are:

**Be first clear about the scientific consensus on climate warning and then on the uncertainties.**

97% of climate scientists and virtually all of the world's climate science literature endorse the idea that humans are causing climate change.

— Corner et al., 2015: 7.

**Communicate risks and not uncertainties – communicating risks make it easier for lay persons to make a cost-benefit ratio.**

DO say: The risk of our town flooding, disrupting our businesses and schools, is now higher than ever before because of climate change.

DON'T say: Although there is a great deal that is unknown about how local services will be affected, climate change is likely to cause more flooding in the future.

— Corner et al., 2015: 8.

**Be clear what type of uncertainty you are talking about, i.e., is it a question of causal relation, time of event, scale of event etc.?**

*Cause of climate change*

DO say: Scientist are as certain about the link between human behaviour and climate change as they are about the link between smoking and lung cancer.

DON'T say: Although we can never be 100% certain of anything, it is highly likely that changes in our climate are due to an anthropogenic influence.

*Climate impacts*

DO say: As the Earth warms there is more moisture in the air, which increases the chances of intense rainfall. So this flood is consistent with what scientists have long been predicting.

DON'T say: No single weather event can be attributed to climate change.

— Corner et al., 2015: 9.

**The most important question for climate impacts is ‘when’, not ‘if’. Shift climate change from a distant risk (= not here, not now) in the future to a risk that can happen in the near future in your neighbourhood.**

DO say: Sea levels will rise by at least 50 cm, and this will occur at some time between 2060 and 2093.

DON'T say: By 2072, sea levels will rise by between 25 and 68 cm, with 50 cm being the average projection.

— Corner et al., 2015: 9.

The first message could be linked to the age to the auditory: Your children will experience this situation when they will be between 40 and 60 years.

**Highlight the ‘positives’ of uncertainty.**

Which of the following statements makes you feel more confident about acting under uncertainty?

If we act now, the chance of destructive winter floods occurring is 20%.

If we fail to act, the chance of destructive winter floods occurring is 80%.

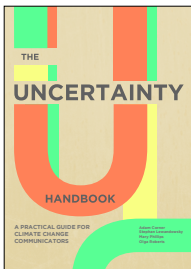
— Corner et al., 2015: 13.

**Communicate effectively about climate impacts.**

**Have a conversation, not an argument.**

**Tell a human story, not a scientific one.**

**Communicate through images and stories.**



**MORE READING**

Corner, A., Lewandowsky, S., Phillips, M. and Roberts, O. (2015). The Uncertainty Handbook. Bristol: University of Bristol.

Retrieved from:  
<https://climateoutreach.org/reports/uncertainty-handbook/>

## 1.3.1. Connecting to frames – message design in risk and uncertainty communication

People link information – including risk and uncertainty communication – to their personal world-views. These are constructed from various mental models; interpretative patterns with which they make sense of the surrounding world. Mental models are based on incomplete facts, prior knowledge and previous experience, as well as on beliefs, values and interests.

Mental models are filters for information. Communication of risks and uncertainties can result in interpretation through these filters.

Selective information uptake of information can happen mainly if it fits the mental model – i.e., if it is consistent with one's feelings, thinking and wishes and avoids change in behavior. This is called **confirmation bias** (CRED and ecoAmerica, 2014).

In communication theory, the term 'frame' is used to describe how risks and opportunities of e.g., technological developments are differently **framed** by stakeholders and societal groups. Frames are built on **worldviews** that set every new technological development in a system of values and beliefs about how the world works and how people should relate to one another. See also 'Workbook 3: Communicating science through the media'.

Communications, for example, on new technology development could aim to link discussion through target-specific messages, to a diversity of frames and to support people in integrating information into their world-views. Communications of risks and uncertainties could be linked to communication of opportunities; however, these are assessed differently in different frames. Table 6 compiles questions that could help to assess the dimensions and frames linked to a topic. We can then structure the questions for the message design in 4 dimensions (IRGC, 2005).

**TABLE 6 — Message design and assessment of the dimensions and frames of a topic.**

Dimensions	Risk pre-assessment questions	Message design questions
<b>Frame(s)</b>	Who are the stakeholders?  How do their views affect the definition and framing of the problem?  Are there conflicting views on the issue?	Who is the communication for?  What frames (world-views, values, identities) does it connect with?
<b>Scope</b>	What are the risks and opportunities within a specific frame?	What to communicate?  What are the messages?  What arguments support the messages?
<b>Assessment</b>	What are the risks and uncertainty indicators?	How can the risks and uncertainty indicators be communicated?
<b>Capacity</b>	What institutions are entrusted with risk assessment and dialogue?	What channels and institutions can be used to distribute the messages?

# EXERCISE 3

Start a message design for your problem. Draft a message and draft the arguments.

## WORKSHEET

Dimensions of a risk	Questions for message design
<b>Frame(s)</b>	To whom do we want to communicate?
	To what frames (worldviews, values, identities of our target groups) do we have to connect our communication?
<b>Scope</b>	What do we need to communicate in the pre-selected frames?
	What are our messages in these frames? What arguments support our messages?
<b>Warning</b>	How do we communicate the risks and uncertainties within the pre-selected frames?
<b>Capacity</b>	What channels do we use to communicate the messages to reach our target groups?

## EXAMPLE 6 — Communication messages as SOCO

The *World Health Organization (WHO)* offers training to communication staff and uses SOCO (= **S**ingle **O**verarching **C**ommunications **O**utcome for designing a message). With their process you will focus on the change that you want to see in your audience as a result of your communication. Normally, this key point should be made at the very beginning of a conservation. The process for defining your SOCO is a 4-step process. We explain how the SOCO process works by developing a message to community gardeners in a town in Switzerland.

Communicating the intended change as part of risk communication is especially useful when precautionary advocacy is necessary.

### **Step 1: What is your issue?**

Soil-friendly gardening practises that are not leaving the soil bare.

### **Step 2: Why do you want to focus on this issue and why do you want to focus on it now?**

Rebinding of CO<sub>2</sub> into the soil through organic matter for climate change adaptation. Keeping soil covered through mulching, green manuring or intercropping will bring carbon into the soil and keep it there.

This practise will also reduce the amount of water necessary in dry periods and can increase harvest because the soil can keep the moisture. Some studies showed that a good soil and water management could re-bound up to 40% of global carbon emissions to the soil (Cohen, 2016; Hickel, 2016).

### **Step 3: Who needs to change their behaviour (audience)?**

Private gardeners.

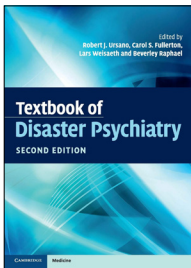
### **Step 4: What is the change that you want to see in your audience as a result of your communication? (This is your SOCO.)**

Private gardeners change the way they treat their soil. They will have mulch or green manuring on their garden beds all year around. They understand that part of the solutions to mitigate climate change are under their feet. Private gardeners can contribute to cooling the planet.

## EXAMPLE 7 — Risk communication to disasters – promoting resilience

Dodgen, Herber and Paul (2017) published a chapter on 'Risk communication to disasters' with useful insights. They suggested that risk communication in disaster situation can build on the **Extended Parallel Process Model** (EPPM, figure 9) a theoretical framework suggested by Witte (1998) that brings together different work from processors. EPPM has been widely used in health communication research and guidance: If people think that they will be protected from a perceived threat through following the recommendations (= response efficacy) and that they can follow the recommendations (= perceived self-efficacy), they will accept the message and respond with danger control processes (= taking up new attitudes and behavioral changes) if the threat is relevant to them. If they are over-helmed by perceived threat (= susceptibility, i.e., how likely one is to contact the bad outcome + severity, i.e., how severe the bad outcome is), they will refuse the message and act with fear control processes (deny of the threat, not being able to act anymore etc.).

However, as a review of Popova, 2012 showed, there are mixed results for outcomes of messages combining different levels of efficacy and threat, but in general a combination of messages that tell about high efficacy and increase the level of perceived threat seem to work in health communication settings.



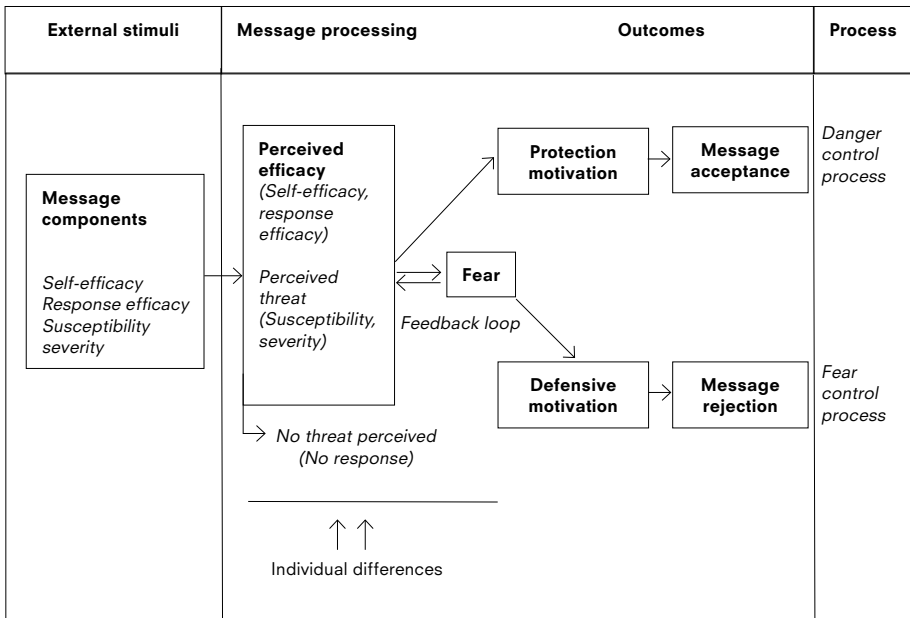
### MORE READING

Risk Communication in Disasters: Promoting Resilience.  
Daniel Dogen, William Hebert and Rachel E. Kaul.

Publisher: Cambridge University Press.  
<https://doi.org/10.1017/9781316481424.012>  
pp. 162–180

Textbook of Disaster Psychatry, 2nd edition (2017).  
Edited by Robert J. Ursano, Uniformed Services University,  
Carol S. Fullerton, Uniformed Services University of the Health  
Sciences, Maryland, Lars Weisaeth, Universitetet i Oslo,  
Beverley Raphael, Australian National University, Canberra.

**FIGURE 9 —The EPPM model.** Reprinted with permission from Witte, 1998.



**SOURCES**

Popova , L. (2012). The extended parallel process model: Illuminating the gaps in research. *Health Education & Behavior*, 39, 455–473. <https://doi.org/10.1177/1090198111418108>

Witte, K. (1998). Fear as motivator, fear as inhibitor: Using the extended parallel process model to explain fear appeal successes and failures. In P. A. Andersen & L. K. Guerrero (Eds.), *Handbook of communication and emotion: Research, theory, applications, and contexts* (pp. 423–450). San Diego, CA: Academic Press.

## EXERCISE 4

Example of risk communication in the face of the covid-19 crisis.

Find below examples from the messages taken from the website of the *Swiss Federal Office of Public Health*. Reflect, if these messages have triggered communities' and individual responses for perceived self-efficacy and response efficacy?

Keep your distance from other people. Infection with the new coronavirus can occur through close (less than 2 metres) and prolonged (over 15 minutes) contact with someone who is already infected. You can protect yourself and others by keeping your distance.

- Avoid groups of people.
- Leave space between you and the person in front of you when standing in line (for example at the checkout, post office or canteen).
- At meetings leave a seat free between you and the person next to you.
- Keep your distance from close family and friends at especially high risk.
- Keep visits to care homes and hospitals to an absolute minimum.

— Retrieved from: [www.bag.admin.ch/bag/en/home.html](http://www.bag.admin.ch/bag/en/home.html)

New coronavirus

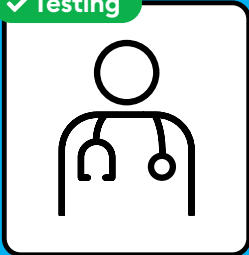
Last update: 6.7.2020

**PROTECT YOURSELF AND OTHERS**



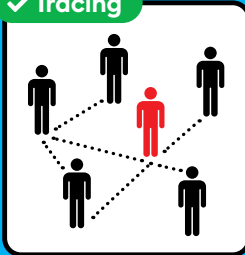
# Be sure to follow the new rules:

✓ Testing



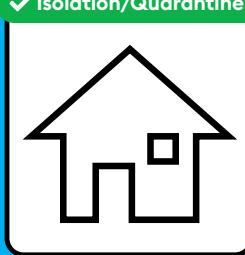
If you experience symptoms, get tested immediately and stay at home.

✓ Tracing



Always leave your contact details whenever possible so you can be traced.

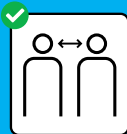
✓ Isolation/Quarantine



Isolate yourself if you test positive.

Quarantine yourself if you've had contact with someone who has tested positive.

## Still important:



Keep your distance.



Recommendation: If it's not possible to keep your distance, wear a mask.



Wash your hands thoroughly.



Avoid shaking hands.



Cough and sneeze into a tissue or the crook of your arm.



Always call ahead before going to the doctor's or the emergency department.

A1158-623.png

[www.foph-coronavirus.ch](http://www.foph-coronavirus.ch)



Schweizerische Eidgenossenschaft  
Confédération suisse  
Confederazione Svizzera  
Confederaziun svizra

Swiss Confederation

Bundesamt für Gesundheit BAG  
Office fédéral de la santé publique OFSP  
Ufficio federale della sanità pubblica UFSP  
Uffizi federal da sanadad publica UFSP



Scan for translation

## 1.4. The role of public engagement in risk and uncertainty governance

Calls for a participatory turn in the production of scientific knowledge and science governance have a tradition. Funtowicz and Ravetz (1993) coined the term *post-normal science* (PNS) for scientific issues where risks and uncertainties, as well as decision stakes, are high. Decision stakes are high when values are in dispute, stakeholders are discordant and decisions are urgent, while the scientific evidence base might be small or uncertain. Scientists should become partners with other social actors in deliberation or social negotiation on the meaning of scientific results for society.

In both academic and political contexts, engaging the public is seen as a way to respond to:

- Public criticism and erosion of trust in scientific self-governance.
- Underlying concerns about the ethical and social implications of scientific advances.
- Concomitant risk debates in science, technology and innovation. (Felt et al., 2008; Braun and Könninger, 2017).

Traditional science communication operated for a long time in a mode known as the **knowledge-deficit model of science**. It assumed that the way to change people's behavior was via efficient and frequent communication of scientific knowledge and results (i.e., facts). Take climate warming, for example: Hulme (2009) finds that scientifically better informed respondents not only felt less personally responsible for global warming, but also showed less concern about it.

**Public engagement** is often seen as a way to overcome this gap between scientific evidence and action by involving scientists and lay people in processes of social inquiry (Irvine and Wynne, 1996). Thus 'science in society' focuses on creating spaces including new societal groups where science-society issues are negotiated through expression, participation and deliberation (Felt et al., 2013).

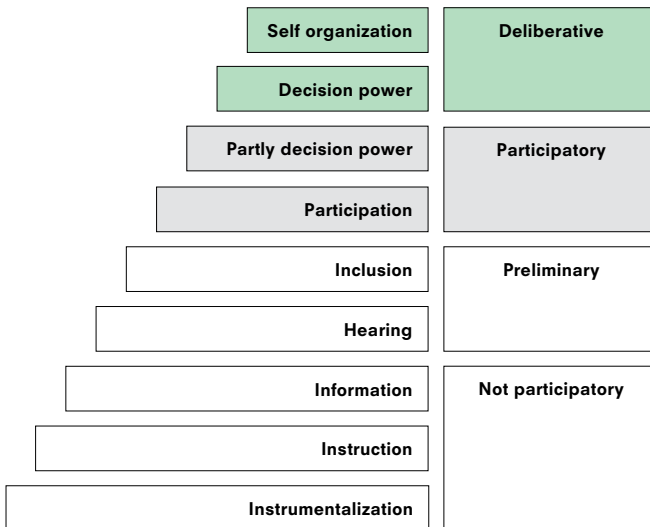
Moreover, it was emphasized that engagement of the public within the science process needed to happen very early in the research process, i.e., at a time when research could respond to the values, needs and expectations of those that were involved or targeted (Stirling, 2007).

Public engagement can range from preliminary public hearings to deliberative processes to share the decision power and self organized processes of social learning as presented in figure 10.

Public engagement in the research process can vary in:

- **Time:** upstream or downstream in the research process.
- **Objectives:** increasing credibility, democratic legitimation, salience and accountability of science in society.
- **Role of the public in the research process:** from being informed, to giving their view and opinions, to becoming legitimated as decision-makers on the scope of research and on scenarios for embedding research in society.
- **The social groups and formats involved.**

FIGURE 10 — Research can include different levels of public engagement. Wright et al., 2010.



In deliberative formats young and old, rich and poor, well-educated and non-educated etc. should participate. Participants should be representative for societal distribution.

**Deliberation** aims to maximize the decision-making power of all those involved and to generate a high level of responsiveness and accountability in scientists toward the needs, values and expectations of the general public. Jane Mansbridge sees deliberation as way of negotiating about power:

The deliberation should, ideally, be open to all those affected by a decision. The participants should have equal opportunity to influence the process, have equal resources, and be protected by basic rights. In the process of mutual justification, participants should treat one another with mutual respect. They should give reasons to one another that they think the others can comprehend and accept. They should aim at finding fair terms of cooperation among free and equal persons. They should speak truthfully. They should achieve their ends by a process of mutual justification, not try to change others' behavior through the exercise of coercive power.

— Mansbridge, 2009: 2.

Deliberation involves communication based on reasoning, argument and mutual respect. Participants may agree to disagree, but are willing to agree on acceptable solutions. They agree that it is acceptable to negotiate about conflicts and to protect their self-interests and values if those are made transparent (Dryzek and Niemeyer, 2006). The process of deliberation can lead to understanding, respect, empathy and a balance of power.

Deliberation through public engagement has been criticized because impact may be limited or difficult to assess, representativeness may be difficult to guarantee, and deliberation can be used as a bypass to well established and legitimated processes in policymaking. In contrast, deliberative systems can create spaces for expression, participation and social learning among participants. In these spaces people can interrelate and the quality of their interrelations will determine the quality of the outcomes of the decision-making process (Braun und Könninger, 2017). Deliberation is of particular importance in situations where risk, uncertainty or ignorance is involved. In the following section we will discuss how risk and uncertainty are perceived in society and how deliberative formats work.

# 1.4.1. Formats of public engagement

Depending on audience and topic(s), different formats of public engagement are possible. We have chosen methods that include a voting option (e.g., citizen jury) or involve consensus-building (e.g., consensus conference, future workshop). More information on these methods is provided in the 'Chapter 2. Tools'.

**TABLE 7 — Overview of public engagement formats.** Adapted from Beckmann and Keck, 1999.

Method	Objectives	Type of conflict	Process
<b>Citizen jury</b>	Recommendations through votes to policymakers on options for action. Prevention of conflicts. Suitable for debates about values.	No open conflict yet.	Jury is informed by means of hearings. Different positions are introduced by witnesses (experts and stakeholders). The jury then judges. Final questioning of the jury members on the procedure and assessment of the procedure.
<b>Consensus conference</b>	Consensus and decision conference on a controversial topic with randomly selected citizens.	Latent, often persistent conflicts.	Citizen group defines issues and selection of experts. They then assess information and write evaluation report. The report contains citizen recommendations on political and social dealings with the topic and is aimed at political decision-makers, experts and the public.
<b>Focus group</b>	Focus groups will help policymakers learn about what people want, need and prefer when different policy options are discussed. They involve a panel of citizens' representatives. Participants should reflect demographic diversity of the population.	Latent conflicts.	Focus group participants should know the purpose of the group but should not know each other, so that honest, open discussion can take place. The facilitator asks participants to discuss and rate different policy options following a discussion guide with open questions. Discussion and statements are recorded.
<b>Future workshop</b>	Motivate citizens and involve those affected in planning processes to design their desired future and to build an action plan on how to implement the consented future.	Latent conflicts.	To create a communicative atmosphere through neutral moderation. Short, factual contributions to the discussion. In a block event of 1–3 days, the sequence is as follows: collection of critical voices. Fantasy phase: joint design of desirable, possible or currently impossible future scenarios. Realization phase: verification of implementation.

## 1.4.2. Design of public engagement process

Public engagement processes can differentiate risk and uncertainty perception in the public. How to engage the public, or a relevant stakeholder group? The following principles are important:

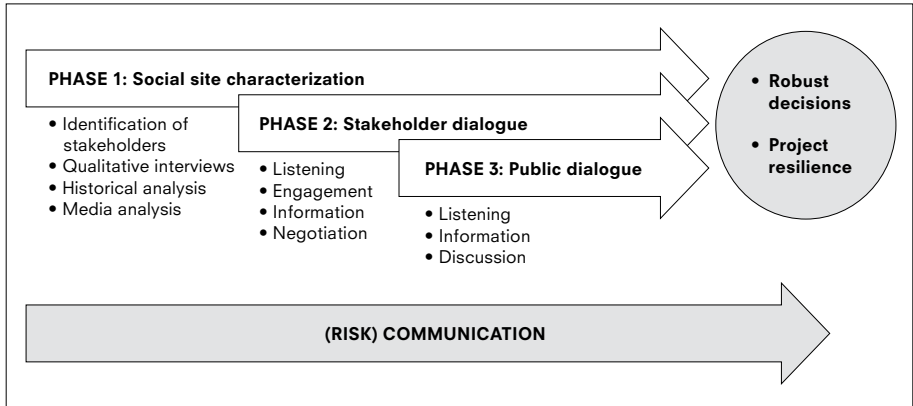
- Take the target group seriously – engage the public or stakeholders in a trustworthy and transparent climate of confidence.
- Ensure flexibility in the implementation of a project or technology.
- Be transparent about risks and uncertainties.
- Public engagement needs to start early in the process.
- Consider efficiency / effectiveness as part of the process – in reality engagement projects have limited financial scope.

**An public engagement process usually has three phases:**

1. **Social site characterization** – What is the project / issue? How did it develop? Who is affected and how? What is the tone and what are the arguments of the debate?
2. **Dialogue with main stakeholders** – to collectively decide best way forward. Stakeholders should act on the precautionary principle, consenting about interpretation of risk evaluation, management options, and measures to increase the resilience of risk-absorbing systems.
3. **Public dialogue** – e.g., a town hall meeting with several hundred citizens about the project and the risks and benefits of involved technologies; informs about the dialogue process so far, as well about risk management strategies negotiated during phase 2 of the engagement process; aims at formulation of individual concerns and defining space for discussion.

A well conducted public engagement process will lead to a social license, or what we call robust decisions, and hence ensure project resilience against protests from stakeholders.

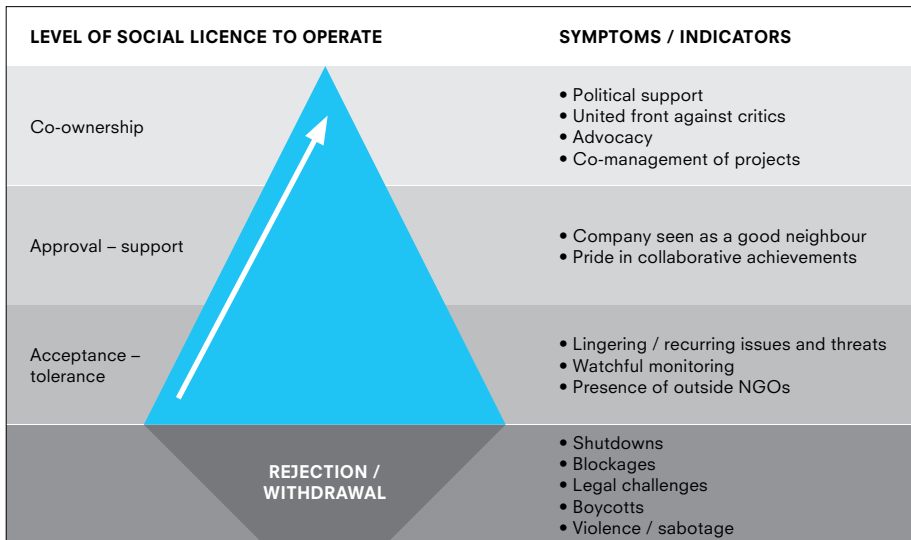
**FIGURE 11 — Phases in a public engagement process.**



### 1.4.3. Appropriate level of engagement through a social license

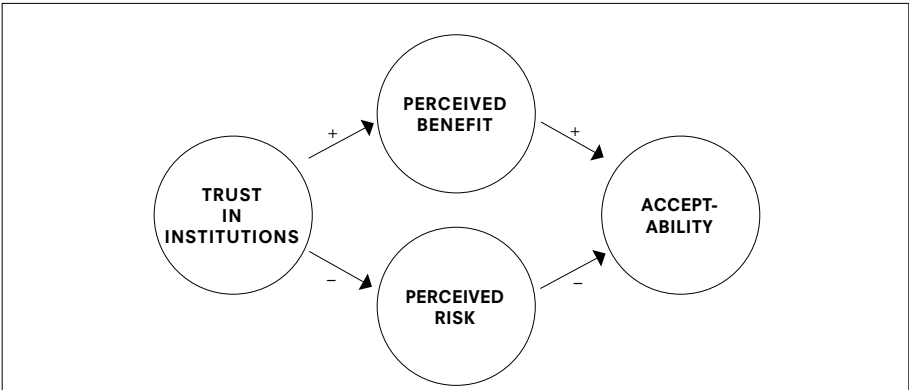
Levels of social license range from bare acceptance (in the sense of tolerance) to co-ownership. In most cases one should aim for acceptance or approval.

**FIGURE 12 — Levels of social license.** Adapted from Thompson and Bouillier, 2011.



Why are organizations between science and the public needed to deliberate social licenses? The reason is trust. One knows certain things about a given technology or project, while being aware that one is ignorant of other aspects. Trust reduces the complexity of a decision: one grants social license to an organization not to act against one's interests. Trust has no direct influence on acceptance or acceptability, but takes effect via the perception of risks and benefits.

**FIGURE 13 — Function of trust in organizations.** Adapted from Siegrist et al., 2000: 356.



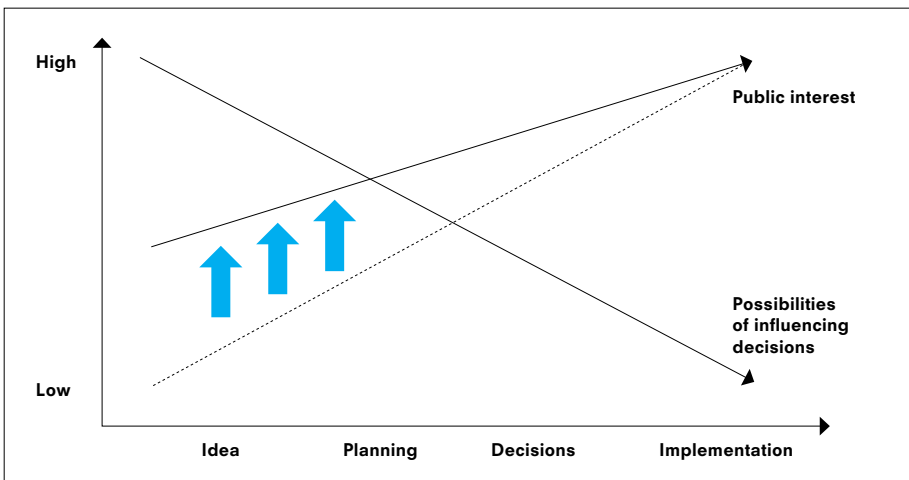
## 1.4.4. The engagement paradox

Almost all types of project that require a public or stakeholder engagement process suffer from the engagement paradox.

As a project moves from idea to implementation, the possibility of influencing decisions decreases. This is because the closer an idea – let’s say building a house – moves toward implementation, the more concrete it becomes, the more decisions have been made. Further down the line planning permissions will have been achieved and considerable sums of money will have been spent on architects, structural engineers etc. If a neighbor now decides he or she does not want a house in that shape next door, the future owner will have to either meet the demands at his / her own cost or will have to argue with the neighbor. But, in the absence of information, the neighbor might only become aware of the project when digging starts – or worse once the walls go up and he decides that he does not like the height, for example. When it comes to building houses, these things are, in fact, largely foreseeable and regulated; but with most projects that need stakeholder or public engagement, sufficient regulation does not exist or may be impossible due to the novel nature of the project or technology.

Hence one of the crucial tasks in stakeholder or public engagement is to engage relevant people and organizations early, when there is still time to change aspects of the project in a way that will raise stakeholder and public acceptability (see figure 14).

**FIGURE 14 — Public engagement should start before policy decisions are taken.**



# 1.4.5. Checking for legitimization of public engagement processes

Several procedural criteria are available to evaluate if all participants accept the process as legitimate, inclusive and responsive to their needs. Often scientists are involved in public engagement processes both as experts or as facilitators. This is when they need to become aware of these procedural criteria and have to follow them.

**TABLE 8 — Procedural criteria for the evaluation of public engagement.**  
 Adapted from Rowe and Frewer, 2000.

<p><b>Acceptance of process</b></p>	<p><b>Criterion of representativeness:</b> public participants should comprise a broadly representative sample of the population.</p> <p><b>Criterion of independency:</b> participation process should be conducted in an independent and unbiased way.</p> <p><b>Criterion of early involvement:</b> the public should be involved as early as possible in the process, as soon as value judgments become necessary.</p> <p><b>Criterion of influence:</b> output of the procedure should have a genuine influence on policy.</p> <p><b>Criterion of transparency:</b> process should be transparent so the public can see what is going on and how decisions are being made.</p>
<p><b>Process criteria</b></p>	<p><b>Criterion of resource accessibility:</b> make resources available to public participants to fulfill their engagement.</p> <p><b>Criterion of task definition:</b> participation task should be clearly defined.</p> <p><b>Criterion of structured decision-making:</b> process should be well structured.</p> <p><b>Criterion of cost-effectiveness:</b> costs of the procedure need to reflect the importance of the decision.</p>

## KEEP IN MIND

While it is impossible to standardize a public or stakeholder engagement project, there are some pointers. What we have discussed so far in this chapter can be condensed into the following seven success factors:

- Start early, establish relationships with stakeholders.
- Declare your own legitimate interests and motivations.
- Declare uncertainties and common criticisms.
- Ensure transparency and fairness in one-way communication and in the process of dialogue.
- Goal must be two-way communication / dialogue – not just information.
- Communicate shades of grey, not just black and white.
- Give guidance: explain new studies / information to stakeholders and lay persons.

With this in mind the next section gives a brief overview of different formats public participation, their aims, types of conflict they are applicable to, and examples of where and when they are typically used.





# 2. TOOLS

## for risk and uncertainty communication and public engagement

### **Christoph Beuttler**

Deputy managing director of the Risk Dialogue Foundation St.Gallen, Switzerland

### **Melanie Paschke**

Director of education at the Zurich-Basel Plant Science Center, lecturer at ETH Zurich and University of Zurich, Switzerland

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<b>2.2.</b>	<b>Quantitative risk communication</b>	<b>56</b>
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## 2.1. How to communicate uncertainty in reports

### Purpose

The way in which people select, understand and digest information and related uncertainties is important for communication. We have to make technical information easy to understand through wording and language, as well as in data and figures.

### Applications

Several guidelines have been developed to allow scientist to present their quantitatively measured risks (= absolute and relative risk) and the related uncertainties in policy reports to policymakers and public.

### Time needed

Risk and uncertainty communication as part of policy reports will need flexible time from several hours to days.

### Implementation

#### Progressive disclosure of information

Public and policymakers need timely, short and prominent presentation of uncertainties. A systematic approach to providing this information is given in Wardekker et al., 2013. Information can be given in several different layers:

- **Outer layer** (e.g., press release) for non-technical information. Uncertainties are communicated as part of the message. Emphasis is on context, implications and consequences for target group.
- **Inner layer** (e.g., appendices, background reports) for detailed technical information. Emphasis is on types, sources and levels of uncertainty, both in knowledge (= epistemic uncertainties) and variability (= aleatory uncertainties).

The OUTER LAYER formulates main messages relating to uncertainties. Desirable qualities here are:

- Robust policy-relevant conclusions, given the uncertainties.
- Extent of robustness is clear from the phrasing.
- Conclusions have the right level of precision. If using quantitative messages, number of significant digits need to be correct. A result should not be expressed more accurately than can be justified given the uncertainties, for example, using 10% rather than 10.6%.
- Consistency with previous messages.
- Main text carries a clear and traceable account of the line of reasoning leading to these conclusions, giving due attention to the uncertainties involved.

**The information in the outer layer**

- Uncertainties could be presented as verbal, numerical or visual information. Each of these formats has certain advantages and disadvantages (see table 10).
- A non-technically oriented public will find information on likelihoods and probabilities difficult to interpret. Use translations in understandable phrases. Verbal presentation of uncertainties should be accompanied by their numerical values to avoid large variation in interpretation of the verbal terms by the lay public.
- The general public interprets terminologies associated with the communication of uncertainties differently from scientists (see table 9):

Be very careful in referring to ‘risk’ and ‘uncertainty.’ Depending on the context, a ‘risk’ often connotes a low-probability event, something that might happen but is not likely, such as the risk of one’s house burning down. Thus, in this context, global warming is not a risk but a reality. Similarly, to the public, ‘uncertainty’ generally means we do not know if something will happen, so uncertainty about future warming is taken to mean that it might not warm at all; it might even cool, for all we know. But that is not what scientists mean; they mean there is a range of possible warming, depending on the level of emissions and how sensitive the climate is to those emissions. So instead of ‘uncertainty,’ try using ‘range.’

— Hassol, 2008:106.

**TABLE 9 — Different interpretations of terminologies in climate change communication.**

Adapted from Hassol, 2008 and Center for Research on Environmental Decisions and ecoAmerica, 2014: 27.

Scientific term	What a lay person understands	Better used wordings
<b>Error</b>	Mistake, wrong incorrect.	Uncertainty associated with a measuring device or model.
<b>Risk</b>	An event that is highly likely or not very likely.	The probability that event x will happen is ...
<b>Bias</b>	Unfair preference or discrimination.	Offset from the observed trend.
<b>Positive trend</b>	A good trend.	Upward trend.
<b>Positive feedback</b>	Constructive criticism.	Self-enforcing cycle.
<b>Negative feedback</b>	Negative criticism.	Balancing feedback.
<b>Anomaly</b>	Abnormal occurrence.	Deviation from a long-term average.

**TABLE 10 — When to use verbal or numeric presentation of risk and uncertainties.**

Adapted and reproduced with permission from Institute of Medicine, 2013: 186–187.

<b>Verbal communication of risk and uncertainties (e.g., unlikely, possible, almost, certain)</b>	
<b>Strengths</b>	<b>Weaknesses</b>
<p>Is easy and natural to use.</p> <p>Translates information on likelihoods, probabilities, frequencies etc. in understandable phrases.</p> <p>Can also express directions (i.e., increase, decrease) or relationships between variables in an understandable way.</p> <p>May better capture a person's emotions and therefore support decision-making and actions.</p>	<p>Especially if the goal is to achieve precision in risk estimates, variability in interpretation may be a problem (= linguistic uncertainty; figure 1).</p>
<b>Numeric communication of risk and uncertainties (e.g., percentages, frequencies)</b>	
<b>Strengths</b>	<b>Weaknesses</b>
<p>Is precise and leads to more accurate perceptions of risk than the use of probability phrases and graphical displays.</p> <p>Can be converted from one metric to another (e.g., 10% = 1 out of 10).</p> <p>Can be verified for accuracy (assuming enough observations).</p> <p>Can be computed using algorithms based on observed data.</p>	<p>Lacks sensitivity for gut-level reactions and intuitions.</p> <p>People have problems understanding and applying mathematical concepts (different levels of numeracy).</p> <p>Algorithms used to derive numbers may be incorrect, untestable, or result in wide confidence intervals that may affect public trust.</p>
<b>Visual (graphic) communication of risk (e.g., pie charts, scatter plots, line graphs)</b>	
<b>Strengths</b>	<b>Weaknesses</b>
<p>Ability to summarize a great deal of data and show patterns in the data that would go undetected using other methods.</p> <p>Useful for priming automatic mathematics operations (e.g., subtraction in comparing the difference in height between two bars of a histogram).</p> <p>Is able to attract and hold people's attention because it displays data in concrete, visual terms.</p> <p>May be especially useful to help with visualization of part-to-whole relationships.</p>	<p>Data patterns may discourage people from attending to details (e.g., numbers).</p> <p>Poorly designed or complex graphs may not be well understood. Some individuals may lack the skills or educational resources to learn how to use and interpret graphs.</p> <p>Graphics can sometimes be challenging to prepare or require specialized technical programs.</p> <p>The design of graphics can mislead by calling attention to certain elements and away from others.</p>

THEORY

TOOLS

EXAMPLE

### The information in the inner layer

The inner layer indicates how uncertainty was dealt with during the study and in the report: What kind of methods were methods employed? How knowledge gaps were taken into account? The uncertainty information in the inner layer could include:

- Communication of the range of minimum and maximum, as well as 95% confidence interval.
- Report of the estimated likelihood or confidence in a particular number (i.e., the likelihood of non-occurrence of type I error).
- Comparison of the results from several studies and models.

There are alternative expressions possible for communicating direct uncertainty about a fact, number or scientific hypothesis, however with decreasing degree of precision (table 11). Direct uncertainty about a fact, number or scientific hypothesis is the type of uncertainty with the most precisely expressions. For relative uncertainty about competing hypotheses or values for a measure: verbal comparisons through statements of the form ‘A is more likely than B’. Alternatively, numerical expressions for example through the use of Bayesian statistics are possible. Van der Bles et al., 2019 shows a large number of examples of different expressions from literature.

**TABLE 11 — Different expressions of direct uncertainty.** The degree of precision is decreasing from top to down with the upper expression reflecting Rumsfelds ‘known unknowns’ and expression 7 the ‘unknown unknowns’. Adapted from van der Bles et al., 2019.

Expression	Form that expression is used
A full explicit probability distribution communicated numerically or visually (1).	Probability ranges: e.g., with a probability of [Numerical term].
A summary of a distribution communicated numerically or visually (2).	E.g., 95% confidence intervals, error bars, margins of error, fan charts.
A rounded figure, range or an order-of-magnitude assessment (3).	E.g., number between x and y, up to x (without information about the underlying distribution).
A predefined categorization of uncertainty (4).	Controlled vocabulary as IPCC uses, see example 2.
A qualifying verbal statement of uncertainty (5).	E.g., around x, roughly x, very likely x, probably x. E.g., not very likely that..., likely that... .
A list of possibilities or scenarios (6).	E.g., it is x, y or z.
Informally mentioning the existence of uncertainty (7).	E.g., Statements about the possibility of being wrong, the fact that uncertainty exists, unknown unknowns, etc.
No mention of uncertainty (8).	
Explicit denial that uncertainty exists (9).	

## 2.2. Quantitative risk communication

The guidelines of Spiegelhalter, 2017 are very comprehensive for the communication of numbers. Some of the recommendations summarized:

### Recommendation 1

Provide the absolute risk in your verbal and numeric information either presented as percentage (x%), absolute numbers or as frequency (x out of 100). Don't only provide the relative risk when comparing groups.

## EXAMPLE 8 — Processed meat and bowel cancer

The *World Health Organization's (WHO's) International Agency for Research in Cancer (IARC)* in 2015 announced that 50 g of processed meat a day was associated with an increased risk of bowel cancer of 18% (Bouvard et al., 2015). What sounds as a large percentage is called the relative risk and describes the increase in bowel cancer cases in the treatment group compared to the control group. Relative risks cannot be interpreted without also knowing the absolute risk: In the control group 6 in every 100 people would be expected to get bowel cancer, while with a diet of 50 g daily bacon there will be 7 out of 100 cases, i.e., an increase of one extra case (Goldin, 2015; Spiegelhalter, 2017).

In Switzerland for example the number of new cases with bowel cancer is around 4100 per year, from these around 585 could be correlated to the regular eating of processed meat.

### Recommendation 2

For single unique events use absolute risk difference or the proportion as 1 in x.

## EXAMPLE 9 — Absolute risk difference for reporting heat waves

In this example the communicators took into account the relatively rare (and therefore still considered as single events) but fast increasing number of heat waves in the Euro-Mediterranean region in the last decade. They used the proportion and the absolute risk difference to highlight the trend of a higher probability of heat waves in the near future (see table 12).

The summer of 2017 was marked by extreme heat in Southern Europe. Scientists with *World Weather Attribution (WWA)* conducted a multi-method attribution analysis to assess whether and to what extent human-caused climate change played a role in both the record hot summer (June–August) across the Euro-Mediterranean region and three-day heat waves such as the early August heat wave dubbed Lucifer. In many towns and cities across the Euro-Mediterranean region there is now around a **1 in 10 of chance** [proportion 1 in x] every year for heat waves at least as hot as those in the summer of 2017. The team found that climate change increased the chances of seeing a summer as hot as 2017 by at least a **factor of 10** [reporting absolute risk difference] and a heat wave like Lucifer by at least a **factor of four** since 1900.

— World Weather Attribution, Sept. 27, 2017.

**TABLE 12 — The risks of occurrence of extremely hot summers.**

Method	1900	2017
Event rate or absolute risk	< 1%	10%
Expected frequency	< 1 out of 100	10 out of 100
Absolute risk difference		10%
Proportion as 1 in X	1 in 100	1 in 10
Relative risk <sup>1</sup>		10%

<sup>1</sup> Relative risk is expressed as a percentage decrease or a percentage increase. The calculation is the absolute risk difference of 10% divided by the absolute risk of the event of an extremely hot summer in 1900 (< 1%).

Definition of relative Risk: RR is often used when the study involves comparing the livelihood, or chance, of an event occurring between two groups.

Absolute risk (AR) = the number of events (good or bad) in treated or control groups, divided by the number of people in that group.

ARC = the AR of the control group.

ART = the AR of the treatment group.

Absolute risk difference (ARD):  $ARC - ART$

Relative risk (RR) =  $ARD / ARC$ .

### Recommendation 3

If you express chance as a proportion, a frequency, or a percentage – be clear about the reference class and the timeline. You can also give a distribution or range, for example, a confidence interval.

Ratio bias describes a phenomenon that when reporting an expected frequency as 1 out of 100, 10 out of 1000 the larger denominator suggests a larger risk to the reader. Recommendation is that you will normally use the x (= nominator) out of 100 (= denominator). Keep the denominator fixed when making comparisons with frequencies.

# EXAMPLE 10 — Reporting chances in risk

You can report changes in risk with different statements for example as:

**Statement 1** reports proportions and includes a time line: A 1 in 10 chance every year for heat waves at least as hot as those in the summer of 2017 in the Euro-Mediterranean region.

**Statement 2** uses expected frequency with fixed denominator and a time line: 10 out of 100 summers will develop heat waves at least as hot as those in the summer of 2017 in the Euro-Mediterranean region. 1900 the frequency was 1 out of 100.

**Statement 3** reports absolute risk difference and a time line: A 10% increase (or an increase of the factor 10) in heat waves at least as hot as those in the summer of 2017 in the Euro-Mediterranean region since 1900.

## Recommendation 4

Provide percentages and frequencies both with and without the outcome to avoid framing bias.

Alternative ways of framing risk information influence risk perception and decision making. Recipients are sensible in their emotional reaction to the statements: In 5% of cases out of a group of 100 the illness xy was developed (received as more negative) vs. 95% of cases out of a group of 100 stayed healthy and didn't develop illness xy (received as more positive). This framing bias could be avoided by a statement as: From 7 cases out of 100 people that developed bowel cancer, 1 case would be expected to be caused by the daily eating of processed meat while the other 6 cases are caused by other factors (Spiegelhalter, 2017).

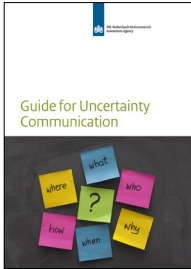
## Recommendation 5

If you provide a measure of statistical significance compared with a null hypothesis, for example a standard p-value, standard error *etc.* use it in the inner layer and not the outer layer of the report.

This might be a standard p-value, but can also be expressed in terms of the number of standard errors from the null can be given but is most of the time part of the inner rather than the outer layer of a report.

## Limitations

Understanding the difficulties in precise phrase about risk and uncertainties is important for informing about risk. However, it does not replace deliberation and public dialogue. People are unwilling to accept probabilistic estimations as the only benchmarks for evaluating risks.



### MORE READING

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### SOURCES — Tools 2.1 and 2.2

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Hassol, S. J. (2008). Improving how scientists communicate about climate change. *Eos*, 89(11), 106–107.

Institute of Medicine (2013). *Communication of Uncertainty*. In: *Environmental Decisions in the Face of Uncertainty*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/12568>

Spiegelhalter, D. (2017). Risk and uncertainty communication. *Annu. Rev. Stat. Appl.* 4: 31–60. <https://doi.org/10.1146/annurev-statistics-010814-020148>

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## 2.3. Controversy frequency matrix

### Purpose

Concern assessments – i.e., social site characterization – are part of phase one in the design of a public engagement process. The aim is to identify the opinions and discourse of the public, and are usually combined with media analysis of current and past discourse to complete the picture of how the current perceived concerns and opportunities came about. They usually entail an assessment on the one hand of perceived concerns or risks and on the other hand of perceived opportunities of a given project, technology or medium carrying relevant risks to the public and/or stakeholders.

### Applications

Concern assessments are usually used in projects with limited geographical scope and a limited number of stakeholders, e.g., geothermal power plants. They can, however, be used for all sorts of social site characterizations.

### Time needed

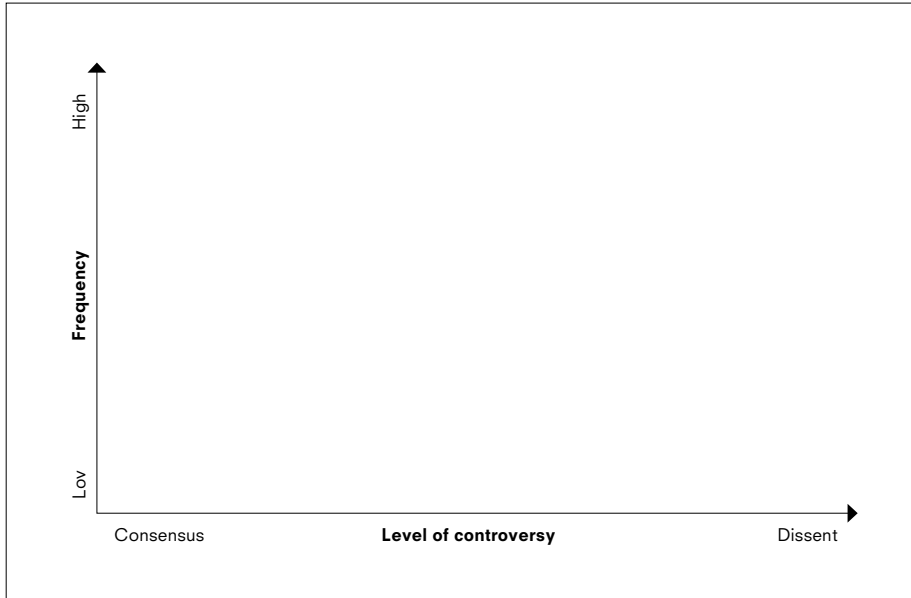
Concern assessments usually involve face to face interviews on a certain topic; hence they are labor and time intensive.

### Implementation

The controversy frequency matrix (figure 15) can be used to carry out the assessment. Typically, individual interviews are conducted with all participants taking part in the dialogue. They are asked about their perceived risks and opportunities and how controversial these are. Opportunities and risks are then listed on two different matrixes. On the y-axis (vertical) the interviewer simply lists how often a certain perceived risk or opportunity is mentioned in the interview. The more often an issue is mentioned, the higher it climbs on the axis. On the x-axis (horizontal) the interviewer lists the level of perceived consensus or controversy of any given risk or opportunity. The more consensus there is among participants that a given issue is a risk, the more it is listed toward the left of the x-axis. With this tool one can immediately see how often a risk or opportunity is perceived to be relevant by the participants and if they agree on the fact that this is a risk or an opportunity.

One example of a completed controversy matrix is given in 'Chapter 3. Example for Public Engagement.'

**FIGURE 15 — Template for a controversy frequency matrix.**



### **Limitations**

There are a number of limitations. First of all, answers depend on how much the participants trust the interviewer. Low trust might lead them not to reveal everything, either for fear of it being misused or for fear of coming across as a non-expert. Furthermore, answers depend and change with the stakeholder's knowledge of the subject. Finally, like all models the matrix is a simplified approach that represents a more complex reality.

## 2.4. Citizen jury

### Purpose

The citizen jury enables informed citizen to provide input into policy decisions. It is a way of involving citizens in democratic decision-making.

### Applications

Citizens can decide, for example, on different evidence-based scenarios or on risk governance options for specific new technologies. They can engage in deliberative value-based discussions, while developing policy recommendations. The method can generate concrete action when it is directly linked to the decision-making process.

### Time needed

4–5 days.

### Implementation

A citizen jury involves the jury, witnesses and sponsor.

### Composition of the jury

12–24 randomly selected citizens reflecting the actual percentage of population in certain sub-categories. The aim is to make the jury a microcosm of the population. Selection criteria are specific demographic variables, including age, ethnicity, education, gender, and geographic location within the community. Additional variables could be demographic characteristics such as tax-paying status etc., or attitudinal questions, such as prior opinions on a specific political issue.

### Selection of witnesses

Witnesses are experts and stakeholders. Witnesses include people who help the jury by explaining the issues in a language that average citizens can understand. Experts from the scientific domain should take an evidence-based position, while stakeholders might advocate their stake in the topic. The board of witnesses must include the different stakes or perspectives proposed in the debate.

### Sponsors

Sponsors are usually government agencies, but can also be NGOs or anyone interested in providing a perspective on the competing options to be deliberated. Sponsors should be unbiased toward a particular outcome.

### Hearings

The jury is informed in hearings. Different positions are introduced by the witnesses. Witnesses give presentations and jury members can direct their questions to the witnesses. The

moderators (normally two) facilitate the entire process. Hearings should start with evidence-based knowledge to provide the context for the different adversely views presented by the stakeholders.

### Deliberation

Jury participants then go through a process of deliberation with the aim of reaching a conclusion on the subject either by consensus or vote. They make recommendations in the form of a report including a description of the process, as well as decisions and arguments. The sponsoring body is required to respond to the report either by acting on it or by explaining why it disagrees with it. The process ends with a round of questions to the jury on the procedure and its assessment.

### Limitations

Staff time is the most significant cost of this method.



### MORE READING

Elliott, J., Heesterbeek, S., Lukensmeyer, C., L., Slocum, N. (2005). Participatory method toolkit. A practitioner's manual. Belgium: King Baudouin Foundation and the Flemish Institute for Science and Technology Assessment (viWTA).

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## 2.5. Consensus conference

### **Purpose**

Consensus can be found on a controversial topic by convoking a conference of randomly selected citizens.

### **Applications**

The citizen group defines issues and selection of experts. They then assess information and write evaluation report. The report contains citizen recommendations on political and social dealings with the topic and is aimed at political decision-makers, experts and the public.

### **Time needed**

Several weeks.

### **Implementation**

The consensus conference involves a panel of citizens drawn randomly from the general public, as well as experts.

### **Selection of citizens' panel**

The members of a citizens' panel are not fully representative of a given population, but many different opinions should be represented in order to exchange different perspectives.

Participants must understand the subject. They decide the agenda, prepare questions to be addressed to experts during the conference, and write recommendations based on the questions, deliberations, and argumentation of the conference.

### **Selection of reference persons**

12–15 reference persons are selected, including scientists with different knowledge, perspectives and stakes. Experts suggested by organizers and facilitators to guarantee diversity of expertise are selected by the citizens' panel. Experts only attend the consensus conference two-day sessions.

### **Principal phases and roles**

Before the public conference, two two-day sessions are held, in which the citizens' panel defines the issues relevant to the topic of concern. From their own perspective they then formulate a set of key questions and choose a panel of experts.

## 1. Study weekend

Tasks of participants of the citizens' panel for the first two-day session:

- Become familiar with the full range of issues relevant to the topic.
- Identify the areas of greatest concern or interest.
- In each of those areas, formulate a set of questions to which they seek answers.
- Set an agenda for the second study weekend.

## 2. Study weekend

Tasks of participants of the citizens' panel for the second study two-day session:

- Refine questions to one or two overarching in each issue area.
- Select experts to address questions at the consensus conference.
- Plan the consensus conference.

## 3. Conference

The consensus conference is a 2–3-day public event in which a citizen-driven discussion takes place between citizens and experts. By then, the members of the citizens' panel will be well-informed on the topic. At the conference they put key questions to the panel of experts. Panels have different roles and tasks:

### EXPERT PANEL

- Responds to cross-examination by the citizens' panel.
- Responds to questions from the audience.

### CITIZENS' PANEL

- Cross-examines the expert panel.
- Writes and presents the final report.

After two days of expert presentation and citizen cross-questioning, the citizens' panel writes a report based on their deliberations, consensus, and expert responses to their key questions. The report is presented on the final day of the conference and then distributed to policymakers, stakeholders, and other interested groups.

## Limitations

This is a very resource-intensive approach, with both staff and citizens' time volunteered for the process.

**SOURCE** — Elliott, J., Heesterbeek, S., Lukensmeyer, C., L., Slocum, N. (2005). Participatory method toolkit. A practitioner's manual. Belgium: King Baudouin Foundation and the Flemish Institute for Science and Technology Assessment (viWTA).  
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[www.pbl.nl/sites/default/files/cms/publicaties/PBL\\_2013\\_Guide-for-uncertainty-communication\\_1339.pdf](http://www.pbl.nl/sites/default/files/cms/publicaties/PBL_2013_Guide-for-uncertainty-communication_1339.pdf)

## 2.6. Focus group

### Purpose

Focus groups are used when you need to know 'what' and 'why'. For example: Why do representatives of the public prefer policy option 1 over option 2? Why do they prefer scenario 1 over scenario 2? Which of the needs of different groups represented in the focus group are more important? How should implementation of different options be measured?

### Applications

Focus groups will help policymakers to learn about what people want, need and prefer when different policy options and policy implementations are discussed; they enable sponsors to be more responsive to citizens.

### Time needed

One day for the focus group meeting, plus preparation time.

### Implementation

The focus group involves a panel of citizens' representatives and external facilitators. Focus group participants should reflect the demographic diversity of the population. Governance bodies can sponsor focus groups; scientists can be experts.

## SETTING UP A FOCUS GROUP

**Set your objectives.** What information are you seeking? Decide how many groups you need. How many sub-groups do you need to invite to become representative for your community?

**Recruiting participants.** Participants should not know each other so that honest, open discussion can take place. Screening of participants could be done with questionnaires that reveal information about demographic status, language skills etc.

**Size of focus groups.** 8–10 participants in a group.

**Focus group record.** Document ongoing decisions and developments, objectives, specifications for participants, how many groups and how often they will be repeated to document the process.

**Discussion guide.** A discussion guide is an outline of all the topics that the facilitator will cover during the focus group discussion. A discussion guide is needed to outline the topics, keep the focus group discussion on track and make sure important areas are covered.

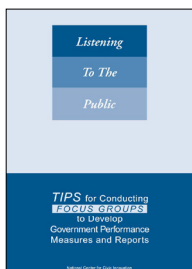
It contains references to expert opinions and necessary background information. Use open questions. The discussion guide is developed by the facilitator and sponsor together.

## CARRYING OUT THE FOCUS GROUP SESSION

- The facilitator opens the session and explains the objectives and what participants can expect.
- The facilitator will explain how the information is documents and that the information will be anonymous.
- The facilitator will follow the discussion guide during the conversations.
- Expert statements and other background information will be available and the facilitator will ensure that participants assess this information in a timely fashion.

### Limitations

The small size of focus groups means the groups might not fully represent the overall population.



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## 2.7. Future workshop

### Purpose

To motivate citizens and involve those affected in planning processes to design their desired future and to build an action plan on its implementation. The method was developed by Jungk and Müller (1987) to develop community-driven solutions to local problems.

### Applications

Future workshops allow participants to discover an ideal future and to come up with new ideas. It is a community-based approach, relevant in situations where community concerns arise, community knowledge and experience is available and participants are willing and have the power to take actions. The method tries to support group creativity and synergy.

### Time

1–3 days.

### Size of the group

No more than 15–20 participants.

### Implementation

Recruiting participants. Future workshops can be created in a totally open way by inviting participants from communities that are concerned with a certain local problem and its solution.

### Phases

- **Critique phase.** Participants generate and collect issues in a brainstorming process. They structure the critical points by common topics through a clustering process or mind-mapping. They evaluate and prioritize critical point to work on.
- **Fantasy phase.** Participants imagine possible futures through drawing, narratives or any other method of visualization. Generally known solutions should be avoided and intuitive or non-verbalized knowledge should be enhanced. Futures can include solutions to the problem and should at this stage be suggested without restrictions, not reflecting on traditions or barriers.
- **Implementation phase.** Possible futures are reduced in scope to those that can be consensually pursued: What is their possible and realizable core? A SWOT matrix is a useful tool to evaluate strengths, weaknesses, opportunities and threats in a group process. This can require additional knowledge from invited experts on economic, technical, social and political matters.
- **Application phase.** Choose the best ideas and transform them into concrete terms; develop action plans that specify who does what, where, when and how.

## Limitations

Future workshops engage communities in decision-making and finding creative solutions to local problems in which they are directly involved. They are legitimate when sponsors and facilitators are willing to involve communities in the outcomes, i.e., either taking the action plan as a mandate for implementation or enabling the involved communities to implement their solution.

**SOURCE** — Jungk, R., Müllert, N. (1987). Future workshops: how to create desirable futures. London: Institute for Social Inventions. Vidal, R., V., V. (2010). Chapter 6: the future workshop. In: Creative and participative problem solving. The art and the science.

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# 3. EXAMPLE for public engagement

**Christoph Beuttler**

Deputy managing director of the Risk Dialogue Foundation St.Gallen, Switzerland

## 3.1. Engaging the public on geothermal energy

*In a shorter version adapted from Wallquist and Holenstein, 2015.*

For a geothermal project in Gross-Gerau, Germany, a three-phase community engagement process for deep geothermal power plants was carried out.

### Background

Geothermal energy is ground heat stored in the earth's crust. Ground heat tapped by means of geothermal drilling can be used as regenerative energy for heating, cooling, the generation of electricity and more. This form of energy is considered cost-effective, reliable, and environmentally friendly. However, depending on geological conditions the expensive drilling process has inherent risks such as failure to create suitable conditions for operation, and the possible triggering of earthquakes, as well as other potential environmental problems. Hence for new projects, it is important for the sites to be examined not only with regard to the characteristics of the reservoirs, but also with respect to the social context.

How the public perceives benefits and risks of power production from geothermal energy is becoming increasingly crucial to the further development of the technology. Public perception influences geothermal projects either directly, in the form of local protests and action groups, or indirectly, by defining the political climate for geothermal energy production.

### ENGAGEMENT PROCESS

In Germany, the *Überlandwerk Gross-Gerau GmbH (ÜWG)*, a publicly held utility company located in Gross-Gerau in the Upper Rhine graben, was taking a pioneering role in terms of public engagement for their hydrothermal project. With the *Swiss Risk Dialogue Foundation*, a non-profit organization, they entrusted an independent and trustworthy facilitator with the formulation and moderation of a broad and comprehensive dialogue process with all local stakeholders and the general public.

#### Social site characterization (Phase 1)

In the first phase of the engagement process, which took place at the outset during the 3D seismic survey in 2011, the *Swiss Risk Dialogue Foundation* conducted a local 'social site characterization' in which the perceptions, hopes, fears, questions, and concerns of stakeholders and citizens around the topic of geothermal energy, as well as other local issues, were identified. With insights from a continuous media analysis and more than 30 semi-structured interviews with representatives of various stakeholder groups from agriculture, environmental

organizations, community groups, and individuals, it was possible to understand the issues people had on their minds regarding the planned geothermal power plant in their vicinity.

### Stakeholder dialogue (Phase 2)

Based on initial interactions with important stakeholders and results of social site characterization, an advisory board of 20 members representing a broad range of stakeholder groups (including local government officials) was established in November 2012. The aim of this board was to take up all questions, wishes and concerns, from other stakeholders and the general public, discuss these, and formulate requests in the form of a report addressed to the project owners. By May 2013 the advisory board had reached a consensus and came up with 31 points that it wanted to be fulfilled before the project could be realized.

One central point was the question of project-induced seismicity, and more importantly, claim settlement in the event of damages caused by an induced earthquake. Here the advisory board proposed a comprehensive insurance concept protecting citizens from potential legal disputes.

FIGURE 16 — Frequency and level of controversy of BENEFIT concepts perceived by interviewees.

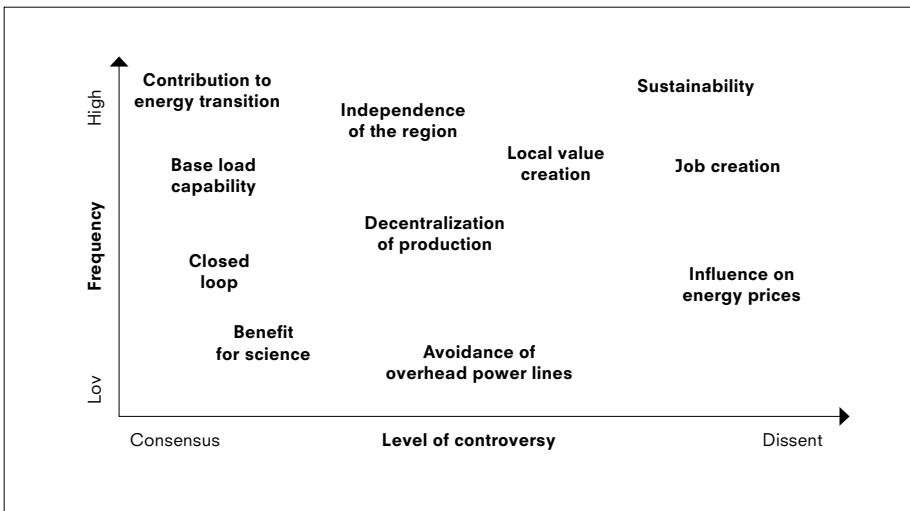
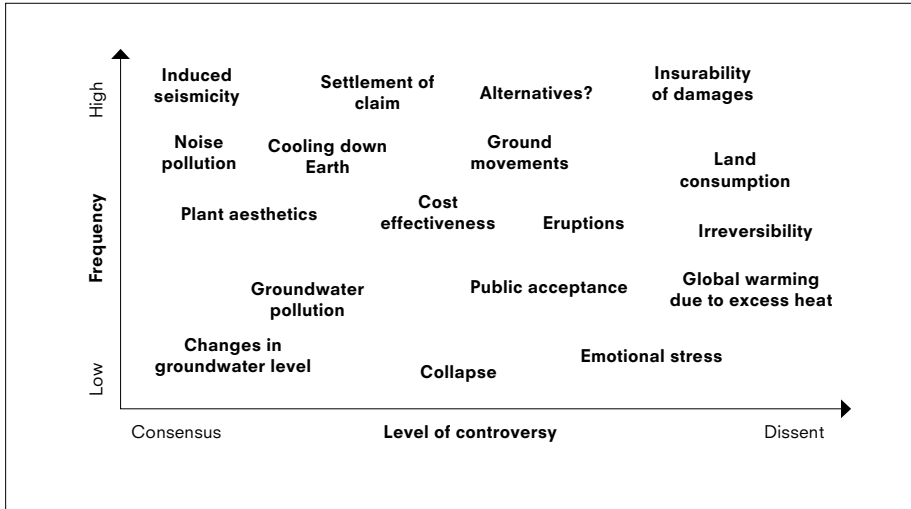


FIGURE 17 — Frequency and level of controversy of RISK concepts perceived by interviewees.



### Civil dialogue (Phase 3)

The civil dialogue process was developed on the basis of findings (information needs, wishes, concerns etc.) of the social site characterization. The aim was to engage as many residents of the region in the development of the geothermal project as possible. This included the provision of information and the answering of questions on the one hand, and a dialogue on controversial issues on the other. Several hundred local residents took part in six public meetings in spring 2013 and had in-depth discussions with experts from academia and industry. Geological and engineering fundamentals as well as the opportunities and risks of geothermal energy for their specific region were among the topics covered. The most controversial issues identified in the social site characterization (e.g., insurability of damages, the utilization of excess heat) were at the focal point of these public meetings. Presentations and discussions were documented and published online. At the final public meeting, members of the advisory board presented their work to the public. ÜWG commented in detail on the demands and evaluations of the advisory board's report and stated that they would base their further project planning on the advisory board's work. In fall 2013 a requested large-scale telephone survey was conducted among 1000 randomly chosen citizens living in the affected communities. Results showed that the engagement process was well received and that a majority of the people living in the surrounding communities now supported the geothermal project. Furthermore, the survey indicated that respondents preferred the deployment of geothermal power over onshore wind and biomass. Workshops with immediate neighbors were the next step. At these workshops, locally relevant details of the project design (e.g., architectural features, noise reduction measures, plantation, illumination) were discussed with particular attention to the given constraints.

### SUCCESS FACTORS: FAIRNESS MATTERS

Because of its roots in the region and its long history as a public utility company, ÜWG benefits from a high baseline level of trust. By way of contrast, private corporations are more often criticized for privatizing profits while socializing the associated risks. This fosters mistrust and increases the need for independent supervision of the engagement process. In addition to adequate risk management, the perceived procedural fairness of the decision process played an important role. Fair procedures in reaching decisions about a geothermal project significantly increase people's trust in the involved parties and promote mutual understanding of different positions. This understanding and willingness to exchange arguments honestly and to learn from each other provides a solid basis for a fruitful, factual debate. An indicator to illustrate the success achieved with the participatory dialogue process in Gross-Gerau so far is the fact that the groups involved (from the operator side as well as the stakeholders and citizens) were satisfied with the chosen approach and the results. The credibility of the process, which was assured by the neutral process design and moderation, as well as through the transparent documentation on [www.dialoggeo.de](http://www.dialoggeo.de), was of crucial importance. The other critical factor was the willingness of the project owners to consider the demands of the stakeholders when planning the geothermal power plant. Otherwise the relevance of the entire dialogue process would have been diminished.

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