Chapter 5: Risk and conflicts about risk

Overview

In this chapter, you will learn about the great importance of risks and the contested perception of risks in environmental sociology. You will gain knowledge about various factors that influence risk perception. We will introduce you to Ulrich Beck's (1992) "Risk Society" and Niklas Luhmann's (1989) "Ecological Communication", two classics of environmental sociology and the sociology of risk that approach this topic differently but which are both still relevant today. Finally, we look at the complexity and uncertainty of overarching risk configurations and examine their contribution to the "co-production" of social change processes through conflicts about risk.

Risk sociology is of particular importance in environmental sociology, as it brings together its central questions as if under a prism. It sometimes focuses on individual substances and processes that are associated with potential harm to the environment and people's health, and analyses their social perception, evaluation and regulation. In recent years, for example, not a day has gone by without "carbon dioxide" and "particulate matter" being debated. Both substances are emissions produced by the combustion processes of motor vehicles and heating systems and are subject to international regulation through the use of limit values. Carbon dioxide is held partly responsible for global warming and particulate matter for considerable health risks. The increase in both emissions is largely due to routines and processes that have emerged with industrialised society and enabled growing prosperity for large parts of a growing world population, but have also caused environmental damage and health hazards. Opportunities and risks, desired progress and its undesired side effects are closely related and it is correspondingly difficult and controversial to characterise undesired effects as "risky" or to try and avoid them. It quickly became apparent that the assessment of such risks is influenced by the point of view of the observer, which is affected not only by social and cultural conditions but also by individual cost-benefit considerations and assessments about whether the risks can be controlled, and also that the cycles of attention depend less on the absolute increase or decrease of substances in the air than on their problematisation in the media and politics. "Asbestos", "dioxin" and "plastic waste" have all had similarly problematic careers in sociological research on risks. However, such research is also dedicated to social risks in other areas including international stock market trading, terrorism and pandemics. However, the sociology of risk does not focus predominantly on the variable individual assessment of such risks, but rather on the difficult connection between controversial and uncertain knowledge on the one hand and political conflicts and decisions on the other. Where risk perceptions differ and, for example, there is considerable criticism of expert analyses and their risk assessments (as happened with regard to the potential risks of nuclear energy, biotechnology and mobile phone systems), controversies about risks develop a sub-political potential (Beck 1992). Conflicts about risk call into question the balanced relations of interpretation; they test the limits of the processing capacity of

institutional responsibilities between decision-makers and those affected, experts and laypersons, as well as between different subsystems, such as the economy and health (Luhmann 2017 [1991]).

The way society deals with air pollutants is an example of the interesting sociological dynamics in the "risk society", which, as Ulrich Beck (1992) has pointed out, have become an issue and a problem due to the unintended side effects of successful modernisation: Traffic emissions were never considered desirable, even horse faeces caused social annoyance and the regulation of exhaust emissions has a long history. But the current conflicts over traffic emissions and their effects are not simply the result of an increase in nitrogen oxides, particulate matter, and carbon dioxide. Facts and values become mixed up in the heated debate about the precise identification of substances deemed to be hazardous, how dangerous they are, the places and processes of their formation, possible methods for reduction and avoidance, and assessments of those methods. In the assessment of what is considered appropriate or unacceptable in terms of air pollution control and which forms of national and international regulatory enforcement are legitimate vis-à-vis the groups affected, legal, social, economic and ecological perspectives struggle for priority in the classification of damage that has occurred versus anticipated disasters, and in the field of tension between stochastic assessments versus changes to existing social orders. These political debates about risk have long since led to a reassessment of motorised private transport and threaten a Western icon of freedom, progress and prosperity – and not without further social consequences.

In the sociology of risk, these complex interrelationships are analysed in order to gain a better understanding of the dynamics of valuation and devaluation that are triggered and their significance for further political and socio-technical development. The social sciences are thereby also making their own contribution to risk assessment, risk communication, and risk governance (Renn 2008). In contrast to other disciplines, the focus is not on identifying the risky characteristics of individual products or phenomena or the legal discussion of regulatory options, but rather on the social significance of risk perception and risk communication, their context- and group-specific variability and the consequences of often controversial risk assessments and regulatory approaches. This brings into focus three central ideas or aspects of the sociology of risk that are shared with environmental sociology as a whole: firstly, the focus on conflicts of interpretation, their backgrounds and typical structures; secondly, the significance of these conflicts of interpretation for social self-images and their successive questioning; and thirdly, the erosion of institutional and sociological categories that takes place when dealing with conflicts about risk and the increasingly difficult demarcation of risks in spatial, temporal and social relationships.

This chapter is organised according to these three aspects. In the first section, we deal with questions about risk perception and show the extent to which neighbouring disciplines such as psychology, anthropology and communication studies can be used to identify typical patterns of risk perception and make them useful for social analysis. In the second section, we look at conflicts about risk, the

politics of risk and the social significance of controversial risk assessments from the social theory perspectives of Ulrich Beck, Niklas Luhmann and Bruno Latour. Each of these authors has a different answer to the question of whether and how risk assessments play a socially transformative role, and thereby proposes different consequences for (environmental) sociology. In the third section, we turn to the current risk configurations, which cannot be limited to individual fields of action. Development trends such as progressive mobilisation, digitalisation and resource exploitation do however cause cross-system effects and make an overarching risk policy an issue and problem in global modernity. Finally, we examine the key question of the extent to which the global confrontation with the anthropogenic risks of environmental changes and global warming not only triggers conflicts over nuclear power and transport development, for example, but also drives the search for alternative social models.

1. Risk perception and defining risks

Social science research on risks was established together with environmental sociology at the end of the 1970s as a reaction to the perceived accumulation of environmental disasters, and has been developed across various disciplines. Since its beginnings, it has been concerned with the tension between risk realities and risk perceptions, i.e., the assumption that risks actually exist and their perception-dependent recognition, communication and evaluation. Wolfgang Krohn and Georg Krücken introduce their 1993 anthology on "Risk as Construction and Reality" with the observation that, on the one hand, the increasing use of technology creates an objectively growing pressure to address problems – be it in the form of the failure of high technologies that could lead to catastrophes, or be it in the form of creeping and irreversible hazards, and that, on the other hand, the perception and assessment of technical risks are subject to social and cultural conditions whose change leads to considerable changes in perception and reassessment (Krohn & Krücken 1993: 9). The dilemma is that risks only become a social fact when they are perceived as such; the fact that they are perceived as a risk, however, makes them one. What does this mean?

Terje Aven and Ortwin Renn (2009: 1) describe risk as "the uncertainty and severity" of possible consequences of actions and decisions in relation to something "that people value". Every perception of risk is therefore uncertain and embedded in socio-cultural and ethical evaluation standards. Until the late 1960s, only Romantic poets and groups involved in nature conservation had made a problematic connection between technological progress and its potential to damage the environment. It was only after awareness-raising publications such as "Limits to Growth" (Meadows et al. 1972) and "Silent Spring" (Carson 1962) had sensitised the populations of Western industrialised countries to this connection that chemical and nuclear accidents were assessed as a "typical" consequence of "risky technologies". Krohn and Krücken were consequently able to write about the "failure of catastrophic high technologies" without any further explanation in 1993. In 1993, readers associated "insidious hazards" with many of the man-made toxins found in foods and the environment that are still discussed

today, however their associations were embedded in patterns of appreciation that are quite different to those seen today. Although risks are generally perceived selectively and in accordance with a particular perspective, modern individuals and organisations generally claim to be guided not by imagined but by actual risks. They often refer to a statistical definition of risk, namely the probabilistic model of risk calculation, with which risks are calculated according to the probability of their occurrence and the amount of damage they would cause. The environmental scientists Robert Kates and Jeanne Kasperson made the important conceptual distinction between risks and hazards in 1983 and emphasised the statistical understanding of risk as a specific, quantifying form of perception: "*Hazards are threats to people and what they value and risks are measures of hazards*" (1983: 7027).

The calculation of risk that is oriented towards "measurement" reveals the origin of the concept of risk and its emergence as a specifically modern form of dealing with uncertainty (Bernstein 1996). It was only when the capitalist economic order and the claim to rational calculability gained central importance and superseded the pre-modern devotion to God-ordained or natural fate (a process to which Max Weber devoted much attention) that risks became conceivable as assessable uncertainties that could be subjected to forward-looking calculations. Etymologically, the term probably goes back to the Italian *risciare* in the context of the medieval long-distance trade of northern Italian cities. It denoted the gamble that merchants took when, for example, they equipped a ship and sent it out in the knowledge of numerous dangers such as storms, rot and piracy in order to increase their wealth as much as possible after its fully laden return – or, in the worst-case scenario, to be financially ruined (Bernstein 1996). They thus assessed the probabilities of success and failure individualistically in relation to their own actions—a historical novelty—and soon developed security-oriented expectations by creating forms of mutual insurance in risk-bearing entities with a new forward-looking approach. To this day, this concept of risk forms the basis of the insurance industry and works above all when empirical values about the extent of past damages and the probabilities of occurrence are available and both variables remain small enough to keep the possibility of (financial) compensation open. This concept of risk is therefore not an "objective" risk assessment, but a socio-culturally specific assessment or "construction". It is firmly linked to a certain social order that only includes certain types of damages and ways of dealing with them in its calculations while "externalising" others from consideration, and it forms new kinds of cooperation beyond informal, mutually supportive communities, such as contractually organised insurance companies.

As the following explanations will show, every type of risk assessment already has at its core an idea of how it intends to deal with uncertainties. The statistical concept of risk, which is primarily used in the insurance industry and engineering sciences, serves to either monetise risks for compensation or to make them comparable so that decisions can be made between alternative actions, materials or processes. In principle, probabilistic risk assessment emerges from decision-making situations and does not arise as a reaction to the mere possibility

of conceivable (negatively assessed) events. Depending on the data situation, the quantifying type of assessment makes a valuable contribution to well-founded decision-making as long as the perceived risk is not so great that it is judged to be completely unacceptable, and as long as avoidance of the risk is actually possible. In the 1980s, however, repeated chemical accidents and the first major accidents at nuclear power plants led to a spread of critical assessments among parts of the population related to technology and the environment, in the light of which these technologies appeared to be too risky and therefore unacceptable, but also avoidable. Protests began, giving rise to environmental movements, green parties, the identification of an expert/layperson dilemma and an intensified social science debate about the different perceptions of risk.

As politics was entirely focused on technological progress and technology-savvy attitudes with positive perspectives on the controllability and cost-benefit ratio of technologies prevailed, particularly among highly qualified developers and users, risk research initially focused on the task of how to support "more rational" risk assessments and create acceptance among the population. The so-called "deficit model of risk communication" emerged, which assumed that "laypeople" were sceptical about technology because they lacked the specialist knowledge of experts. However, if they were provided with "correct" information about risks, they could correct their "incorrect" risk perception in favour of greater acceptance of technology (Irwin & Wynne 1996). In the period from 1970 to 1990, risk research was initially dominated by psychological approaches focusing on the individual, then by more anthropological and communication theory-based approaches focusing on "newspaper-reading communities".

The first studies focusing on the problem of acceptance of the potential risks of new technologies came from engineers themselves. Chauncey Starr (1969) went beyond probabilistic assessments to include social contexts by comparing scepticism towards novel risks (rail transport) with already accepted probabilities of harm from known risks (smoking) and from this derived "*how safe is safe enough?*" for public risk assessments. He came to the conclusion that risks are considered acceptable if they are associated with a good degree of benefit, if they are entered into voluntarily, if only limited harm is foreseeable, and especially if the death rate does not exceed that of common diseases (Fischhoff et al. 1978: 128). Psychologists continued his investigation in the "psychometric paradigm" of risk research with quantitative attitude studies in order to measure the supposed acceptability of risks in surveys and experiments. In doing so, they also focused on qualitative assessment characteristics, such as perceived catastrophic potential, lack of control or the distribution of costs and benefits, as well as other factors that influence risk perception (Slovic 2000). The large number of subsequent studies were disappointing with regard to the search for clear, stable conditions of acceptance. Instead, they highlighted the context- and object-specific variability and temporal changeability of risk perceptions now labelled as "social", but did not allow any predictions regarding acceptance due to the manifestly uncertain connection between attitudes and actions. With its focus on individual risk

perception, psychometrics can contribute little to sociological risk research on different risk assessments and their significance.

Mary Douglas and Aaron Wildavsky (1982) addressed the issue from the perspective of cultural anthropology and developed a cultural theory of risk perception (→ chap. 4 on environmental attitudes and action). According to this theory, it is not individual assessments but collective "ways of life" and forms of social organisation that determine risk assessments. They assume that in modern societies subjects do not form their own judgement for every possible risk. Rather, they orientate themselves according to superordinate worldviews, which are essentially characterised by two dimensions, namely a stronger or weaker orientation towards compliance with norms and rules in dealing with hazards, and stronger or weaker group ties (*grid-group scheme*): While strong group ties (*high group*) require a high degree of collective control, this is less pronounced in social groups with weak group ties – instead, those social groups have a stronger emphasis on personal responsibility. A way of life with a strong focus on structure and norms (*high grid*) is oriented towards permanent hierarchies and rules, whereas a low-grid way of life tends towards an egalitarian order. According to cultural risk theory, in political conflicts over risky technologies and environmental damage, people in milieus with a strong orientation towards rules and a high level of group loyalty ("hierarchists") rely on state and norm-based regulation, while members of more market-based and individualistic milieus with a weak orientation towards rules and group ties ("individualists") rely on the independent actions of individuals. So called "fatalists" with a strong focus on rules but weak group ties tend to hold back apathetically due to their low conviction regarding the effectiveness of action, while so called "egalitarians" can be expected to scandalise and politicise environmental damage and technical risks due to group pressure and their focus on solidarity.

With its heuristics of typical attitudes towards risk, cultural theory of risk was considered superior to psychometric risk research for a number of years because it enabled a supra-individual reconstruction of the connection between risk perception and the preferred (political) social order, which appeared to be confirmed in some case studies. It showed the extent to which controversies about risk are a) linked to questions of political (not legal) regulation, and b) can be attributed to institutional differences in the way uncertainty is dealt with. On the other hand, this approach lacks any reference to different risk characteristics and processes that could be used to assess the appropriateness or plausibility of risk perceptions or explain the temporal and spatial differences in the occurrence of protest or acceptance, which, from an expert perspective, are often unexpected. These risk perception reference points are also ignored in the integrative analyses related to communication theory that were subsequently developed, which suggest the *social amplification or attenuation* of debates about risk are a result of psychological, social, institutional and cultural processes and their interactions. Instead, these analyses focus on the heuristics of individual information gathering and processing and work with multi-level concepts.

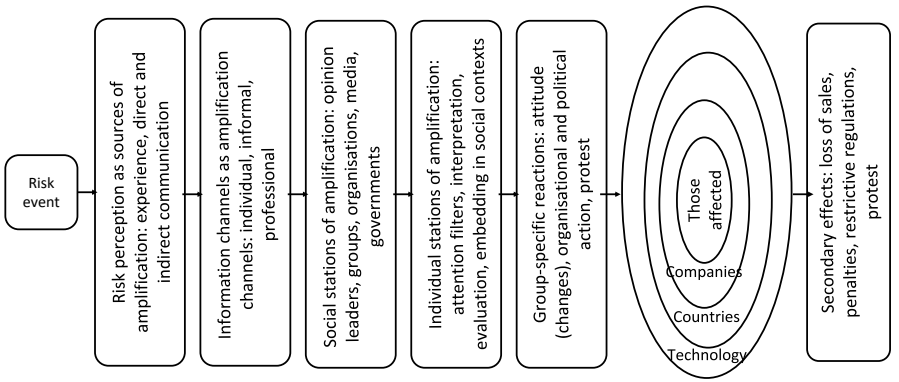

Figure 8: Simplified illustration of the effects of social amplification; source: own illustration based on Kasperson et al. (1988: 185)

The central assumption of this perspective is that the evaluation of hazards interacts with psychologically and socially based attention filters as well as with institutional and cultural forms of risk processing, and that this results in a strengthened or weakened perception of risk (Renn et al., 1992). In terms of communication theory, in this approach "risks" (*risk events)* send bundles of signals consisting of technical and symbolic information to the public via various stations of information processing and evaluation, through which they are influenced by communication from politics, science, mass media, opinion leaders, peers, etc. In the individual recipients, who in turn filter and select, the decoded risk signals lead to behavioural reactions that firstly indicate a strengthening or weakening of the original message and secondly trigger secondary effects such as arousal or (institutional) adaptation measures that contribute to a further escalation or de-escalation. On the input side the approach is implicitly based on hazards identified by experts, which on the recipient side, filtered through the various communication stations, are translated into individual perceptions of risk with corresponding reactions. These perceptions no longer correspond to the expert assessments, but rather "overestimate" some risks (protest against nuclear power), while "underestimating" other sources of risk (smoking). From today's perspective, it is remarkable how the authors differentiate the public's assessment from that of experts, viewing public assessments as a "product of intuitive bias and economic interests as well as cultural values" (Kasperson et al. 1988: 178) while expert assessments are seen to virtually coincide with "the risk" itself, so that experts formulate objective assessments supposedly free of these influencing factors.

It was precisely this assumed difference between experts and laypeople that became increasingly problematic politically, especially when the first nuclear power critics emerged from among the experts themselves and became "counter-experts". The public no longer unquestioningly accepted expert judgements as better and "rational" in political debates. The dispute over technology policies and

their hidden side effects and the public debates on risk assessments and risk management increasingly called for more comprehensive and context-sensitive risk assessments than the probabilistic calculation of risk can provide. In view of the various approaches and case studies, Sheldon Krimsky and Dominic Golding (1992) clearly oppose the deficit model of risk communication in their anthology on social theories of risk. In view of the complex interrelationships between direct and indirect technological consequences and risks and their inconsistent assessment, it is necessary to take a closer look at the construct of "scientific objectivity" and to conceptualise a differentiated "social rationality" on a par with expert rationality. Since every social construction and assessment of "risk" is inevitably embedded in contexts of experience and assessment with specific mixtures of knowledge and ignorance—and there is no difference between experts and other actors in this regard—Sheila Jasanoff views risk assessment per se as a political experiment in which other context-related, for example social and ecological assessment criteria must be taken into account in addition to technical criteria (1999: 150). This is where the sociological theory of risk makes a useful contribution.

2. The sociological theory of risk

As we have seen, risks are constructed in social contexts according to the relevant attention filters and this has different consequences for their assessment. These constructed concepts of risk can be statistical or orientated towards controllability, adjustability, familiarity or other standards, which in turn generate secondary effects, for example for insurability, acceptance, and legal and political containment. According to the model of the social amplification of risk, these "ripple effects" trigger social learning and adaptation effects that impact existing institutions (e.g., risk management) or business areas. In risk theory, the secondary effects are viewed as "side effects" (Beck 1992) or as "re-entry" (Luhmann 2017 [1991]). The sociological theory of risk thus faces the challenge of being confronted less with direct risks in the form of estimated environmental and health hazards or unintended technological consequences than with indirect consequences and interactions, namely the institutional modifications and political changes triggered by risks. This is aggravated by the fact that risks often do not become visible and socially virulent in the direct context of their emergence, but are temporally, spatially and socially displaced and delimited (Beck & Kropp 2007).

2.1. The risk society by Ulrich Beck

Politically, it soon proved to be much easier to lose than to gain trust when dealing with debates about risk, partly because possible hazards and incidents that have occurred are perceived, communicated and observed differently in a sensitised environment, which then calls into question the competence and trustworthiness of existing institutions and actors. In the risk society described by Ulrich Beck (1992) in his widely acclaimed book—which was published a few weeks after the reactor accident in Chernobyl—chemical and nuclear pow-

er accidents, emissions, food scandals and the potential risks of biotechnology lead to a politicisation of the institutional and political status quo, as well as biographical risks that arise in the wake of progressive individualisation, professionalisation and emancipation. Above all, Beck observed a loss of confidence in the ability of existing institutions to solve problems, particularly in science and politics, and more fundamentally an erosion of the consensus on progress and growth of the post-war years. In the years that followed, he observed how the established starting points for attribution, evaluation and differentiation were disintegrating far beyond risk management and how a political arena of conflict was forming instead. The rampant consequences of the Chernobyl disaster and later of Fukushima, but also the financial crises, the risks of climate change and the countless accidents and disasters on the world's oceans first undermine the control fictions of the responsible experts and then call into question central industrial/modern solutions and distinctions in science and politics, for example national vs. global, nature vs. technology, useful vs. dangerous. For Beck, "living in world risk society means living with ineradicable non-knowing" (2008: 115), because more and better knowledge does not reduce the uncertainties. Instead, more science and new and better expertise always produce new risk theories and hypotheses – especially on the expert side. The considerable consequences of risky technologies such as chemical accidents, nuclear disasters or asbestos prove to be almost uninsurable, often affect populations in other places and at later times and were soon no longer regarded as special cases, but as the new reality of the world risk society under conditions of reflexive modernisation (Beck 2008, 2016). In reflexive modernity, social change is no longer driven by the desired achievements of "progress", but by its unintended side effects and their social problematisation and politicisation.

For Beck, the increase and intensity of debates about risk heralds a new age which, unlike the "first" (industrial) modernity, is not centrally defined by the distribution of positive gains in the wake of further modernisation. Rather, the unbounded, "cosmopolitan" contemporary society is slipping into a "second" modernity due to unintentionally co-produced uncertainties, risks and damages – i.e., "modernisation risks" (Beck 1992). This society is losing recourse to sectoral and national solution schemes precisely because it is forced to deal with the unintended side effects and uncertainties of successful action. Charles Perrow (1999 [1984]) describes a new kind of "normality" of disasters, which owes itself to the ever-closer networking of socio-technical developments and creates risks particularly where there is a high level of complexity and close coupling due to uncontrolled functional entanglements. This new normality contributes to an experience of the present as a form of "organised irresponsibility", according to a bon mot by Beck, whose institutional order is no longer able to cope with the globally produced socio-technical interlinkages.

According to Beck's risk theory, the rapid production of secondary consequences, which do not stop at national borders, leads to a reflexive self-confrontation with modern societies and their promises of order and security. These consequences reform and (unintentionally) revolutionise the institutional foundations and social

relations, but take the form of successive change ("metamorphosis") rather than a radical revolution (Beck 2016). Global risks therefore not only bring about the possibility of new types of disasters, but also new types of opportunities to create structures and institutions for cooperation across borders that do more justice to the everyday experience of globality than nationalist container thinking. They create new reflexivities for the self-application of the promise of modernisation, partly with existing institutions (democracy, capitalism, globalisation), for example in the form of a "cosmopolitan community of risk", and partly through institutional change towards cosmopolitan forms of solidarity. The generalised awareness of risk creates a connection with transnational public spheres that spans different locations and species. Beck (2016) expected the development of these transnational publics and their associated demand to have a say to lead to the emergence of the necessary global climate movement, such as the Fridays for Future movement of global youth initiated by Greta Thunberg in 2018. A social self-examination that reforms the institutional foundations of modernity and fundamentally questions its modes of representation is, of course, only possible if alternatives are conceivable and options are recognisable. In this respect, as is often pointed out, the earlier risks of famine or war may have been greater, but they were, as we will come back to in a moment with Niklas Luhmann, attributed to external fates, not internal decisions. Societal development itself was not placed in the context of political options as a risky problem related to control, as is typical for risk societies, where it subsequently causes conflicts and debates about the right way to deal with optionality.

In contrast, these days the perceived risks of developments within society, which are often triggered by science and technology, lead to environmental and technological conflicts in which the underlying definitional relationships become contentious (→ chap. 6 on the environmental movement and environmental conflicts). Ulrich Beck therefore considered risk politics to be the socially consequential debate about whose perception of risk can prevail, which scientific and legal criteria it is based on, and which liability arrangements, costs and compensation claims will result. The reflexive learning of consequences, with which foreseeable damage such as the ecological and health consequences of traffic emissions are processed, politicises the validity of political control, the way responsibility is organised, and the appropriateness of the underlying "definitional relationships" against the background of a flexible space that also makes other understandings of risk, responsibilities and decisions conceivable. Thus, for Beck, risk is "a socially constructed and staged phenomenon through and through in which some have the capacity to defi ne risk and others do not" (Beck 2008: 142).

2.2. Risks and ecological communication in the work of Niklas Luhmann

It is precisely this difference between decision-makers and those affected that is central to the work of the second most important sociological risk theorist, Niklas Luhmann (Luhmann 1989, 2017 [1991]). Unlike Beck, the development of Niklas Luhmann's theory is not based on an increase in new types of hazards, but on an increase in social debates about risk, in the course of which the social problems

of decision-making behaviour change fundamentally (Luhmann 1993: 131). As is usual in Luhmann's systems theory, his analysis of society deals exclusively with communication as a mode in which societies reproduce themselves (*autopoietically)*. Possible "environmental changes", however, lie in the environment of these communications that are orientated towards social reference systems, which they only observe self-referentially: "The system introduces its own distinctions and, with their help, grasps the states and events that appear to it as information. Information is thus a purely system-internal quality" (Luhmann 1991: 18). In this respect, Luhmann views the starting point of statistical and psychological understandings of risk as a self-referential observer construction that says more about the perspective of its users than about the underlying problem.

For him, the concept of risk refers to the historically recent phenomenon of making decisions about the future in the present on the basis of probabilities, which inevitably influences the interests of others. Decisions communicated as "risky" divide social relations into "decision-makers" and "those affected" and, against the backdrop of potentially catastrophic effects, create a reduced willingness to accept risk among those who see their future prospects affected in one way or another. Socially, the question of "who or what decides whether (and within which material and temporal contexts) a risk is to be taken into account or not" (Luhmann 2017 [1991]: 4), becomes central. The sociologically relevant concept of risk therefore does not problematise the "certainty" or "uncertainty" of contingent cases of damage or their avoidance, which itself involves a risk, but rather whether the damage can be attributed to a decision. For Luhmann, the antonym of risk is therefore danger. In contrast to dangerous natural or everyday events that are attributed externally or to oneself, controversies about risk focus on possible damage that is attributed to the decisions of others. The term risk becomes politically explosive as a "second-order observation", i.e., when critical publics criticise the observation criteria that are guiding the actions of decision-makers.

For Luhmann, controversies surrounding risky technologies and their ecological consequences indicate the emergence of a new kind of problematisation of the indeterminacy of the future, against the backdrop of larger decision-making spaces. Due to the social demands of welfare states, the management of controversies can no longer be justified by recourse to economic calculations and existing regulatory norms, but instead raises the question of how far society can establish itself in its environment through its own operations and justify the acceptance of risks. From this perspective, for Luhmann the risks perceived by some people become dangers facing other people who were not involved in the decision and cannot control the decision criteria (Luhmann 1993). The further apart the social groups of decision-makers, beneficiaries and those potentially affected are, the greater the conflicts that can be expected in the political system. It is interesting that Luhmann chooses the same starting point for his analysis of the social significance of conflicts about risk as the pragmatist John Dewey (1996 [1927]) by focusing on the tense relationship between "decision-makers and those affected" in relation to the future options for action of third parties. Whereas in Dewey's case the

direct and indirect effects of decisions at the expense of third parties can lead to the formation of a public sphere and, with successful communication, also of a "large community", Niklas Luhmann (Luhmann 2017 [1991]) fears that explicit risk communication is more likely to fail, as it cannot transcend divergent observational perspectives and instead structurally reproduces the discrepancy between decision-makers and those affected and their divergent risk situations. Another phenomenon leads him to judge attempts to defuse conflicts about risk through communication or participation as useless (Luhmann 2017 [1991]): The enormous complexity of modern dangers, their barely controllable socio-technical interactions and their ecological effects universalise concern on the one hand and make causal attribution to individual decisions difficult on the other, as illustrated by climate change.

In this respect, Ulrich Beck and Niklas Luhmann agree in their observation that interlinkages with serious consequences are increasing as a result of advancing technological possibilities, the potential risks of which can no longer be dealt with through the normal operations of modern industrial institutions (Kropp & Wagner 2005). For Beck, this is the starting point for the emergence of institutional reflexivity, but also for unavoidable controversies about which problem-solving strategies are available for dealing with the consequences of modernisation and its potential threats, and how they can be implemented in a democratically legitimate way. Ortwin Renn (2008), drawing on a co-operation with the International Risk Governance Council (2005) and a number of colleagues, proposes a risk governance procedure in which the complexity, uncertainty and ambiguity of the risks in question are first determined in order to then provide analytical and deliberative recommendations for the risk assessment, communication and prevention, which take into account the various perspectives. For Beck and Renn, communication lays the foundation for the development of suitable forms of response. For Luhmann, on the other hand, the threat lies more in an exaggerated public discussion about new types of risk situations, as this "fear communication" threatens to destabilise social systems.

2.3. The co-production of risky networks in the work of Bruno Latour

Bruno Latour (2007) has developed a completely different perspective on risks. He also assumed that the number of interlinkages with serious consequences is increasing, but did not separate the social space in which they are debated from that of their production and spread. In his perspective, the production and communication of risks such as particulate matter, nuclear radiation and novel viruses takes place in principle in the same "social" space, because materialities and perceptions are mutually dependent. However, there is not just one social space, but several different ones in which networks of actors bring about cultures of nature as assemblages in different ways. This can be illustrated, for example, with the different mobility worlds in European countries, Africa or the USA, in which diesel vehicles feature different technical equipment and are also perceived differently. Latour (1993) thus described nature and society as a hybrid network, which only modern epistemology separates into nature (danger) – society (polit-

ics) – technology (risk), but in which these dividing lines are blurred by the results of the increasing linking and mixing of all elements.

Latour therefore viewed the dualistic "separation" between natural and technical objects on the one hand, and political and social objects on the other, as a modern delusion. It is maintained discursively and epistemically through corresponding practices of "purification", for example through the dominant distinction between social and natural sciences and between social risk perceptions and the technical risk reality. At the same time, however, this is contradicted by the practices of permanent and ever faster mixing and the resulting new hybrids between the fields labelled nature, politics, and technology. This is why, for example, societies before and after their electrification and also those with or without nuclear power plants are fundamentally different, because they each form different "collectives" with their own associations between human and non-human beings in socio-technical networks. In these networks, it is above all the scientifically and technologically produced "quasi-objects"—a concept developed by Michel Serres (2007: 224ff.)—that make a difference by creating links with all their consequences (side effects) and stabilising a new order. Non-human knowledge objects, i.e., physical things and materialities such as nuclear power or particulate matter, circulate as effective artefacts or "actants" in the actor networks and become reference points for human, but also non-human actions, which they simultaneously change in an interactive way: They are "quasi-objects" because, as agents and mediators of action, they expand the spectrum of relevant actors (Latour 2005: 76, 238) and initiate modifications in the social world of associations. Climate and health-related emissions and the practices, controversies and arenas of negotiation centred around them are a fine example of this, as are viral epidemics. In all cases, quasi-objects, in the form of electricity, atoms, emissions or a severe acute respiratory syndrome (SARS), transform the socio-technical networks from which they emerge and the social orders that have made them possible. They transcend distinctions and overcome demarcations such as national or sectoral boundaries of responsibility (as per Beck), and do not even stop at subsystemic references (as per Luhmann). Anyone talking about particulate matter cannot do so without addressing combustion engines, traffic, mobility constraints, and patterns of settlement. Anyone dealing with the dangerous spread of corona viruses must take into account today's globally networked society and the specific nutrition, health and mobility routines of different groups, including their technological equipment. However, this hybrid activity fails to achieve a disciplinary, purifying understanding of risks as either entities described by the natural sciences or constructs observed by the social sciences. For although "risks" such as particulate matter and global warming are always "*simultaneously real like nature, narrated, like discourse, and collective, like society*" (Latour 1993: 6), only partial facets ever come to light, for example calculated probabilities from a technical perspective, controversial perceptions from a social science perspective or problematisations of organised regulatory requirements from a management perspective. The production of ontologically and epistemologically mixed forces and realities goes unrecognised.

In contrast, Bruno Latour shifted the focus anthropologically to a "social history of things and a 'thingy' history of humans" (1999: 18). He thus directed his attention to the consequences of the many quasi-objects created in the course of modern technological science in new socio-technical networks, which he understood as assemblages of epistemic practices, materially instituted possibilities for and constraints on action, ecological risks, economic interests, and unwanted emissions. In these assemblages (for example around particulate matter), properties, effects, interests and developmental trajectories interact in relational interrelationships that also involve the perspectives from which they are described. For this reason, from Latour's perspective, the conceptual distinction between risk and risk perception does not do justice to the problem. Rather, the extent of the long chains of mediations through objects of any nature", beyond their abbreviated and extraterritorial representation as "environmental problems" or "climate change", only becomes apparent through the reconstruction of the controversies surrounding these "constructs" (Latour 2005).

Instead of carving up the actor networks (e.g., of traffic emissions) in order to understand them or describing them from only one perspective, the aim should be to trace all those involved and the social materiality of their interrelated interactions and characteristics. It then quickly becomes clear that the very definition of particulate matter is location-based and cannot be separated from location-based models about the "current state" and the "desired state", in which modes of transport, transport users, settlement patterns, economic constraints, local preferences and fears all play interdependent roles. According to Latour (2018), by looking at these assemblages from a "terrestrial" perspective, which is understood as being spatially and materially connected to all variety of things as acting beings (2018: 91), it is possible to see that "modernity" has by no means liberated people and dominated nature, but instead become entangled in mutually constructed and competing nature-culture relationships with new dependencies, which are now under threat on planet Earth. Latour argued that in the Anthropocene, the Earth system ("Gaia") reacts to the risky quasi-objects and repoliticises its networks in a "new climatic regime" (Latour 2018). From this perspective, there are no "external" places of cognition from which "global environmental change" as a whole or even an individual risk would become "objectively" visible, since the various cultures of nature are themselves contested, relational, and unstable. In view of the uncontrolled proliferation of risky things such as particulate matter and carbon dioxide, however, whose threatening existence has long since become a political issue, it is high time to explicitly design new procedures with mindfulness and caution (Latour 2004), in which the already assembled collectives analyse the controversies surrounding their composition and the resistance of those involved. The aim of such a "parliament of things" would be to carefully consider and examine which new arrivals (for example, self-driving cars with all their consequences) should be associated as participants in a "life terrain" (such as urban or rural spaces) and which, in favour of the existing actors, should not (Latour 2004). In the next section, we look at the entanglements resulting from the "new risks" that would be involved in such new procedures.

3. The criticality of new types of systemic risk situations

The spatial, temporal and social extent of risky interrelationships, which are held responsible for problems such as anthropogenic climate change, pose challenges for risk theory due to their complexity and are also important topics among various bodies in business, politics and the public sphere. On the one hand, these interrelationships attract attention due to an understanding in welfare state societies that collective threats to the common good that are attributed to decisions require not only appropriate risk management but also justification. On the other hand, the spatially, temporally and sectorally fluid nature of risky developments creates conflicts that stem from the different assessment perspectives of potential winners and losers, and are exacerbated by the different assessment contexts, places and times. In addition, there is even less cognitively clear knowledge and normatively unambiguous assessment criteria available for the multi-perspective assessment of risks that affect various systems. For example, assessments of the opportunities and risks arising from the future possibilities of biotechnology, digitalisation and robotisation vary greatly from group to group and depending on where they are viewed. This diversity of assessments is further amplified by the fact that each evaluation cannot be based on experience and the side effects of the opportunities and risks are temporally delayed, emerge in other areas or affect other social groups. Christoph Lau (1992) described as "new risks" those hazards which, as mixed forms, can be traced back to human "acceptance", but which, as unintended "natural disasters", cannot be specifically attributed to anyone and remain "in many ways unspecified" (1992: 239). The inability of new risks to be socially attributed elevates them to the status of natural hazards to a certain extent, but at the same time problematises the rationality of the modernisation process from which they emerge, and specifically the responsibility and fairness of scientific, economic and political action related to risks.

These new types of risks, whose negatively assessed consequences can hardly be limited to specific damage categories and whose effects jump from one system to another and ultimately affect entire societies, have been referred to in risk research as "systemic risks" (Renn & Klinke 2004) following an OECD report on "*emerging systemic risks*" that was published in 2003. Unlike conventional risks, their negative direct and indirect effects extend far beyond the contexts in which they arise, transcend national borders and areas of responsibility, and can lead to unforeseen market collapses, trade conflicts and the loss of institutional trust and capital value – just as particulate matter, for example, first jeopardises health, but then also the car industry and the politicians perceived as responsible. Almost all "ecological risks" are to be regarded as systemic risks because their effects interact, are simultaneously felt economically, ecologically and socially, and cannot be limited in terms of time, space, and society. Climate change makes this abundantly clear.

Systemic risks have three central characteristics (Renn 2008): They exhibit considerable complexity due to their underlying, highly interconnected problems; the assessment of their negative, cross-sectoral effects is accompanied by immense uncertainty; and they pose assessment problems, as their hazardous effects are

viewed negatively but their emergence is due to contexts that are assessed positively overall, such as individual mobility, globalisation, and economic growth. As a result, the concept of systemic risks focuses less on individual risks (illness, poverty, accidents) and more on their embedding in civilisation's risk complexes and their cumulative disaster potential (infrastructure failure, pandemics), which results from precisely these developments. As such, investigations into systemic risks tend to focus on global supply chains, densely populated areas, large-scale technological infrastructure systems and their ever-closer internal linkages and ever more extensive external networks. These in turn fulfil precisely the characteristics that Charles Perrow (1999 [1984]) identified as particularly catastrophic, namely close linkages with complex functional restrictions. The risks associated with global networking and entanglement, which transcend system boundaries, are therefore perceived as almost uncontrollable. They arouse individual and collective concern that is reinforced by the media and, conversely, they lead to an increased awareness of risks and security, which, in organisational terms, is countered by only very limited risk management mechanisms. This reinforces the dynamic identified by Beck and Luhmann that socially internalised risks, i.e. risks attributed to decisions, are creating ever greater mitigation tasks for the institutions perceived as responsible – tasks which they are less and less capable of carrying out. It is quite obvious that social forms, institutions and procedures are required to overcome the unbounded primary and secondary effects of systemic risks. Science, business and politics are faced with the challenge of developing new procedures to make the internal production of risks and uncertainties acceptable, without being able to precisely name who the new procedures will be directed at and the causal contexts.

Against this backdrop, forms and procedures for dealing with systemic risks in society emerge in two fundamentally different ways. From a sociology of risk perspective and in accordance with the work of Ulrich Beck, we differentiate between a "knee-jerk" approach and a "reflexive fiction of responsibility" approach. On the one hand, there is an increasingly strong individualisation of risks that is taking place rather reflexively and unconsciously – individuals are made responsible for avoiding risks even though the complex causal conditions systematically overstretch the individual's ability for risk control. One example of this is to demand a change in individual nutritional or mobility behaviour in response to climate change, even though climate change cannot be curbed at an individual level but instead requires a system-wide change. Regulatory responses that make drivers or product liability responsible for "networked" goods such as self-driving cars or software applications appear similarly powerless, as does the nationalisation of responsibility in times of pandemics. On the other hand, deliberately reflexive procedural proposals are developed that conceptually aim to deal institutionally with the complex cause-and-effect chains, the categorical forms of uncertainty, and interpretative evaluation variance and ambivalence. An example here is the previously mentioned multi-level and participation-orientated concept of risk governance (IRGC 2005); a similar example is the older, much-cited ideas of Silvio Funtowicz and Jerome Ravetz (1993) about "post-normal science". According to them, when decisions about risks need to be made and the facts are uncertain,

the figures are disputed, but the potential for damage is high and therefore the statistical risk calculation fails, preparations for the decision-making should be organised with broad participation of those potentially responsible, accountable and affected – instead of relying solely on disciplinary expertise and stochastic assessments. Such concepts are well-meaning and frequently quoted, yet in reality there is usually a lack of institutions that could guarantee the implementation of the required procedures, and furthermore it remains unclear what kind of potential for risk control these discursive procedures can ultimately have in the face of the challenges posed by systemic risks. The new types of risk are products of socio-technical networking that span different organisations and sectors in divergent living and economic environments, and, as such, they generally evade isolated control and regulatory efforts. Accordingly, in a recent paper with Roger Strand, Funtowicz revises the approach and instead argues in favour of directly addressing the lack of capacity to act by gradually initiating solutions that are anchored in current knowledge and oriented towards humane living conditions and testing them in ways that are appropriate for the respective context (Funtowicz & Strand 2011).

But how will it be possible in the future to ensure socially acceptable, experimental or institutionalised risk management for those network-like infrastructures on whose functioning modern life and economic activity depend so extensively that they can be referred to as "public service" structures? Their "vulnerability" has received growing attention under the abbreviation CRITIS (critical infrastructures), partly as a result of armed conflicts, but above all because they are increasingly digitally controlled (Graham 2010; van der Vleuten et al. 2013). Critical infrastructures such as water and energy supply systems, transport networks and internet and communication networks form the backbone of modern and, above all, urban lifestyles. They extend across national borders and at the same time are subject to increasingly fragmented forms of management and responsibility that are organised partly by the private sector and partly by the state. Their increasing size and interconnectedness are thus contrasted by the highly fragmented approaches used to manage them. Also, the resilience of critical organisations that operate these infrastructures is considered essential to modern societies. As a result, several European directives have been aimed at coordinating critical infrastructure protection (CIP), but these have always been overtaken by the possibilities of cyber-physical attacks faster than they could be established. The European Parliament and the Council of the European Union define critical infrastructures as "an asset, a facility, equipment, a network or a system, or a part of an asset, a facility, equipment, a network or a system, which is necessary for the provision of an essential service" (European Parliament & Council of the European Union 2022: Article 2, 4). The functioning of infrastructures can be restricted, disrupted or collapse completely as a result of deliberate acts of terrorism, natural disasters, accidents, negligence, computer problems, cyber hacking, criminal activities, excessive complexity and system failure as well as the failure of other infrastructure systems.

An interruption to the energy supply, the likelihood of which has risen sharply due to the increasingly heterogeneous supply landscape and its transnational organisation, has direct consequences such as the failure of transport systems, traffic lights and locking systems, internet and communication facilities, right through to water supplies. Alarmed by large-scale power failures that affected entire countries in Europe in 2003, 2005 and 2006, which were the result of chain reactions caused by weather-related or organisationally induced technical disruptions, European countries have drawn up national and international precautionary measures and strategies for cooperative prevention and management. In doing so, they are also grappling with the "vulnerability paradox", namely that a country whose supply services are expected to be good is shaken all the more strongly and profoundly by failures because individuals and organisations rely on their functioning and have no backup plans. For this reason, the strategies formulated in various places for dealing with critical infrastructures require the development of a 'risk culture' suited to the complexity, vulnerability and networked nature of large-scale infrastructure systems. This requires appropriate measures for cross-sectoral and open risk communication, as well as cooperation and the strengthening of self-protection and personal responsibility. In reality, however, crises continue to be dominated by nationally and regionally compartmentalised approaches, top-down communication geared towards appeasement and technical clarification, one-sided problem definitions, mutual attributions of blame, and a general lack of clarity as to what is considered vulnerability and who should and can assume responsibility for which areas with which measures and resources and when (van der Vleuten et al. 2013). The interdependencies highlighted on the previous pages and the difficulty in allocating decisions in the face of overlapping impacts and problems have hardly been addressed to date, nor has the fact that poorer and vulnerable population groups are particularly affected by infrastructure failure.

It is also becoming increasingly clear that ensuring the secure functioning of cyber-physical systems in particular places high demands on risk management; in these systems, digital, mechanical and organisational components interact in the management and control of complex infrastructures, such as today's mobility systems and smart cities. In a comparison of national strategies for cybersecurity, the OECD (2012) emphasised that *cybersecurity* is understood in very different ways. However, it is unanimously agreed that ensuring the security of critical infrastructures requires holistic approaches in which economic, social, educational, legal, technical, diplomatic, military and computer science aspects must be taken into account, and that sovereignty considerations of a technical and organisational nature are also becoming increasingly important. The characteristics of systemic risks—complexity, uncertainty and assessment ambivalence—obviously play a major role in connection with the digital transformation. The mixtures of cyber-physical arrangements, with their interdependencies that cross national boarders, sectors and areas of responsibility, are categorically difficult to grasp and therefore lead to conflicts about risk at the organisational and national levels. These conflicts have already become apparent, for example, in the discussion about the approval of Chinese providers for the 5G network in Europe, and

involve a far-reaching socio-technical restructuring of modern societies. This once again highlights the fundamental characteristics of the politics of risk, namely the unequal and conflict-ridden struggle over which and whose rules, interests and resources determine the identification of risks, which forms of risk management can be derived from this, and which potential changes can be implemented as a result.

4. The relationship between global environmental risks and large-scale technical systems

Environmental sociology and the sociology of risk are closely linked: Global environmental changes are primarily perceived as risks for the lifestyles of individuals and societies, and for the functioning of modern market economies and the social order. They are dependent on social attention filters, drive social forms of reaction and, as environmental disasters, have the potential to change modern society's self-image and dominant economic and governance forms – sometimes disruptively, sometimes insidiously. As a field of social science, the sociology of risk has long focused on investigating and explaining conflicts of interpretation, while paying comparatively little attention to the change and spread of new types of risky situations.

However, in order to do justice to the socio-technical configurations of the 21st century, research in this field must engage more closely with the dynamics of the various social, technical and ecological perspectives and how they relate to each other. Accordingly, in their article "*Things are different today*", Renn and his colleagues (Renn et al. 2019) focus on the challenge of dealing with internally complex microdynamics and critical macrodynamics and their external interactions with various system environments in relation to global (financial market) risks. The authors apply their thinking to global environmental risks and, due to their catastrophic potential, also include disagreements about alternative future developments, non-linear development dynamics, tipping points and complex feedback processes with a strong focus on quantitative modelling, in order to make the outcomes of serious risks conceivable – from the failure of systemically relevant subsystems to complete system collapse.

In view of the unsustainability of the world's currently unstoppable growth trajectory, social polarisation trends and the crisis of liberal democracies, there are certainly plenty of reasons for taking a closer look at the complex interactions of interconnected risks. When dealing with global warming and its various direct and indirect, often non-linear effects, it is not possible to separate "risk realities", "risk perceptions" and "risk dimensions". Instead, it is necessary to conceptually and methodologically assess the interdependencies and interactions between the ecological and societal, technical and social, organisational and financial, political and cultural aspects of risk assessment and risk management. In the age of the Anthropocene, air quality, soil, climate, collective lifestyles, infrastructure systems, information technology control systems, agricultural and construction technologies and many other components interact ever more closely with each

other. As such, thinking in terms of stable categories of investigation is an illusion that can only be remedied by a new epistemology – also for risk research (Latour 1996). A new epistemology could also make other social futures conceivable (beyond the narrow view of market societies), so that corresponding transformations can be explored.

What students can take away from this chapter:

- An understanding of what is meant by risk from a sociological perspective
- Knowledge about which factors influence risk perception
- Knowledge about different risk theories
- An understanding of how risks are politicised in society
- Knowledge about what is meant by systemic risks

Recommended reading

Beck, U., 2008: World at risk. *An updated version of Beck's classic "Risk Society". This book provides a broad overview of the political dynamics of globalised risk societies and their conflicts of interpretation.*

Funtowicz, S.O. & J.R. Ravetz, 1993: Science for the post-normal age. *A much-discussed contribution on the appropriate form of science in risk societies.*

Luhmann, N., 1989: Ecological communication. *A key work of the sociology of risk that can also be read for an introduction to Luhmann's systems theory.*

Perrow, C., 1999 [1984]: Normal accidents: Living with high-risk technologies. *Surprisingly topical when it comes to understanding how disasters arise and are processed in high-tech societies.*

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