In a perspective derived from actor-network theory (ANT), ‘risk’ can be considered as a specific assemblage of heterogeneous entities as well as a proliferation of hybrids. The concept and ideas of ANT offer a meaningful approach to addressing the hybridity and heterogeneity of complex assemblages of risk. Furthermore, the theory provides a theoretical vocabulary to analyse settings of risk and disasters. Especially for ex post analysis of disasters, ANT is able to identify errors in process chains and management practice. In this regard, it deals with questions of stability/instability in management and organisations within the broader context of risk governance. The article discusses the following questions from an ANT perspective: What is ‘risk’ and how can it be managed? What are the general implications and benefits of an ANT approach to disaster risk management? In what ways does an ANT approach challenge some of the conventional wisdoms in the field of disaster risk management? The article shows the potential of ANT as an analytical tool in disaster risk management and as a tool for planning, design and decision-making.

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Introduction

The rising number of economic losses and people affected worldwide due to ‘natural’ and technological disasters in the past few decades has given rise to a pressing demand for coordinated efforts to mitigate and respond to disasters (Alexander, 2002; Dikau and Weichselgartner, 2005; Coyle and Meier, 2009; UNISDR, 2009a, b).
Disaster risk management aims at reducing or avoiding losses and assuring efficient and effective response and recovery. Not only devastating single events that stick in our collective memory, like the tsunami in the Indian Ocean in 2004, hurricane Katrina in 2005 or the cascading events in Fukushima in 2011, but also the general trends and total numbers (MunichRe, 2010, 2012; ADRC, 2011; UNISDR, 2011; IFRC, 2012) illustrate the increasing demand for suitable management strategies in the context of disaster risks. Information about the disaster, the geographical region and the circumstances, as well as expert knowledge in various fields, coordination and cooperation between stakeholders, the implementation of technology, and material objects (such as technical early warning systems, flood barriers, dikes, warning signs and so on) are essential pillars of today’s risk management (Neisser, 2013). Simply put, ‘Disaster managers face two important types of issues, technical and sociopolitical’ (Denis, 1991; Denis, 2001, p. 196). But does this distinction meet the complexity of issues faced in risk management? To answer this question, the article will define and disassemble the term ‘disaster risk management’ and open up a perspective that questions this distinction.

First of all, a brief review of the terminologies, basic principles, themes, state-of-the-art insights and phases of development in the context of managing disaster risk will be given. The distinction between ‘natural’ disasters (or hazards) originating in natural spheres such as the hydrosphere or atmosphere, technological disasters such as collapsing buildings or hazmat (hazardous material) transport accidents, and finally social disasters such as crowd surges or terrorist attacks is questionable. The term ‘natural’ is a misleading one, as the root causes of a natural disaster (see also Blaikie et al., 1994) very often depend on human decision-making, planning and socio-economic circumstances and developments (Alexander, 2000, pp. 9–10).

Since the International Decade for Natural Disaster Reduction conference in Yokohama in 1994, the term ‘natural disaster’ has been conceptualised and discussed in a different light. After natural, scientific and engineering solutions had been highlighted in the first half of the decade, social aspects were now integrated to address the human dimension of causation and solutions regarding disasters (Dikau, 2004, p. 181).

The insights from Yokohama 1994 were the basis for the World Conference on Disaster Reduction in Kobe, Hyogo, Japan in 2005. The major outcome, the Hyogo Framework for Action (HFA), represents a strong commitment to disaster reduction and emphasises in particular the management and reduction of risk as a global challenge in the decade 2005–2015 (UNISDR, 2007). The continuous consultative process facilitates the development of a post-2015 framework (HFA2) for disaster risk reduction (DRR) and aims to reflect an enhanced understanding of risk, calling ‘for an understanding of the interaction of natural or physical and behavioural factors’ (UNISDR, 2013, p. 6).

In this regard, the author will draw on a theoretical approach questioning the distinctions between ‘nature’ and ‘society’, ‘human’ and ‘non-human’ by...
applying a different perspective on risk and its management to facilitate an understanding of the interrelations between these commonly artificially separated dimensions. The article will propose a more comprehensive approach based on the principle of symmetry immanent in actor-network theory (ANT).

Disaster, Risk and Management

Disaster risk management is defined by UNISDR as ‘the systematic process of using administrative directives, organisations, and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster’ (2009c, p. 10). In a nutshell, disaster risk management is or should be a holistic, comprehensive approach involving identification and assessment of hazards, risk, vulnerability and resilience with a future-oriented focus on the development of strategies for risk reduction as well as capacity building and operational measures to fulfil this goal. Furthermore, it encompasses mitigation, preparation, response and recovery and underlines reactive and proactive components of handling disasters. Therefore, disaster risk management can be further broken down into (1) corrective disaster risk management and (2) prospective disaster risk management. The former addresses the mitigation or reduction of disaster risks already present, while the latter is concerned with management activities aimed at avoiding novel or increased disaster risks (UNISDR, 2009c, pp. 8, 22).

In the name ‘disaster risk management’, there are three components. Let us begin with the term disaster: disasters are commonly defined as sudden, massive disruptions with above-average perceived losses (Felgentreff and Dombrowsky, 2008, p. 13). Disasters are usually described with a low frequency and high magnitude relationship (Schrott and Glade, 2008, pp. 134–139; Williams, 2008, p. 1115; Smith and Petley, 2009, pp. 56–59). Nevertheless, there are recent discussions of high frequency, low magnitude events within the 2011 Global Assessment Report (GAR) on DRR (UNISDR, 2011) and the Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX) (IPCC, 2012). ‘There is a curious paradox about disasters. On the one hand they are extraordinary events that require special organisation and resources to tackle the damage, casualties and disruption that they cause, and on the other hand they are sufficiently frequent and similar to each other to be normal, not abnormal, events’ (Alexander, 2002, p. ix). This calls for reactive measures and preventive planning and shows the comprehensive requirements of dealing with disasters. Therefore, ‘[t]o understand and cope with disasters of enormous scale and complexity demands fundamentally different perspectives’ (Williams, 2008, p. 1118). Furthermore, distinctions are made between natural and technological disasters. As Williams
has noted, some disasters defy the traditional distinction between natural and technological disasters (Williams, 2008, p. 1115) and he suggests a ‘post-social understanding of disasters’ (Williams, 2008, pp. 1128–1130) as a paradigmatic change. This calls for a much more elaborate epistemological and ontological debate on disasters, risks and their management. This article takes up the discussion in this direction.

‘Risk’ is a rather diffuse and ambivalent term (Weichhart, 2007) as it is at the same time an analytic and a normative concept (Klinke and Renn, 2002, p. 1071). There exists an extensive and rich literature on ‘risk’ from different academic disciplines. Even within the social sciences it encompasses a wide scope (Douglas and Wildavsky, 1983; Beck, 1986, 2008; Luhmann, 1991, 1993; Lupton, 1999; Slovic, 2000; Kaspmer and Kaspmer, 2005; Renn et al., 2007). Definitions of risk might simply be the product of probability and extent of damage, while other, more social science-oriented approaches outline the aspects of perception, communication and decision-making (Renn, 2008a, b; Zwick and Renn, 2008). The latter are largely influenced by the distinction between ‘Gefahr’ and ‘Risiko’ made by the German sociologist Niklas Luhmann (Luhmann, 1991, 1993, 2004; see also Japp, 1996). Especially the dependence on decisions signifies risk (Luhmann, 1991, p. 30), and this approach underlines the inherent aspect of risk in management as well as the demand for management strategies to avoid or reduce risks (Eriksson-Zetterquist, 2009). Decision-making is very often about dealing with uncertainty and making decisions in incalculable situations of hitherto uncertain extent or with unforeseeable future consequences. These situations and management solutions might also be ambiguous and therefore contested among diverse stakeholders (Klinke and Renn, 2002) as ‘uncertainty manifests itself within the various organisational responses made to that risk’ (Fischbacher-Smith, 2011, p. 1). Thus, the question of how to deal with risk and uncertainty (in assessment and making decisions) as well as how to organise communication and enhance the integration and acceptance of measures is important.

Klinke and Renn name the three major challenges for the handling of risk issues in and for society: complexity, uncertainty and ambiguity (2002, p. 1085). The events of Fukushima in 2011 highlight not just these three aspects but also the interconnectedness of nature and society, materiality and sociality (Fischbacher-Smith, 2011, p. 2; Neisser and Pohl, 2013, pp. 25–26; Müller-Mahn and Everts, 2013, pp. 22–23). Many approaches tend to oversimplify and do not acknowledge heterogeneity, non-linearity or hybridity.

After briefly examining the terms ‘disaster’ and ‘risk’, the term ‘management’ also needs some clarification. The Oxford English Dictionary defines the term ‘management’ as ‘the process of dealing with or controlling things or people’ (Oxford English Dictionary, 2013, Online). This is very interesting as it highlights the procedural character, the aspects of operation and agency, and last but not least the domains of materiality and sociality. In general, it is about
handling processes and especially about processes of handling a(n) (un)certain situation in the sense of ‘controlling’. Furthermore, it is for people and/or things – for their well-being, may it be economic, social or ecological. But an important question is whether or not it is possible to distinguish between sociality and materiality in the management of (un)certain situations.

However, there is another challenge and stream of debate in risk research that coalesces around the question: How can we deal with interdependent socio-ecological interactions? All in all, the above-mentioned aspects of disaster risk management point towards a range of theoretical discussions and pragmatic demands. ‘What risk managers need is a concept for evaluation and management that on the one hand ensures integration of social diversity and multidisciplinary approaches and, on the other hand, allows for institutional routines and easy-to-implement protocols’ (Klinke and Renn, 2002, p. 1072). But, as will be argued here following the principles of ANT, it is not just about social diversity or sociality in general, but rather about hybridity. In studies of risk, security and vulnerability, the prevailing frames of analysis are either a perspective focused on social practices and institutions, or a view with a technocratic stance. A new and different approach (Miles et al., 2012, p. 366) to disaster risk management would be to avoid these a priori distinctions and dichotomies without focusing on any one element of the network. ‘In the end, appeals to a pure and unitary human “culture” are no more able to engage with complex networks of risk identification, assessment and management than are appeals to the real “nature” of the risks themselves’ (Crook, 1999, p. 177). In this regard, ANT offers an alternative view by emphasising the hybridity and heterogeneity of human and non-human interrelations. When Klinke and Renn (2002, p. 1076) talk about the dual nature of risk and a dual strategy for risk management, they mean the double structure of realist and constructivist perspectives on risk. The principles and the vocabulary of ANT, as it will be argued, provide a suitable framework for examining the inherent double structure of risk in order to gain insights about the processes and relations that constitute risk.

Principles and Vocabulary of ANT

ANT is rooted in the sociology of science and technology and was developed in the 1980s as a theoretical contribution to the sociology of knowledge (Law, 1992; Fox, 2000, p. 857; Schulz-Schaeffer, 2000, p. 187). It was chiefly shaped by Bruno Latour, Michel Callon and John Law. It cannot be called a unitary theory as it is made up of different strands and has developed in different directions; there is even a ‘Post-ANT’ or ‘After-ANT’ (see Latour, 1999; Law, 1999; Gad and Jensen, 2010). It is a dynamic framework permitting variations in use and interpretation.
In general, ANT offers a perspective ‘on understanding patterns of “ordering” which we recognise as “structures” or “organisations” of ideas and matter’ (van Loon, 2006, pp. 309–310). The theory recognises the heterogeneous characteristics of society and the multiple co-evolutionary interrelations of society, technology and nature (Callon, 1986a; Schulz-Schaeffer, 2000) that other models and theories may not adequately describe in the context of today’s knowledge society (Belliger and Krieger, 2006). As I will outline, ANT offers a powerful analytical schema for talking about the constellations constituting what has been called ‘world risk society’ (Beck, 2008). In this context, the central focus and proposition of ANT has been pertinently summed up by Wickramasinghe et al (2010, p. 33): ‘What seems, on the surface to be social is partly technical, and what may appear to be only technical is partly social’. Thus, it is a theory recognising the heterogeneous nature of society and the multiple co-evolutionary interrelations of society, technology and nature.

As developed in Science and Technology Studies (STS), ANT was used as an explanatory model for ‘knowledge’ and the process of gaining knowledge in science. In this context, ‘knowledge’ is seen as an effect or result of a network combining heterogeneous materials (Law, 1992, p. 381). Thus, ANT differs from other scientific theories by its explicit emphasis on hybridity and heterogeneity. By the implied negation of pure technological determinism and social constructionism ANT is a remarkably interesting and suitable tool for analysing not only human–technology interaction or knowledge production but also management processes – whether successful or not. The approach makes it possible to study the conditions and mechanisms that constitute the relations, or networks, of society (Akrich, 2006, p. 409) and specifically to study the conditions, mechanisms and demands of management of risks and uncertainties. The focus on fluidity in STS approaches underlines the preoccupation with process flows as well as with uncertainty (Blok, 2010, p. 906).

While both ‘technologism’ and ‘sociologism’ denote reductionist, one-sided, deterministic views (Bingham, 1996, pp. 641–642), ANT overcomes the dualism of nature/society, technology/society, human/non-human, geographical space/cyberspace, and so on, with its own language of symmetry (Koch, 2004, p. 173; Grabher, 2006, p. 101; Belliger and Krieger, 2006, p. 18). To put it in the way Latour phrased it, ANT does not overcome these alternations but explores their conditions (Latour, 1999, p. 16). In this sense, ANT considers nature, technology and culture not as ontologically separate divisions but rather as characteristics of the forms of common existence (Zierhofer, 1999, p. 11). As Haraway noted, today’s high-tech culture is challenging the above-mentioned dualisms because ‘it is not clear who makes and who is made in the relation between human and machine’ (1991, p. 177). ‘Risk’ will be examined through the lens of ANT in the following section of this article, followed by a discussion of the explicit aspect of management in the context of risk management.
But first it is necessary to shed light on some key terms of the ANT vocabulary. A brief and comprehensible description of the term actor-network would be the one given by Law: ‘Hence the term, actor-network – an actor is also, always, a network’ (Law, 1992, p. 384). Actor-networks are black-boxed entities consisting of a network of actors. Disassembling the hyphenated term, the meaning of an actor is: ‘any element which bends space around itself, makes other elements dependent upon itself and translates their will into a language of its own’ (Callon and Latour, 1981, p. 286). The second term, ‘network’, as used in ANT, differs from the term in common language use. It does not mean network in a purely technological sense of cables, tubes or rails; nor is it used in the social or political sense of formal or informal networks. It does not refer to mere social networks of persons, but to heterogeneous networks comprising all of these elements (Bosco, 2006; Kneer, 2009). Every element of such a network (or: actor-network) is defined by the heterogeneous chain of its links (Latour, 2006, p. 541). Thus, it is impossible to think of a knowledgeable and skilled person without thinking of the artefacts, the tools and materials he or she is engaged with, as Law (1997, p. 3; see also Fox, 2000) has outlined for the manager. In this perspective, the manager is a network, a process (Law, 1997, p. 3), an assemblage of heterogeneous bits and pieces and therefore the manager is unthinkable without his contact database, his computer, his phone and so forth. The conception of ANT is based on this different understanding of agency and actors. Agency is described as the capacity to affect something and therefore is not just attributed to human actors. Actors structure agency by offering a certain performance repertoire (Grabher, 2006, pp. 101–102). Although they sometimes act more passively, non-human materials are not just seen as resources or limiting textures. It is important to note that they have been made passive and this could change in a different configuration (Callon and Law, 1997, p. 171). Actors are agents with a certain form, identity and consistency, or, as Latour puts it, figuration. Simpler or pre-figurative agents are called actants and they might transform into figurative actors in a process of allocation of figuration, also called network translation (Latour, 2005, p. 71; Kneer, 2009, p. 23).

Using ANT as an analytical framework is about identifying what draws things together (Latour, 1990) to make a functioning network. ANT examines the so-called ‘process of translation’ to understand and explain the process of assembling an actor-network from heterogeneous entities. The process of forming a network by which the identities, competencies and agencies of the actors are negotiated, transformed and assigned (Kneer, 2009, p. 25) is called ‘translation’ in ANT terminology. It is a necessary process resulting in an established actor-network (Callon, 1986a). This process contains four moments: problematisation, interessement, enrolment and mobilisation (Callon, 1986a). It is the heart of the ANT approach: the question of how actants mobilise, juxtapose and bind the elements of which they are
composed; how they manage to form a network out of heterogeneous bits and pieces to produce a functioning order, an established network (Law, 1992, p. 381). All actants involved have to pass through a so-called obligatory passage point, a critical channel of the network. This is a situation or condition that has to occur in order for all actants to have the interests that have been defined and set by the focal actant. By passing this point, the actants make themselves indispensable. The process of translation forms actor-worlds out of the assembled entities. It adds characteristics and establishes more or less stable relations. The process of translation is the definition and distribution of roles and the depiction of a scenario or setting. The obligatory passage point is the channel that all entities have to pass through to successfully create the actor-network. The process of translation depicts a topology of obligatory passage points for the elements that will be involved and will evolve in this making of the actor-network. If the process of translation is stable and successful, a black box, a new entity emerges.

In the terminology of ANT, there is another important term that should be explained: the term ‘inscription’. In a nutshell, ‘inscription’ can be seen as the negotiated assignment of an actant to a script, a role or a behavioural pattern (Schulz-Schaeffer, 2000) and agreement to work towards a common goal by passing through the obligatory passage point (Fox, 2000). This means inscribing modes of action to an entity or a set of entities.

All things considered, ANT helps to observe ‘how an endless array of things are placed together in precise and particular ways, including phrases, conversations, material objects, spaces and bodies’ (Simpson, 2007, p. 29). It is able to include people, devices, geographic locations, discourses and so forth, in its perspective on interrelations and assemblages of heterogeneous entities. Therefore, using ANT as an analytical tool offers great potential to address the three above-mentioned challenges in risk management: complexity, uncertainty and ambiguity (Klinke and Renn, 2002, p. 1085). But it has to be noted that it depends on the defined setting that is to be analysed and how deep one wants to go down the rabbit hole – which means how many entities will be included, which ramifications will be integrated and which actors will be followed (and how far!) when using the ethnographic approach of ‘following the actors’ (Callon, 1986a, p. 228; Latour, 2005, p. 12). In this way, the ‘Alice in Wonderland’ metaphor of following someone down the rabbit hole is not farfetched – it denotes the dynamic tendency towards openness of actor-networks and their incorporation of chances and risks (Raab, 2010, p. 374). It is an approach that, similar to Leibniz’s concept of monads (Leibniz, 1996; Tarde, 2009), regards networks as complex, dynamically open and association-aspiring entities (Raab, 2010, p. 373). Furthermore, it states the terminological similarities between Latour’s actors and the sociology of associations. As actors are themselves actor-networks consisting of heterogeneous actants (Law, 1992, p. 384), the translation of the monad concept to the sociology of associations
developed by Latour and others draws on the etymological derivation of ‘social’ from the word stem seq-, sequi meaning ‘to follow’. Moreover, the Latin word formation socii has the meaning ‘ally’ or ‘to ally with’ and socius comes with the meaning ‘associate’ (Latour, 2010, pp. 17–19).

As noted above, there have been various developments with different focal points within the sphere of ANT. Peuker (2010, p. 326) has described at least three developments and their core questions: (1) the first phase with the central question how stability and durability of knowledge and technology is achieved by processes on the local level; (2) the second phase of ‘classical’ ANT involving questions focused on how relations in networks might be strengthened or weakened to strategically establish network structures; (3) the third phase, also termed Post-ANT, with questions around multiplicity, difference and fractionality. The latter seems to be a suitable approach to capture the aspects of complexity, uncertainty and ambiguity immanent in ‘risk’. Nevertheless, the ‘classic’ ANT approach also makes a meaningful methodological contribution by its representativeness and operational feasibility.

ANT provides a framework for understanding interactions between social and technological actants and, additionally, the success or failure of innovations (Tatnall and Gilding, 1999, p. 963) or management strategies. In order to synthesise all these aspects in a conceptual discussion of risk management, it is necessary to look at the term and the phenomenon of ‘risk’ through the lens of ANT.

**Conceptualising Risk and ‘Riskscapes’ from the Perspective of ANT**

Every actor-network, every actor-world has its distinct reality, its own setting (Callon, 1986b). The configuration is contingent – its setting is not necessarily as it appears (a common definition of contingency is given in Baraldi et al (1997, p. 37)). Aspiring for extensiveness and completion, searching for new possibilities to associate are qualities that characterise a movement that may fail and lead to a new assemblage (Latour, 2010, p. 21; see also Raab, 2010, p. 376). Thus, actor-networks are always associated with risk. Depending on which entities are assembled, different settings are established, discarded and new ones formed. In other words, processes of structural change (Raab, 2010, p. 377) are inherent to actor-networks. There is always the possibility of alternative configurations (Pohler, 2010, p. 132; see also Callon, 1986a; Law, 1992, p. 387). Therefore, the contingency of actor-networks is not necessarily negatively connoted but it can be, which means it is characterised by risk. The alternative configuration may be negative, a disastrous one (Lane et al, 2013, p. 340).

With the term ‘risky accounts’ (Latour, 2001, p. 37ff.), Latour is referring to the fact that objects are embedded in collectives. However, the mode of
existence of the object is not unchangeably set. It is able to have various and varying modes of existence – it is characterised by multiplicity and indeterminacy (Peuker, 2011, p. 161). This is the inherent moment of risk and chance. Following this argumentation, every potential change in the meaning of contingency is associated with risk. As contingency is a central quality of actor-networks, the risk lies in the potentially changing configuration of the setting. This highlights the fact that risk is not necessarily negatively connotated, as it can also imply innovation or a turn for the better (Peuker, 2011, p. 161).

November (2011, pp. 84–85; see also November, 2008) conceptualises risk as an assemblage and interaction chain between technical artefacts, natural substances and human organisation or disorganisation. An apt description of ‘risk’ was given by Latour himself: ‘A perfect translation of “risk” is the word network in the ANT sense, referring to whatever deviates from the straight path of reason and of control to trace a labyrinth, a maze of unexpected associations between heterogeneous elements, each of which acts as a mediator and no longer as a mere compliant intermediary’ (Latour, 2003, p. 36). Therefore, risk is not, as Haug (2012, p. 90) suggests, the mediator but an inherent quality of networks with different elements acting as mediators. However, Haug (2012, p. 80) is right insofar as ‘risk’ does not emerge from one particular entity but is constructed in the network and ‘that a network considered as safe transforms into a network of danger’ (2012, p. 90) due to the contingency of its setting. Thus, risk is a relational quality of the actor-network. This is important because ‘[i]n this perspective then, risk is neither a property of the human or non-human world but arises from the interactions between them and is performed by the complex ensembles they constitute’ (Healy, 2004, pp. 284–285). A very similar approach to risk using the means of ANT is suggested by Beck and Kropp (2011, p. 14) who define risks as invisible ‘quasi-objects’ and emphasise the relational and historically accrued aspects of actor-networks ‘which only become visible once a network breaks down and the search for responsibility starts distinguishing decision-makers and those affected by the decisions made’ (Beck and Kropp, 2011, p. 14, footnote 1). Especially the reference to stability and visibility in relation to decision-making is important. In general, neither objects nor people determine the stability of a network configuration (Law, 1992, p. 383). Stability (and instability) is constituted by the set of relations. These relations are subject to continuous making and re-making – a ‘continuous making and re-making of risks and risk control’ (Beck and Kropp, 2011, p. 14). The black box, the relatively stabilised network appearing as a simple and coherent entity standing for the heterogeneous assemblage (Callon and Law, 1997), reveals its constituent entities only in the case of a breakdown. In the perspective of ANT, ‘it makes no analytic difference whether the chain breaks down at a human or a non-human link’ (Fox, 2000, p. 863). Therefore, from an ANT point of view, the distinction between human error and technical failure is not as important as the resulting consequences and the aspect of
complexity of the actor-network, as the strategies to maintain stability and durability, as well as to manage consequences, depend on the complexity of the assemblage (Healy, 2004, p. 288). ‘Risk’ is existent and persistent when the performance and shape of an assemblage varies or is not congruent with the intended one, resulting in unwanted and even disastrous consequences (Healy, 2004, p. 285). This means, if actor networks couple different programmes of action with different logics, this setting bears a certain risk, which reveals itself in man-made disasters (Weyer, 1994, p. 332).

Recently, there are few applications of ANT to the topic of risk, all of which are more or less variations of Latour’s notion of risk as a network in the ANT sense. Nevertheless, it may be interesting to take a closer look at the different conceptions with their specific implications and accentuations. In 2001, Healy drew on central propositions by Beck, Giddens and Latour (as well as other authors) to outline risk as a social process and to make a plea for reshaping the governance of risk (Healy, 2001). In his 2004 article he then proposed a ‘post-foundational’ concept of risk, predominantly based on ANT (Healy, 2004). The next step of his discussion on risk, influenced by the theoretical work of Latour and others, was to regard risk as embodied circumstance (Healy, 2006) – a remarkable relational perspective on risk.

Another very interesting approach using ANT in risk studies was based on observation of the events concerned with the severe acute respiratory syndrome (SARS). Pohler and Schillmeier (2006) explicitly used the symmetric principle of ANT by considering humans, nature and technology and avoiding a priori definitions in their research on the topology and cosmo-politics of SARS. This approach was extended and described by Schillmeier and Heinlein (2009) as Risk-Actor-Networks. The authors examined the agency of the virus and regarded SARS as a spatiotemporal, multiple event, which was characterised by delocalisation and heterogeneity (Pohler, 2010). The spatiotemporal aspect of risk and the reckoning of materiality and sociality in the production of spatial dynamics of risk was also a major point in an article by Maintz (2008). In her study of bioterrorism, specifically anthrax threats via letter bombs, she used ANT as an integrative approach to cover materiality and sociality. The study combined the observation of material entities with that of social practices and discourses. Interestingly, it was enriched by the spatial-theoretical dimension of network space and facets of Bachelard’s concept of fire space (1964) to explain the emergence and process of risky situations. This concept was also used in combination with ANT in Cidell’s (2012) article on the transport of hazardous materials and the discourse on the associated risks. A similar concept was used by Bickerstaff and Simmons in their study of proximity, experience with and perception of technological hazards. The authors examined the aspect of absencing and presencing risk using a topological approach to space to understand the production of risk subjectivities (Bickerstaff and Simmons, 2009, p. 869). Based on Law (2006) and Appadurai (1990), this concept of risk is
described as a space of flow and the neologism ‘riskscape’ may be used to approach these topologies and imaginative spaces without explaining the term any further (Bickerstaff and Simmons, 2009, p. 870). This will be returned to in subsequent sections of this article.

Beck and Kropp (2011) also wrote an article with a focus on the observation and delineation of risk controversies inspired by ANT. The authors conceptualise what they call ‘hidden infrastructures of risk’ (Beck and Kropp, 2011, pp. 6–8) based on the vocabulary and principles of ANT. Beck and Kropp conceptualise the ‘world risk society from the outlook of a sociology of associations’ (2011, p. 2) and treat the associated aspects of complexity, uncertainty and ambiguity (Klinke and Renn, 2002) as central challenges of risk governance in relation to invisible risk infrastructures. The latter are defined as ‘technical systems, social beliefs and routines’ (Beck and Kropp, 2011, p. 7), which ‘black box some parts of risk production’ (Beck and Kropp, 2011, p. 7). Additionally, they integrate the very often ambiguous and contested discourses on risks and normativity and offer a way of ‘mapping’ risk controversies in the sense of following the paths of these controversies.

In an article published in 2012, Christmann et al discuss the terminology and phenomena of vulnerability and resilience in relation to ANT and other theoretical approaches. They address the problem that essentialist approaches do not question aspects of exposition and adaptation and focus one-sidedly on either materiality or immateriality (Christmann et al, 2012, p. 12). They acknowledge the useful concept of agency in ANT – especially its anti-essentialist notion. The authors claim that this approach has not been much used for studying the terms and phenomena associated with vulnerability and resilience but that they use it in their article to fill this gap. According to them, the ‘constructions of vulnerability and resilience create relational spaces’ (Christmann et al, 2012, p. 25) as ‘networks of heterogeneous elements’ (Christmann et al, 2012, p. 25). The inherent strengths of such a perspective are sublation of the dichotomies of nature and culture, the ability to address questions of global effects in local contexts, the potential to integrate concepts of knowledge and perception, the assessment of interrelations and finally – and associated with the latter – the relational conceptualisation of time and space in observing constructs of vulnerability and resilience, as well as risk and uncertainty. All the different concepts and applications of ANT on the topic of risk mentioned here highlight these strengths. Studies of the concepts of risk and uncertainty illustrate that it is important to recognise action under uncertain, complex and ambiguous circumstances, which is a central principle of modern societies. ‘Supposed risky things are not risky in general but in particular assemblages. Material level and discursive level cannot be analysed separately as both are intrinsically entangled with each other and with the ways in which the involved actors make sense of what is permissible, possible or dangerous’ (Beck and Kropp, 2011, p. 9). This highlights what Klinke and Renn called the
need for risk-based, uncertainty-based and discourse-based management (2002, p. 1092).

One-sided approaches do not capture interrelations and therefore have problems with the examination and management of risks. Christmann et al (2012) also point out the relationship between vulnerability and resilience regarding aspects of governance (Christmann et al, 2012, p. 24). In addition to their discussion of ANT as a suitable theoretical framework for addressing questions of vulnerability and resilience, this also presents a potential framework for the study of risk governance (IRGC, 2005; Renn, 2008c), and therefore risk management, without adopting an essentialist stance. But, as Beck and Kropp indicate, ‘[e]stablished procedures of risk governance are no longer adequate to deal with new risks. Their dynamics and boundary-transgressing character transform society, which in turn has to adopt its routines of risk assessment and regulation’ (2011, p. 6).

As mentioned earlier, a central question from the ANT perspective concerns the stability and instability of network configurations. This connotes the aspect of risk and uncertainty, which is, as pointed out, an inherent quality of actor-networks. Actor-networks are contingent by definition and the border between stability and instability is a thin line. The ANT approach emphasises the uncertainties and transformations in the processes of construction and configuration that lead to the formation of more or less stable structures (Peuker, 2011, p. 156). However, this perspective does not come without contradictions. The difference between nature and society is transferred to the inside of the collective and a new blindness arises (Peuker, 2011, pp. 165–166). When the dichotomy of nature and society is overcome, the new dichotomy between stability and instability is introduced (Peuker, 2011, p. 168). The question is whether this is a deficiency and a hindrance or a useful and necessary distinction when analysing disasters and risk. In addressing uncertainty as the standard condition of a contingent world (Christmann et al, 2012, p. 8), this might be a useful distinction for identifying and discussing the conditions of instability. Of course, this is a highly normative issue, but probably a pragmatic one, too. For practitioners and stakeholders, normative postulation and analytical description usually go hand in hand. Problems arise when normative postulations do not match the descriptions. Even more so, the distinction between stability and instability is a central criterion for action. In meeting the necessities and conditions of the ‘world risk society’ (Beck, 2008) with its ‘multiple intensification of risk: from the increased instability of simplified environments; from human error or noncompliance with system demands; and in the necessity for “tight coupling” (Perrow, 1984) between them’ (Healy, 2004, p. 282), it is not only legitimate to use the distinction between stability and instability but also to fulfil protection targets. Gaining a deeper understanding of all involved actants and the prevailing and potential interrelations is the benefit of such an approach. Such an approach addresses multiplicity,
heterogeneity and contingency as central facets of risk and is also adequate to deal with uncertainty, complexity and ambiguity, which go hand in hand with the aforementioned facets. Thus, in conceptualising risk as actor-networks of heterogeneous entities, a third path between risk objectivism and risk subjectivism (Peuker, 2011, pp. 156–157) is offered to include material, social and discursive entities (and processes).

Combining a study of these different dimensions and conceptualising risk as a space of flow, the aforementioned term ‘riskscape’ offers a potential tool for description and analysis. Fischbacher-Smith (2011, p. 4) speaks of ‘destructive landscapes’ or ‘configuration of risk’ referring to the interaction between ‘natural’ and ‘socio-economic activities’. This is a similar approach, but the term ‘landscape’ seems to be too narrow and is associated with a long debate in cultural geography, although the concept of ‘scapes’ in general seems to be fitting. Scapes are fluid and constantly shifting, as has been outlined for contexts of risk. As mentioned above, this term ‘riskscape’ was introduced by Bickerstaff and Simmons (2009, p. 870), but not elaborated extensively. Other important articles outlining the implications of the term ‘riskscape’ and bringing it into the debate on risk management are those by Brooks et al (2010), Sutherland et al (2012) and Müller-Mahn and Everts (2013). Their use of the suffix ‘-scape’ is vaguely based on the scape concept proposed by Appadurai (1998) and highlights the fluidity as well the perspectival setting and situatedness of such phenomena (1998, p. 33). Appadurai conceptualised five ‘-scapes’: financescape, ethnoscape, technoscape, mediascape and ideoscape, as a framework for exploring the different relations between various actors (1998, p. 33) constituting a continuously fluid and uncertain interplay (1998, p. 41).

Müller-Mahn and Everts (2013, p. 24) have adapted this concept and developed the term riskscape to refer to global risks and their embeddedness in particular ‘landscapes’ with local effects. Importantly, Müller-Mahn and Everts (2013) stress that there is not one riskscape but multiple riskscapes, which are partially overlapping and dependent on a particular perspective (Müller-Mahn and Everts, 2013, pp. 25–26). Thus, riskscapes are intertwined with the other scapes Appadurai conceptualised; for example with financescapes in respect of the relation between poverty and vulnerability; with ethnoscapes in respect of migration, and social and cultural transformations and their relationship to risk perception and behaviour; with technoscapes in respect of technical incidents, global communication and so on; with mediascapes in respect of media coverage of disasters, produced imaginations and the consequences of it; and finally with ideoscapes in respect of constitutive ideologies relating to what risks are, what constitutes them and how to counter or mitigate them. Therefore, the term ‘riskscapes’ encapsulates (1) notions of fluidity and subjectivity, (2) perspectives on the hybridity of material and discursive productions of space, (3) reflections on risk narratives and trajectories, and finally (4) aspects of agency and framing (Müller-Mahn, 2011). Especially the entanglement of
materiality and spatial semantics (Müller-Mahn, 2011) offers significant options to deepen this notion using the tools of ANT.

Riskscapes cross and are intertwined with the other scapes mentioned, but it is not just a mixture of different scapes that defines the compound nature of a riskscape. Czarniawska has made a significant explanatory statement about the contextually dependent characteristics of one entity: ‘The same hammer can serve as an ideological symbol, an object to threaten someone or to defend oneself with, but also a tool for pounding a nail into a wall. The task of researchers is to capture such transformations of what appears to be the same object, explain how such transformations are possible, and describe their consequences’ (Czarniawska, 2008, pp. 51–52). This metaphor can easily be applied to the topic of risk and risk management in the light of ANT-inspired riskscapes. For example, a risk or vulnerability map is a symbol, a discursive element as well as a tool for political consulting or a mediator between scientists, stakeholders and the public. Therefore, the map potentially has the function of an obligatory passage point for the planning process (Porter and Demeritt, 2012, p. 14). Following this path, a new concept results from combining the above-mentioned aspects of ANT with the scapes concept of Appadurai (1998) in the light of risk research and risk management.

A conceptualisation of tourismscapes by van der Duim (2005, 2007) used an ANT perspective in order to focus on how ‘global flows emerge or how the local and the global are interconnected’ (van der Duim, 2005, p. 77). The constituents of tourismscapes according to van der Duim are: (1) people and organisations, (2) ‘an array of networked objects, media, machines, and technologies’ (2007, p. 968) and, (3) relational spaces. Analogously, riskscapes constitute themselves as complex, heterogeneous and constantly shifting networks spanning local and global relations of risk, and it is important to note that ANT does not differentiate between different scales. In its topological perspective, actor-networks span different scales, they are always locally grounded and scale is an outcome rather than a cause of relations (Latour, 1993; Latour, 2005; van der Duim, 2007). The heuristic approach to understanding the geography of ‘warscapes’ by Korff et al (2010) is similar albeit not based on ANT, but targeting the multiple, dynamic and interrelated configurations constituting ‘warscapes’.

Müller-Mahn and Everts conceptualise ‘riskscapes’ in the context of Schatzki’s theory of social practice (Schatzki, 1996). In this regard, they argue that ‘[l]andscapes are not given networks of material objects but they are experienced and made sense of through practice’ (Müller-Mahn and Everts, 2013, p. 26). In an ANT-inspired conceptualisation of ‘riskscapes’, these should not be misunderstood as given networks of material objects but as stabilised networks of relations with both humans and non-humans playing an agential role. Adopting a Schatzkian perspective of risk may neglect the inherent aspects
that make a practice a practice. Using practice as an *explanans* neglects the fact that it also appears to be an *explanandum*. To take the practice of firefighters as an example: what is their practice based upon if not training with material objects, in order to gain tacit knowledge regarding the functions – or inscriptions – of these objects, such as for instance fire hoses, water supply, hydrants, extinguishing foam and so forth? ANT helps us to understand how ideas and practices are constituted and how they shift through active practice (Büter and Pohl, 2011). Schatzki’s idea of ‘a net of interwoven timespaces’ (1996, p. 40) is not so much different from action nets (Czarniawska, 2008) or actor-networks but, ‘Schatzki does not provide any mechanism to account for how practices can be connected at a distance (one of the central topics of Latour’s sociology of translation)’ (Nicolini, 2012, p. 179).

Neither actor-networks nor ‘riskscapes’ should be misunderstood as ‘given networks of material objects’ (Müller-Mahn and Everts, 2013, p. 26), but rather seen as assemblages constituted by material, social and discursive entities and processes. The dictum of ANT to ‘follow the actors’ (Callon, 1986a, p. 228; Latour, 2005, p. 12; Simpson, 2007) goes further and helps to discover the constitution of practices – or action nets (Czarniawska, 2008) or actor-networks.

**Review of Existing and Potential Methodological Approaches Informed by ANT in Risk Research**

A complete register of existing and potential methodological approaches (in all fields of enquiry) would go beyond the scope of this article. Nevertheless, a few remarkable approaches using ANT directly or indirectly in the context of risk research should be noted.

There is of course a wide range of ethnographic approaches to be found within the original work of Latour (see Latour, 2010, p. 96, footnote 18). He utilises the heuristic programme of ‘following the actors’, building a bridge between Greimas and Garfinkel (Schüttpelz, 2013, pp. 19–25) and delivering a ‘thick description’ in the sense of Geertz (1973). Variations and derivations of this can be found in several works as the idea of ‘following the actors’ is fundamental to ANT-based approaches.

There are enquiries into risk controversies (Garrety, 1997; Stassart and Whatmore, 2003; Peuker, 2008; Beck and Kropp, 2011) or controversies concerning the use of science for politics (see MACOSPOL project), outlining cases and applying a network analysis or even mapping of risk-related controversies. These works draw on ANT, harnessing its potential of tracing the pathways of these controversies and identifying the relevant actors. They make use of the concepts of ‘hot situations’ and ‘hybrid forums’ (Callon, 1998), ‘centres of calculation’ (Latour, 1987) or ‘Rechenschaftszentren’ (Rottenburg, 2002),
‘matters of fact’ and ‘matters of concern’ (Latour, 2004) and in general the process of translation (Callon, 1986a).

Another methodological strand is the emerging field of experimentation and modelling inspired by ANT. By means of a modelling method like that of Fink and Weyer (2014), not only the perspective of human actors but also the role of non-human actants can be captured (Fink and Weyer, 2014, p. 55) and non-human agency can be empirically investigated (ibid., p. 61). Their study has an affinity to ‘risk’ as it has a traffic setting and considers the risk of accidents. Furthermore, the whole issue of decision-making in socio-technical environments is not far away from issues in disaster risk management. In such experiments, it is possible to study the conditions in which networks are formed and also to study dynamic processes of interaction (Lindner, 2008, p. 571). This can also be done by qualitative experiments, combining the explorative character of this approach with the instruments of ANT to test the variability of actants and to study the formation of actor-networks or ‘black boxes’ (Lindner, 2008, pp. 574–575). Workplace studies (for example, Luff et al, 2000) seem to be a promising approach to conducting qualitative research on the practices and interrelations of human and non-human entities in risk management. An example of this is the video-based study ‘Les Gardiens du risque’ realised by Mélanie Pitteloud and produced by November (2012).

A potential new application of ANT for risk research purposes is the combination of the common fault tree and event tree analysis in the Bow-Tie method (de Dianous and Fiévez, 2006). Bow-Tie is a suitable method for assessing technological disasters. This approach could be broadened by applying it to riskscapes in the sense of risk settings as relational properties of heterogeneous assemblages. A link to ANT would be the examination of the process of translation and the obligatory passage point to understand the topologies leading to the event and the resulting effects. The notion of barriers (Law, 2006) and constraints (Leveson, 2004) seem to be helpful categories in terms of corrective and prospective disaster risk management (UNISDR, 2009c, pp. 8, 22). This analysis could be inspired or informed by Hägerstrands (1985) time-geography to identify and classify constraints, adding potential visualisations of risks and management strategies in relation to time and space. Moreover, ANT has the potential to reconstructively open black boxes (Schulz-Schaeffer, 2000, p. 205) and is suitable for interdisciplinary work between social scientists and engineers. Furthermore, a conceivable combination with the ideas of the pressure and release model proposed by Blaikie et al (1994) could be a promising way to address dynamic pressures and root causes, taking the field of vulnerability studies into account. Further research on methodological aspects is needed to fully outline such an approach. As mentioned above, it is not within the scope of this article to go into the details of each of these approaches. But in combination with ANT they have great potential for studies on disaster risk management.
Prospects for Disaster Risk Management in the Light of ANT

Having examined the principles and vocabulary of ANT and the concept of ‘riskscapes’, the question is: What are the prospects for disaster risk management in the light of ANT? This broader question encompasses a series of practical questions: (1) How does ANT affect our understanding of risk management? (2) In what ways does an ANT approach challenge some of the conventional wisdoms in the field of disaster risk management? (3) Which challenges arise from following these approaches? (4) And, finally, What are the implications for future research and practice?

First, it must be stated that the ANT approach is not a theory in the conventional sense as it is primarily descriptive and post-foundational (Healy, 2004; Law, 2009, p. 141). In this regard, the task is to observe actor-networks and this involves switching the perspective between the observation of actors taking part in the process of translation and the observation of the process itself where actors change or stabilise (Schulz-Schaeffer, 2000, p. 199).

How does ANT affect our understanding of risk management?

When Healy (2004, p. 288), drawing on Law (2001), talks about a fundamental way of securing network settings guaranteed by ensuring the durability of their constituting materials, it has to be added that the broader term entities or actants is more suitable. But basically, this is the central management strategy: for ensuring durability and stability of the configuration, durable and stable constituting elements and relations are the key. ‘Whether we are considering an industrial plant or an organization the requirement is not only for a robust plan or strategy but one that is durably embodied in material realities. A safety culture that is not embodied or reflected in organizational and material realities may prove to be not only unproductive but counterproductive’ (Healy, 2004, p. 288). Beck and Kropp point out that: ‘[f]rom an actor-network perspective, we need a much deeper understanding of all involved agents and mediators of a risk infrastructure which may produce those connections which retrospectively are identified to present serious risk’ (2011, p. 13). Especially the aspect of retrospective appraisal seems to be the obvious application of ANT-inspired risk research. Ex post analysis of events can easily be carried out and provide analytical insights from a non-essential, relational perspective. But ex ante views are also possible as they may serve as guidance for design and planning (Bleek, 2004, p. 177). This marks the potential of ANT as an analytical tool in disaster risk management and as a tool for planning, design and decision-making. In a row with other social theories and streams of analysis, ANT has its specific strength and eligibility for risk management studies. For example, systems theory stresses different intrinsic logics and their role in observations on risk communication and management; the cultural
theory of risk has important advantages for comparative studies, risk perception studies and for identifying biases; the social amplification of risk concept is useful for highlighting the process-related aspects of risk perception and communication; and the ANT approach focuses on the interrelations and interdependencies between human and non-human entities, prying open different perspectives in the field of risk research. The concept of ‘riskscapes’, as outlined above, underlines this perspective. This allows an understanding of risk-related processes and its constituting entities, recognising the agency of different elements without a priori distinctions.

In what ways does an ANT approach challenge some of the conventional wisdoms in the field of disaster risk management?

By applying the symmetric principle used in ANT-based approaches, it is possible to open up perspectives on relations and interdependencies that might be blurred or hidden by a priori distinctions. This has been aptly expressed by Whatmore: ‘[t]he “hybrid geographies” that I embark on here exercise other modes of travelling through the heterogeneous entanglement of social life that refuse the choice between word and world by fleshing out a different conception of fabric-ation’ (Whatmore, 2002, p. 3). Applied to the field of disaster risk management, this means covering a broader spectrum of influencing factors and calls for more interdisciplinary and transdisciplinary research.

The idea is to create a closer relationship between the science and practice of risk management and to gain a better understanding of risk management by recognising the intertwined processes of what are called ‘technical’ and ‘social’ risk-contributing factors and the issues arising from their dynamic interrelations. The socio-technical, socio-material character of, for example, embankments, levees, debris barriers, sabo dams, early warning systems, and so on, can be stressed, leading to a view of the embeddedness of those entities. This calls for a common ground, a common language for engineers, spatial planners, natural and social scientists, practitioners in the field of disaster management and so forth. An ANT approach facilitates this by offering a non-dichotomous, process-oriented perspective.

In retrospective views, assignment of blame is often essentialist and one-sided. However, this is too simplistic because ‘[p]rofessional work may seem individual, but it is, in fact, always embedded in action nets, networks and multiple interactions’ (Czarniawska, 2008, p. 70). This is also true of disaster risk management. In the case of a disaster, it seems to be the idea of individual action – not in an anthropocentric sense but encompassing human and non-human entities, which leads to attaching blame either to human failure or to technological error. But in fact, individual attributions fail to see the more complex networks and interactions. An individual attribution fulfils the role of a scapegoat – simplifying the networks behind it. A different approach would
be to shift from the focus on ‘cause’, with its limited orientation, to an understanding of disasters and risks in terms of reasons (Leveson, 2004, p. 241). Strategies of disaster risk management for prevention and mitigation based on an ANT approach could have two major components: superimposing inscriptions and expanding the network (Hanseth and Monteiro, 1998, p. 116) to ensure stability and durability by learning from past events and anticipating the catastrophe. The debate also encompasses central considerations regarding achieving a balance between established plans and well-practised improvisations (Czarniawska, 2009, p. 166). The plea for more well-practised improvisations is also a plea for a more case-related, idiographic approach. Combining the principles and vocabulary of ANT with a practical and figurative Bow-Tie approach by following the actors without a priori assumptions and dichotomies will lead to deeper insights and a better understanding of the specific complexity, uncertainty and ambiguity of riskscapes. The Bow-Tie approach uses diagrams centred around critical events combined with fault trees (usually on the left of the diagram) and event trees (usually on the right). This offers a good overview of accident scenarios and existing or planned safety measures (de Dianous and Fiévez, 2006, p. 221). A combination with ANT could enhance the understanding, tracing and visualising of risk settings.

The researcher on risk issues is a detective or a forensic expert (Burton, 2010) tracing the relations and conditions under which riskscapes emerge. This is what can be called the impartial aetiology of disasters (Alexander, 2000, p. 32). To be truly investigative, such an approach ‘needs to pursue the evidence wherever it leads’ (Burton, 2010, p. 37), following the actors to find ‘a greater disaster risk management process in its entirety’ (Burton, 2010, p. 37). By this, risk research is able to gain a deeper understanding not just of causes, but also of the reasons for riskscapes, challenging established wisdoms in the field of disaster risk management. Furthermore, it is possible to design different scenarios in order to address questions of how to avoid disasters by different kinds of management.24

Which challenges might arise from following these approaches?

Nevertheless, using ANT is not a panacea and has its obstacles and constraints. A repeated object of criticism is the reflexive regress (Hamlin, 1992; Schulz-Schaeffer, 2000, pp. 202–203) of ANT and the problem of suppositions like the existence of networks or the principle of symmetry that are not questioned. The solution of infra-reflexivity (Latour, 2009, p. 168) is basically to follow the actants without a priori presumptions (Schulz-Schaeffer, 2000, p. 203). The subsequent problem of following non-human actors could be addressed by finding ‘spokespersons’, either in the direct sense of human actors like practitioners, persons in charge, affected population, and so on, who can speak for the non-human actants or by integrating non-human entities that give
insights into the field (plans, manuscripts, manuals, and so on). However, it has to be stated that this poses a central methodological and epistemological problem and workarounds might weaken the intended general principle of symmetry. But participatory observation may serve as a good way to access ‘hidden’ and ‘silent’ entities. This calls for openness, thorough fieldwork applying different methods to various fields of observation and integrating them into the description by using the infralanguage (Peuker, 2011, p. 166) given by ANT. Of course, this does not come without further challenges: there is the challenge of freeing oneself from accustomed dichotomies and linguistic delimitations, and there is the question of how to delimit the field of enquiry. It seems to be a balancing act between openness and practical case orientation.

Finally, a new dichotomy stability/instability (Peuker, 2011, p. 168) could, as mentioned above, be harnessed as strength in the study of disaster risk management. Instead of refusing all dichotomies and presuppositions, it offers a chance to adopt a pragmatic orientation towards protection targets, safety objectives and political aims, for instance regarding civil protection and disaster management.

What are the implications for future research and practice?

Finally, what are the implications of this discussion for future research and practice? First of all, there is a challenge and a suggestion for future research in the move towards a perspective that goes beyond the human–nature divide and acknowledges complexities (Davies, 2003, p. 7), analysing interrelations and at the same time being aware of the role of science and the potential benefits of local knowledge in the whole process (Lane et al, 2011). The issues associated with risk are too important and complex for essentialist or foundationalist frameworks (Healy, 2004, pp. 280–281). There is therefore a need for a broader perspective in the way we approach phenomena of risk. ‘Categories of risk and … their interrelationships must be studied together rather than in isolation’ (November, 2008, p. 1526).

As ‘each risk situation generates its own process of arguments, strategies, calculations, alliances, and procedures’ (ibid., p. 1526), the relation between idiographic and nomothetic approaches needs to be discussed. Does this mean risk management should be more case-related and practice-oriented and at the same time theory-driven and holistic? How could this be implemented? These are some pressing questions. Definitely, advances in interdisciplinary and transdisciplinary work will be necessary for future research and practice regarding research on and management of risks. The potential of an infralanguage like that provided by ANT has been highlighted here. Further research needs to clarify how to apply these ideas and how they could change interdisciplinary and transdisciplinary research on risk as well as actual risk management.
Conclusion

In general, ANT has not just stimulated an academic debate with its radical approach to agency, but it has also helped to make sense of how different processes and situations materialise in various settings (Cresswell et al, 2010, pp. 75–77). Moreover, hermeneutical-empirical research is able to gain theoretical foundations (Raab, 2010, p. 380). By de-composing and reconstructing (Holifield, 2009, p. 655) the ‘riskscape setting’, the approach presented here traces its emergence and constituent elements. Thus, ‘an actor-network approach opens up lines of inquiry’ (Holifield, 2009, p. 654). Issues and processes relating to disaster risk management can and should be tackled using this approach, as shown in a review and synthesis of ANT literature and potential approaches to disaster risk management in this article.

Using the concept of an ANT-inspired disaster risk management, a path between risk objectivism and risk subjectivism is chosen in order to understand assemblages of risk constituted by a multitude of entities playing their roles. Therefore, risk and its management are conceptualised in a comprehensive way, prying open common distinctions and seeking more differentiated knowledge of the contexts.

The management of disaster risks needs to address the assembled and entangled heterogeneous character of riskscapes. It is important not just to focus on material, social or discursive aspects but to comprehend these as interrelated aspects of the problem. Facing the challenges of complexity, uncertainty and ambiguity means understanding multifaceted riskscapes by learning from past disasters and thinking in terms of contingency. Risk management is then seen as a collective effort to achieve the necessary stability and flexibility to mitigate and to cope with disasters. Going even further, it would mean a shift from risk management to riskscape governance, acknowledging the role of human and non-human agency, as reflected in decision-making processes and risk subjectivities, in enabling and/or constraining pathways determined by complexity, uncertainty and ambiguity. Inter- and trans-disciplinary research and the management of risks could gain valuable insights from this.

Notes

1 According to MunichRe NatCatSERVICE, the overall insured losses from 1950 to 2011 display such a rise (MunichRe, 2012). To differentiate this statement, it is important to note the different geographical distribution of these losses. Loss of property, especially insured losses, tends to be the central problem in industrialised countries, whereas the number of affected people, and to some extent the number of fatalities, are a greater problem in developing countries, especially in Asia (MunichRe, 2010; ADRC, 2011; UNISDR, 2011). It is also important to recognise the various caveats regarding the data of (natural) disasters. First of all, data may differ greatly according to selected sources.
Second, data can be incomplete and ‘for natural disasters over the last decade, data on deaths are missing for around one fifth of reported disasters; data on people affected are missing for about one-quarter of disasters; and data on economic damages are missing for 80 per cent of disasters’ (IFRC, 2012, p. 164).

The following publications selected for further reading deepen this notion and highlight the questionable character of this distinction, not just by notable titles like ‘Unnatural disasters’, ‘Disasters by design’ or ‘There is no such thing as a natural disaster’, but also by their content and discussions: Davis, 1999; Mileti, 1999; Steinberg, 2000, 2001; Hartman and Squires, 2006; Felgentreff and Glade, 2008; World Bank and United Nations, 2010.

‘The scope of this Framework for Action encompasses disasters caused by hazards of natural origin and related environmental and technological hazards and risks. It thus reflects a holistic and multihazard approach to disaster risk management and the relationship, between them which can have a significant impact on social, economic, cultural and environmental systems, as stressed in the Yokohama Strategy (section I, part B, letter I, p. 8)’ (UNISDR, 2007, p. 1, footnote 3).

These phases are part of the so-called ‘disaster cycle’ (Alexander, 2000, p. 3). The scientific and the practice-oriented literature is quite heterogeneous regarding the way the cycle is actually named and what phases it comprises. The most common one is basically the disaster cycle illustrated by Alexander (2000, p. 3), but there is also for example the one referred to as the ‘disaster management cycle’ (Weichselgartner, 2001, p. 90) or the ‘Risikomanagementkreislauf’ (risk management cycle) proposed by Merz and Ennermann (2006), both with a similar but different segmentation.

Probably the best translation is threat or danger.

German expression for ‘risk’. The edited volume ‘Organizing in the face of risk and threat’ by Czarniawska (2009) bases its definitional outline of risk and threat on the work of Luhmann, applying insights from organisation theory to the field of risk research and risk management. The second chapter of the volume, written by Eriksson-Zetterquist, explicitly draws upon Luhmann, and highlights the inherent aspect of decision-making in risk management (2009, p. 15). Although she states that it contributes to organisation theory rather than risk theory (2009, p. 2), the concept of action nets is valuable for the discussion in this article.

Klinke and Renn point out that there are different ways of describing uncertainty, which themselves have various dimensions. There is the notion of incertitude, variability, nonlinearity, indeterminacy, lack of knowledge and so on (Klinke and Renn, 2002, p. 1074). The power of predictions is at stake due to these issues and it means a move from probabilities to possibilities (Glade and Greiving, 2011, p. 16).

In this context, it can only be a selection of some of the central terms in ANT and only a brief description.

The term ‘actor-network’ is in fact oxymoronic and embodies a certain tension (Law, 1999, p. 5). This tension lies in the opposition between the ‘actor’ characterised as centred on the one hand and the decentralised ‘network’ on the other (Law, 1999, p. 5). Therefore the combined term elides this opposition and in a broader sense also the distinction between structure and agency (Law, 1999, pp. 1–5).

Or what makes them non-functioning – which might be even more interesting. Malfunctions, errors or instability show that the formerly functioning black box in fact consists of different heterogeneous bits and pieces (Kneer, 2009, p. 31). For further discussion, see the paper on repair and maintenance by Graham and Thrift (2007).

The term ‘actor-world’ describes the character of the assembling and closing of the entities, and the term actor-network connotes that it has a certain structure and ‘that this structure is susceptible to change’ (Callon, 1986b, p. 33). Both terms are similar
although they describe two different aspects of one phenomenon. Callon argues that they can be used synonymously (1986b, p. 33) and I will proceed in the same manner, but still it is worthwhile to bring this differentiation to mind. In a way, it is reminiscent of the fable of the ant and the spider referred to by Ingold (2011, pp. 89–94) and the inherent debate on ‘meshwork’ versus ‘network’.

12 In ANT terminology, the expression should be ‘all entities considered’ or ‘all actants considered’.

13 In ANT and the political ecology of Latour, a core principle is that all phenomena are at the same time social, material and discursive, and only the modern viewpoint makes an artificial distinction between these aspects (Peuker, 2011, p. 156).

14 ‘... actors gain advantages from networks, but also suffer from their autodynamics, which can run counter to the individual actor’s interests’ (Weyer, 1994, p. 322).

15 It is very interesting that Beck and Kropp refer to Luhmann at this point, in particular in respect of the aspect of decision-making. Other notable attempts to bring together aspects of the theories of Latour and Luhmann are made by Bammé (2008), Noe and Alroe (2003), Reddig (2006) and Werber (2011). Unfortunately, this cannot be discussed here; however, although there are a lot of differences and obstacles to such an undertaking, the combination of both theories delivers some interesting intersections and ties.

16 In the German original it is called ‘Risiko-Akteur-Netzwerke’, which translates as ‘Risk-Actor-Networks’.

17 The German version was published in September 2011 and the English version in May 2012.

18 This may be discussed in relation to Hegel and the German term ‘Aufhebung’, which implies the tension between ‘to cancel’ and ‘to keep’ – preserving and changing, and in a way emphasising ‘becoming’ (Hegel, 1978, p. 57). It is not possible to conduct a discussion here on vulnerability and resilience in the light of Hegel’s dialectics or on the similarities and differences between Latour and Hegel, but this could prove to be an interesting and fruitful approach.

19 The reference to the term ‘landscape’ is to be seen as a metaphor, as Müller-Mahn and Everts (2013, p. 25) point out: ‘the term –scapes itself is deliberately chosen to produce variations of the metaphorically understood term “landscape”’ and ‘it is never one landscape, which is the same to all observers’ (ibid.).

20 Before this the term was used in a medical context in Morello-Frosch (1997), Morello-Frosch et al (2001) and Morello-Frosch and Shenassa (2006). Although it is notable that the authors used the term, they did not base it on Appadurai’s scapes concept or discuss it on a comprehensive theoretical basis.

21 Soneryd (2004) explores ‘soundscapes’ in a context of active sense-making of environmental risk, and the soundscape is part of the broader riskscape (Brooks et al, 2010, Art. #324, p. 5). In this context, Ingold (2011, p. 136) ‘deplore[s] the fashion for multiplying scapes of every possible kind’ due to the limitation of the concept to a specific sensory register. However, the concept of ‘riskscape’ contains not just the different perceptions of various perceiving beings but also different reactions to such perception. Therefore, ‘riskscapes’ may comprise, for instance, sound as a nuisance, chemical substances that produce an unpleasant smell, as well as visible signs of risk.

22 Czarniawska notes that the concepts of action nets and actor-networks are partially overlapping and that the difference is that action nets are conceptualised in a wider frame. Action nets do not necessarily succeed and aggregate to a black boxed entity, respectively an actor, and they may continue to exist even after disassembly (2009, pp. 3–4).
23 The Mapping Controversies on Science for Politics (MACOSPOL) project is a joint European research enterprise with Bruno Latour as scientific coordinator (See: http://www.mappingcontroversies.net/Home/AboutMacospol)
24 This is what Burton calls 'projective or predictive forensic' (Burton, 2010, p. 39).

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