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Vulnerability and Resilience from a Socio-Spatial Perspective

Towards a Theoretical Framework

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1. Introduction

The perception and handling of dangers are an integral part of the history of human societies. Human beings have always tried to protect themselves against perceived hazards. In their responses it is possible to detect spatial, social and temporal differences. For instance, neighbouring societies in coastal regions may still adopt differing approaches to the threat of storm tides even if their general contexts of action are similar. Furthermore, the ways in which threats are perceived and managed in one particular coastal region may change over the course of time.

Modern societies appear to have become increasingly aware of hazards and have, in turn, developed a greater concern for finding means to avoid them. There is talk of insecurities, risks and even the Risk Society (cf. e.g. Beck 1986), but also of sustainable action and development. While such notions have found their way into everyday conversation, the concepts of vulnerability and resilience remain less well known, even if they have recently been the subject of much scholarly debate (cf. e.g. Adger 2000, Birkmann 2008, Bohle et al. 1994, 2002, Brand/Jax 2007, Folke 2006, Janssen/Ostrom 2006).

Although they also describe ways of dealing with hazards, there are sometimes crucial differences to the risk and sustainability concepts. Thus far the vulnerability and resilience concepts have been shaped largely by the natural sciences, closely connected to so-called "natural" hazards (cf. e.g. Felgentreff/Glade 2008). Our assumption is that they may also be utilised to discuss hazards emerging in fields such as technology, economy or social issues. Our aim is to define the concepts in a generic way. This will allow them to be applied as analytical instruments to a broader range of current issues of intense debate that, taken together, point to an increasing sense of insecurity with regards to the future. These issues include:

- Strategies aimed at containing and tackling climate change,
- The susceptibility of so-called critical infrastructure systems to accidents, natural events or terrorist attacks,
- The side-effects of human interventions on complex systems (from financial markets through ecological systems to cultural landscapes),
- Novel volatile markets in a globalised knowledge economy,
- Processes of stigmatising (sub-)regions and their concrete consequences.

We thus intend to develop a social scientific, theoretically grounded approach to vulnerability and resilience. It will be rooted in spatial science and give due consideration to temporal factors. Departing from social-constructivist assumptions and drawing upon relational spatial theory, we examine social practices and dynamics related to the construction and management of spatially relevant hazards. In doing so, we assume that there are social and spatial variations as to how actors perceive and anticipate hazards and as to how they raise public awareness of these threats. Moreover, we assume that there are also social and spatial differences in the precautionary and preventative measures aimed at dealing with hazards, and that measures aimed at developing resilience can be understood in the same way. In such cases, we speak of socio-spatial disparities within attempts to develop resilience. Finally, we argue that constructions of vulnerability/ vulnerability awareness and formations of resilience develop differing socio-spatial dynamics over time.

As stated, this contribution should be viewed as an attempt to grasp and make sense of the concepts of vulnerability and resilience from a socio-spatial perspective.[1] In order to achieve this, we outline first the 'state of the art' as regards discussions of vulnerability and resilience and from this derive desiderata we believe to be particularly relevant to social scientific re-

[1] Kilper/Thurmann (2010) provide a preliminary overview of this enterprise.

search on vulnerability and resilience (chapter 2). Next, we examine the concept of sustainability as well as the thematically related concepts of risk and uncertainty. In doing so we identify differences and similarities in relation to the concepts of vulnerability and resilience, highlighting distinctions and making amendments where appropriate (chapter 3). We argue that it is necessary to move away from the widespread essentialist concepts of vulnerability and resilience to a more relational perspective which draws on aspects of the social construction of reality. To achieve this we explore approaches in the social sciences that reflect upon materiality-immateriality and nature-culture relationships (chapter 4). From this we develop our own approach and propose a social scientific definition of vulnerability and resilience that broadens existing definitions (chapter 5). The paper concludes with a summary (chapter 6).

2. Outlining the Current State of Research and Identifying Desiderata

Since the 1990s, the concepts of vulnerability and resilience have risen to prominence as descriptive categories for the threats to ecological, social and economic systems and the safeguarding of their functions (cf. Bürkner 2010).[2] These concepts were originally developed in the field of ecology (cf. Holling 1973). Today, however, their application is not confined to analysing the functioning of ecosystems or to explaining so-called natural hazards. Instead, they refer to a broad spectrum of social, economic, institutional and ecological hazards as well as the complex interplay between them.

Both human ecology and research on developing countries have long dealt with questions of vulnerability and resilience. Human ecology addresses the issue of human reactions to both natural hazards and catastrophes such as earthquakes or floods (cf. e.g. Adger 2006, Dietz 2006). From this perspective, vulnerability constitutes a potential or actual impairment of social systems and ways of life. Resilience signifies the successful adaptation of societies to natural hazards, one that may help to avoid or compensate for damages and functional impairments. Research on developing countries understands problems related to the development of poverty and the situations of disadvantaged population groups as expressions of structurally induced vulnerability (cf. e.g. Blaikie et al. 1994, Bohler et al. 1994, Bohle 2002, Deffner 2007, Prowse 2003, Watts/Bohle 1993). In this context, the vulnerability of individuals and social groups implies a precarious access to resources essential to life: food, water or money.

In recent times, researchers from a more diverse range of scientific disciplines have come to address issues of vulnerability and resilience, particularly those social scientists concerned with spatial research. Geographers, planners and regional development researchers have shown great interest in natural hazards and related questions of vulnerability and resilience (cf. Greiving 2002, Birkmann 2008). Here, too, vulnerability implies the susceptibility of the human-environment system to natural risks and environmental change (e.g. climate change). Resilience, however, is understood as an adaptation strategy which is developed by societies upon the basis of vulnerability assessments. In the German-speaking world there has been an increasingly strong orientation of research towards current events (such as floods), the formulation of implementation-oriented research questions, and the provision of policy advice for politicians and planners (cf. Birkmann 2008) since 2000. In urban studies natural hazards (cf. Pelling 2003) is the thematic focus of vulnerability and resilience studies. In addition to this, security issues also play a role – especially terrorist threats (cf. Coaffee/Wood 2006) and crime. The city, seen as a threatened entity, usually serves as the object of study. Additionally,

[2] Bürkner (2010) has provided a detailed overview of research on vulnerability and resilience. For this reason, we limit ourselves to a concise outline.

aspects of vulnerability and resilience are examined within studies on megacities in developing countries (cf. Kraas/Mertins 2008).

Social scientific research on vulnerability and resilience has also been conducted within the fields of socialisation and social therapy (cf. e.g. Obrist 2006, Welter-Enderlin/Hildenbrand 2008, Wustmann 2004, Zander 2009). Here, subjects are to be empowered to realise and accept their own psycho-social vulnerability so that they can then establish resilience. Although these studies refer to individuals, they still offer valuable theoretical insights for socio-spatial research on vulnerability and resilience inasmuch as the two concepts are action-focused. In other words, vulnerability and resilience are understood as the outcomes of social action and seen as closely entwined with social relations.

It is clear, then, that a variety of disciplines have adopted the concepts of vulnerability and resilience and that different disciplinary contexts bring different foci and priorities (cf. Brand/Jax 2007, Janssen/Ostrom 2006, Anderies et al. 2004, Birkmann 2008). Birkmann et al. (2011) have compiled the most comprehensive and, given the variety of approaches, broadest definitions of vulnerability and resilience to date.

According to Birkmann et al. (2011, 25), *vulnerability* comprises conditions and processes that determine the exposure and susceptibility of a system or object to hazards, as well as its capacities to respond effectively to them, be they physical, social, economic or environmental. It is not only external natural hazards (such as those arising from climate change) that are deemed responsible for a particular form of vulnerability. Instead, internal, or societal, variables are also viewed as determining factors for vulnerability. Moreover, the definition also explicitly mentions response capacities that thus may be separately defined as an aspect of resilience. The intention here is to assess the degree of vulnerability, which does not simply emerge from the interactions between external natural hazards and internal factors (such as social inequality). To a great extent it is also shaped by a system's capacity to deal with threats. It is for this reason that vulnerability may be low even if exposure to threats is high. In short, response capacities are seen as crucial to understanding vulnerability.

According to Birkmann et al. (2011, 8f.) we should avoid equating the concept of vulnerability with the terms *hazards* or *threats*, which at best constitute one element of the far more complex concept of vulnerability. Hazards denote an objective threat caused by a potentially damaging event that occurs under specific conditions or with a certain degree of probability (Birkmann et al. 2011, 8). The term threat refers, then, to the potential damage of a certain good.

The concept of *resilience* emerged originally from ecology and describes a system's capacity to absorb shocks and disturbances in order to continue existing with as little damage as possible (Birkmann et al. 2011, 17). Thus far researchers have identified three dimensions of resilience. First, the resistance of a system with regards to shocks, or towards gradual changes. Second, its capacity to restore original conditions relatively quickly. Finally, the capacity of system to learn and adapt in changing contexts. Of particular relevance, Folke (2006) proposes understanding resilience as a process rather than a state and thus he argues for a consideration of processes of adaptation, learning, and innovation.[3] Aside from the fact that existing notions of vulnerability and resilience have generally lacked a theoretical footing, it is also evident that they are based upon an essentialist perspective of the world. While vulnerability is understood as the de facto susceptibility of systems, resilience is seen as a system's coping capacity in an equally clear-cut, concrete fashion. Hence, both concepts are

[3] The concept of resilience has been further refined through its operationalisation in both research and practice. For instance, Whittle et al. (2010, 11f.) distinguish between four levels of resilience: a) resistance, b) restoration of a status, c) adaptations to changing contextual conditions, and d) radical transformation. Brand/Jax (2007) name three general preconditions for examining resilience: a) the reference unit for resilience must be specifiable, b) for specific conditions, it must be possible to determine the degree of resilience, c) it must be possible to assess the degree of resilience for a specific condition.

seen as objective, yet modifiable, matters of fact. From this perspective, a system simply *is* vulnerable or resilient in a certain way by virtue of particular, objectively measurable factors. Such an understanding is widespread in both the natural and social sciences.

It is clear that analyses of vulnerability and resilience have taken into account aspects of social differentiation – not least because of experiences drawn from research on developing countries. Moreover, there is consensus that not all actors in a concrete context are equally vulnerable or capable of developing resilience.[4] With respect to factors such as economic status, ages or gender, social inequalities are assumed to become manifest in terms of various vulnerabilities and forms of resilience, hence talk of *social* vulnerability (cf. e.g. Bohle et al. 1994, Bohle 2002, 2005, Wisner et al. 2004, Birkmann 2007, 2008, Birkmann/Fernando 2008, Cutter/Finch 2008, Morrow 2008, Kusenbach et al. 2010). As Morrow (2008, 4) puts it: "Social vulnerability is a catchall phrase that has become part of the discussion related to how social and cultural conditions place some at higher risk to environmental impacts such as climate change or natural hazards. Simply stated, social vulnerability occurs when unequal exposure to risk is coupled with unequal access to resources." By way of example, researchers have frequently highlighted a regularly observable occurrence: People with little economic capital usually reside in areas threatened by natural hazards and, therefore, are more vulnerable than other, wealthier, societal groups. Indeed, they are often even exposed to multiple threats that may reciprocally influence each other. At the same time, however, they lack the necessary economic, cultural and/or social capital that would enable them to alter their situation: to move away, to protect or insure themselves, to avert, minimise, or repair potential damages. It is for these reasons that such groups of persons are deemed to be more vulnerable than others. All this, however, cannot conceal the fact that more wealthy people may be vulnerable as well.[5] From such an essentialist perspective, however, specific groups of persons simply *are* vulnerable. Taking into account various economic, social, and ecological factors, this way of thinking encourages us to measure, estimate and compare the form and extent of a group's vulnerability in terms of objective matters of fact.

Such conceptions are without doubt legitimate, especially as prior experience has shown that thinking in terms of potential threats is not at all spurious. There are ways of foreseeing the occurrence of particular hazards. Some threats do actually become realities and may cause damage (material or immaterial) of a severe or even life-threatening kind. This perspective does, however, suffer from an absence of a sense of how vulnerability and resilience can be socially constructed (not be confused with the construction of social inequality). Broadly speaking, conceiving of vulnerability from a social constructivist perspective (cf. chapter 5.2 for details) means the following: Subsequent to the processing of certain events they have perceived, persons (or categories of persons), cities, regions, enterprises or entire societies may feel threatened by something at a certain point in time, in a certain way and to a certain extent. According to this logic, vulnerability does not simply (and merely) signify an objectively given exposure to threat. Instead, it denotes a shared *assumption* that we might be threatened or in danger. For example, if members of society come to a shared conclusion about climate change upon the basis of cumulative, yet quite differing, extreme weather events, this should be viewed as an outcome of social construction. Similarly, if they also determine the necessity of particular actions or protective measures in anticipation of potential threats for themselves and/or their goods, this also occurs through social construction. Further, ideas of what kind of protective measures to choose as appropriate and conducive to generat-

[4] This applies analogously to different sectors (cf. Stock et al. 2009, 100 ff.).

[5] For instance, Ebert/Weltz et a. (2010) have raised this point in their study on flood risks in Chile. They state that rich households are also endangered by flooding since they prefer to settle at the attractive lower slopes of the Andes.

ing resilience must also be regarded as a social construct. In this context, prevailing perceptions of vulnerability form the basis for modes of perceiving possible resilience formations.

Given that the anticipation of hazards is always subject to uncertainties (cf. Böhle/Weihrich 2009), it is, however, equally possible that vulnerability will be absent from actors' construction of reality – even if certain factors might suggest vulnerability.

Things become more complex once we start considering cultural differences and social inequality. For example, the vulnerability constructions of (groups of) persons, cities, regions or entire societies may differ according to their varying socio-cultural knowledge. In turn, this will have consequences for constructions of potentially resilient action. Essentially, then, it is possible that potential hazards (e.g. caused by natural events) will remain 'unseen' by particular (groups of) persons living in certain areas, while other (groups of) persons will have a sense of vulnerability. Needless to say, these varying outcomes of construction may form the basis for social conflicts that can have implications for coordinating actions in, for example, governance processes. For this reason they are of particular importance.

Despite prior attempts in the social sciences to incorporate aspects of social differentiation, gaps remain. Our research addresses these deficiencies, first by focusing on the following issues:

- *The lack of attention given to the social construction of vulnerability and resilience.* All the abovementioned definitions do not, at least explicitly, accept that the vulnerability of a person, household, company or city is dependent on how humans interpret a certain hazard. Jansen/Ostrom (2006) have recently noted that moving beyond conceptions of vulnerability as independent from human perception is a key challenge for research on the topic.
- *The lack of attention given to the governance dimensions of vulnerability and resilience.* Janssen and Ostrom (2006, 238) have, again, highlighted this as a key challenge for future research: "(T)o incorporate governance research on the mechanisms that mediate vulnerability and promote adaptive action and resilience" (cf. also Young 2010). We need to learn more about forms of governance that, on the one hand, emerge as reactions towards crises or endangerments (cf. Schott 2010) and, on the other hand, are developed in anticipation of potential threats (the "governance of preparedness", Medd/Marvin 2005). In this context, learning processes and the interplay between everyday and institutional "coping strategies" deserve particular attention. Differing interests, power relations and conflicts have to be addressed as well.

Moreover, it is also necessary to address:

- *The normative way in which numerous terms are used*. Contrary to conventional interpretations, vulnerability should not necessarily be seen as inherently negative. Similarly, resilience should not simply be understood as an inherently positive thing. From a long-term historical perspective, the collapse of some vulnerable systems may be regarded as triggers for vital development processes (cf. Schott 2010, Walker et al. 2004). Ultimately, then, vulnerability may provide opportunities for necessary developmental, while resilience structures may have negative outcomes. They might, for example, have unintended effects that create problems if they disregard alternative solutions or if they increase the power of particular individuals (cf. Coaffee et al. 2008, Hodson/Marvin 2008).
- *The lack of attention given to the spatial dimensions of vulnerability and resilience*. Beyond Birkmann's (2008) criticism that spatial planning in Germany deals primarily with the physical sources of vulnerability, further references to the spatial dimension are hard to find. Reference to spatiality include, inter alia, the dual perspective on

physical and social space and their interdependencies; the designation of concrete entities in relation to vulnerability and resilience (urban districts, cities or regions, individuals or social groups, systems or functions); exposure to threats (e.g. due to physical or cognitive proximity); multilevel governance of processes of resilience formation (cf. Medd/Marvin 2005); and finally, the spatial contextualisation of vulnerability and resilience. The latter issue underscores that the vulnerability of an entity (e.g. a person) does not necessarily result from the (potential) effect of a specific hazard, but can only be understood with reference to the particular conditions (i.e. social, economic, institutional and other contexts) under which a person has to cope with this hazard (cf. Whittle et al. 2010).

- *The lack of attention given to the temporal dimensions of vulnerability and resilience*. Beyond a general understanding of resilience as a process of adaptation, the temporal dimension is absent from most definitions. First, from a historical perspective, the effects of natural disasters, periods of socio-economic instability or cultural identity crises upon regions, cities, groups or individuals should be viewed as ambiguous. The environmental historian Schott (2010, 2) has outlined a broad spectrum of reactions as to how people experience, cope with and overcome disasters. Disasters imply a loss of human life, trauma, as well as material damage and property loss. However, there are many differing ways in which societies can come to terms with them. Hence, disasters may ultimately enhance a society's capacity for self-generation. Second, debates on vulnerability and resilience have been (at least implicitly) oriented towards the future. As such, they convey constructed futures of potential vulnerabilities (e.g. owing to climate change) or resilient conditions (e.g. by means of pre-emptive flood protection). Third, both vulnerability and resilience may change over time. As Whittle et al. (2010) demonstrated in their study of serious flooding in the city of Hull, entirely different meanings were ascribed to the concept of resilience during the flood, immediately after the flood and in hindsight long after flooding had occurred.

3. Vulnerability and Resilience and other Related Concepts and Paradigms

As was mentioned in section 1, social scientific terms such as risk and insecurity, as well as sustainability, have long been integral to the analysis of threats as well as the design of preventative measures and forms of protection. For this reason, we need to clarify the interlinkages between vulnerability and resilience and these concepts. In the following, we examine the extent to which the concepts of "risk" and "insecurity" (cf. section 3.1) and the paradigm of sustainability (cf. section 3.2) are compatible – or compete – with the concepts of vulnerability and resilience. How far do they actively shape each other? In which cases are conceptual distinctions apparent? Despite close similarities, we reveal that the terms have very different purposes and at best overlap only to a very small extent.

3.1 Risk and Uncertainty

As early as 1986, the year of the Chernobyl nuclear disaster, sociologist Ulrich Beck published his book "Risk Society" in the German original (the English translation appeared in 1992). He presented a critical diagnosis of society that focused on the threats and risks inherent to a phase of modernity which had become reflexive. While Beck does not develop a consistent, theoretically systematic set of concepts, he was one of the first to introduce a new

theoretical perspective: away from security and towards a perspective of uncertainty. Given the scientific, rationalised worldview and highly technological strategies oriented towards the appropriation and management of nature, realisation that life is increasingly characterised by various uncertainties can be a source of irritation. The need for security thus appears to grow in correlation to an increasingly universal sense of enlightened uncertainty (cf. Beck 1986).

We can find terminologically consistent social scientific concepts of risk and uncertainty in the writings of Luhmann (1991) and – from a decision-theoretic perspective – Knight (1921). According to the latter, uncertainty should be seen as a counter term to risk. Knight describes risk as measurable uncertainty, for which it is possible to determine the likelihood of certain outcomes of action either a priori or by experience. In contrast, Luhmann (1991) introduces danger as a counter term to risk. The crucial point for him was that this distinction rests on the particular attribution of undesired consequences of action. These consequences may be attributed either to the decision-making system itself (risk: I decide to live next to a nuclear power station) or to the environment in which this system is located (danger: a nuclear power station is being built next to my house). In the context of decision-making processes, a system thus incessantly produces risks for itself as well as dangers for its environment. Despite the differing meanings both approaches attribute to the term "risk", both share a focus on the uncertain consequences of actions and decisions. With this concept of uncertainty in mind, it appears more appropriate to use the terms risk, vulnerability and resilience instead of falling back upon the normative concept of "(in)security".[6]

Given this, risk, vulnerability and resilience seem to be the norm in a world that, according to the principles of social meaning, is to be regarded as contingent *per se* and as such lies "below" or "behind" the reality of social certainties and regularities.[7] Decisions are based upon uncertain expectations with regard to the future consequences of our actions or, in other words, upon anticipation (cf. Knight 1921, 201). Accordingly, certainty becomes an empty term of social construction in the context of decision situations (cf. Japp 1996), and social action can never occur under reliable conditions. One main criterion of social action thus lies in minimising contingencies and dealing with uncertainty in a constructive manner – and thus in facilitating scopes of action and choice. When dealing with uncertainty, the societal production of risk appears as a constant process geared towards managing contingency and complexity. Empirically, action strategies dealing with uncertainty are as numerous as they are different.[8] Nonetheless, they seem to share the following characteristic: future action scenarios are anticipated for the benefit of sustainable decisions in the present. In other words, the contingency of uncertainty is transferred into risks by means of expectations.

Against this background, the dilemmatic relation between uncertainty and risk becomes palpable. Risks are socially constructed and, due to "blind spots", new uncertainties will be co-produced as threats. On the one hand, the content and practice of risk construction will engender new forms of uncertainty for their authors (e.g. due to false presumptions). On the other hand, the duality of uncertainty and risk production analytically designates a circular process of reciprocal avoidance of uncertainty. In doing so, one person's action entails uncertainties for third parties, who are then required to react with requisite assessments of risk and

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[6] See e.g. Ullmann (1983) or Baldwin (1997) for discussions on these concepts.

[7] For example, Berger and Luckmann (1969, 111) speak of society as a construction at the edge of chaos.

[8] For example, uncertainties may be tackled by combining them into relatively homogeneous groups according to the principles of insurance, or by delegating the decision to an expert (cf. Knight 1921). Another option lies in a highly reflexive course of action, where one's own expectations are constantly questioned and adapted and, as a result, the basis of the decision will change (cf. Weick/Sutcliffe 2007, Rittel/Weber 1973). In contrast to this reflexive strategy, Knight (1921) portrays the entrepreneur who acts in a context of uncertainty, yet manages to create facts due to his proactive approach. In general, such strategies cannot eliminate uncertainty. At best they help to render it more manageable.

so on. As a result, agents appear both as actors *and* addressees at the same time (cf. Birgmeier 2007, 266).[9] In addition, this nexus is not to be regarded as a linear one, i.e. it is not oscillating only between two entities. In the spirit of "wicked problems" mentioned by Rittel/Webber (1973)[10], we ought to understand these interconnections as multi-faceted phenomena that spread in different directions and into multiple environments, generating complex and contingent resonances there.

Despite numerous strategies geared towards a better handling of insecurity, we cannot assume that problems in the field of social action will be manageable, readily comprehensible, and amenable to simple solutions in the sense of "tame problems". In view of the incalculable side effects and complex and unpredictable resonances, potential security expectations in the social sphere always remain provisional and tied to the limited scope of specific risk conceptions.

The relation to time is fundamental to both uncertainty and risk. Uncertainty points to a general insecurity in terms of future developments and events. In contrast, risk productions imply a construction of potential futures within the present (e.g. scenarios). The reference to time in both categories also reveals the overlap with the concepts of vulnerability and resilience: future threats are constructed and then projected onto the present in the form of vulnerability. Conversely, the concept of resilience departs from the uncertainty of a future that is constructed in the present. As such, we should develop strategies of resilience in order to be equipped to deal with unforeseeable threats and surprises.

Social scientific research on vulnerability and resilience is located within the context of societal management of uncertainty. Due to its distinction between various observation levels (cf. Tacke 2000), risk research, from the perspective of systems theory, certainly provides an appropriate starting point for positioning this research. While a first-order observer observes the world, a second-order observer does not observe the world itself, but rather the way it is observed (Japp 1996, 55). Within this process, a second-order observer may discover the aforementioned inevitability of blind spots and thus, in turn, an observation's arbitrariness and unfeasibility (Luhmann 1985, 37). Hence, the first-order construction of security, its construction logic, and the blind spots which emerge, may be understood and reflected upon by means of secondary observation (at least within the scope of its own blind spots). In practice, first- and second-order observations are often inextricably interwoven (e.g. in organisations). Second-order observation elucidates existing uncertainties, while first-order observation enables decision-making. Importantly, the difference between the observers' perspectives enhances a system's potential to deal with uncertainties (cf. Japp 1996). Within this context, critical social scientific research can position itself on a second-order observation level. This allows us to observe and critically reflect upon the concepts of vulnerability and resilience as first-order concepts, i.e. concepts related to the decision-making level. From this perspective, the concepts of vulnerability and resilience allow us to address the ubiquitous incertitude in action and decision-making processes. By means of deciding what or who is vulnerable to what kind of threat, external (environmental) hazards are translated into internal (systemic) risks and are thus rendered manageable. Resilience may then be regarded as a rational approach, which allows uncertainty and blind spots in planning and decision-making processes to be addressed. The concomitant expectations of (un)certainty are, then, socially constructed and afflicted by blind spots. As a result they remain uncertain themselves. In this manner, definitions of vul-

[9] For an emphasis on the active and passive ways in which social structures are re-produced, cf. also the fundamental dualism of action and structure in Giddens' (1984) theory of structuration.

[10] Rittel and Webber (1973) make a distinction between "tame" and "wicked problems". "Tame problems" allow for a clear definition of problems whose final solutions depend on a limited number of variables. So-called "wicked problems" prove trickier because they are concerned with complex causal networks and are, therefore, more difficult to demarcate and remain diffuse. It is for these reasons that they represent the most common type of problem in the social sphere, for instance in planning.

nerabilities and the implementation of resilience strategies reproduce hazards and risks for third parties. We can hence conclude that societal management of contingency constantly produces contingency itself.

3.2. The Sustainability Paradigm

Sustainability is another crucial term within research on vulnerability and resilience. Sustainability, unlike "risk" or "insecurity", has no foundation in social theory. Rather it is a socio-political and application-oriented concept. As we are primarily interested in theoretical and conceptual dimensions of vulnerability and resilience, the sustainability concept may at first appear to be of little relevance. However, it has become such a dominant concept that it is impossible to ignore it when thinking about research on vulnerability and resilience. Unlike risk and insecurity, the sustainability concept is characterised by a pronounced awareness of spatiality and, moreover, there is a partial overlap with the concept of resilience. For these reasons the notion of sustainability is useful for the development of a socio-spatial perspective on vulnerability and resilience.

The sustainable development concept became globally well-known in 1987, when the Brundtland Commission for Environment and Development presented its report "Our Common Future" (WCED 1987). The principles of sustainability are, however, somewhat older, having emerged in German forestry as early as the 16th century. It shaped the guiding principle of silviculture: never fell more trees than you can re-grow within a certain period of time. The concept emerged from experiences with decreasing profits in forestry that occurred as a result of excessive clearings. The aim was to guarantee long-term economic utilisation of forests. Such thinking reveals an awareness of the effects human actions may have in the distant future. Since the Brundtland Report was published sustainable development has been defined as development that satisfies the demands of the present generation without jeopardising the opportunities of future generations. In other words, the actions of today's generation should be shaped in a way that allows future generations to satisfy their own needs and to freely choose their own lifestyle.

The insight that ecological, economic and social factors are inextricably intertwined and thus must not be separated or played off against each other has been celebrated as an important achievement of the Brundtland Report. The core principle of the sustainability concept is that the long-term safeguarding of life-sustaining natural resources needs to be linked to economic stability, without disregarding social responsibilities. Ecological sustainability refers to the goal of preserving our nature and environment for subsequent generations. Economic sustainability centres on the design of an economic system that is conducive to long-term and widespread societal prosperity. Social sustainability aims to achieve societal development which allows for the participation of all persons and helps to safeguard a decent quality of life for everyone. As this brief description clearly illustrates, the notion of sustainability is extremely normative.

As already mentioned, the sustainability concept, unlike "uncertainty" and "risk", has always had an explicitly spatial dimension. The Brundtland Report emphasised that local actions have effects at the global level and – vice versa – global actions leave their mark at the local level. Although the notion of sustainability was still by-and-large oriented to the global level in the Brundtland Report, it has since been adopted at, and adapted to, various spatial scales. The principle of sustainable action has now become firmly anchored at the international as well as the European, national and local scale, while spatial planning processes have been extensively influenced by the implementation of this concept.

The United Nations adopted the programme of action "Local Agenda 21" at the Rio Summit in 1992. This initiated a worldwide move to more sustainable municipal development. Under the motto "Think globally – act locally!" Local Agenda 21 consists of measures spanning a variety of policy fields, all of which provide advice about a future-oriented economy and sustainable ways of life in our cities. For their respective territories, all signatories of Local Agenda 21 were requested to develop a sustainability-oriented and differentiated action programme in collaboration with citizens as well as civil society organisations and the private sector.

Within this broader context, the "Charter of European Towns and Cities Towards Sustainability" (European Conference on Sustainable Cities and Towns 1994) was approved in Aalborg in 1994. It contains a commitment from the signatories (European municipal and regional administrations) to sustainable and future-oriented social, economic, environmental, housing, transport, land, spatial and budgetary policies, as well as participation in the Local Agenda 21-process.[11]

In Germany, when the planning law ("Raumordnungsgesetz") of 18 August 1997 was revised, the concept of sustainability became integrated in the law and thus sustainable spatial development has become a general principle at the national level (§ 1, par. 2 ROG, 22 December 2008). As a consequence, regional plans ("Regionalpläne") and state development plans ("Landesentwicklungspläne") became more ecologically oriented. Several German states ("Länder") and municipalities have now developed their own strategies for sustainable development.

Overall, the sustainability concept has had wide-ranging consequences for spatial planning processes. Most notably, action has been taken to reduce urban sprawl, the functional separation of living and working areas, services and leisure, as well as the increase of motorised private transport. Moreover, this shift has been understood as an attempt to move away from sectoral, static and short-term thinking as well as from thinking in terms of large systems (cf. ARL 2000, Beckmann 2000, BfLR 1996, Fuhrich 2000, Kühn/Moss 1998).

Regardless of the positive resonances associated with sustainability, the often harsh criticism of the concept cannot be ignored. In particular, researchers have criticised its analytical fuzziness, its pronounced normative character and the weak linkages between the three dimensions of ecology, economy and social equity.

For instance, Görg (1996, 178) notes that the sustainability concept has been over-used and in often vague terms, while the frequency of its use is in reverse proportion to the clarity of its content. What is striking is that this ambiguity has been interpreted as an inherent and unalterable feature of the concept rather than a weakness that needs to be addressed (cf. Eblinghaus/Stickler 1996, 37). It is accepted that actors with differing interests think that the term offers them specific advantages and they hence try to exploit it for their respective purposes.

Furthermore, several authors have frequently noted the highly normative character of sustainable development as a guiding principle for societal development (see especially Eblinghaus/Stickler 1996, 41). Accordingly, a weakness of the term is that the origins of the normative principles and objectives embodied in sustainability are unclear and the relevant thinking upon which it is based has not been sufficiently substantiated (Homann 1996, 34 f.).

The disconnect between the dimensions of ecology, economy and social equity has also been subjected to criticism (cf. e.g. Eblinghaus/Stickler 1996, 52). Some claim that the sustainability concept has simply been an economic concept from the very outset (Eblinghaus/Stickler 1996, 42 f.). Others have stated that the ecological dimension has instead been pre-eminent (e.g. Harboth 1991, 7), while various researchers have argued that the linking of

[11] Subsequent to this Summit, further meetings were held at regular intervals. All broached the issue of the sustainability of European cities and municipalities with regard to the latest economic, social and climate-related challenges as well as networking between relevant actors, sectoral integration and assessments of progress: Lisbon (1996), Hanover (2000), Aalborg (2004), Sevilla (2007), Dunkerque (2010).

the economy and ecology dimensions has always been integral to the sustainability concept (cf. e.g. Sauerborn 1994, 5). What unites critics, however, is the opinion that the social dimension has been neglected and that sustainability has thus fundamentally failed on its own terms (cf. e.g. Sauerborn 1994, 6, Hauff 2003, 12).

The notions of "uncertainty" and "risk" are linked to various theoretical concepts that attempt to grasp threats as well as create resilience in an analytical way. In contrast, the paradigm of sustainability is characterised by its highly pragmatic orientation to develop courses of action and measures to enable life without hazards in the future. What is absent from the paradigm is the analysis and anticipation of concrete threats. Crucially, "sustainability" is more limited in scope than the resilience concept. Sustainable development aims, first and foremost, to prevent the emergence of threats. In contrast, the literature on resilience frequently refers to the terms "resilience creation" to express both a preventive approach to anticipated hazards as well as an adaption to (and a certain mode of dealing with) expected threats.

Due to its lack of analytical sharpness, it may at first appear that the sustainability concept has little to offer us in our conceptual work. However, we should not overlook the notable features of sustainability. For instance, it implies a distinctly long-term time perspective. It underscores the fact that all planning needs to consider the potential effects this action may have in the distant future. Moreover, the sustainability concept has a spatial dimension and it rests on an awareness of the interrelations between local action and global effects as well as between global phenomena and local effects. Furthermore, it is a concept firmly embedded in contemporary politics and one which has the capacity to mobilise actors.

Recently, research on sustainability and resilience has drawn links between the two notions. Overall, it is apparent that the resilience concept is becoming gradually more integrated into the discourse on sustainability. In some cases, the concepts of sustainability and resilience have even been used interchangeably. Occasionally, the concept of resilience has also been utilised to provide greater analytical sharpness and theoretical foundation to discussions of sustainability. In such cases, resilience is seen as a necessary precondition for sustainable development (cf. Derissen et al. 2009, 2f., Fiksel 2006, 20).

As this literature analysis has shown, thinking of sustainability without reference to the notion of resilience is now a thing of the past. By the same token, a conception of resilience which did not refer to the sustainability would lack a long-term, future-oriented perspective. It is therefore neither possible nor desirable to draw a clear distinction between the two concepts. In fact, it is necessary to seek synergies between these terms.

4. Social Scientific Reflections on Conundra Materiality-Immateriality and Nature-Culture

As stated, our aim is to provide a social-scientific footing to conceptions of vulnerability and resilience, one which also takes into account the dimensions of space and time (section 1). We noted the gaps and weaknesses in prior conceptions of vulnerability and resilience (cf. section 2). We then shed light on the social-scientific terms of most relevance to the fields of vulnerability and resilience, assessing their strengths and weaknesses, as well as their potential to provide a social science-oriented conception of vulnerability and resilience (section 3). We will now turn to the question of how we are to conceptualise relations between a) materiality and immateriality and b) nature and culture.

As already noted, we are critical of approaches that view vulnerability and resilience as objective givens (cf. chapter 2). Rather we depart from social constructivist assumptions and think of vulnerability and resilience particularly in terms of space as a social construct, per-

ceived threats and human agents. It is important to note, however, that material entities remain as important as immaterial constructs such as perceptions or interpretations of reality. For instance, it is necessary to engage with materialities in the form of (human or animal) bodies, "natural" and manufactured objects (e.g. trees, residential or industrial buildings), "nature" areas (e.g. oceans, woods, agricultural or urban landscapes), as well as "natural" phenomena (e.g. storms, storm tides, heavy rains, or floods). The latter may also have material repercussions: they may kill humans and animals, destroy plants, damage or wipe out landscapes, houses and infrastructures. Even immaterial constructs such as negative images of spaces may have observable material effects. The negative image of a particular area can lead certain groups of people to move away. It may make investors lose interest in the area and result in a situation where infrastructures are underutilised or removed, where houses remain uninhabited and dilapidated, where public spaces fall into disrepair and so on.

One problem is that essentialist approaches unquestioningly depart from a desire to reveal real exposition or adaptability to hazards and tend to emphasise the importance of materiality and its impacts in a one-sided manner, while social constructivist approaches tend to stress the importance of immateriality in an equally one-sided fashion. From a social constructivist perspective, material objects or objects of nature are not simply 'out there' for humans; they only become real, and thus acquire their specific meaning, through human interpretation and this always occurs within a particular socio-historical context. In this reading, "natural" objects become appropriated, re-shaped, stripped of their "naturalness" and socialised through the social attribution of meaning and constructions of reality. Accordingly, socialisation extends into the very construction of materiality and nature. Landscapes are formed, houses and entire cities are built and animals are reared according to human ideas. As a consequence, "natural" spaces are turned into cultural or urban landscapes and wild animals are transformed into domestic or farm animals. As Görg (1999, 11) aptly put it, we cannot avoid the assumption that all natural facts are socially mediated. In effect, it is difficult to make a clear-cut distinction between materiality and immateriality or between nature and culture. Both categories can be justified and it is necessary to consider the other when outlining the one. However, the dichotomy of materiality vs. immateriality seems to be deeply embedded, at least in the thinking of the Western world. The philosophy of nature is evidence that there has long been an awareness of the problems with distinguishing between nature and culture. However, there are hardly any approaches in the natural or social sciences that have managed to effectively avoid this nature-culture dichotomy.[12]

We aim, on the one hand, to avoid the tendency towards essentialism apparent in research on vulnerability and resilience, to steer clear of viewing these categories as naturally given. At the same time, we are at pains to avoid the trap of a reductionist constructivism, one in which materiality and nature are not seen as relevant research categories. To provide a theoretical grounding for our approach, we have thus searched for concepts that address materiality-immateriality relations. In line with our purposes, we have selected and assessed theoretical approaches from the social sciences which consider in particular more than one of the following analytical areas: knowledge or ways of perception, agency, space and time. In doing so, we have also drawn on concepts that make no explicit reference to vulnerability and resilience.

We distinguish between three different categories of approaches. The first category is characterised by a strong emphasis on the features of immateriality, without neglecting the importance of corporeality (section 4.1). Even if the concentration on immateriality observable in these approaches is to be avoided, it is worth exploring the benefits which can be

[12] Subsequent to his analyses of sociological approaches (Spencer, Marx, Durkheim, Mead, Parsons, Adorno, Luhmann and Beck), Görg (1999) comes to the conclusion that some kind of constructivism and socio-centricism appears unavoidable. This does not, however, necessarily entail a denial of actually existent ecological problems – just as it does not per se imply a hierarchical dualism of nature and society.

gained from combining the dimensions of knowledge, space and time in a socio-scientific analysis of vulnerability and resilience. The second category, then, comprises approaches that assume a dichotomy between materiality and immateriality and, upon this basis, describe interactions, metabolisms or hybridisations (section 4.2). As this category is more closely aligned to our own objectives than the first, and since it comprises a range of different approaches, we will assess the strengths and weaknesses of a number of differing conceptions. In so doing, our focus eventually falls on an approach that should be seen as a category on its own as it is directed against any dichotomisation of materiality and immateriality – actor-network theory (section 4.3). In contrast, we do not examine approaches oriented only to materiality. For the purposes of social-scientific research on vulnerability and resilience, a solely natural science perspective can provide little insight (cf. also Brklacich/Bohle 2006). Moreover, genuinely social-scientific theories that favour a concern for materiality or nature are essentially non-existent.

4.1 Approaches Emphasising Immateriality – Considering the Aspects of Corporeality

Unlike these approaches, constructivist approaches are particularly concerned with information, knowledge, interpretations of reality, ways of seeing or, in other words, the immaterial dimension. The "Structures of the Life-World" approach of Alfred Schütz and Thomas Luckmann (1980) differs in that it – albeit only partially - reflects on the links between immateriality and corporeality. Ultimately, however, we are confronted with the main question of how knowledge comes into existence, is processed and socialised in our lifeworld –how it structures human action.

Reflections on how our lifeworld becomes spatially layered are of particular interest to us. According to this thinking, a subject's lifeworld is divided into top and bottom, front and back, and left and right, due to its corporeality, its upright posture and the alignment of its sensory apparatus. Together, the characteristics of corporeality and the way our lifeworld is spatially layered around it constitute a key part of a subject's capacity for agency and experience. On the one hand, this implies that this capacity depends on the particular spatial contexts in which a subject is located. On the other hand, since the everyday lifeworld also comprises the sphere of bodily action, the subject also shapes the outside world through physical action.

In the first instance, the 'Wirkzone' or zone of operation can be taken as the point of departure for a subject's agency. The zone of operation is defined as the immediate surroundings within which it is possible to exert influence. Schütz and Luckmann (1980) differentiate between the primary zone of operation (i.e. the sphere of immediate corporal agency) and the secondary zone of operation (whose limits are defined by a society's technology standards). Accordingly, innate agency may be enhanced in the secondary zone of operation with the aid of vehicles, cranes, guns and so forth. As these remarks indicate, it is possible to leave a specific zone of operation to reach another. The world within *actual* reach is that surrounding the zone of operation. This is the place where the subject is located and it provides a guide for orientation – even though the subject is certainly unable to act in an immediately physical way there. For example, if we take a desk in an attic room as a subject's immediate zone of agency and operation, the subject is, however, able to explore the world in actual reach – namely the attic room. Physical action is, then, only possible within the close surroundings of the desk. In contrast, the world in *potential* reach is defined as the world that is not in actual reach but – in principle – may be brought into reach.

Schütz and Luckmann thus demonstrate the interlinkage of perception, corporeality, agency (and its consequences) and the material environment. Implicitly, they also provide

insights for an analysis of vulnerability and resilience. For instance, it becomes clear that differing spatial ranges allow for differing opportunities for experience, agency and exerting influence. Depending on location, the world of immediate or direct threats (e.g. caused by climate change in the form of storms and damage to roofs, heavy rainfall and basement flooding) is either entirely absent from the world in actual reach, or differs from the one that exists at another place. In this manner, it is possible to identify locally specific forms of knowledge or, to put it differently, spatial disparities as concerns the perception or awareness of vulnerability. Of course, threats may also be experienced from within the world in potential reach, whether that be through direct experiences arising from temporary changes of location (experiences of heavy rainfall and flooding during a holiday), or through experiences medially conveyed by watching the news. In such cases, this approach offers the possibility to make a distinction between differing empirical worlds of threats (direct and indirect) and, where possible, to connect them with differing motivations to act. Furthermore, this approach makes it clear that possible courses of action differ according to the locality and the lived worlds found there. Therefore, in order to avoid or minimise potential damage, specific patterns of action may have evolved over time as a result of direct experiences with threats in actual reach (e.g. building dams made of sandbags so as to prevent basement flooding). Such forms of target-oriented action require particular material resources to be available in the local environment. While these resources may originally come from other places as well, they have to be organised and brought into reach to offer protection. Courses of action vary from place to place, as do the resources and communities of action. Through an appreciation of these details, it becomes possible to untangle locally specific forms of action as regards resilience, i.e. spatial disparities in the active construction of resilience.

Going further, it is striking that Schütz and Luckmann (1980) do not confine themselves to analysing the spatial layering of our lifeworld, but also investigate its temporal structure. Without going into greater detail here, they make (among other things) a differentiation between “subjective time” and “world time”. The key consideration made here is that actions and experiences always have a temporal structure and as such are temporally limited. Taking into account these temporal structures is also of great importance to the analysis of perceptions of vulnerability and actors’ construction of resilience. For example, we should examine the time frames actors assign to certain threats, the time frames they use in the creation of protective measures and the extent to which these perspectives are synchronous.

The strengths of this approach lie in the connections drawn between concepts of corporeality, (target-oriented) action, the acquisition of experience and knowledge, and the coupling of temporal, spatial and local dimensions. However, limits are also apparent. A conception of materiality is, for instance, missing. Moreover, the influence of human action on the environment (i.e. other human subjects as well as objects located within their spatial environment) is addressed in a rather one-sided manner. Although the approach does touch on the conditionality of subjective experiences, as a result of corporeality and spatiality, it ultimately does so only in a superficial fashion.

4.2 Approaches Emphasising Dichotomy, Interdependency and Hybridisation

The following approaches have all managed to avoid such a one-sided perspective, providing instead a clear focus on the interactions between materiality-immateriality and nature-culture. There are, however, great differences in how these interrelationships are described.

Social Metabolism and Action Settings

Peter Weichhart's (2003, 17) approach is rooted in Action theory. He starts from the basic assumption that there is a difference as well as a reciprocal relationship between sense/symbolism and matter (ibid., 19). In a similar fashion to Schütz and Luckmann, he states that people are embedded in physical-material processes because of their corporeality, which also implies that the social world is anchored within the physical-material world. Weichhart identifies the following key questions:

> "Is the physical-material world capable of influencing the social world in a causal way? (…) 2.) How are we to deal with the problem of determinism? How can we avoid an over-hasty relapse into one-sided naturalism? (…) 3.) How do we address the 'androgynous' character of numerous phenomena in reality [this question e.g. refers to objects of the physical world that may not be clearly assigned to either nature or culture; added by the authors]? (…) 4.) How can the interplay of both levels of interaction [i.e. the social-symbolic and the physical-material; added by the authors] be best described?" (Weichhart 2003, 21f., translated by the authors).

In his attempt to answer these questions, Weichhart does not provide a coherent theoretical framework. However, he proposes Setting Theory, which emerged in the field of environmental psychology, as a potential approach. Although rooted in the theoretical tradition of behaviourism, it provides significant insights to the description of relations between physical and social structures. The approach is based on the observation that human behaviour always occurs in the same way at particular places or settings. Specific places with a distinct constellation of entities thus tend to be characterised by generally stable behaviour patterns, and these appear to be determined by the respective setting.

Weichhart argues, however, that it is necessary to reformulate this statement in accordance with action theory. He does so in the following way: It is subjects rather than places that form the point of departure for reasoning: Through joint action with other subjects and with the aid of material resources, subjects take possession of places. In the course of these actions habituations and "standing patterns of *action*" (Weichhart 2003, 31; emphasis in original) are formed in terms of conventions, customs and norms. As such, they become incorporated in the respective cultural and social system, whilst thereby simultaneously also playing a role in its constitution. However, actors view these habituations as cultural guidelines for action rather than creative and subjective activities. In this case, shaping, the constitution of things, occurs more in the sphere of the cultural and social system than in the physical-material realm of the place itself. Weichhart also points to the potential emergence of couplings between specific action patterns and places. He refers to these as "milieux" - particular constellations of places, action and time. Incidentally, Weichhart also introduces a temporal dimension at this point, though he fails to follow this up. Against this background, Weichhart (2003, 36) comes to the following conclusion:

> "In a double sense, we should regard Action Settings as hybrid entities. First, they are constituted through the interplay of performed actions and physical-material structures, 'tools', 'means' or 'enabling elements' of action. As a result, they appear to represent objectifiable elements in the interplay between the involved actors and their material surroundings. Second, the milieu quality of settings can be regarded as hybrid in the sense that it belongs to both the physical-material world and the social world simultaneously. We are thus dealing with a 'colonised' or 'cultivated' matter, which has become 'socialised' by means of appropriation processes – and has hence become integrated into the social system"(translated by the authors).

Overall, it is fair to say that Weichhart's approach is comprehensive. From the outset, he emphasises the need to link concepts of corporeality, materiality, symbols, knowledge, culture and – above all – action. From this, he arrives at a means of dealing with the challenge of na-

ture-culture interdependencies: through their actions, members of society need to apprehend, take possession of entities and socialise them. They have to cultivate matter and create hybrids and hermaphrodites. Despite Weichart's mention of hybrids and hermaphrodites, his approach departs from an assumption of difference between the material and immaterial and nature and culture (which he openly admits) and proceeds to emphasise the interdependencies. Although there is much of merit in Weichhart's Action Setting approach, we do not think it is appropriate for resolving the fundamental problem of dichotomy. The problem remains – it is merely concealed by the assumption of hybridisation.

While this approach does not explicitly touch on questions of vulnerability and resilience, its action theoretical foundation and its emphasis of the corporal character of human action allow us to draw conclusions (similar to the ones noted in the writings of Schütz and Luckmann) for analyses of vulnerability and resilience. The observation that locally specific and setting-specific forms of action may occur is perhaps the key insight here.

Social Metabolism in Space

Fischer-Kowalski and Erb (2003) have also made an attempt to elucidate the interdependencies between nature and culture. Though there they do not refer to Action Theory, their characterisation of the interrelationships between these entities is highly abstract.

The Marxist concept of labour is a central theoretical element in their approach. Labour is seen as a means to organise the metabolism between society and nature. Fischer-Kowalski and Erb extend this conception of labour further by drawing on the cultural-anthropological approach of Godelier (1984). For them, Godelier demonstrates how nature changes as a consequence of processes of social appropriation; how this modified nature in turn has effects on society; and how it eventually places humans under pressure to change. It is clear that this approach may be highly useful for an examination of vulnerability and resilience, at least one concerned with ecological issues. The overall benefits of this approach are, however, limited because the authors confine themselves to an assessment of material exchange processes.

In concrete terms, the authors describe processes of metabolism and interaction. Human beings withdraw resources (e.g. wood, coal, plants etc.) from the natural cycle, process and transform them (through work), and finally incorporate them into the social cycle (in the form of goods and products). Through integration in social processes, resources ultimately transform social conditions. Since resources are first withdrawn from the natural cycle and then reintroduced in an altered form (e.g. as waste, emissions etc.), the natural context is also modified. This leads to the emergence of new living conditions for humans, and societies must react to these changes. From this it is apparent that this approach does not view nature as static, but as historically contingent, just like societies. The underlying argument here is that nature and society are mutually dependent, though theoretically it is formulated in terms of metabolic processes. Drawing on Godelier, Fischer-Kowalski and Erb explicitly draw attention to the fact that society comprises both ideational and material elements. Consequently, they also reject as misleading those perceptions that assign material aspects solely to the natural sphere and, in turn, associate ideational processes exclusively with the social sphere.

Moreover, the authors draw inspiration from Luhmann's theory of autopoietic systems, especially in its attempt to describe social processes with recourse to key terminology in biology. Nonetheless, Fischer-Kowalski and Erb argue that there are limits to this approach. For instance, this form of system theory fails to explain how social systems are capable of actually influencing natural systems in real, concrete terms. To address this problem, they turn to they Sieferle's (1997a, 1997b) culturalist system theory.

Sieferle distinguishes between three systems, each of which contains specific elements. The socio-ecological system consists of nature (N), population (P) and culture (C). The social system comprises population (P) and culture (C), the ecological system, nature (N) and population (P). It should already be clear that this approach avoids simply contrasting nature to

culture in a dichotomous way. Instead, nature and culture are conceptualised as a complex web of entangled systems. Populations or, more precisely, human bodies, act as a link between these systems: they are viewed as "amphibians" of material and symbolic reality. As such, they allow for a structural coupling between cultural and biophysical structures. Although "structural coupling" is introduced as a device intended to help clarify interactions, it remains largely abstract.

In our opinion, this is where the approach reaches its limits. Through combining very diverse elements from (culturalist) system theory, structuralist cultural anthropology and historical materialism, its primary concern is systems and structures. It is a conceptualisation of materiality and corporeality that entirely neglects agency, knowledge, space and time.

If the approaches to materiality and immateriality thus far discussed have only limited implications for social-scientific research on vulnerability and resilience, the following literatures are, in contrast, of great relevance.

The Co-Evolutionary Approach in Resilience Research

In most recent literature, vulnerability and resilience are increasingly thought of in terms of coupled socio-ecological or economic-ecological systems and not as purely ecological or social entities (cf. section 2). The concern here is not only an integrated assessment of social and physical phenomena, but also the mutual interdependence between human beings and their environments. For example, the leading research organisation, Resilience Alliance, employs the so-called co-evolutionary approach, which holds that the development of society and ecological systems is inextricably interwoven (cf. Berkes et al. 2003). Accordingly, they constitute a unit that must not be separated artificially in either research or politics: "The nature-culture split is seen as arbitrary and artificial" (Brand/Jax 2007).

While at first glance these reflections on the relation between humans and their environment appear to be of an integrative and balanced character, Kirchhoff et al. (2010) have shown that closer inspection reveals an at times narrow and imbalanced approach. First, the Resilience Alliance's understanding of a socio-ecological system implies that man is part of an ecosystem (cf. Walker et al. 2006, Berkes et al. 2003). In this reading, the "social" dimension of "social ecology" is regarded as a subordinate category. Second, in terms of the explanation of socio-ecological interrelationships, the Resilience Alliance's systemic approach asserts a claim to universal validity. For ecologists, the dominance of an organismic understanding of ecosystems excludes alternative ecological theories (cf. Kirchhoff et al. 2010). For social scientists, the problem lies in the fact that systems theory assumptions drawn from ecology are not related to social phenomena with sufficient reflection:

> "[The proponents of the resilience approach] have extended their systems notion from ecological systems to social, economic, and coupled social-ecological systems (…), and assume that all these systems can be described and analyzed 'in a common conceptual, theoretical, and modelling framework' (Walker et al. 2006)" (Kirchhoff et al. 2010, 31).

According to Kirchhoff et al., this dominant, systems view in resilience research has a cultural basis and is particularly influenced by specific epistemological assumptions made by researchers involved in these debates:

> "Ecological theories, even if they are empirically well-founded, do not solely copy or mirror distinct aspects of reality-as-such. Instead, they also provide constructions of realities-for-us, which are determined by cultural ideas" (Kirchhoff et al. 2010, 30).

This criticism of the systemic approach adopted by the Resilience Alliance highlights a number of imbalances in the interpretation of human-environment relationships, which in the prevailing literature on resilience are concealed under the guise of socio-ecological integration. In terms of second-order observation (cf. section 3.1), it is necessary to scrutinize this ap-

proach, paying particular attention to its underlying core assumptions and its impacts on academic discourses on resilience. Considering the discursive dominance enjoyed by the Resilience Alliance, an important element of critical social-science research on resilience would be to assess how far the organisation influences the thinking and acting of policy-makers.

Urban Political Ecology: Human-Environment Relationships as a Political and Spatial Process

In their book "In the Nature of Cities" the editors Heynen, Kaika and Swyngedouw aim to overcome the dualism of nature and culture. In doing so, they outline entirely different premises and perspectives to those found in the approaches previously discussed. Political, rather than socio-ecological, interrelationships are the intellectual concern of this explanatory approach. Departing from David Harvey's key argument that "There is in the final analysis nothing unnatural about New York" (1993, 28), they elaborate (in the introductory chapter) on the need to end the conventional separation of nature and culture in both research and practice. For example, distinguishing between "untouched" nature and "built" cities does not allow for an appreciation of the deep imprint of human activity on seemingly near-natural artefacts. By the same token, it conceals the fact that a vast amount of natural resources and ecology are contained within our cities.

Through their Urban Political Ecology approach the authors develop a framework for research that serves to explain the interrelatedness of social processes, material metabolism and spatial form. Their aim is "to disentangle the interwoven knots of *social processes*, *material metabolism*, and *spatial form* that go into the formation of contemporary urban socionatural landscapes" (Heynen et al. 2006, 8; emphasis in original).

On the one hand, this approach entails an attempt to bring physical and ecological processes to the fore in urban theories ("re-naturing urban theory", Heynen et al. 2006, 2). On the other hand, it entails a greater concern for the city in environmental research. Specifically, the authors are especially interested in the significance of historical-geographical processes for the so-called urbanisation of nature (Heynen et al. 2006, 6). Within these processes, social and ecological changes are mutually dependent and highly political and cultural. The material production of the urban environment is, for instance, strongly affected by the mobilisation of certain discourses and interpretations of nature (cf. Kaika 2005).

Research on Urban Political Ecology is thus always confronted by the following questions: Who promotes particular forms of socio-ecological configurations? Why and with what intention do people draw on certain kinds of cultural interpretations of cities, society, or nature? What important insights to power-relations in the city can be gained from examining the historical origins of its physical structures?

While the concept of urban political ecology – as developed by Heynen et al.– does not make explicit reference to the concepts of vulnerability and resilience, it still offers important insights that may help address the research gaps mentioned in section 2. They concern a) the spatial dimensions of nature-culture relations and b) the role of power in the design of socio-ecological urban landscapes. This critical human geography perspective treats the dimensions of space and time as constituent factors in human-environment relationships and not simply as framework conditions. The vulnerability of urban societies owing to, for example, deficiencies in the water supply system or flood control measures cannot be determined simply with reference to the degree to which certain needs are seen as satisfactorily met by key public services. Instead, this vulnerability depends on the importance these artefacts acquire as a result of historical processes of materialisation, institutionalisation and habituation within a specific spatial context.

A further reason that the Urban Political Ecology approach is highly relevant for research on vulnerability and resilience is its concern to understand how space-society relations

emerge and develop through negotiation processes between unequally powerful actors. Heynen, Kaika and Swyngedouw (2006) highlight the political motives and resources behind such debates and actions geared towards a realignment of urban human-environment relations. In doing so, they consciously distance themselves from the established problem-solving approach found in governance research. However, one problematic feature of the Urban Political Economy approach is its underlying normative and neo-Marxist assumptions. It is not clear, for example, whether the arguments may also be applied to non-capitalist societies. Moreover, the focus solely on the urban is unsatisfactory because human-environment relations also require perspectives reaching from the regional to the global (which is apparent in other works by the authors). In general, the Urban Political Ecology approach (thus far) suffers from a lack of theoretical depth and critical self-reflection.

Socio-Technical Research on the Co-Evolution of Cities and Infrastructures

Running in parallel to these works on the relations between man and nature in the urban context, another strand of social-scientific research on technology and urban studies focuses upon the co-evolution of cities and infrastructure systems. It addresses the relations between society and nature in the sense that it conceives of infrastructure systems of supply and disposal as interfaces between natural resources and human usage. Key processes of urban metabolism are located within the material, institutional and socio-cultural configurations of infrastructure systems.

This co-evolutionary approach of contemporary socio-technical research can be traced to the emergence of social-scientific approaches to technology studies. Initially, from the 1960s onwards, research was dominated by technological determinism, until the 1980s when social constructivism came to the fore. Today, the mutual interdependencies between society and technology, the "social shaping of technology" and the "technological shaping of society" (Wissen/Naumann 2008, 20), have become the key point of departure in the literature (cf. Hommels 2005a). Utilising the highly pertinent term the "seamless web", researchers have explored the dense networks so characteristic of socio-technological systems: of physical artefacts and technologies, organised and individual actors, institutional rules and norms, and cultural values and economic resources (cf. Summerton 1994, Star 1999). Drawing also on actor network-theory (section 4.3), this approach represents an important step towards overcoming the dichotomy between the material and the immaterial.

Those works offering an explanation for the vulnerability, robustness or adaptability of these socio-technical systems are of particular interest to research on vulnerability and resilience (cf. especially Moss 2009). Technology and environmental historians have long carried out research on the special path-dependencies of grid-bound infrastructure systems (cf. Hughes 1983, Melosi 2000). Their works provide valuable insights into historical processes of system formation, consolidation and adaptation as forms of achieving resilience. In doing so, they illustrate the close ties between the technical, social, cultural and institutional in such processes. These authors are primarily concerned with the initial development of today's large-scale technical systems and, to a lesser extent, their transformation in response to current developments.

This latter point has, however, been the focus of social-scientific studies on the liberalisation, privatisation and commercialisation of supply and disposal systems. This research understands socio-technical transitions as processes of "reconfiguration". According to this approach, an established configuration, the "seamless web" (see above) of a socio-technical system, is unravelled and subsequently reconfigured. Such processes may be understood as attempts to increase the infrastructure's resilience to novel requirements (or requirements which are perceived as such). This approach entails an examination of change and stability in relation to particular components of a socio-technical system. Of particular importance to us is the far-reaching research in the spatial sciences on this topic (cf. Graham/Marvin 2001, Guy et al.

2001, Moss et al. 2008). These works not only examine the spatial impacts of socio-technical change, but also, conversely, the effects of changing spatial structures upon infrastructure systems.

Another strand of research on socio-technical systems in transition reflects upon the interplay of technologies and institutions (cf. Bender 2007). This approach is strongly influenced by actor-centred institutionalism (ACI) and, on the one hand, attempts to understand how certain forms of governance (and change within them) shape the organisation of infrastructure systems (cf. Mayntz 1993). On the other hand, it assesses the ways in which new technologies can prompt the adaptation of existing institutions (cf. Dolata/Werle 2007). There is, however, only one emergent strand of research that directly refers to the issues of vulnerability and resilience in an explicit way. This "critical infrastructures" research emerged in response to recent public debates on the maintenance of infrastructures' performance in the event of natural disasters, accidents or terrorist attacks. The vulnerability and resilience of infrastructure systems is the explicit focus of this research (cf. Bundesministerium des Innern 2009, Hodson/Marvin 2008). In the absence of a theoretical footing, this approach is, however, dominated by highly technical readings of both concepts. Recent research, though, is opening this debate to more critical, reflexive perspectives (Graham 2010).

4.3. Against Dichotomisation: Actor-Network Theory

Actor-network theory (ANT) rejected the basic assumptions of all prior social-scientific approaches to materiality. It proposed a radical re-think and, in the process, developed a thoroughly novel concept of agency. For the purposes of advancing understanding in the fields of vulnerability and resilience, we see actor-network theory as a source of inspiration and worthy of detailed consideration. As is apparent in much of the recent literature (e.g. on socio-technical systems in transition), actor-network theory has had a considerable influence on a variety of relevant debates, particularly in terms of its relational and agency-oriented understanding of the social and other 'actors' (cf. Hommels 2005b; Coutard 2005). The insights offered on these subjects provide the particular focus of the following section.

His 2005 monograph, "Reassembling the Social", represents Bruno Latour's attempt to bring coherence to an analytical approach which had until then been characterised by diverse individual contributions (see e.g. Law 1986, 1992, 2002, Callon 1986, Latour 1987). In fairly polemical fashion he refers to all previous sociology as the "sociology of the social". In their efforts to establish a distinct academic discipline and research object, Latour states that sociologists adopted the stance that the social should be regarded as the defining feature of sociology's objects of research. From such a perspective, the world is divided into social phenomena (for which sociology feels responsible), and non-social phenomena (which fall into the remits of other disciplines). As Latour claims, this is why sociology either ignores material objects or sees them as being in opposition to social phenomena. Furthermore, it is why sociology is only able to think about interrelations and hybridities in the course of subsequent operations. This has resulted in a paradox. An academic discipline which emerged during an age characterised by the growing importance of technical artefacts has developed a blind-spot with regards to precisely those objects that have increasingly determined our everyday lives.

In opposition to this sociology of the social, Latour introduces what he calls the "sociology of associations". It implies that sociology should be concerned with the work required to a) form associations between entities or to b) alter existing associations. The social does not manifest itself as an isolated group of objects, but rather finds expression in the dynamics through which associations of all kind are formed. Social dynamics connect heterogeneous entities that may also be incommensurable (i.e. different in nature). Social relations are not,

then, exclusive to human beings. They are just as likely to occur between humans and machines and may find their expression in the interaction between entities.

Actor-network theory is primarily a theory of action. Agency is regarded as a dispersed competence. In contrast to classical approaches, actions are not simply an outcome of the interests, motivations, intentions and capabilities of actors. Instead, the realisation of actions is explained by exploring the points where an actor's dispositions meet the opportunities to act provided by concrete situations, contexts or constellations. In this sense agency, the ability to act, is not possessed by an individual person or intrinsic to a certain situation. Rather, it is "dispersed" across a network of relationships in a complex way. This network of relationships also comprises objects and artefacts, whose existence and availability may suggest, facilitate, promote or even provoke particular forms of action.

To the extent that objects participate in processes of action, actor-network theory even attributes agency to them. "Objects too have agency" (Latour 2005, 63ff). Prior sociological approaches showed little interest in material objects and, when so, treated these objects as neutral, passive entities subject to human creative will. In contrast, actor-network theory tries to grasp more precisely the role objects and artefacts play in actions, whilst assessing their impact upon these courses of action. Actor-network theory rejects explicitly the notion that there is a fundamental difference between social and material actants. The decisive question is always whether the presence of an object really makes a difference for a particular course of action. If the answer is yes, this means that the object actually participates in the action. Instead of unambiguous causal relations, most cases will yield loose, yet by no means arbitrary relations that reveal the ways in which objects either enable or impede, prevent or facilitate, or appear to encourage or obstruct certain actions. For example, a loaded pistol provides the opportunity to commit violent crimes; remote controls allow the viewer to flick through a number of channels without getting up from the sofa, etc.

Apart from its concern for agency, the actor-network approach is also characterised by the great importance it attributes to human knowledge. The "sociology of associations" approach did not emerge from a clear social scientific programme. It was rather a result of necessity, arising from the challenges of conducting a sociological analysis of the production of scientific knowledge and the observation of scientific practice in laboratories (cf. Latour/Woolgar 1979; Knorr Cetina 1981). Actor-network theory addressed the need for theoretical approaches to incorporate an understanding of knowledge and perception. As the literature has amply demonstrated, facts and truths do not exist independently. Rather, they are discovered by researchers. Indeed, scientific facts are to a large extent artificially produced by way of forming precarious, fragile associations. Actor-network theory views science as a form of heterogeneous engineering "in which bits and pieces from the social, the technical, the conceptual and the textual are fitted together, and so converted (or translated) into a set of equally heterogeneous scientific products" (Law 1992, 381). For example, we can describe a linguist's work as the production of associations related to the representation of actual speech acts (in the form of tape recordings, literary or journalistic texts, transcripts): drawing on passages from specialist publications, their own recordings or writings, inspiration from colleagues from within or outside the own institution, etc. (cf. Latour 2005). The insights thus produced will only be as reliable as the associations formed between these heterogeneous entities. In other words: the knowledge is stored within the network produced to generate it; in the associations between the heterogeneous elements.

Finally, actor-network theory formulates a constructivist approach. It is, however, fundamentally different to more common interpretations of "social construction" based on the assumption that social actors attribute meaning to objects and thereby construct their symbolic content. Here, this symbolic content remains extrinsic to these objects, and the act of attribution remains one-sided. Such a conception reinforces long-held dichotomies between nature and culture, the social and the material, subject and object. In actor-network theory, however,

the concept of construction emphasises that knowledge and action are produced; they emerge from generated or consciously modified associations between non-social entities.

Ultimately, the strength of this approach lies in its ability to overcome the dichotomies between culture and nature and the social and the material. This is achieved first through acknowledging the capacity of objects to participate in action and second by explicitly rejecting any fundamental divide between social and material things. Moreover, the approach is compatible with a constructivist perspective. It has even been labelled "radically constructivist", as it considers the connections created between incommensurable entities as central. Finally, it also offers a theory of human knowledge. However, actor-network theory is not primarily concerned with the key issues of spatial sciences, even if several successful applications in this field (cf. Mol/Law 1994, Murdoch 1998, Law/Mol 2001) have proven that such a transfer may be useful. Indeed, questions related to the global impacts of local associations and interactions (cf. Latour 1987, 2005) and the potential to influence 'action at a distance' (cf. Law 1986, Murdoch 1998) have become prominent research issues. One clear weakness is that this theoretical approach has yet to be utilised to conceive of vulnerability and resilience. The following section addresses this gap.

5. Vulnerability and Resilience from a Socio-Spatial Perspective – Towards a Social-Scientific Framework

Through summarising the benefits of the individual theoretical approaches examined (5.1), this section develops a definition of terms (5.2), which are then discussed in relation to the underlying understandings of time and space (5.3).

5.1 Conceptual Insights from the Literature Analysis

As discussed, one insight drawn from social-scientific discussions of risk and insecurity is that insecurity with regard to the implications of action should be understood as a characteristic experience in today's society. As such, it both precedes, and is implicit to, every kind of future-oriented action. Furthermore, with regard to the construction of vulnerability and resilience, we have made a distinction between different levels of analysis. In political and economic practice, both concepts have been applied in first-order observations. As such, they help systems to scrutinize their respective environments and provide findings for decision-making. For a critical social science approach, however, the level of second-order observation appears to be of most interest: this perspective allows for the construction of vulnerability and resilience within certain systems to be observed. Blind spots, which inevitably result from actions related to the production of security, become discernable. Moreover, it also reveals the potential side effects (new forms of vulnerability) that attempts to achieve resilience in one system may entail for another system. Most importantly, it has shown that these concepts run the risk of underestimating the material level in practices relevant to the construction of vulnerability and resilience (for example, system theory is exclusively interested in communication). Moreover, an explicit reference to the spatial dimension remains underdeveloped and, for the most part, has not even been considered.

The concept of sustainability may be more pragmatic and normative than theoretical or analytical. Nonetheless, it draws our attention directly to the issues neglected by concepts of risk and insecurity: the dimensions of time and space. The notion of sustainability illustrates the close inter-linkages between present action and action in a distant future, as well as local and global action, whilst managing to interconnect them. This perspective can be beneficially utilised for developing notions of resilience. In an attempt to advance the theoretical basis of

sustainability, a number of approaches trying to intertwine the concepts of sustainability and resilience have emerged within the academic literature. Such efforts do, however, presuppose the existence of a consistent theoretical understanding of the resilience concept, which is currently not in sight. This reveals that the concepts of sustainability and resilience require clarification in relation to each other.

The discussion of the different concepts of materiality and immateriality has yielded the following insights. First, it is important to note that neither an unreflective essentialist acceptance that materiality is simply 'out there' nor an equally one-sided emphasis on the social construction of threats will advance our understanding. While the former would imply a naturalisation of hazardous situations as well as ignorance towards the constructive capacities of humans, the latter is blind to the material aspects of vulnerability and resilience. Second, the variety of approaches viewing the relationship between nature and culture as hybrid in form present conceptual strategies to tackle the means through which these reciprocity emerges e.g. the notion of metabolism, the socio-ecological system, Urban Political Ecology, Action Setting, or structural coupling. Common to all these strategies is the assumption of an essential qualitative distinction between the two realms. Paradoxically, these attempts to understand the interdependency between the social and the material actually serve to intensify the separation between them and thus keep returning to the basic problem that they aimed to overcome. Finally, actor-network theory has introduced a new perspective on the materiality of social dynamics without maintaining the dichotomy between culture and nature, or material and social. Through understanding both objects and subjects as actants participating in social actions, it manages to eliminate the fundamental categorical distinction between the material and the social. Crucially, however, there remains the challenge of discovering the best ways of making use of actor-network theory in the conceptualisation of vulnerability and resilience.

5.2. Towards a Social-Scientific Conceptualisation of Vulnerability and Resilience

Vulnerability and resilience are concepts that can be re-interpreted on the basis of such a combination of social-scientific perspectives. As noted above, this paper aims to draw attention to the dimension of social construction, to the possibility of quite different or selective ways of seeing. At the same time, we want to better account for the aspects of materiality that are integral parts of action situations. By bringing these aims together, we can understand vulnerability and resilience as practices of construction and as processes that help to establish, reform or problematize associations of heterogeneous elements.

Accordingly, *vulnerability* is a concept that synthesises social practises in which any entity (be that a subject, a group, a technical or ecological system, or a territory) may take centre stage in the analysis. The underlying process of construction consists in locating the centrally placed entity in a relational arrangement with other entities. In doing so, the aim is to outline the damaging or compromising effects resulting from the interdependencies that come into view. All three core elements in this form of social practice, from the centrally placed entity itself, to its key relations with other entities, and the level at which its vulnerability is observed, are all far from natural. Instead, they are perceived selectively and linked in a causal fashion. For instance, in cases of individual vulnerability within the context of volatile labour markets, the actors concerned tend to move themselves to the centre of vulnerability assessments. Subsequently, they view their position with regard to potential employers, competitors, as well as existing or accessible social security benefits so as to assess the likelihood of their own unemployment occurring and the consequences thereof. In principle, both material objects and immaterial rules may be equally relevant constitutive elements in this construction process.

In contrast, *resilience* comprehends action in terms of calculations of vulnerability occurring within a relational arrangement. This kind of action aims to transform the relational arrangement in a way that will decrease (or, ideally, eliminate) the vulnerability of the key, or centrally placed, entity. In principle, the following forms of re-arrangement are possible:

- First, the centrally placed entity may alter *its own position within the relational arrangement*. In other words, it may distance itself from other entities and, in doing so, approach others. For example, in view of a perceived threat caused by flooding, a person may relocate her/ his household to a territory that is known to be less (or not at all) susceptible to flooding. Repositioning the central entity thus modifies the relational arrangement perceived as threatening.
- Second, it is possible to *alter entities that are part of the relational arrangement,* so that they cease to constitute a threat to the focal entity. This can, for example, be achieved by equipping washing machines with a water-stop system, by expanding the protective capacities of dikes by increasing their height, or by increasing the cover provided by an insurance policy.
- Third, it is possible to *remove elements from the relational arrangement* in order to eradicate a threatening situation e.g. by demolishing steep staircases or rusty bridges.
- Fourth, *elements may be added to the relational arrangement*. For instance, we can reduce a building's vulnerability to fire hazards by installing fire doors, emergency staircases, fire extinguishers, and smoke detectors. Similarly, taking out fire insurance adds an element to the relational arrangement and thereby changes vulnerability calculations.
- Fifth, *the form and/or the intensity of the relations with other elements in the arrangement can be altered*. For example, the realisation that our jobs are vulnerable may encourage us to increasingly look at old friends as strategic contacts and lead us to pay more attention to acquaintances.
- Finally, it is possible to *question and shift the level upon which we analyse vulnerability*. By doing this, already perceived elements may appear in a different light. Some will suddenly appear irrelevant, while other elements will come to the fore. To give an example: In their professional life, people will almost certainly attach less importance to income and status as soon as they find fulfilment in their work –the fulfilment itself will become perceived as the most important thing about working.

Attempts to create resilience are not usually confined to the transformation of single elements. Instead, they tend to be characterised by an attempt to combine several of the obvious lines of action (points 1 to 6 above). Through doing this, they bring very different entities into association with each other e.g. through physical/ structural modifications, the acquisition of an object, the strengthening of contact or taking out insurance (cf. Evers/Nowotny 1987).

Vulnerability and resilience also make reference to the issue of *governance*. Whenever individuals are capable of changing only a limited number of elements (that they deem important) on their own, questions of coordinating action and mobilising supporters will arise. In this context, vulnerability can be associated with proto-governance (Christmann 2010), i.e. the negotiation of threat scenarios and the communicative construction of vulnerabilities (What is the key entity? What are the relevant sources of danger and the protective mechanisms that can be mobilised?). In contrast, resilience has an affinity to classical governance concepts, which scrutinise coordinated action under conditions of distributed competence.

5.3 Vulnerability and Resilience and their Relation to Time and Space

A preliminary definition of terms can be drawn from combining social-scientific concepts on risk and insecurity with insights from actor-network theory that material and social entities should be treated symmetrically. Next, we will discuss the spatial and temporal dimensions of the proposed definitions.

If we understand calculations regarding vulnerability and constructions of resilience as a network of heterogeneous elements that associates non-social entities (cf. Latour), then it follows that a spatiality is inherent to the definition. Positioning in relational arrangements reflects both the positioning and the extension of the respective entities in physical space, their mobility or immobility and the spatial scope of their harmful or protective effects. For instance, threat assessments arising from a flood that is only just contained by dikes will implicitly or explicitly address

- the positioning of key entities in physical space (e.g. the positioning of households, dikes and coastlines);
- questions about the mobility of important entities (while an individual is able to move when a flood is expected in three days, the same is clearly not true of a house);
- the spatial range of relevant phenomena (what territories are threatened by flooding, and which ones are safe);
- the reach of effects (while a flood is first and foremost a local threat, the threat of epidemics afterwards may also span larger distances).

In other words, constructions of vulnerability and resilience create relational spaces. This allows social scientists to analyse such practices from a spatial perspective. The temporal dimension of these concepts is, meanwhile, construed in three ways:

First, time is an integral component of the relational arrangements of perceived threats. While positioning, extensions, or ranges, are spatial categories, their meaningfulness nonetheless depends on the temporal component. The term mobility describes the ability to move with respect to time scales; territories have a certain range, the meaning of which cannot be understood without referring to time scales; and a high or low degree of accessibility also always implies an event's possible proximity in time.

Second, we stated that vulnerability and resilience are constructs that help social systems or actors to act, to generate agency. It has to be emphasised here that this is always achieved in real time, i.e. during the course of action. In this way, relational arrangements are analysed and modified, while at the same time other actors are taking similar actions within the same context. Accordingly, constructs of resilience bear resemblance to what Rittel and Webber (1973) have referred to as "wicked problems". They have to prove themselves through real action, which also means under time pressure. They thus represent "One-Shot-Operations", in which each and every attempt matters and incurs consequences. If a new threat situation emerges from the avoidance of a preceding threat, this will necessitate new constructions of vulnerability and resilience.

Another trait of "wicked problems", which points to the historical situatedness of these constructs, is that it is impossible to provide a conclusive assessment as to whether they are right or wrong. The evaluation of both threats and adopted counter-measures often changes over time. For example, swine flu was viewed as highly threatening throughout 2010. Shortages of vaccines were feared despite the fact that infusions were produced as quickly as possible. However, when large amounts of vaccines were finally available, threat assessments had already changed and, as a result, huge amounts ultimately remained unused. The same resilience strategies that were criticised as insufficient were soon exposed to ridicule and labelled as panic-fuelled overreactions. Conversely, events with initially disastrous conse-

quences have, with hindsight, often been viewed as offering favourable opportunities for new developments.

6. Conclusion

This paper brings together the results a research programme which shed light on the concepts of vulnerability and resilience from a social science perspective, developing a better understanding of their spatio-temporal dimensions.

Going beyond existing approaches, we have also highlighted the processes of social construction inherent to vulnerability and resilience. This is of particular relevance as threats to, and opportunities for, achieving resilience are not necessarily perceived as such by potentially affected groups, even if there are clear indications. Actors may well develop diverse ways of perceiving potential hazards and the protective measures required, and this has consequences for coordinating action in governance processes. However, highlighting the significance of immaterial factors (such as different constructions of reality) should not be confused with a neglect of material factors. It is necessary to inter-link both realms.

We have also scrutinised a variety of conceptual approaches closely related to the fields of vulnerability and resilience. We have assessed the extent to which concepts related to risk and uncertainty and the paradigm of sustainability are antagonistic or compatible with the concepts of vulnerability and resilience. Further, we have asked to what extent they may offer useful insights for our own conceptualisations of these terms. We have dealt with concepts that bring together materiality and immateriality, nature and culture and which reflect upon the inter-relationships between humans and nature.

A key insight gained from our research is that no single social-scientific concept is multifaceted enough to effectively integrate notions of corporeality and materiality, cognition, experiences or knowledge, action and its consequences, space and time. As a result, we were compelled to draw together a variety of approaches. By combining them in a novel manner we were ultimately able to develop a new perspective on vulnerability and resilience and the practices of managing insecurities of action connected therewith.

As concepts of risk and vulnerability make clear, action under conditions of insecurity has to be regarded as a core principle of modern societies. Moreover, they encourage us to make a differentiation between first-order and second-order observations in our research on agency in contexts of insecurity. In doing so, second-order observation is of particular relevance, as it allows us to introduce a cogent, analytical and theoretical perspective on social constructions of vulnerability as well as resilience-targeted action.

The paradigm of sustainability shows a marked reference to space and combines it with a long-term time perspective. Moreover, recent literature has shown that the concepts of sustainability and resilience have already been closely linked and as such are difficult to separate.

The differing conceptions of the relations of materiality-immateriality or nature-culture have offered very different opportunities to create incentives for interconnecting features of knowledge, action and its consequences, space and, perhaps, also time. However, they are either one-sidedly geared to either materiality or immateriality, or they ultimately fail to overcome this duality, despite their best efforts. The social-scientific approach of actor-network theory might be able to make an important contribution here in four ways. First, it aims to provide a theory of action; second, it attempts to understand the functions and impacts of material objects and artefacts during courses of action; third, since it outlines a sociology of associations, it also allows for an integration of knowledge and perception in the analysis; finally, it formulates a constructivist perspective. Through these means, the actor-network approach may offer a suitable way of overcoming the dichotomy of materiality-immateriality.

Building on this range of insights it became possible to present novel social-scientific definitions of vulnerability and resilience, both of which addressed issues of space and time and moved beyond essentialist or purely social-constructivist assumptions. These new definitions should be seen as an attempt to develop upon and broaden existing approaches.

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