

Societal Aspects of Vulnerability to Natural Hazards

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Abstract To date, social vulnerability research has focused primarily on the individual and household levels, and on social institutions relevant to these two benchmarks. In this paper, a widening of the perspective of social vulnerability to natural hazards is proposed to include socio-structural aspects. For a number of reasons, the sociological system theory, which is inextricably linked with the name of Niklas Luhmann, is an obvious choice for this undertaking. Firstly, Luhmann developed a consistent social theoretical definition of risk, which has significantly influenced risk and hazard research in social science. Furthermore, the system theory provides a theory of society that claims to be able to cover all social levels and to describe all social phenomena. The system theory assumes that in modern society social systems are formed of communications. Therefore, in this paper the view is taken that a system-theoretical inspired concept of social vulnerability must also assess communication. First, this paper describes empirical observations about the vulnerability of social systems. This is achieved on the one hand through a categorisation of four forms of social vulnerability. On the other hand, it is based on examples of vulnerability to flood risks in selected social systems. Finally, consideration is given to a system-theoretical concept of social vulnerability that sees the sensitivity of a social system in each of the respective system structures. Vulnerabilities can only be observed for a particular social system, because the configuration of system structures differs from system to system. These fundamental considerations have to be further explored in

future work on a consistent social theoretical concept of vulnerability.

Keywords Social vulnerability · Risk · Society · System theory · Floods

Gesellschaftsstrukturelle Aspekte von Vulnerabilität gegenüber Naturrisiken

Zusammenfassung Die bisherige soziale Vulnerabilitätsforschung hat sich überwiegend auf das Individuum und die Haushaltsebene sowie auf für diese beiden sozialen Bezugsgrößen relevante Institutionen fokussiert. In diesem Beitrag wird eine Weitung der Perspektive sozialer Vulnerabilität gegenüber Naturrisiken um gesellschaftsstrukturelle Aspekte vorgeschlagen. Dazu bietet sich aus mehreren Gründen die sozialwissenschaftliche Systemtheorie, die untrennbar mit dem Namen Niklas Luhmann verknüpft ist, an. Zum einen entwickelte Luhmann eine konsequente sozialtheoretische Definition von Risiko, die maßgeblich die sozialwissenschaftliche Risiko- und Hazardforschung beeinflusst hat. Zum anderen bietet die Systemtheorie eine Gesellschaftstheorie an, die für sich selbst den Anspruch erhebt, alle sozialen Ebenen ebenso zu umfassen, wie sämtliche soziale Phänomene beschreiben zu können. Die Theorie sozialer Systeme geht davon aus, dass sich in der modernen Gesellschaft soziale Systeme aus Kommunikationen bilden. Daher wird in diesem Beitrag die Ansicht vertreten, dass eine systemtheoretisch inspirierte Konzeption von sozialer Vulnerabilität auch am Kommunikationsbegriff ansetzen muss. Dieser Beitrag beschreibt zunächst empirische Beobachtungen über die Vulnerabilität sozialer Systeme. Dies geschieht zum einen über eine Kategorisierung von vier Formen gesellschaftlicher Vulnerabilität.

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Zum anderen anhand von Beispielen zur sozialen Vulnerabilität ausgewählter Sozialsysteme (Funktionssysteme Politik und Wirtschaft sowie staatliche Organisationen) gegenüber Hochwasserrisiken. Am Ende werden Überlegungen für ein systemtheoretisches Vulnerabilitätskonzept erläutert, das die Anfälligkeit eines sozialen Systems in den jeweiligen Systemstrukturen sieht. Vulnerabilitäten können immer nur für ein bestimmtes soziales System beobachtet werden, da sich die jeweilige Ausgestaltung der Systemstrukturen von System zu System unterscheidet. Diese Überlegungen gilt es durch weitere Arbeiten zu einem konsistenten gesellschaftstheoretischen Vulnerabilitätskonzept zu präzisieren.

Schlüsselwörter Soziale Vulnerabilität · Risiko · Gesellschaftsstruktur · Systemtheorie · Hochwasser

1 Social Vulnerability

The significance of research on social vulnerability has greatly increased in the last two decades. There are two identifiable strands of research that have emerged in both conceptual and empirical work on social vulnerability: development research and risk and hazard research. In both cases many different approaches and concepts have been developed, some of which differ greatly from one another. Current research is thus characterised by a certain lack of clarity in terms of definitions and concepts (see Birkmann 2006a: 16), partly due to the differing contexts and academic disciplines in which they have emerged.¹

The concept of social vulnerability was initially developed within development research and, more specifically, as part of the concept of “famine crisis”. Such development policy approaches primarily aim to support the coping capacities of those affected or vulnerable (Bohle/Glade 2008: 101 f.). Social vulnerability is thus considered in relation to the exposure of individuals and households to shocks and stress (see Chambers 1989: 1). A distinction is drawn between external factors, that is the events and risks affecting a person or household from the outside (*exposure*), and internal factors that describe the coping capacities of an individual or household (*coping*) (see Bohle 2001).² In risk and hazard research the vulnerability approach was introduced mainly by Blaikie/Cannon/Davis et al. (1994). They define vulnerability in the context of natural hazards: “By ‘vulnerability’ we mean the characteristics of a person or group

and their situation that influence their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard (an extreme natural event or process)” (Blaikie/Cannon/Davis et al. 1994: 9). Within natural risk and hazard research this generated much interest for social vulnerability, although the geographical focus of the work is primarily, if not exclusively, on developing countries. This is not the place for a detailed overview of the further development of the concepts and various definitions of social vulnerability. Other good overviews are, however, available (see, for instance, Tapsell/McCarthy/Faulkner et al. 2010). The present paper aims to build upon the findings of vulnerability research and concentrates on societal vulnerability to natural hazards. The spatial focus of attention is on western societies where functional differentiation is most advanced.

This paper is concerned with extending the term “social vulnerability”. Both society and sub-spheres of society are vulnerable. While the majority of work on social vulnerability to date focuses on the level of the individual, groups and institutions, this paper is intended to direct attention towards society. In this context the assumption is made that society has an emergent character and cannot be adequately described using only observation of individuals, groups and institutions. This is equally valid for the investigation of societal vulnerability. To do this topic justice, a strict sociological and social scientific perspective must be taken, and the most comprehensive possible theory of society should guide the observation and description of societal vulnerability. In particular, individual natural hazards (floods, earthquakes, storms, volcanic eruptions, etc.) should not form the starting point of investigation, the focus is rather on conditions and characteristics of social—or better: societal—vulnerability that can be generalised. Section 2 establishes sociological system theory as an appropriate choice of social theory and briefly introduces a few of the fundamentals of the theory. In the course of this explanation it becomes clear that this understanding of a social theoretical version of the vulnerability concept puts social systems at the focus of the analysis.³ As there is as yet no comprehensive system-theoretical concept of vulnerability, observations of societal vulnerability are undertaken, and different forms of societal vulnerability outlined and investigated in further depth with the aid of selected empirical examples (Sect. 3). The paper concludes with an outlook in which consideration is given to a system theory concept of social vulnerability (Sect. 4).

¹ Other papers in this themed issue give an insight into different concepts of vulnerability and the terminology used.

² A focus on the individual and household levels can already be seen in these first concepts, a tendency reflected throughout later development of social vulnerability approaches and related empirical investigations using systems of indicators (see, e.g. Birkmann 2006b).

³ This paper is concerned solely with social vulnerability. To this end a systems theory perspective is taken that examines only social systems. This approach is not able to consider vulnerabilities of technical systems, for instance the stability of buildings or technical infrastructure systems.

2 Vulnerability and Social Structure

2.1 The Question of the Appropriate Social Theory

The scientific investigation of societal vulnerability clearly requires a social theoretical foundation. Without answering the question of what the “societal” in “societal vulnerability” is, a scientifically tenable concept cannot be developed. What is understood by the term society must first be clarified, before it is possible to tease out exactly where the vulnerability of this society and its elements lie. This paper refers to the sociological system theory of Luhmann, taking this underlying understanding of society as a starting point for investigation into the socio-structural aspects of vulnerability.

There are a number of reasons for choosing sociological system theory (see Mayer/Zehetmair/Pohl 2012). Firstly, this theory of society provides starting points for the investigation of risk and hazard. Indeed in the 1980s Luhmann himself examined the way in which society deals with ecological problems (Luhmann 1986; English translation: Luhmann 1989), turning a few years later to intensive consideration of the sociology of risk (Luhmann 1990; Luhmann 1991, English translation: Luhmann 1993c). In the following years system theory research into risk was further developed by other authors (e.g. Japp 1996; Japp 2000; Japp/Kusche 2008) and particularly applied to natural hazards (e.g. Weichselgartner 2002; Egner 2008; Danscheid 2010; Egner/Pott 2010; Zehetmair 2012; Pohl/Zehetmair/Mayer 2012). Furthermore, the system theory is a social theory that claims to be comprehensive and thus to be able to comment on all social phenomena. “In addition, the system theory understands itself as a non-exclusive and at the same time universal theory that is able to produce statements about all the objects of sociology, not excluding itself as a social system among others” (Kieserling 1999: 28). Light can thus be shed not only on the micro scale—already well-investigated by vulnerability research related to the household scale and individuals—but also on other types of social systems, such as organisations (economic organisations, state authorities, charitable organisations etc.) and societal subsystems like politics, the economy, science or education.⁴ The sociological system theory provides a set of tools with coherent terminology, concepts and theory that can be used to capture all social scales, to investigate

reciprocal relations and relationships and to observe societal developments. The social levels here do not emerge as socio-spatial levels, as is the case with research into social vulnerability such as that carried out by Schneiderbauer and Ehrlich (2006: 84) that differentiates between the levels of individual, household, administrative municipality, cultural region, and national and regional levels. The system differentiations rather emerge from the conception of society and always reveal their own distinctive structuring elements. Luhmann’s sociological system theory thus provides a promising social theoretical set of tools for investigating socio-structural aspects of social vulnerability.

2.2 Society, Social Systems and Environment in System Theory

A detailed presentation of the construction of sociological system theory is beyond the scope of this paper. However, several key assumptions of the theory are outlined here. The social system theory is inextricably linked to the German sociologist Luhmann, who developed the fundamentals of the theory in the 1970s, 1980s and 1990s (Luhmann 1984, English translation: Luhmann 1995b; Luhmann 1997). Social systems are not interactions defined by an observer (e.g. a researcher), rather they emerge through the succession of operations. The system is formed through connecting operations, at the same time thus delimiting itself from its environment. The environment of social systems is then not equivalent to the material world and “nature”. It is rather the case that everything that cannot be counted as belonging to a system itself is located in the environment of the system. According to Luhmann, communication is the specific form of operation of social systems. Social systems thus produce themselves through successive connecting communication operations. It follows that social systems are not defined by observers, for instance by scientists, risk managers or vulnerability researchers, but are the results of communications. Due to their self-referential character, social systems are operatively closed, which means no direct interactions or flows of material or information between the systems are possible. It is rather the case that the environment can only ever irritate but never determine a system, as the characteristic of system openness to the environment makes clear.

These short explanations are necessary in order to understand the relationship between the social system and the natural event (e.g. flooding, an earthquake or a volcano) that threatens the system. The possible natural event has no direct access to society other than in the form of destruction. Communication systems are indeed self-referential coherences that cannot be externally determined, however system theory recognises certain imperatives that are necessary for communication. In particular, material conditions and the biological life of individuals involved in the communication

⁴ The aspiration of systems theory to be a comprehensive theory of society does not, however, represent a claim to exclusivity. For many questions other social or societal theories are clearly more appropriate. However, especially when it is an issue of social interactions that should be observed in isolation from the individual level, system theory develops great explanatory strengths. The theory is thus particularly well suited for investigation of the question of socio-structural aspects of social vulnerability due to its great analytical selectivity.

are of especial relevance here (see Lippuner 2010). Thus an apocalyptic catastrophe that wiped out all human life on earth would of course also mean the end—the destruction—of society and all social systems. The achievement of communication is further dependent on material conditions, for instance on the functionality of technical mass media, information channels and infrastructures. A large scale electricity cut can thus bring multiple communicative interactions to a standstill—at least temporarily.⁵ These vulnerabilities located in the environment of society (biological life, cognition, the material world) do not, however, represent the primary field of social science research. Many of the relevant findings have already been made by other disciplines. Sociological and social-geographical observations of societal vulnerability is less interested in this destructive character than in the maintenance, transformation and adaption of the modes of operation of society and social systems at risk. Except for destruction, the environment can only irritate the system. Further processing of the irritation occurs exclusively within the system, following the mode of operation and logic of the system.

System theory sees society as being formed from communication operations. In the course of a continuing increase in complexity as social evolution progressed, a form of society developed that we today find most pronounced in the western world.⁶ Modern society is primarily a functionally differentiated society that in terms of modes of operation differs fundamentally from previous segmented and stratified societal forms. Modern society thereby differentiates itself according to functional aspects—like politics, economics and science—into so-called functional systems. The social systems of modern society are each located in the (social) environment and thus also elude direct influence and control (see Luhmann 1993b).

2.3 Initial Examination of the Relationship Between Risk and Vulnerability in System Theory

The concept of vulnerability has not yet been comprehensively and conclusively considered within the system-theoretical development of theory, unlike the concept of risk which is firmly integrated in its theoretical structure. The fact that risk is so integrated in this theory of society is one

aspect constituting the aforementioned appropriateness of system theory for the investigation of questions of societal vulnerability, and allows the concepts of risk and vulnerability to be linked. Luhmann's risk concept has had a permanent influence on risk and hazard research and has led to the broadening of research, as Weichselgartner (2002: 66) points out, "his works have connected risk research to social theory and thus given another turn to scientific risk discourse and new impulses to research".

According to Luhmann the term risk refers to a possible future event of damaging nature to which a decision is ascribed: "When then eventual damages are seen as the result of one's own decision and are ascribed to this decision, it is a issue of risk, no matter whether and with what notions of rationality risks have been offset by opportunities" (Luhmann 1991: 140). A danger, in contrast, is not based on one's own decision but on the decisions of others—or no decision can be attributed to it at all. Luhmann uses the umbrella to illustrate the distinction between risk and danger. "If there are umbrellas then it is no longer possible to live risk-free: the danger of getting wet in the rain becomes a risk that is run when the umbrella is left behind. But if one takes it along then one runs the risk of forgetting it somewhere" (Luhmann 1993a: 328). Applying this to the topic of natural hazard can lead to the following line of argument. A flood can, for instance, represent a threat to a municipality when the municipality has decided to designate in the land-use plan a development area where there is danger of flooding. These days most natural hazards can no longer be described as dangers, but must rather be termed risks. Knowledge about possible damaging events is available—naturally not for all those who may potentially be affected, but certainly for the public authorities making the decisions. The granting of a building permit in a flood-prone area, decisions about flood protection measures or the building of housing in an earthquake zone therefore become risks (see Zehetmair 2012: 86 ff.).

Risk thus describes a possible damaging event, e.g. an earthquake, a landslide or a flood to which a decision is ascribed. This does not yet say anything about the concrete possible damage that would be connected to the risk materialising. And the risk concept gives equally little information about which properties and conditions influence the materialisation of the risk and the extent of damage. Here the focus is on certain attributes of the social system that is threatened by the risk, that is, on its vulnerability. Social vulnerability therefore describes very generally the way in which the mode of operation of a social system is impaired by the materialisation of the risk, that is, by the actual occurrence of the earthquake, the landslide or the flood. In addition to the threatening of the system by self-created risks, social systems are also vulnerable to dangers that can be ascribed to the decisions of others. In the latter case the system finds

⁵ For instance the electricity cut in the German region Münsterland in 2005 (see Spangenberg 2011).

⁶ In developing countries the functional structures are still to varying extents overlaid by persisting societal structures (segmented and stratified structures) (see Luhmann 1997: 613). For an initial approach towards a system theory concept of vulnerability it seems reasonable to first direct observations towards societies where functional differentiation is most advanced. This does not, however, mean that further work will not also be able to investigate other societal formations using system-theoretical instruments.

itself in the position of the affected party, while the decision-making system and thus that which triggers the risk is to be seen as the perpetrator. First attempts to capture the concept of vulnerability from the perspective of system theory emphasise the significance of the dimensions of time, space and material as dimensions of meaning for communication related to social vulnerability (Weichselgartner/Deutsch 2002). In addition, the significance for social vulnerability of knowledge (internal to the system) is underlined (Weichselgartner 2006). In this paper the attempt is made to analyse in relation to social vulnerability, on the one hand, the peculiarities and commonalities of social structures and, on the other hand, specific system structures.

3 Society and Vulnerability

As a comprehensive system theory concept of vulnerability has not yet been developed, an inductive approach is used to describe societal vulnerability. This involves the empirical observation of societal vulnerability in order to then, in a further step, derive first conceptual reflections on a social-theoretical concept of vulnerability. The basis for this is provided by the initial examination of the societal vulnerability concept and therewith the question of the way in which the materialisation of a risk can impact on or indeed bring to a standstill the mode of operation and performance of a social system. This observation leads to the identification of four forms of societal vulnerability (Sect. 3.1). The last two forms are subsequently illustrated using selected examples (Sect. 3.2 and 3.3).

3.1 Forms of Societal Vulnerability

3.1.1 *Psychic-Biological Destruction of Communication*

“Only communication can communicate” (Luhmann 1995a: 113) is a key assumption of the system theory understanding of communication, and particularly conveys that it is not individuals, people or human beings who communicate. For system theory, communication forms social systems, people are however located in the environment of this communication system. This assumption of Luhmann is fundamental, at the same time it is not disputed that communication is dependent on cognition and biological life (see Lippuner 2010). It is rather the case that consciousness (also known as the “psychic system” in system theory) is linked to communication through structural coupling. Even if this coupling does not have a determining effect, the existence of consciousness and human life is existential for communication. Without human individuals and without consciousness communication is unthinkable. The first form of societal

vulnerability is related to this possibility: *If a disastrous natural event leads to people being killed and injured who then lose their spoken articulation or writing abilities, then communication is destroyed.*

3.1.2 *Technical-Material Destruction of Communication*

Communication uses various media for distribution. Language and writing are the most fundamental distribution media. The technological developments of modern society have additionally produced a series of further technical distribution media, all of which serve either the spoken or the written word: printing, telephone, radio, television, and the internet as the latest of these technical achievements. All these modern distribution media are dependent on material conditions for their functionality: printers need electricity, paper and newsprint to be able to print the daily paper; telephoning requires a functioning wiring system that also needs electricity; radio and television are dependent on media institutions in which the programme is produced, and on transmitters and receivers. Using the internet again requires electricity, as well as the appropriate equipment and a functioning phone line, wireless or satellite connection. These examples make clear that in most cases communication in modern society requires certain technical-material conditions for distribution media to function. The examples cited are also relevant to contemporary discussions about critical infrastructure, consideration of which is not possible here due to space constraints.⁷ *The possibility of the breakdown of these conditions can be described as the technical-material destruction of communication and represents the second form of societal vulnerability.*

3.1.3 *Endangerment of the Social System by the Social Environment*

Modern society is particularly characterised by its differentiation into numerous autopoietic systems on all system levels.⁸ These numerous social systems cannot, however, be integrated or controlled. While society as a whole is dependent on the functionality of all social systems, there is nonetheless no integrating central unit in modern society (see Willke 1983; Willke 1992).⁹ At the same time the indi-

⁷ See, for example, the German Federal Ministry of the Interior guidelines on protecting critical infrastructure: “Schutz Kritischer Infrastrukturen” (BMI 2011), that illustrate the political-administrative processing of the threat to relevant infrastructure networks.

⁸ Autopoiesis refers to the simultaneousness of operatively closed communicative interactions and openness of systems to the environment. The system is not, however, operatively accessible to its environment but can only be irritated by it (see, for example, Luhmann 1992: 28 f.).

⁹ This function cannot be fulfilled by politics. Although politics can communicate collectively binding decisions, it has no determining

vidual social systems are dependent on the performance of other social systems, that is, from their respective intra-societal environments. Thus it is not possible for any organisation, emergency response authority, hospital or school to cope without economic operations—barring very short periods of time. Employees must be paid and goods must be bought in order to remain functional. The delivery of food, aid and goods of any sort is dependent on functioning haulage companies and infrastructure management (streets, railways, airports and airway companies). The necessity of an operative electricity network has already been mentioned. Here economic organisations are also involved and provide services for almost all other social systems. *The third form of societal vulnerability thus describes the failure of societal services required by other systems, which can lead to the endangering of existence and thus may in some cases mean that communicative connections are no longer possible.* Thereby it is assumed that the endangerment perspective will affect the victim system, to which the decisions of the perpetrating system are ascribed.¹⁰

3.1.4 Internal Susceptibility of the Social System

Impairment of connecting communications can be caused not only by psychic-biological, technical-material destruction and the breakdown of the functionality of other systems in the social environment. *The fourth form of societal vulnerability describes the risk that system-internal issues lead to connecting communications being unable to occur, and that thus the operative mode and the ability of the system to perform are impaired.* If a social system is not prepared for the possible damage caused by severe flooding, an earthquake or a hurricane then this is, in the first instance, a risk for the system. Better preparations could have been made and appropriate catastrophe and risk management planning carried out. When a natural catastrophe leads to a situation where an emergency response authority can no longer deal with the catastrophe (e.g. the US FEMA¹¹ in the early phase of Hurricane Katrina with devastating consequences especially in New Orleans in August and September 2005), flood warnings fail to reach the right people in time and in some cases contradictory forecasts are made by state authorities

influence on other systems. The frequently discussed powerlessness of politics to influence economic developments, most recently in the context of the worldwide financial crisis, emphasises this. Politics can introduce laws to manage the financial markets. How the financial markets react to these and whether they have the intended effects is, however, outside the sphere of control of politics.

¹⁰ Even if situations can be envisioned where the affected system finds itself once again in the risk perspective, e.g. when the cheapest electricity supplier has been chosen in the knowledge that they practice poor risk management and often suffer electricity cuts.

¹¹ Federal Emergency Management Agency.

(as, for instance, during the August 2002 floods in Sachsen, Germany), then these are primarily system-internal risks that make the social system susceptible and thus vulnerable. In this way the system can be impaired in its own functionality. At the same time the failure or impairment of the system can endanger other social systems.

3.2 Vulnerability of Social Subsystems

Society is the comprehensive social system that is differentiated into numerous further social systems. According to Luhmann (1984: 14) a fundamental distinction can be made between three basic types of social system: society, organisation and interaction.¹² Each of these three types of social system possesses its own criteria and mechanisms for its mode of operation and for the demarcation of boundaries. For the investigation of the socio-structural aspects of vulnerability the first two system types seem to be of particular interest. Although interaction systems also demonstrate susceptibilities, the view is taken here that the system types society and organisation are of primary interest for a social theoretical investigation.

Modern society represents the most comprehensive social system, including all possible communications that can be connected. On the macro-level it is differentiated into subsystems, the so-called functional systems. Examples of these are politics, economy, science, religion, education, art and treatment of the ill. They are characterised by that fact that they each take on a specific function for the whole of society. Thus politics is responsible for making collectively binding decisions and the economy for regulating the problem of scarcity of goods and services. The functional systems create their internal structure through a specific code and in some cases through system-specific programmes. Through the code and programme the connectability of communications is determined. They decide whether a topic will be further pursued (i.e. further communicated) in the system or not. Table 1 shows several characteristics of the structures of the functional systems of politics and economy in relation to natural hazards.

In principle the functional systems are relatively stable and thus less vulnerable than other types of social system. However, the functional subsystems of modern society can be constrained in their functionality. Thus a large damaging

¹² Social networks are also a topic considered in current system theory discussions. The issue of whether networks represent a distinctive type of social system has not yet been fully clarified (see, for example, Teubner 1992; Tacke 2000; Bommers/Tacke 2006 and most recently the volume edited by Bommers/Tacke 2011). In many approaches to vulnerability the role played by inclusion in social networks when dealing with catastrophes is highlighted. Although this demonstrates the significance of networks for social vulnerability, the system theory frame for the vulnerability of networks cannot be discussed in the present context.

Table 1 Communication about natural hazards in politics and the economy. (Source: Author's compilation, elaborated from Mayer/Zehetmair/Pohl (2012))

| Functional system | Structuring element | General | Related to natural hazards |
|-------------------|----------------------|---|---|
| Politics | Function | Provision of the capacity to produce collectively binding decisions | Collectively binding decisions related to natural hazards (limit values, laws e.g. flooding acts, building standards for earthquakes and landslides) Politics is the addressee for demands and problems related to natural hazards (demands for compensation etc.) |
| | Code | Inferior position/superior position Government/opposition | Political communication about natural hazards is structured with reference to the code government/opposition (e.g. blaming, assigning responsibility) |
| | Programme | Elections and political programmes | Weighing up of communications about natural hazards in terms of the consequences for elections (e.g. media presentation of politicians in flooded areas, pledges of assistance) Natural hazards can be included in political programmes |
| | Communication medium | Power | Enforcing decisions related to natural hazards |
| Economy | Function | Overcoming the problem of scarcity | Allocation of goods and services to reduce risk and for other purposes |
| | Code | Property/no property Payment/non-payment | Payments and non-payments in relation to natural hazards, e.g. for technical protection measures, insurance, compensation, reconstruction |
| | Programme | Prices | Prices for risk-related goods and services (e.g. insurance premiums) |
| | Communication medium | Money | Money is needed for the transaction of payments for necessary goods and services |

event, such as a severe earthquake, can disrupt public order. This can then ultimately mean that politics can no longer enforce collectively binding decisions. In system theory terms it is then possible to speak of a crisis in the communicative medium of power. Looting and other criminal acts can be the consequence and are not unusual following natural disasters. Usually politics then attempts to restore public order through appropriate emergency decisions and the deployment of state authorities like the police or, where necessary, the military.

The functional system economy is responsible for dealing with the problem of scarcity. In order to be able to buy goods and services, payments must be made, which requires money. A scarcity of goods, including food in a disaster zone, is not in the first instance an indication of the vulnerability of the economic system. Through the price setting mechanism the economy reacts to the situation with a rise in prices. However, participation in the economic system requires an ability to pay. That is to say, without money and without the possibility of obtaining credit there is no ability to pay and thus no participation in the economic system is possible. This does not call into question the entire economic system though. It is rather the case that connectivity possibilities are reduced or are lost altogether, causing the system—measured by communication events—to shrink.

Overall the functional subsystems of modern society seem to show relatively little vulnerability, barring the psychic-biological (first form of societal vulnerability) and the technical-material (second form of societal vulnerability)

destruction of communication. They are very flexible in their mode of operation and are thus less vulnerable in their existence than, for instance, organisations.

3.3 Vulnerability of Organisations

In system theory organisations are seen as an independent type of social system (see Baecker 1999; Tacke 2001; Dreyer 2003; Luhmann 2006). Organisations are characterised particularly by the fact that they consist of members that are usually connected to the organisation by a contract of employment¹³ and that they communicate through decisions. Decisions are in this understanding a particular form of communication. There are many very different organisations that are of interest for the question of societal vulnerability to natural hazards. Thus state institutions such as emergency response authorities, spatial planning agencies, public water companies and ministries play just as important a role as the so-called blue-flashing light brigade (police, fire fighters, rescue services). However, private organisations—particularly those in the transport sector, in energy and water provision, and in the food trade but also other economic companies—are also susceptible to natural hazards. They are all necessary for everyday life (and thus for the

¹³ However organisational members are not necessarily employees. Associations, for example, are characterised by voluntary unpaid membership so that no contract of employment exists. Nonetheless with this form of membership there is also a formal act of joining that can in the same way be later dissolved.

fulfilment of basic needs) as well as for handling and managing a damaging event. Without a functioning state and, in part, private economic sector, it is not possible to cope with a crisis situation triggered by a natural risk. It follows that organisations play a key role in considerations of societal vulnerability due to a number of reasons:

- Organisations carry out risk management (they provide against risks, manage catastrophes and undertake the reconstruction process).
- Organisations are indispensable for everyday life (organisations ensure provision and sale of food, operate mass media, and carry out supply and disposal, etc.).
- Organisations provide employment through which employees receive their wages and are thus put in a position from which they can take part in economic payments.

Organisations pre-structure their operations and thus limit the possible room for manoeuvring of the organisation system. An organisation cannot concern itself with all societal themes and tasks, but must concentrate its work on one or several aspects. Organisations use so-called decision premises for the configuration of their mode of operation. Luhmann distinguishes here between communication channels (the internal organisation of the organisation), decision programmes (like laws, statutes, rules of procedure, regulations) and personnel assignment, which decides which specific person at which specific time is entrusted with which task (see Luhmann 2006: 222 ff.).

The configuration of the decision premises has a major influence on the vulnerability of organisations, as the example of state flood risk management is intended to illustrate. In the first place it is of decisive importance which concrete tasks (e.g. the drawing-up of flood protection concepts, the organisation and undertaking of flood forecasts and warnings, coordination and cooperation with other countries) the state takes on itself, how it anchors these tasks in its organisational structure and how many and which personnel are allocated to each task. Each state agency is responsible for certain tasks, other topics are not able to be connected within the organisation—indeed this is impossible because otherwise the complexity would overtax the system. Of course it is nonetheless possible that the state agencies assimilate irritations from the environment and assign themselves new tasks that are then consequently built into the decision premises of the organisation. For instance, demands regarding the improvement of flood risk management can be made on state authorities by members of the population or other organisations. How the organisation deals with these irritations from the environment and whether they can be connected to the decision premises internal to the organisation, is decided by the organisation system itself. Only then is decision-making communication deployed along the premises in the organisation.

Decision programmes of the German state flood administration are, for example: the EC Water Resources Act and the Federal State Water Acts (Wasserhaushaltsgesetz) for the water authorities; the Spatial Planning Act (Raumordnungsgesetz), the Federal Building Code (Baugesetzbuch) and the Federal State Spatial Planning Acts (Landesplanungsgesetze) for area related precautions; the laws on hazard prevention and a series of further norms relevant to flood risk management. In addition, treaties that regulate cooperation across national borders are to be viewed as decision programmes in the same way as the national flood protection concepts, regulations and administrative decrees. They all pre-structure the reaching of decisions in the organisation. The effects of decision programmes on vulnerability (in the sense of form 4) can be illustrated using the example of the flood alert service in Sachsen, Germany during the August 2002 floods. Numerous authorities were involved in collecting the water level data, producing the flood warnings and disseminating the warnings. The assessment of the flood situation was the responsibility of a total of four agencies (the Federal State Agency for the Environment and Geology [LfUG] and three national environment agencies). The dissemination of the water level data and warnings was carried out according to a strict hierarchical alert system (LfUG and national environment agencies → regional council → districts → municipalities). This chain of notification caused considerable delays so that “the emergency response authorities [were] regularly alerted by actual developments earlier than by the flood alert service” (Kirchbach/Franke/Biele 2002: 214 f.). The delays meant that no time margin remained in which preventative measures could be undertaken. The endangerment for those affected (individuals and social systems) could thus not be reduced. The organisational problems of the flood alert service during the Elbe floods of 2002 are also pointed out by, for example, Weichselgartner and Breviere (2011). After the flood the legal regulations for the flood alert service in Sachsen were fundamentally modified so that flood alerts and warnings are now produced in the newly established Federal State Flood Centre (Landeshochwasserzentrum) and disseminated directly to the affected districts and municipalities.

The *communication channels*, i.e. the internal structures of the organisation that are often illustrated using an organigramme, are also significant for the vulnerability of organisations. This can also be demonstrated using the example of Sachsen flood management. The so-called *Kirchbach-Report* (Kirchbach/Franke/Biele 2002), which summarises the conclusions of the independent commission that investigated the 2002 flooding disaster in Sachsen, criticises not only the legal basis of the flood notification and alert service but also the form of organisation of flood management. Fragmented areas of responsibility and the large number of authorities and organisational units repre-

sent the main problem of national flood risk management in Germany, as the German Committee for Disaster Prevention (DKKV) underlined shortly after the 2002 flooding of the Elbe in the much respected study *Hochwasservorsorge in Deutschland. Lernen aus der Katastrophe 2002 im Elbegebiet (Flood Risk Reduction in Germany. Lessons Learned from the 2002 Disaster in the Elbe Region)* (Grünewald/Kaltofen/Schümborg et al. 2004). They render state flood management vulnerable, create an immense need for agreement and coordination and often lead to enormous losses of time and energy that can have grave consequences for other social systems. After the flood disaster of 2002 the flood administration in Sachsen was completely restructured and a new central organisational unit in the form of the Federal State Flood Centre was created. Also problematic is when a specific task is scheduled in the decision programme but is not adequately (for instance through a dedicated position or unit) accommodated in the organisational structure. Thus even before 2002 the state capital Dresden, as a local water authority, was responsible for certain flood management tasks. There was, however, no unit scheduled with the tasks and no specialist personnel in the authority.

And this brings us to the third decision premise, *personnel assignment*. Through the hierarchical structure of the communication channels, the tasks of an organisation are divided between particular positions. These positions must be staffed by people. Here it is essential, firstly, that the units are actually staffed and are not left vacant owing to financial restrictions. Secondly, the specialist abilities of the staff also play a large role. Following the 2002 floods the city of Dresden was able to transfer a qualified specialist from another agency of the city authority to the local water authority and thus adequately staff the position.

A further example is provided by the Federal State Conservation Office in Sachsen. In the course of the flood disas-

ter very quick decisions had to be made about securing and in some cases also demolishing protected buildings, so as to avoid further damage. The Conservation Office was completely surprised by this task and had neither experience in flood issues nor suitable staff. This finding is of relevance to the general discussion about the significance of knowledge in the context of societal vulnerability (e.g. Weichselgartner 2006) and the issue of ignorance in organisational situations of flood management. Kuhlicke and Kruse (2009: 249 ff.) speak in this context of the way in which the 2002 flooding of the Elbe represented a “radical surprise”, particularly owing to the trust that had been placed in the “knowledge seen as valid” so that the extent and consequences of the devastating floods had been unimaginable for those involved. In the case of the Federal State Conservation Office quickly arranged trainings were used to compensate these weaknesses, at least in part (see Zehetmair 2012: 205 f.). These examples describe the vulnerability of organisations in several ways. First, specific organisations are created in order to render the (whole of) society less vulnerable, in that they practice risk mitigation and provide coping capacity in case of disasters. Second, all organisations are themselves vulnerable and, third, the impairment of performance or the failure of an organisation can threaten other social systems.

It should be borne in mind that every organisation shapes its own decision premises. Consequently, this also means that every nation, every federal state and every municipality sets its decision premises itself. This makes it clear that vulnerability can always only be determined system specifically. How different the configuration of decision programmes can turn out to be in different—formally similar—organisation systems, can be observed by referring to the flood relevant stipulations in the regional spatial plans of selected federal states (Table 2). No regional plan exhausts all the possibilities for flood mitigation, and at the same time there are

Table 2 Stipulations in the investigated regional plans. (Source: Zehetmair (2012: 181))

| State | Instrument | Effective | Textual stipulations on flood protection | | | | Stipulations in plans | |
|-------|--|-----------|--|--|--------------|------------------------------|-----------------------|----------------|
| | | | Protection of existing retention areas | Protection of additional retention areas | Reserve area | Preventative measures: dikes | Restricted areas | Priority areas |
| BB | Regional plan Prignitz-Oberhavel | 2000 (D) | A | | B | B | X | X |
| MV | Regional spatial development programme Westmecklenburg | 2009 (D) | A | A | (IC) | B | X | X |
| NW | Regional plan Köln (Cologne) | 2006 | A | A | (IC) | B | X | X |
| NI | Regional spatial planning programme Lüchow-Dannenberg | 2004 | A | A | A | A | | X |
| | Regional spatial planning programme Lüneburg | 2003 | A | A | A | A | | X |
| SC | Regional plan Oberes Elbtal/Osterzgebirge | 2009 | B, A | A | A | | X | X |
| ST | Regional development plan Altmark | 2005 | A | A | A | | | X |
| | Regional development plan Magdeburg | 2006 | B, A | B, A | A | A | | X |

Annotations: (D) Draft, B Basic principle according to the Spatial Planning Act, A Aim according to the Spatial Planning Act, (IC) Included as comment, X Stipulation as restricted area or priority area in place

clear differences in the depth of regulation in the regional plans. As a result it can be assumed that there is a tendency towards differing vulnerabilities that in turn have different possible effects on the vulnerability of other systems in their environment (third form of societal vulnerability).

4 Reflections on a System Theory Understanding of Vulnerability

The discussion thus far has provided insights into the vulnerability of social systems. To date no comprehensive system theory based vulnerability concept has been elaborated, this can also not be finalised within the framework of the present paper. The following, however, reflects on how a system theory understanding and a theoretical-conceptual version of societal vulnerability could appear.

Vulnerabilities refer to certain characteristics of the social system that is threatened by risk. How a social system is affected by the occurrence of the damaging event, how it can deal with it and whether it is at all impaired in terms of its ability to function—at least for a limited time—depends on the internal structure of the system. Social systems cannot handle all imaginable topics because then the advantage of system differentiation would lapse. It is rather the case that they have to limit themselves in terms of connectable operations, i.e. communications. To describe this self-limitation the term structure is introduced, because a “structure, whatever else it may be, exists then in the *limitation of those relations allowed in the system*” (Luhmann 1984: 384¹⁴). Structures thus stipulate the communicative connection possibilities within a social system. Going to the building authorities with an application for social benefits will have little success beyond being directed towards the responsible agency. In social systems that produce themselves from communications, structures manifest themselves in expectations, specifically in expectation of subsequent connecting communication. Luhmann goes even further, concluding his discussions with the proposition “that structures of social systems exist in expectations, that they are *expectation structures* and that for social systems there are *no other possibilities to create structure* because they temporalise their elements as action events. This means: structures exist only as present ones; they act through time only in the temporal horizon of the present” (Luhmann 1984: 398 f.¹⁵). Structures are thus not fixed for all time; instead they are valid only in the present and can change in the future.¹⁶ System

structures therefore make connecting communications more probable (when they follow the structures) or they exclude them (when they are not envisioned in the system structures). In this respect they reduce the complexity of the social system but at the same time make it better able to perform and function. The vulnerability of social systems manifests itself in the structures.

A system-theoretical description of societal vulnerability focuses on communications and thus on social systems. A first approach to a system-theory concept of vulnerability describes the endangerment to the continued existence of a social system. As social systems form through communicative interactions in which communication connects to communication, the failure of connecting communications to materialise leads to the autopoietic communication interactions coming to a standstill and so to the end of the social system. The threat can stem from a destructive force from the environment of the social system (psychic-biological or technical-material destruction) or the social system can demonstrate internal susceptibilities that emerge from the structures that have been operatively formed in the system (expectations of expectations).

5 Conclusion

The analysis and empirical investigation of socio-structural aspects of social vulnerability requires a theoretical basis. For the array of reasons discussed above, the sociological system theory is appropriate here. In addition to the comprehensively discussed level of individuals, households and groups introduced in systems of indicators in vulnerability analysis, it offers the further advantage that all other types of social systems (especially organisations and functional subsystems) can be included in the definition of social vulnerability. Thereby the system structures have a decisive influence on societal vulnerability. It is thus possible to present an initial examination of a system theory concept of vulnerability that should be deepened in further work.

The sociological system theory has most explanatory capacity for modern, western societies where functional differentiation has developed to a large degree. Although thanks to its theoretical basis, system theory can in principle also address segmented and stratified societies, added value is found especially in the analysis of modern functionally differentiated societies. For this reason the main area of application will tend not to be development research and the investigation of social vulnerabilities in developing countries, more appropriate is rather the vulnerability of

¹⁴ Emphasis in original.

¹⁵ Emphasis in original.

¹⁶ Structures are thus subject to social evolution, whereby structural changes do not proceed in a goal-oriented manner and are not controlled, but are subservient to a social evolution that is conceptually

based on neo-Darwinism (variation, selection and restabilising) (see Luhmann 1997: 413 ff.). On structures and their evolutionary changes in the context of natural hazards see, for instance, Zehetmair (2009).

societal structures in modern western societies. The examples discussed show how the structures may be empirically assessed, which consequences then emerge and which conclusions can be drawn for politics and science. The theoretical rejection of social systems being controllable does not mean that social systems are unchangeable. On the contrary, the configuration of the structures—and thus also the vulnerability of social systems—is subject to continuous evolution. This is, however, implemented only through the system, that is through an organisation or a social subsystem, itself. The systems can be irritated from the outside¹⁷, how this is actually dealt with, heeded and filled with life within the system is, however, not determinable.

The system theory perspective offers several insights for the issue of societal vulnerability to natural hazards. If social vulnerability to flooding, mass movements or storms is considered in terms of social theory, then the observer perspective takes on a key role. Vulnerabilities are then always dependent on the context of the individual system and the specific system structures. Every social system moulds its structures from within and therefore no one system parallels another. For the management of natural hazards this approach offers the possibility to understand social systems and their specific structural vulnerabilities and to work towards structural changes. As management of the entire system and direct intervention is not possible, the willingness of the affected social systems is required, no matter whether they are state agencies responsible for flood management, economic organisations, agricultural businesses or other relevant systems. At the same time the overall societal context must not be forgotten, because vulnerability to natural hazards is only one challenge facing a society. Social systems also have to deal with many other endangerments both internal and external to the system—and the evaluation is once again carried out by the systems themselves.

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¹⁷ For example, by the requirement to introduce risk management in organisations, as is currently in preparation with the DIN ISO 31000 norm (see Brühwiler 2009).

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