Measuring vulnerability to promote disaster-resilient societies: Conceptual frameworks and definitions

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Introduction

This chapter stresses the need for a paradigm shift from quantification and analysis of the hazard to the identification, assessment and ranking of vulnerabilities. It underlines the importance of measuring vulnerability and developing indicators to reduce risk and the vulnerability of societies at risk, as mentioned in the final document of the 2005 World Conference on Disaster Reduction. Different conceptual frameworks of vulnerability in the context of disaster resilience are presented. The links between vulnerability and sustainable development are also discussed.

From hazard analysis to assessment of vulnerability

The ability to measure vulnerability is increasingly being seen as a key step towards effective risk reduction and the promotion of a culture of disaster resilience. In the light of increasing frequency of disasters and continuing environmental degradation, measuring vulnerability is a crucial task if science is to help support the transition to a more sustainable world (Kasperson et al., 2005).

UN Secretary-General Kofi Annan has underlined the fact that hazards only become disasters when people’s lives and livelihoods are swept away (Annan, 2003). His view is in contrast to research and strategies in the past, which were often purely hazard-oriented (Lewis, 1999).
Instead of defining disasters primarily as physical occurrences, requiring largely technological solutions, disasters are better viewed as a result of the complex interaction between a potentially damaging physical event (e.g. floods, droughts, fire, earthquakes and storms) and the vulnerability of a society, its infrastructure, economy and environment, which are determined by human behaviour. Viewed in this light, natural disasters can and should be understood as “un-natural disasters” (Cardona, 1993; van Ginkel, 2005). Thus the promotion of disaster-resilient societies requires a paradigm shift away from the primary focus on natural hazards and their quantification towards the identification, assessment and ranking of various vulnerabilities (Maskrey, 1993; Lavell, 1996; Bogardi and Birkmann, 2004). It is part of UNU-EHS’s mission to contribute to the identification of various vulnerabilities and the development and testing of relevant indicators and assessment tools (Birkmann, 2005) in order to expand the environmental dimension of human security further (Brauch, 2005).

In the final document of the World Conference on Disaster Reduction, “Hyogo Framework for Action 2005–2015”, the international community underlined the need to promote strategic and systematic approaches to reducing vulnerabilities and risks to hazards (United Nations (UN), 2005, preamble). The declaration points out that:

The starting point for reducing disaster risk and for promoting a culture of disaster resilience lies in the knowledge of the hazards and the physical, social, economic and environmental vulnerabilities to disasters that most societies face, and of the ways in which hazards and vulnerabilities are changing in the short and long term, followed by action taken on the basis of that knowledge. (UN, 2005)

In this context the Hyogo Framework stresses the need to develop indicators of vulnerability as a “key activity”:

Develop systems of indicators of disaster risk and vulnerability at national and sub-national scales that will enable decision-makers to assess the impact of disasters on social, economic and environmental conditions and disseminate the results to decision makers, the public and populations at risk. (UN, 2005)

Although the international community does not formulate guidelines on how to develop indicators or indicator systems to assess vulnerability, the Hyogo Framework for Action underlines the fact that impacts of disasters on (1) social, (2) economic, and (3) environmental conditions should be examined through such indicators. Since sustainable development is characterised by three pillars – social, economic and environmental (UN, 1993; WCED, 1987) – the formulation used in the Hyogo Framework for
Action can be interpreted as implying a link between vulnerability assessment and sustainable development. Moreover, the declaration underlines the necessity to develop methods and indicators which, based on those recommendations, can be used in policy and decision-making processes. Furthermore, it is evident that measuring vulnerability requires, first and foremost, a clear understanding and definition of the concept of vulnerability.

Definitions

The current literature encompasses more than 25 different definitions, concepts and methods to systematise vulnerability (for example, Chambers, 1989; Bohle 2001, Wisner et al., 2004; Downing et al., 2006; UN/ISDR, 2004: 16; Pelling, 2003: 5; Luers, 2005: 215; Green, 2004: 323; UN-Habitat, 2003: 151; Schneiderbauer and Ehrlich, 2004; van Dillen, 2004: 9; Turner et al., 2003: 8074; Cardona, 2004b: 37). The website of the ProVention Consortium includes about 20 manuals and different guidebooks on how to estimate vulnerability and risk (ProVention Consortium website). These manuals also include different definitions and various conceptual frameworks of vulnerability.

Although vulnerability has to be viewed in its multifaceted nature (Bohle, 2002a, 2002b), the different definitions and approaches show it is not clear just what “vulnerability” stands for as a scientific concept (Bogardi and Birkmann, 2004: 76). We are still dealing with a paradox: we aim to measure vulnerability, yet we cannot define it precisely. Although there is no universal definition of vulnerability, various disciplines have developed their own definitions and pre-analytic visions of what vulnerability means. An overview of different definitions is given by Thywissen in this book, and can also be studied for example in Schneiderbauer and Ehrlich (2004), Green (2004) and Cardona et al. (2003). Nevertheless, it is useful to give a brief introduction of the terms vulnerability, hazard, risk and coping capacity in order to discuss different concepts of how to systematise vulnerability.

Vulnerability

Vulnerability is a concept that evolved out of the social sciences and was introduced as a response to the purely hazard-oriented perception of disaster risk in the 1970s (Schneiderbauer and Ehrlich, 2004: 13). Since the 1980s, the dominance of hazard-oriented prediction strategies based on technical interventions has been increasingly challenged by the alternative paradigm of using vulnerability as the starting point for risk reduc-
tion. This approach combines the susceptibility of people and communities exposed with their social, economic and cultural abilities to cope with the damage that could occur (Hilhorst and Bankoff, 2004: 2). Additionally, some authors distinguish between social vulnerability on the one hand, which deals with the susceptibility of humans and the conditions necessary for their survival and adaptation, and biophysical vulnerability on the other (WBGU, 2005: 33). Biophysical vulnerability in this context is a concept developed from global environmental change research, where it is widely used to describe the extent to which a system is vulnerable to adverse effects of climate change and to what extent it is (un-)able to adapt to such impacts (see in detail WBGU, 2005: 33). Although there is still much uncertainty about what the term vulnerability covers, Cardona (2004b) underlines the fact that the concept of vulnerability helped to clarify the concepts of risk and disaster. He views vulnerability as an intrinsic predisposition to be affected by or to be susceptible to damage; that means vulnerability represents the system or the community’s physical, economic, social or political susceptibility to damage as the result of a hazardous event of natural or anthropogenic origin (Cardona, 2004: 37–51).

One of the best-known definitions was formulated by the International Strategy for Disaster Reduction (UN/ISDR), which defines vulnerability as:

The conditions determined by physical, social, economic and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards. (UN/ISDR, 2004)

In contrast, the United National Development Programme (UNDP) defines vulnerability as:

a human condition or process resulting from physical, social, economic and environmental factors, which determine the likelihood and scale of damage from the impact of a given hazard. (UNDP, 2004: 11)

While the definition of vulnerability used by the ISDR encompasses various conditions that have an impact on the susceptibility of a community, the UNDP definition understands vulnerability as a human condition or process. The human-centred definition used by UNDP affects the method used to calculate its Disaster Risk Index, especially with regard to the calculation of relative vulnerability (UNDP, 2004: 32). The Disaster Risk Index measures the relative vulnerability of a country to a given hazard by dividing the number of people killed by the number of people exposed (see Peduzzi, Chapter 8; Pelling, Chapter 7). Using people killed
divided by people exposed as the indicator to measure relative vulner-
ability corresponds with the understanding that vulnerability is primarily
a human condition. Furthermore, the lack of appropriate data at the
global level has restricted UNDP’s opportunities to establish a broader
index. Although one has to take into account that human society is the
main focus of concepts of vulnerability, a fundamental question has to
be clarified: can human vulnerability be adequately characterised without
considering simultaneously the vulnerability of the “surrounding” eco-
sphere? (e.g. Turner et al., 2003).

Furthermore, other authors, such as Vogel and O’Brien (2004: 4) stress
the fact that vulnerability is:

- **multi-dimensional and differential** (varies across physical space and
  among and within social groups)
- **scale dependent** (with regard to time, space and units of analysis such as
  individual, household, region, system)
- **dynamic** (the characteristics and driving forces of vulnerability change
  over time).

Regarding the concept of social vulnerability, Cannon et al. (2003: 5)
argue that social vulnerability is much more than the likelihood of build-
ings collapsing and infrastructure being damaged. They describe social
vulnerability as a set of characteristics that includes a person’s:

- initial well-being (nutritional status, physical and mental health)
- livelihood and resilience (assets and capitals, income and qualifications)
- self-protection (capability and willingness to build a safe home, use a
  safe site)
- social protection (preparedness and mitigation measures)
- social and political networks and institutions (social capital, institu-
tional environment and the like).

The definition by Cannon et al. (2003) reflects the fact that vulnerability
is only partially determined by the type of hazard; it is mainly driven by
precarious livelihoods, the degree of self-protection or social protection,
qualifications and institutional settings that define the overall context in
which a person or a community experiences and responds to the negative
impact of a hazardous event (Cannon et al., 2003: 5). However, the con-
cept of social vulnerability also lacks a common definition, which means
that different authors use it differently. Current literature reveals the fact
that social vulnerability can encompass various aspects and features,
which are linked to socially created vulnerabilities. Therefore, the con-
cept of social vulnerability is not limited to social fragilities, but rather in-
cludes topics such as social inequalities regarding income, age or gender,
as well as characteristics of communities and the built environment, such
as the level of urbanisation, growth rates and economic vitality (Cutter et
al., 2003: 243). Downing et al. (2006) define six attributes to characterise
social vulnerability based on the experiences of over two decades of research on this topic. They emphasise that social vulnerability is:

- the differential exposure to stresses experienced or anticipated by the different units exposed
- a dynamic process
- rooted in the actions and multiple attributes of human actors
- often determined by social networks in social, economic, political and environmental interactions
- manifested simultaneously on more than one scale
- influenced and driven by multiple stresses.

Consequently, the concept of social vulnerability refers to more than socio-economic impacts, since it can also encompass features of potential physical damage in the built environment (Cutter et al., 2003: 243). Other experts such as Carreño et al. (2005a and 2005b) clearly distinguish between socio-economic fragilities and lack of resilience as social context conditions (that favour the second order impacts) on the one hand, and the physical damage caused by exposure and physical susceptibility of the built environment on the other hand (related to first-order impacts) (Cardona, 1999 and 2001; Cardona and Hurtado, 2000a, 2000b, 2000c; Cardona and Barbat, 2000; Carreño et al., 2004, 2005a, 2005b).

Downing et al. (2006) underline the fact that the concept of social vulnerability encompasses various vulnerability features, which are driven by multiple stresses and differential exposure, and are often rooted in multiple attributes of human actors and social networks.

One has to conclude that the concept of social vulnerability is much more broadly used than just for the estimation of traditional social aspects of vulnerability (gender, age and income distribution). Seen from the perspective of the social vulnerability school of thinking, “social vulnerability” can also encompass economic and physical aspects, provided they are the expressions of a socially constructed vulnerability. Although the conceptual classification of vulnerability differs, for example between Cutter et al. (2003) and Carreño et al. (2005a and 2005b), both schools of thinking underline the fact that vulnerability should not be limited to an estimation of the direct impacts of a hazardous event. Rather, it has to be seen as the estimation of the wider environment and social circumstances, thus enabling people and communities to cope with the impact of hazardous events or, conversely, limiting their ability to resist the negative impact of the hazardous event. This underlines the fact that vulnerability can also take into account the coping capacity and resilience of the potentially affected society. However, it important to acknowledge that also the analysis of damage patterns can contribute to the identification of revealed vulnerabilities as well as to the estimation of current and potential vulnerabilities in the future. Therefore, the challenge lies in devel-
oping a balanced approach between the general context and the macro indicators, on one side, and more precise and specific indicators on the other, which can also be based on revealed vulnerabilities in the past.

**Coping capacity**

According to ISDR, coping capacity can be defined as:

a combination of all strengths and resources available within a community or organization that can reduce the level of risk, or the effects of a disaster. (UN/ISDR, 2002)

Vulnerability and coping capacity manifest themselves once a vulnerable community is exposed to a hazardous event. In this context hazard is understood as:

A potentially damaging physical event, phenomenon and/or human activity, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. (UN/ISDR, 2002)

Compared to the terms hazard and vulnerability, the term risk can be described as the product of the interaction between hazard and vulnerability.

In risk sciences the term risk encompasses the probability and the amount of harmful consequences or expected losses resulting from interactions between natural or human induced hazards and vulnerable conditions. (UN/ISDR, 2002)

Moreover, the term resilience gained high recognition in the Hyogo Framework and the debate thereafter. The current literature reveals different interpretations of the term, especially concerning the question of whether resilience is defined as the capacity to absorb disturbances or shocks, and is thus more linked to the understanding of resistance, or whether the term refers to the regenerative abilities of a social or an ecosystem, encompassing the ability to learn and adapt to incremental changes and sudden shocks while maintaining its major functions. This meaning relates more to the coping and adaptation phase (see e.g. Adger et al., 2005: 1036; Allenby and Fink, 2005: 1034). In some cases resilience is also understood as the opposite of vulnerability (Adger et al., 2005), while others view vulnerability as the opposite and lack of human security (Bogardi and Brauch, 2005). Generally, a common ground can be seen in the understanding that resilience describes the capability of a system to maintain its basic functions and structures in a time of shocks and
perturbations and can continue to deliver resources and ecosystem services that are essential for human livelihoods (Adger et al., 2005; Allenby and Fink, 2005). This definition of resilience also implies that the respective system or unit is able to adapt and learn, meaning that the system – e.g. social system, ecosystem or coupled human–environmental system – can mobilise sufficient self-organisation to maintain essential structures and processes within a coping or adaptation process.

What have we learned so far? Preliminary observations

The overview of key-terms associated with vulnerability and risk has revealed that although the concept of vulnerability has achieved a high degree of recognition in different fields, such as disaster management, environmental change research and development studies, the concept is still somewhat fuzzy and often used with differing connotations. In this context it might be misleading to try to establish a universal definition. Therefore the author provides an overview of the different spheres of the concept of vulnerability (Figure 1.1), without intending to be comprehensive.

Nearly all concepts of vulnerability view it as an “internal side of risk”, closely linked with the discussion of vulnerability as an intrinsic characteristic of a system or element at risk. That means the conditions of the exposed element or community (susceptibility) at risk are seen as core characteristics of vulnerability (UN/ISDR, 2004; Cardona, 2004a/b: 37; Wisner, 2002: 12/7; Thywissen, in this book) and this can be defined as a common ground (the inner circle in Figure 1.1). Interestingly, the understanding that vulnerability is seen as an internal side of risk and as an intrinsic characteristic of an element at risk can be applied for very different elements, such as communities and social groups (socio-economic conditions, institutional framework), structures and physical characteristics of buildings and lifelines (physical structure), as well as eco-systems and environmental functions and services (ecosystem, environmental capital).

An extension of this definition can be seen in definitions such as Wisner’s (2002), which defines vulnerability as the likelihood of injury, death, loss and disruption of livelihood in an extreme event, and/or unusual difficulties in recovering from negative impacts of hazardous events – primarily related to people (Wisner, 2002: 12/7). This definition underlines the fact that the main elements of vulnerability are those conditions that increase and determine the likelihood of injury, death, loss and disruption of livelihood of human beings. Thus a second sphere can be associated with this human-centred definition of the likelihood of death, injury and loss (Figure 1.1).
Furthermore, the “likelihood of injury” is extended by the focus of a dualistic structure of vulnerability, which can be observed in the definitions by Wisner (2002) and also partially by Chambers (1989) and Bohle (2001). Wisner clearly identifies the “likelihood of injury” and “unusual difficulties in recovering” from such events as the key features of vulnerability. This means the concept of vulnerability is widened by viewing vulnerability as implying a dualistic approach of susceptibility on the one hand and the unusual difficulties in coping and recovering on the other. However, Bohle’s double structure of vulnerability (Figure 1.1) is not just “exposure” and “coping”; rather, it refers to vulnerability features which are external to an exposed element or unit at risk and those factors that are internal. The distinction between these two spheres “external exposure” and “internal coping” emphasises that vulnerability deals on the one hand with features and characteristics linked to capaci-
ties to anticipate and cope with the impact of a hazard, and on the other, with the exposure to risks and shocks (Bohle, 2001). In this context a third sphere can be associated with the “dualistic structure of vulnerability”, which underlines the fact that vulnerability is shaped and determined by the likelihood of injury (susceptibility, negative definition) and by the ability and capacity to cope with (positive definition) and recover from these stresses and negative impacts of the hazardous event (Wisner, 2002: 12–17).

An additional extension of the concept of vulnerability can be seen in the shift from a double structure to a multi-structure. The conceptual framework of Bohle (2001) already stresses the fact that vulnerability is a multifaceted concept, and also the discourse of vulnerability within the climate change and sustainability community (Turner et al., 2003) highlights that vulnerability not only captures susceptibility and coping capacity, but also adaptive capacity, exposure and the interaction with perturbations and stresses. This implies a fourth sphere (Figure 1.1) widening the concept of vulnerability to a multi-structure that encompasses exposure, sensitivity, susceptibility, coping capacity, adaptation and response.

While the traditional engineering perspective of vulnerability focused primarily on physical aspects, the current debate regarding vulnerability clearly underlines the necessity to take into account various themes and parameters that shape and drive vulnerability (UN/ISDR, 2004), such as physical, economic, social, environmental and institutional characteristics. Some approaches also stress the necessity to integrate additional global drivers that have an impact on vulnerability, such as globalisation and climate change (Vogel and O’Brien 2004: 3; O’Brien and Leichenko, 2000). This implies that the focus of attention has shifted from a primarily physical structure analysis to a broad interdisciplinary analysis of the multidimensional concept of vulnerability (e.g. Cardona, 2004b: 39–49).

The widening of the concept of vulnerability is illustrated in Figure 1.1. It shows that starting from a general basic understanding (first inner sphere), a process of broadening took place and this is shown through the arrow in the figure.

The different spheres of the concept of vulnerability are also reflected in the various conceptual frameworks to systematise vulnerability. Selected conceptual frameworks will be discussed in the following pages.

Conceptual frameworks of vulnerability

The different views on vulnerability are reflected in various analytical concepts and models of how to systematise it. Since these conceptual models are an essential step towards the development of methods mea-
suring vulnerability and the systematic identification of relevant indicators (Downing, 2004: 19), the following paragraphs give an insight into different conceptual frameworks, such as the double structure of vulnerability as defined by Bohle, selected approaches of the disaster risk community, such as the UN/ISDR framework for disaster risk reduction, and lastly the two conceptual frameworks developed by UNU-EHS.

The double structure of vulnerability

According to Bohle (2001), vulnerability can be seen as having an external and an internal side. The internal side, coping, relates to the capacity to anticipate, cope with, resist and recover from the impact of a hazard; in contrast, the external side involves exposure to risks and shocks. In social sciences the distinction between the exposure to external threats and the ability to cope with them is often used to underline the double structure of vulnerability (van Dillen, 2004). Based on the perspective of social geography and the intensive famine research carried out by Bohle (2001: 119), the pre-analytic vision of the double structure underlines the fact that vulnerability is the result of interaction between exposure to external stressors and the coping capacity of the affected household, group or society. Thus the definition clearly identifies vulnerability as a potentially detrimental social response to external events and changes such as environmental change. Interestingly, Bohle’s conceptual framework describes exposure to hazards and shocks as a key component of vulnerability itself.

Viewed in this way, the term exposure goes beyond mere spatial exposure since it also encompasses features related to the entitlement theory and human ecology perspective. Within the debate of social vulnerability the term exposure also deals with social and institutional features, meaning processes that increase defencelessness and lead to greater danger, such as exclusion from social networks. These alter the exposure of a person or a household to risk (Cannon et al., 2003). Moreover, the conceptual framework of the double structure indicates that vulnerability cannot adequately be characterised without simultaneously considering coping and response capacity, defined here as the internal side of vulnerability.

The sustainable livelihood framework

The ‘sustainable livelihood framework’ can also be seen as a framework or vade-mecum for vulnerability assessment. Key elements of this approach are the five livelihood assets or capitals (human, natural, financial, social and physical capital), the ‘vulnerability context’ viewed as shocks, trends and seasonality, and the influence of transforming struc-
tures for the livelihood strategies and their outcomes (see in detail DIFID (1999) and Figure 1.3).

The sustainable livelihood framework encompasses two major terms, sustainability and livelihoods. The original concept developed by Chambers and Conway (1992) viewed livelihoods as the means of gaining a living, encompassing livelihood capabilities, and tangible and intangible assets. Within the livelihood framework, the term sustainability is often linked to the ability to cope with and recover from stresses and shocks as well as to maintain the natural resource base (DFID, 1999; Chambers and Conway, 1992). The framework emphasises that especially the transforming structures in the governmental system or private sector and respective processes (laws, culture) influence the vulnerability context, and determine both the access to and major influences on livelihood assets of people. The approach underlines the necessity of empowering local marginalised groups in order to reduce vulnerability effectively (see in detail DFID, 1999; Schmidt, 2005). A central objective of the approach was to provide a method that views people and communities on the basis of their daily needs, instead of implementing ready-made, general interven-
tions and solutions, without acknowledging the various capabilities poor people offer (de Haan and Zoomers, 2005). The approach views vulnerability as a broad concept, encompassing livelihood assets and their access, and vulnerable context elements such as shocks, seasonality and trends, as well as institutional structures and processes.

Although the sustainable livelihood approach underlines the multiple interactions that determine the ability of a person, social group or household to cope with and recover from stresses and shocks, it remains abstract. The transforming structures and processes in particular, including influences and access aspects, remain very general. In this context, de Haan and Zoomers (2005: 33 and 45) emphasise that access and the role of transforming structures are key issues which have not been sufficiently examined so far. In particular, the flexibility of the interchanges of different capitals and assets (human capital, financial capital, social capital) has to be more closely considered, which means that the configuration of power around these assets and capitals as well as the power and processes of transforming structures need to be explored in more depth. They argue that access as a key element in the sustainable livelihood framework heavily depends on the performance of social relations, and therefore more emphasis in sustainable livelihood research should be given to the role of power relations. De Haan and Zoomers conclude that the current concept has the tendency to focus on relatively static
capitals and activities within different livelihoods and livelihood strategies (de Haan and Zoomers, 2005).

Furthermore, it is interesting to note that the concept of livelihoods accounts solely for positive outcomes (livelihood outcomes). Additionally, some of the feedback processes underestimate the role of livelihood outcomes on the environmental sphere; for example, a “more sustainable use of natural resources” can be seen as an important tool to reduce the magnitude and frequency of some natural hazards such as droughts, floods or landslides. These linkages between the human–environmental system play a major role in the resilience discourse (see e.g. Allenby and Fink, 2005; Folke et al., 2002; Adger et al., 2005). Nevertheless, this approach, especially the five livelihood assets, can also serve as an important source and checklist for other approaches aimed at identifying susceptibility and coping capacity for hazards of natural origin. The framework can also be linked to categories used in the disaster risk community such as hazard, exposed and susceptible elements, driving forces/root causes, and potential outcomes and responses. While the various shocks encompass hazard components, the five livelihood assets could represent elements that are exposed and susceptible, while the transforming structures and processes in other frameworks are viewed as root causes, dynamic pressures or driving forces (see e.g. PAR framework). The livelihood strategies and outcomes can be viewed as a mixture of intervention and response elements. However, the understanding of vulnerability in the sustainable livelihood approach is very broad, also encompassing the hazard sphere.

Vulnerability within the framework of hazard and risk

A second school, the disaster risk community, defines vulnerability as a component within the context of hazard and risk. This school usually views vulnerability, coping capacity and exposure as separate features. To illustrate this school of thinking three approaches will be presented: the definition of risk within the disaster risk framework by Davidson (1997), adopted by Bollin et al. (2003), the triangle of risk of Villagrán de León (2004), which reflects the “risk triangle” developed by Crichton (1999), and the UN/ISDR framework for disaster risk reduction (2004). Davidson’s (1997) conceptual framework, adopted by Bollin et al. (2003), is shown in Figure 1.4. It views vulnerability as one component of disaster risk. The conceptual framework distinguishes four categories of disaster risk: hazard, exposure, vulnerability and capacity measures (Figure 1.4).

This conceptual framework views risk as the sum of hazard, exposure, vulnerability and capacity measures. While hazard is defined through its
probability and severity, exposure is characterised by structures, population and economy. In contrast, vulnerability has a physical, social, economic and environmental dimension. Capacity and measures – which seem to be closely related to the subject of coping capacity – encompass physical planning, social capacity, economic capacity and management. In contrast to the framework of the double structure of vulnerability developed by Bohle (2001), this approach defines vulnerability as one component of disaster risk and differentiates between exposure, vulnerability and coping capacity (Davidson 1997; Bollin et al., 2003). Villagrán de León also explains vulnerability in the hazard and risk context. He defines a triangle of risk, which consists of the three components of vulner-

Figure 1.4 The conceptual framework to identify disaster risk.
Source: Davidson, 1997: 5; Bollin et al., 2003: 67.

Figure 1.5 Risk as a result of vulnerability, hazard and deficiencies in preparedness.
ability, hazard and deficiencies in preparedness (Villagrán de León, 2004: 10). His figure reflects the “risk triangle” developed earlier by Crichton (1999).

However, he defines vulnerability as the pre-existing conditions that make infrastructure, processes, services and productivity more prone to be affected by an external hazard. In contrast to the positive definition of coping capacities, he uses the term “deficiencies in preparedness” to capture the lack of coping capacities of a society or a specific element at risk (Villagrán de León, 2001, 2004). Although the term exposure is not directly mentioned, he views exposure primarily as a component of the hazard (Villagrán de León, Chapter 16).

**The ISDR framework for disaster risk reduction**

A different conceptual framework was developed by the UN/ISDR. The UN/ISDR framework views vulnerability as a key factor determining risk. According to UN/ISDR, vulnerability can be classified into social, economic, physical and environmental components (see Figure 1.6).

Vulnerability assessment is understood as a tool and a pre-condition for effective risk assessment (UN/ISDR, 2004: 14–15). Although the framework provides an important overview of different phases to be taken into account in disaster risk reduction, such as vulnerability analysis, hazard analysis, risk assessment, early warning and response, the framework does not indicate how reducing vulnerability can also reduce risk. Vulnerability is placed outside the risk response and preparedness framework. This makes it difficult to understand the necessity of also reducing risk through vulnerability reduction and hazard mitigation. In fact, in this conceptual framework risk and vulnerability cannot be reduced directly. The arrows from vulnerability and hazards only point out into the direction of the risk analysis; the opportunity to reduce the vulnerabilities themselves is not explicitly shown. The figure underlines the fact that early warning, preparedness and response could reduce the disaster impact, even though a link between the risk factors (vulnerability and hazards) and the application of risk reduction measures is not included. Moreover, the conceptual framework does not give an answer as to whether exposure should be seen as a feature of the hazard or of the vulnerabilities.

The UN/ISDR report *Living with Risk* (UN/ISDR, 2004) views physical vulnerability as the susceptibility of location. This may be interpreted as a sign that physical vulnerability encompasses spatial exposure, but no precise answer is given (UN/ISDR, 2004: 42). Furthermore, the report differentiates between coping capacity and capacity. While capacity is understood as all the strengths and resources available within a community, society or organisation that can reduce risk, the term coping capac-
Vulnerability is defined as the way in which people or organisations use available resources and abilities to face adverse consequences of a disaster (UN/ISDR 2004: 16). This differentiation indicates that one has to consider the fact that potentially available capacities and applied capacities are different with regard to disaster risk reduction.

Additionally, the UN/ISDR conceptual framework places vulnerability and the disaster risk reduction elements within a framework called the “sustainable development context” (Figure 1.6). This is meant to underline the necessity of linking risk reduction and sustainable development, which means risk reduction strategies should promote sustainable devel-

Figure 1.6 The ISDR framework for disaster risk reduction.
opment by making the best use of connections among social, economic and environmental goals to reduce risk (UN/ISDR, 2004: 18). Although it is important to link risk reduction with sustainable development, the perception that risk reduction is similar to and always compatible with sustainable development is inadequate. The general recommendation of “making the best use of connections among social, economic and environmental goals” is a sort of ill-defined “balancing exercise” between social, economic and environmental goals. In practice, vulnerability reduction and sustainable development are confronted with deeply rooted social, economic and environmental conflicts, which cannot be wished away through a simple balancing exercise. There is therefore a need to define more precisely what sustainable development and risk reduction have in common as well as where the differences are (see section Vulnerability and sustainable development).

Vulnerability in the global environmental change community

The conceptual framework developed by Turner et al. (2003), considered here as being a representative of the global environmental change community, defines vulnerability in a broader sense. Their definition and analytical framework of vulnerability encompasses exposure, sensitivity and resilience. Moreover, vulnerability is viewed in the context of a joint or coupled human–environmental system (Turner et al., 2003: 8075; Kasperson, 2005). In contrast to the disaster risk community, this conceptual framework of Turner et al. (2003) defines exposure, coping response, impact response and adaptation response explicitly as parts of vulnerability (Figure 1.7). The framework also takes into account the interaction of the multiple interacting perturbations, stressors and stresses. Another important difference between the frameworks discussed earlier and this one lies in the fact that the conceptual framework of Turner et al. examines vulnerability within the broader and closely linked human–environment context (Turner et al., 2003: 8076; Kasperson, 2005).

The conceptual framework also takes into account the concept of adaptation, which is viewed as an element that increases resilience. This framework constitutes an interesting alternative to the conceptual frameworks discussed earlier. However, some questions remain, such as whether the distinction between drivers and consequences in this feedback-loop system is appropriate.

The onion framework

UNU-EHS has developed two different conceptual frameworks of vulnerability, the “onion framework” and the “BBC conceptual framework”
The onion framework defines vulnerability with regard to different hazard impacts related to the economic sphere and the social sphere. The impact of a disaster and the vulnerability it reveals is illustrated by the example of floods. Analytically the framework distinguishes a reality axis and an opportunity axis. The reality axis shows that a flood event could affect the economic sphere and cause flood damage, while if the impact of the flood caused huge additional disruption in the social sphere, a disaster would occur (Figure 1.8). Economic assets can be replaced, but the disruption of the inner social sphere of a society would cause long-term injuries and losses, which in this model are primarily associated with the term vulnerability. Different capacities exist within the centre of the social sphere (C1–C3), which means that whether a flood event becomes a disaster or not depends almost as much on the preparedness and coping capacity of the affected society as on the nature of the flood event itself (Bogardi and Birkmann, 2004). While C1 shows the fact that although the social sphere is affected, adequate coping capacities still exist; an impact of the flood event on the inner circle of the social sphere C3, however, would imply that social capacities are entirely insuf-
ficient to deal with the flood event, thus precipitating the occurrence of a
disaster (Bogardi and Birkmann, 2004).

The “onion framework” relates the terms risk and vulnerability to po-
tential losses and damages caused in the three different spheres. The
d framework emphasises that vulnerability deals with different “loss cate-
gories”, such as economic and social losses. This means it stresses the
fact that if a community’s or a person’s losses go beyond economic losses,
for example extending to loss of confidence and trust, the flood event has
reached the “intangible” assets. This implies a serious disruption of the
functioning of the society to the point that vulnerability becomes evident.
According to this framework, the more comprehensive concept of social
vulnerability should incorporate the monetary dimension (likelihood of
economic harm) as well as “intangibles” like confidence, trust and fear
as potential consequences of the flood. Furthermore, the onion frame-
work shows potential response activities related to the different spheres.

Figure 1.8 The onion framework.
Finally, one has to remark that the onion framework does not account for environmental vulnerability. It defines the environment primarily as the event sphere. The aspect of exposure is also not specifically incorporated.

**The pressure and release model (PAR model)**

The pressure and release model (PAR model) views disaster as the intersection of two major forces: those processes generating vulnerability, on the one hand, and on the other, the natural hazard event. The PAR approach underlines how disasters occur when natural hazards affect vulnerable people (Blaikie et al., 1994; Wisner et al., 2004: 49–86). The conceptual framework stresses the fact that vulnerability and the development of a potential disaster can be viewed as a process involving increasing pressure on the one hand and the opportunities to relieve the pressure on the other. The PAR approach is based on the commonly used equation:

\[ \text{Risk} = \frac{\text{Hazard}}{\text{Vulnerability}} \]

In this context vulnerability is defined within three progressive levels: root causes, dynamic pressures and unsafe conditions (Figure 1.9). Root causes can be, for example, economic, demographic and political processes, which determine the access to and distribution of power and various resources. These root causes are also closely linked with the subject of good governance, such as the nature of the control exercised by the police and military and the distribution of power in a society. The category dynamic pressure encompasses all processes and activities that transform and channel the effects of root causes into unsafe conditions, such as epidemic diseases, rapid urbanisation and violent conflicts (Wisner et al., 2004: 54). Interestingly, the authors of the approach stress the fact that dynamic pressure should not be labelled as negative pressure per se. Root causes implying dynamic pressures lead to unsafe conditions, which are a third column of the PAR model approach. Unsafe conditions are specific forms in which human vulnerability is revealed and expressed in a temporal and spatial dimension. These conditions can encompass lack of effective protection against diseases, living in hazardous locations, or having entitlements that are prone to rapid and severe disruption (Wisner et al., 2004: 52–80). The approach also accounts for access to tangible and intangible resources.

The differentiation of root causes, dynamic pressures and unsafe conditions underline the author’s opinion that measuring vulnerability should go beyond the identification of vulnerability; rather, it should address underlying driving forces and root causes in order to be able to explain
Figure 1.9 The Pressure and Release (PAR) model.
Source: According to Wisner et al., 2004: 51.
why people are vulnerable. However, the different elements of the PAR framework are dynamic in that they are subject to constant change, and hence the task of identifying and verifying the causal links between root causes, dynamic pressures and unsafe conditions in a quantitative way might be very difficult. Also Wisner et al. (2004) stress that, in multi-causal situations and a dynamic environment, it is hard to differentiate between the causal links of different dynamic pressures on unsafe conditions and the impact of root causes on dynamic pressures. For example, although urbanisation as a dynamic pressure leads to unsafe conditions in many developing regions, such as Latin America or Asia, the general assumption that urbanisation leads to unsafe conditions is inappropriate. For example in Western European countries and the United States the increasing sub-urbanisation and urban sprawl (de-urbanisation) might be an appropriate surrogate indicator to point at unsafe conditions.

Overall, the PAR model is an important approach and one of the best-known conceptual frameworks worldwide that focuses on vulnerability and its underlying driving forces. It is particularly useful in addressing the release phase and the root causes that contribute to disaster situations. On the other hand the approach underlines the fact that the real effort to reduce vulnerability and risk involves changing political and economic systems, since they are viewed as root causes of, for example, dynamic pressures such as rapid urbanisation or rapid population change. This conceptual framework puts a heavy emphasis on the national and global levels, although many dynamic pressures and unsafe conditions might also be determined by local conditions.

**A holistic approach to risk and vulnerability assessment**

The conceptual framework for a holistic approach to evaluating disaster risk goes back to the work of Cardona (1999, 2001) and his developments with Hurtado and Barbat in 2000. In their first concept, vulnerability consisted of exposed elements that took into account several dimensions or aspects of vulnerability (Wilches-Chaux, 1989), which are characterised by three categories or vulnerability factors:

- physical exposure and susceptibility, which is designated as hard risk and viewed as being hazard dependent
- fragility of the socio-economic system, which is viewed as soft risk and being non hazard dependent
- lack of resilience to cope and recover, which is also defined as soft risk and being non hazard dependent (Cardona and Barbat, 2000: 53).

According to this framework vulnerability conditions depend on the exposure and susceptibility of physical elements in hazard-prone areas on the one hand, and on the other, on socio-economic fragility as well as on
a lack of social resilience and abilities to cope. These factors provide a measure of the direct as well as indirect and intangible impacts of hazard events. The approach emphasises the fact that indicators or indices should measure vulnerability from a comprehensive and multidisciplinary perspective. They intend to capture conditions for the direct physical impacts (exposure and susceptibility), as well as for indirect and at times intangible impacts (socio-economic fragility and lack of resilience), of potential hazard events. Therefore the approach defines exposure and susceptibility as necessary conditions for the existence of physical (hard) risk. On the other hand, the likelihood of experiencing negative impacts, as a result of the socio-economic fragilities, and inability to cope adequately are also vulnerability conditions, which are understood as “soft” risk.

Although the classification of vulnerability conditions into “hard” and “soft” risk is controversial, the conceptual framework suggests a broader understanding of vulnerability, encompassing exposure, susceptibility and lack of resilience. The consequences of the interaction of the hazardous events and vulnerabilities are defined as risks from which a feedback
loop starts: it encompasses a control and an actuation system that represent risk management organisation and corrective and prospective interventions. The feedback loop starts after the risk has become evident (Cardona and Barbat, 2000).

Carreño et al. (2004, 2005a, 2005b) have developed a revised version of the holistic model to evaluate risk that redefines the meanings of hard and soft risk in terms of “physical damage”, obtained from exposure and physical susceptibility, and an “impact factor”, obtained from the socio-economic fragilities and lack of resilience of the system to cope with disasters and recovery. The revised version of the holistic model of disaster risk views risk as a function of the potential physical damage and the impact factor (social and economic fragilities and lack of resilience). While the potential “physical damage” is determined by the susceptibility of the exposed elements (e.g. a house) to a hazard and its potential intensity and occurrence, the “impact factors” depend on the socio-economic context – particularly social fragilities and lack of resilience. Based on the theory of control and complex system dynamics, Carreño et al. (2004, 2005a, 2005b) also introduce a feedback loop encompassing corrective and prospective interventions, to underline the need to reduce both the vulnerabilities and the hazards. Thus risk management requires a system of control (institutional structure) and an actuation system (public policies and actions) to implement the changes needed.

The holistic approach to estimating vulnerability was also presented by Cardona (2004) in Geneva. However, because his presentation outlined only some elements of the approach, we examine the original model here (Figure 1.10). At present, this model has been used to evaluate disaster risk at the national level in the Program of Indicators for Disaster Risk and Risk Management for the Americas (see Cardona, Chapter 10) as well as at the sub-national level and for cities, including Barcelona and Bogotá (Carreño et al., 2005a, 2005b).

Reflection and introduction of the BBC conceptual framework

The BBC conceptual framework combines different elements of the frameworks discussed earlier. Therefore, the presentation of this framework will also reflect on the frameworks analysed before and will stress some key aspects which are still controversial.

The term “BBC” is linked to conceptual work done by Bogardi and Birkmann (2004) and Cardona (1999 and 2001), which served as a basis for this approach. It grew from three discussions: how to link vulnerability, human security and sustainable development (Bogardi and Birkmann...
2004; see also Birkmann section Vulnerability and sustainable development); the need for a holistic approach to disaster risk assessment (Cardona 1999, 2001; Cardona and Hurtado 2000a, 2000b, 2000c; Cardona and Barbat, 2000; Carrero et al., 2004, 2005a, 2005b, Cardona et al., 2005); and the broader debate on developing causal frameworks for measuring environmental degradation in the context of sustainable development (e.g. OECD, 1992: 6; Zieschnak et al., 1993: 144).

The BBC framework stresses the fact that vulnerability analysis goes beyond the estimation of deficiencies and assessment of disaster impacts in the past. It underlines the need to view vulnerability within a process (dynamic), which means focusing simultaneously on vulnerabilities, coping capacities and potential intervention tools to reduce vulnerabilities (a feedback-loop system). Furthermore, as shown in the BBC conceptual framework, vulnerability should not be viewed as an isolated feature. Rather, vulnerability assessment has also to take into account the specific hazard type(s) and potential event(s) that the vulnerable society, its economy and environment are exposed to, and the interactions of both that lead to risk. This means, the BBC framework underlines the necessity to focus on social, environmental and economic dimensions of vulnerability, clearly linking and integrating the concept of sustainable development into the vulnerability framework. Within the three sustainability dimensions (social, economic and environmental sphere), additional frameworks can be integrated, e.g. the sustainable livelihood framework within the social sphere.

In contrast to a risk analysis, the main focus of the BBC conceptual framework is on the different vulnerable or susceptible and exposed elements, the coping capacity and the potential intervention tools to reduce vulnerability.

In contrast to the model of holistic approach to estimate vulnerability and risk (Cardona and Barbat, 2000), the BBC conceptual framework does not account for hard and soft risk, but rather the three main thematic spheres of sustainable development define the inner thematic composition in which vulnerability should be measured: the economic, the social and the environmental dimensions. In this context the environmental dimension is not represented within the framework of the holistic approach to estimate vulnerability and risk developed by Cardona and Barbat (2000), but rather encompasses vulnerability regarding “exposure and physical susceptibility”, “social and economic fragilities” and “lack of resilience or ability to cope and recovering”. Another difference between the two frameworks refers to the response chains. The BBC framework distinguishes between the response before risk and disasters are manifested ($t = 0$) and the response needed when risk and disasters occur ($t = 1$). While during the disaster, emergency management and di-
Saster response units play a crucial role, vulnerability reduction should give particular emphasis to responses, thus focusing on preparedness rather than on disaster response and emergency management.

Through the linkages between sustainable development and vulnerability reduction, the BBC conceptual framework emphasises the necessity to give due consideration to environmental considerations, on which human conditions depend (Turner et al., 2003). Organisational and institutional aspects are important, as are physical vulnerabilities, but they should be analysed within the three thematic spheres (economy, social and environmental) (Figure 1.11). Moreover, the BBC conceptual framework promotes a problem-solving perspective, by analysing the probable losses and deficiencies of the various elements at risk (e.g. social groups) and their coping capacities as well as the potential intervention measures, all within the three key thematic spheres. In this way it shows the impor-

![Figure 1.11 The BBC conceptual framework.](source: Author, based on Bogardi/Birkmann (2004) and Cardona (1999/2001).)
tance of being proactive in order to reduce vulnerability before an event strikes the society, economy or environment \((t = 0)\) (Figure 1.11). In this context, the framework is also open for links to other approaches, such as the sustainable livelihood approach. Especially within the social and economic spheres of vulnerability in the BBC framework, the five livelihood assets can serve as an important orientation and as a kind of vade-mecum to select relevant sub-themes and indicators to assess susceptibility and coping within vulnerability to hazards of natural origin. Furthermore, potential intervention tools could also encompass measures and processes (e.g. planning processes) conducive to improve the access to important livelihood assets, e.g. to human, social and physical capital.

The various elements and links shown in the BBC conceptual framework – with a special emphasis on the key element vulnerability – also suggest a risk reduction strategy, since the intervention system encompasses measures to reduce vulnerability and also measures to reduce the frequency and magnitude of events, such as floods, droughts or landslides linked to a hazard of natural origin.

While some approaches view vulnerability primarily with regard to the degree of experienced loss of life and economic damage (e.g. DRI, Hotspots), the BBC conceptual framework addresses various vulnerabilities in the social, economic and environmental sphere. These three spheres have been defined as the three main pillars of sustainable development (UN, 1993; WCED, 1987). Although the vulnerability of the society and the economy (anthroposphere) are seen as core areas, the BBC conceptual framework also takes into account the importance of the biophysical basis of human life: the environmental sphere. In this way the conceptual framework shows the close link between nature and society and does not limit the environment to the “hazard sphere”.

In this regard, Oliver-Smith (2004, 12) points out that dominant Western constructions of the relationship between human beings and nature often place them in opposition to each other. This means that the understanding of dividing human and environmental issues is also culturally determined. In contrast to the pre-analytic vision of separating the human and environmental systems, the BBC conceptual framework views the environment on the one hand as the “event sphere” from which a hazard of natural origin starts, and on the other hand the environment itself is vulnerable to hazards of natural origin and to creeping processes, especially when it comes to natural-technological hazards.

According to Kraas (2003) and Cardona (2004b) vulnerability can also be directly related to environmental degradation in rural areas and to rapid urban growth patterns that bring about socio-economic fragmentation in urban agglomerations, particularly megacities (Kraas, 2003: 6; Cardona, 2004b: 49; MunichRe, 2004: 18). Interestingly, Cross (2001: 63)
argues that, contrary to popular wisdom, small cities and rural communities are more vulnerable to disasters than megacities, since megacities are more likely to possess the resources needed to deal with the hazard and disasters, while in smaller and rural communities these capacities do not exist. In terms of the theoretical and conceptual development of vulnerability assessment, this debate is important because it underlines the fact that vulnerability estimation should also consider the capacities to cope with hazardous events.

The BBC conceptual framework stresses the fact that vulnerability assessment should take into account exposed, susceptible elements and coping capacities, which might have an important impact on the likelihood to suffer harm and injury due to a hazardous event. Although one should distinguish between vulnerable elements and coping capacity, there is a certain overlap (Figure 1.11), especially if one enters into the discussion of social capital; for example, whether to be part of a social network should be viewed as less vulnerable or whether the network itself can be associated with coping capacity. The role of social capital as ‘social’ or ‘anti-social’ capital examined more in-depth in Bohle (2006). Also, the time scale for a natural disaster which is not defined per se is important: if a disaster is defined as ending whenever the community regains functionality, then coping capacities are crucial drivers.

Finally, the BBC conceptual framework shows that one has two options to reduce vulnerability ($t=0$) and ($t=1$) (see Figure 1.11). In this context it is important not to wait till the next disaster occurs, but rather to take into account the opportunities to reduce the various vulnerabilities before risk turns into catastrophe. Although disaster management capacities are important for limiting the impact of catastrophes and managing the crisis, the BBC conceptual framework points out the importance of anticipating risk and taking actions before it occurs ($t=0$) (see Figure 1.11). Especially with regard to early warning at a political level, it is important to underline the necessity to promote vulnerability reduction as an integrated approach in daily decision-making processes. The improvement of disaster and emergency response capacity ($t=1$) is only one part of the picture and often occurs at the end of the chain. Instead, forward-looking and pro-active interventions are needed (preparedness, mitigation) in order to reduce vulnerability. For example, it is widely acknowledged that investments in mitigation and preparedness have a much higher return than investments needed to cover the costs of relief and recovery.

Regarding the controversial discussion of exposure, Cardona underlines the fact that an element or system is only at risk if the element or system is exposed and vulnerable to the potential phenomenon (Cardona, 2004b: 38). The BBC framework views exposure as being at least
partially related to vulnerability. Although one can argue that exposure is often hazard-related, the total exclusion of exposure from vulnerability assessment could render this analysis politically irrelevant. If vulnerability is understood as those conditions that increase the susceptibility of a community to the impact of hazards, it also depends on the spatial dimension, by which the degree of exposure of the society or local community to the hazard or phenomena is referred to. The author views the location’s general exposure primarily as a feature of the hazard, whereas, for example, the degree of exposure of a specific unit e.g. a critical infrastructure (schools) as well as the number of houses in the hazard-prone areas are a part of exposure that characterises the spatial dimension of vulnerability. Thus exposure is partially a characteristic of vulnerability.

Concerning vulnerability to climate change, O’Brien and Leichenko (2000) emphasise that extreme climate events can strike the wealthy and poor alike, particularly in high-risk zones. It follows, therefore, that all owners of coastal properties are susceptible to storm surges, even though their vulnerability will also depend on their capacity to recover from such impacts, meaning that the wealthy population will have less difficulties than the poor (O’Brien and Leichenko, 2000: 225).

The BBC conceptual framework considers the phenomenon of exposure, at least in part, since it recognises that the location of human settlements and infrastructure plays a crucial role in determining the susceptibility of a community. Yet it acknowledges the fact that within the given high risk zone there are other characteristics that will have a significant impact on whether or not people and infrastructure are likely to experience harm.

Besides the examination of the vulnerable elements within the society, the economy and the environment, the BBC conceptual framework shows the importance of reducing the risk by reducing vulnerability and mitigating hazard even before a risk can manifest itself. Vulnerability assessment should therefore also encompass the identification and analysis of potential intervention tools to reduce the various vulnerabilities and to increase the coping capacities of a society or system at risk (Figure 1.11).

Finally, the framework also stresses that the changes of vulnerability from one thematic dimension to another should be taken into account and viewed as a problem, since these shifts do not imply real vulnerability reduction. For example, if a company compensates for its economic vulnerability in a disaster situation by reducing loans to its employees, then it is the personnel who will have to deal with the negative financial impact of the event. Because the company did not have adequate disaster insurance, its vulnerability (economic vulnerability) is shifted to the employees (social sphere), but without achieving any real reduction in overall vulnerability.
First conclusions

The discussion of different conceptual and analytical frameworks on how to systematise vulnerability has revealed that at least six different schools can be distinguished:

- the school of the double structure of vulnerability (Bohle, 2001)
- the conceptual frameworks of the disaster risk community (Davidson, 1997; Bollin et al., 2003)
- the analytical framework for vulnerability assessment in the global environmental change community (Turner et al., 2003)
- the school of political economy, which addresses the root causes, dynamic pressures and unsafe conditions that determine vulnerability (Wisner et al., 2004)
- the holistic approach to risk and vulnerability assessment (Cardona, 1999 and 2001; Cardona and Barbat, 2000; Carreño et al., 2004, 2005a, 2005b)
- the BBC conceptual framework, which places vulnerability within a feedback loop system and links it to the sustainable development discourse (based on work by Birkmann and Bogardi, 2004 and Cardona 1999 and 2001).

While the model of the double structure of vulnerability views vulnerability as the exposure to shocks and stressors and the ability to cope with these shocks (Bohle, 2001), the second approach widely used in the disaster risk community separates vulnerability from coping capacities and exposure (Davidson, 1997; Bollin et al., 2003; Villagrán de León, 2004). A third school, illustrated by the framework used by Turner et al. (2003), shows a broader definition of vulnerability, which also encompasses exposure, sensitivity and response capacity, including adaptation responses. The fourth school emphasises the root causes and dynamic pressures that determine vulnerability and unsafe conditions. This school of thinking is closely linked with the school of political economy. The fifth school, illustrated by the holistic approach to vulnerability and risk, considers exposure/susceptibility, socio-economic fragilities and lack of resilience, and uses complex system dynamics to represent risk management organisation and action (Cardona, 1999 and 2001; Cardona and Hurtado, 2000a, 2000b, 2000c; Cardona and Barbat, 2000; Carreño et al., 2004, 2005a, 2000b).

The sixth school, illustrated by the BBC conceptual framework and based on Bogardi and Birkmann (2004) and Cardona (1999 and 2001), includes elements of different schools and links – in particular – vulnerability assessment to the concept of sustainable development. The framework stresses the need to focus on exposed and susceptible elements and on coping capacities, at the same time. It includes an understanding of
vulnerability, which goes beyond the estimation of damage and the probability of loss. Furthermore it stresses the fact that vulnerability should be viewed as a process. Vulnerability reduction also has to address both coping capacities and potential intervention tools at different levels. The BBC conceptual framework underlines the fact that the specific vulnerabilities and coping capacities at the different levels have to be examined with regard to the social, economic and environmental spheres that constitute the three dimensions of sustainable development.

Despite some similarities between the different schools of thinking, such as the understanding that vulnerability represents the inner conditions of a society or community that make it liable to experience harm and damage, as opposed to the estimation of the physical event (hazard), there remain many areas of uncertainty:

- Is coping capacity part of vulnerability or should it be viewed as a separate feature?
- Does vulnerability encompass exposure or should exposure be seen as a characteristic of the hazard or even a separate parameter?
- Which parts and characteristics of vulnerability are hazard dependent and which are hazard independent?
- What dimensions and themes should vulnerability assessment cover?
- How can the root causes of vulnerability be defined and measured?
- How far can one measure the interlinkages of the root causes at the national and global levels (economic system) and the major driving forces and root causes (economic condition of individuals) at the local level that determine local vulnerability?
- Is resilience the opposite of vulnerability or a concept that covers coping and adaptation capacity as these relate to vulnerability?
- Should vulnerability focus primarily on human vulnerability alone or is it more appropriate to view vulnerability within a coupled human–environmental system?
- How far is environmental degradation a hazard or a revealed vulnerability of the environment?

Regarding the thematic focus of the different conceptual frameworks under review it is interesting to note that some concepts – such as the double structure of vulnerability (Bohle, 2001) – have no explicit thematic limits, while others define the precise thematic areas needed to be taken into account (UN/ISDR, 2004; Bogardi and Birkmann, 2004; Cardona, 1999 and 2001).

Before presenting fundamental principles and a theoretical basis for indicators to measure vulnerability, the links and the differences between sustainable development, vulnerability and disaster risk reduction will be discussed.
Vulnerability and sustainable development

Linking sustainable development, risk and vulnerability

International declarations and documents, such as the Hyogo Framework for Action 2005–2015, the UN/ISDR report “Living with risk” (UN/ISDR, 2004: 15) and the UNDP report “Reducing disaster risk” (UNDP, 2004: 19, 84), stress the necessity to integrate risk and vulnerability reduction into sustainable development. Therefore it is important to understand the links and also the differences between risk and vulnerability reduction, on the one hand, and sustainable development on the other. The Hyogo Framework for Action states:

There is now international acknowledgement that efforts to reduce disaster risks must be systematically integrated into policies, plans and programmes for sustainable development. Sustainable development, poverty reduction, good governance and disaster risk reduction are mutually supportive objectives. (UN, 2005: Chapter 1a)

It seems that international efforts to reduce disaster risk are increasingly being viewed within the context of sustainable development. On the other hand, the idea of integrating disaster risk reduction and vulnerability reduction into sustainable development does not appear in such important documents as AGENDA 21 or the Millennium Development Goals (MDGs).

Admittedly, some MDGs, especially MDG 1 (“eradicating extreme poverty and hunger”), MDG 3 (“promoting gender equality”) and MDG 7 (“ensuring environmental sustainability”) are indirectly linked to certain aspects of disaster risk and vulnerability reduction; for example, alleviating extreme poverty often also reduces vulnerability. However, the main focus of the MDGs is on socio-economic development and there is no reference to risk or vulnerability reduction as part of these development processes. This strong emphasis on issues of socio-economic development overlooks the fact that at a time of global environmental change (creeping environmental degradation processes), traditional socio-economic development strategies are proving inappropriate to achieve a balance between socio-economic demands on the one hand and the environmental capacities of various ecosystems on the other. The MDGs pay very little attention to the new demands and challenges that global environmental change will make on the socio-economic development strategies that try to address sustainable development (Kempmann and Pilardeaux, 2005: 28). Although the MDGs can be linked to di-
saster risk reduction strategies and their goals, the current links and interrelations of global environmental change, socio-economic development and sustainable development remain abstract.

The UN/ISDR report “Living with risk” states the need to link sustainable development and risk reduction directly:

Promoting sustainability in disaster reduction means recognizing and making best use of connections among social, economic and environmental goals to reduce significant hazard risk. All countries require a healthy and diverse ecological system that is productive and life sustaining, a healthy and diverse economy that adapts to change and recognizes social and ecological limits. This cannot be achieved without the incorporating of disaster reduction strategies, one of the six principles of sustainability supported by strong political commitment. (UN/ISDR, 2004: 18–19)

The UN/ISDR is explicit about the need to integrate risk reduction into sustainable development. However, the question of how that can be achieved and whether the two approaches are compatible remains open. In particular, the UN/ISDR definition of sustainable development is unclear. The formulation making the best use of connections among social, economic and environmental goals (UN/ISDR, 2004: 18) opens an enormous space for differing interpretations. The six principles of sustainable development given in the report by Monday (2002) could be considered as a first conceptual framework, even though these principles are very different and in same cases contradictory to each other (Figure 1.12).

The assumption, for example, that the concept of “quality of life” is part of community sustainability neglects important contradictions between the two concepts. The Brundtland Commission had already de-

Figure 1.12 The six principles of sustainability.
Source: Natural Hazard Center 2006.
fined intra- and intergenerational justice as key principles of sustainable development, by pointing out that:

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. (WCED, 1987)

Although this root definition covers only a part of the current discourse of sustainability, the Brundtland Commission underlines the fact that intra- and intergenerational justice are constitutive elements of any development that might be described as sustainable. In contrast, “quality of life” approaches focus on the needs of the present and have very little in common with a strategy to reduce or balance the needs of the present to ensure the ability of future generations to meet their own needs (e.g. Ewringmann, 1999).

From a scientific standpoint, the broadening of the concept of sustainable development and the accumulation of very different concepts under this label is misleading. The conflicts between current socio-economic development patterns and the limitations and changes of the surrounding environment cannot be whisked away through a simple balancing exercise. Implementing sustainable development means dealing with deeply rooted social, economic and environmental conflicts (Davoudi and Layard, 2001: 17).

Since reduction of disaster risks associated with hazards of natural origin was, until the 1970s, often viewed as a struggle against physical occurrences and environmental threats that required technological interventions and solutions (Hilhorst and Bankoff, 2004: 2), the contrast with an understanding of the vulnerability of the coupled human–environmental system, such as Turner et al. (2003) describe, is evident. Integrating sustainable development into risk and vulnerability reduction strategies (see e.g. Dikau and Weichselgartner, 2005) means recognising the fact that the social and the economic are closely linked with the environmental sphere. Thus, in the current discourse, two main analytical models can be distinguished: the triangle of sustainable development and the egg of sustainability.

**Sustainability: the “triangle” versus the “egg”**

The “triangle of sustainability” and the “egg of sustainable development” are two different schools within the discourse of sustainable development. While the “triangle of sustainable development” places the environment, the social system and the economy at the three different angles, the “egg” model defines a clear hierarchy between these dimen-
sions. The model of the triangle was mainly developed by the World Bank (Serageldin, 1995: 3, 13), and it had broad repercussions, especially in Local Agenda 21 processes. According to Serageldin’s conceptual framework:

This triangle recognizes that whatever we are talking about in terms of sustainability has to be economically and financially sustainable in terms of growth, capital maintenance and efficiency of use of resources and investments. But it also has to be ecologically sustainable, and here we mean ecosystem integrity, carrying capacity, and protection of species…. However, equally important is the social side, and here we mean equity, social mobility, social cohesion. (Serageldin, 1995: 17)

Although Serageldin points out that the economic, social and ecological spheres are interconnected, the conceptual model does not provide an integrative view. The three spheres are placed in relative isolation to each other. The questions of what sustainable growth means and whether the goal of sustainable economic growth is compatible with the goal of ecosystem integrity and carrying capacity remain open. In this regard, Daly argues:

The term sustainable growth when applied to the economy is a bad oxymoron…. When something grows it gets bigger. When something develops it gets different. The earth ecosystem develops (evolves), but does not grow. Its subsystem, the economy, must eventually stop growing, but can continue to develop. Politically it is very difficult to admit that growth, with its almost religious connotations of ultimate goodness, must be limited. But it is precisely the non-sustainability of
growth that gives urgency to the concept of sustainable development. (Daly, 1993: 267–268)

Implicit in Daly’s criticism is the notion that promoting traditional economic growth – also as a strategy of risk and vulnerability reduction – does not generally correspond with the concept of sustainable development. Within the international debate the criticism of the “triangle of sustainable development” focuses especially on the problematic isolation of the three dimensions. According to Prescott-Allen, the conceptual framework of the triangle of sustainability is misleading.

The common three-dimensional model of sustainability (economic sustainability + environmental sustainability + social sustainability) . . . obliges people to balance economic, social and environmental concerns. It sets human and ecological needs against each other rather than accommodating both: sustainability cannot be achieved by compensating for reduced environmental goods with increased economic or social goods (or vice versa). (Prescott-Allen, 1995: 3)

The “triangle of sustainable development” does not show how the three main spheres of sustainability are interrelated (Birkmann, 2004; Fues, 1998). It implies an isolated goal definition for each of the three dimensions, neglecting the linkages between them (Bogardi and Birkmann, 2004: 77). When it comes to implementation, traditional conflicts between the social, the economic and the environmental spheres become apparent (Birkmann, 2004).

Contrasting with the triangle of sustainable development is an alternative conceptual model “the egg of sustainability”, based on the science of the ecological economy. The alternative model defines a clear hierarchy and interdependency between the three dimensions (Figure 1.14).

The pre-analytic view of sustainable development as an “egg” should help to define goals that respect the linkages between the environmental sphere, the society and the economy and to put them into the right balance (Prescott-Allen, 1995; Busch-Lüty, 1995). Goals for sustainable economic development need to take into account goals of the social sphere as well as goals of the surrounding environmental sphere. The vulnerability and the sustainability of the human system both depend on conditions of the surrounding environmental sphere, as well as on the inner conditions of the socio-economic system. If vulnerability to disasters, as Wisner et al. (2004) argue, can also be seen as a function of the way in which humans interact with nature, the “egg of sustainability” is a good theoretical basis to start from. The degradation of the environmental sphere, especially through creeping processes like ongoing climate change and land degradation caused by unsustainable land use, production and
consumption patterns, increases the risk of disasters for the inner human sphere. Unsustainable development due to higher risk and natural disasters can be interpreted in this regard as the loss of the ability of a (sub-)system (economic, social or environmental) to return to a state similar to the one prevailing prior to the disaster (Bogardi and Birkmann, 2004: 78). The ability to bounce back to a reference state after a negative hazardous event, as well as the capacity of a system to maintain certain structures and functions under stress conditions, is a key component of a broader vulnerability assessment and often captured by the term resilience (Turner et al., 2003: 8075). The concept of resilience is based on theories and experiences drawn from ecology.

If one accepts that sustainable development is based on the principles of intra- and intergenerational justice (WCED, 1987) that integrate social, environmental and economic aspects at the same time (UN, 1993, Agenda 21), as expressed by the “egg of sustainable development”, it is evident that risk and vulnerability reduction have to promote strategies that increase the resilience of the inner spheres (human system) against the negative impacts of hazards of natural origin and at the same time ensure that socio-economic development acknowledges the limitations of the surrounding environmental sphere.

That does not mean that vulnerability assessment and risk reduction strategies have to focus only or primarily on the interaction between the human and natural systems, but it should be taken into account. Besides its importance for setting up stronger social protection of the inner spheres to deal with the impacts of a hazardous event by ensuring sus-
tainable livelihoods, the conceptual framework of sustainable development also implies that such livelihood strategies are only sustainable if they take into account the surrounding environmental conditions and accepts intra- and intergenerational justice as a guiding principle. Viewing hazards of natural origin and vulnerability reduction strategies from the perspective of sustainable development means acknowledging the necessity of a dualistic approach: one that ensures a higher resilience of the inner human sphere while, in parallel, it promotes a more sustainable human–nature interaction by taking the limitations of the regional and local environmental capacity into account. Additionally, political ecologists and economic anthropologists emphasise the fact that human–environmental relationships are generated in social relations through the double nexus of production and consumption. In this regard, Oliver-Smith (2004) argues that environmental degradation and environmental resource limitations are not only a question of exceeding natural limits, but should be viewed as results of the socially contracted system of production and social exploitation (Oliver-Smith, 2004: 16). In terms of sustainable development and vulnerability reduction we therefore need to realise that we must take account not only of the biophysical resource budget, but also of the underlying patterns of production and consumption which define the other aspect of the limitations in which we constructed the relationship between human societies and the surrounding environment.

Overall, it can be concluded that the principles of intra- and intergenerational justice should be seen as key principles also for risk and vulnerability reduction. The exclusive focus on the needs of the present generation, along with the tendency to export risks and vulnerabilities from one dimension to another, is not sustainable. Moreover, it is important to acknowledge the fact that the environmental sphere is not only the event-and-hazard sphere (protection from environmental threats), but also the underlying biophysical basis of human activities. In this context a broader and long-term reduction of vulnerability would require also the analysis and reflection of how we construe our relationship with nature. This discussion was illustrated by two different pre-analytic visions of sustainable development and underlines the fact that the integrated perspective of the environmental sphere seems to be more appropriate for taking a holistic view of vulnerabilities to hazards of natural origin.

Note

1. Such degradation processes include for example land degradation, loss of biodiversity and climate change.
REFERENCES


