CapHaz-Net

Social Capacity Building for Natural Hazards Toward More Resilient Societies

Social vulnerability to natural hazards

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Preamble

This report is a revised version of the Work Package (WP) 4 report on Social Vulnerability originally completed in February 2010. In the logic of the CapHaz-Net project it fulfils a specific function as one of the thematic work packages within the project, which directly relates to the other work packages, as shown in the figure below. Within the project, the central concepts of WP 1 and 2 – social capacity building and risk governance – were identified prior to the project as the major framework concepts. These concepts directly relate to this WP4 on social vulnerability and all relate to the other thematic work packages on risk perception, risk communication, risk education and social resilience.

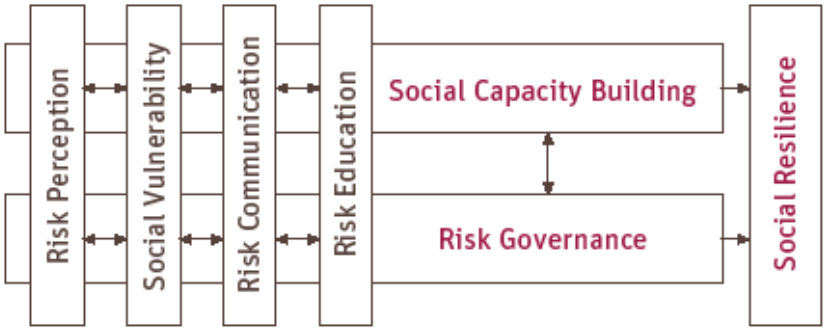

Figure 0: CapHaz-Net's thematic structure.

The original version of the report was presented at a workshop in Haigerloch, Germany, on the 11th and 12th March 2010 to a wider audience of round 50 participants. We have used the Haigerloch workshop to discuss the ideas presented in this report with a number of experts in this field and subsequently to further improve the content and the structure of the report. Unlike reports for WP1 and WP2, which will be so-called 'living documents' that will be further enriched throughout the project, this revised WP4 report will be the final version.

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Introduction

This report examines social vulnerability, how it might be understood in the context of natural hazards in Europe, and how social vulnerability can be addressed to increase social capacity. The report is a key deliverable from Work Package 4 of the CapHaz-Net FP7 project. The objective of the report is to review the existing 'state of the art' literature on social vulnerability, and particularly that within the Europe, including both academic and practitioner literature. In addition the report will examine how the concept of social vulnerability, and approaches to measuring it, have been or could be applied to natural hazards.

Along with the literature review, three empirical examples written by members of the research team have been included from past natural hazard events to illustrate particular approaches to studying social vulnerability, and to raise some key issues in our understanding of the concept. The studies included in this draft report are:

- Fluvial flooding: the River Elbe flood of 2002 in Germany
- Alpine hazards: flooding and mudflows in 2002 in Italy
- The 2003 heat waves in Europe and particularly in Spain

Following the empirical examples the report raises some issues on the relationships between social vulnerability and the other work packages (WPs) on social capacity building, risk governance, risk perception, communication and education and social resilience. Finally, in the concluding section it looks ahead to consider some future challenges related to social vulnerability and natural hazards in the European context as well as the remaining gaps in research.

1 Rationale

There are various rationales for examining the relevance of social vulnerability to natural hazards. Vulnerability assessment has now been accepted as a requirement for the effective development of emergency management capability, and assessment of social vulnerability has been recognised as being integral to understanding the risk to natural hazards (Blaikie et al., 1994). In the USA, one of the lessons of Hurricanes Katrina, Rita and Ike has been that of all the social effects associated with storms and floods their impact on socially vulnerable populations has been woefully overlooked and underestimated (Dunning, 2009). This has also been the case in Europe.

Social vulnerability is most apparent after a hazard event has occurred, when different patterns of suffering and recovery are observed among certain groups in the population (Cutter et al., 2003). While all people living in hazard areas are vulnerable, the social impacts of hazard exposure often fall disproportionately on the most vulnerable people in society – the poor, minorities, children, the elderly and disabled. These groups are often the least prepared for an emergency, have the fewest resources with which to prepare for a hazard, tend to live in the highest-risk locations in substandard housing, and lack knowledge or social and political connections necessary to take advantage of resources that would speed their recovery (Dunning, 2009; NRC 2006).

There is now a realisation that true natural hazard prevention and mitigation will need to address not only the hydrological-meteorological factors, but also the economic, social and political factors influencing wider society and underpinning the impact of hazardous events (White and Howe, 2002). In order to develop effective strategies it is essential to understand the processes and specific factors which alter the impact of natural disasters. Many factors can be identified as influencing the change in approach to hazard and disaster management and response, including:

- the increasing economic and financial cost of disasters and rising impact potentials and the perception that it is not possible to protect against all natural disasters;
- the density of infrastructure and sheer number of people living in at risk areas;
- expansive and intensified land use and increasing conflicts between socio-economic land use and hazard mitigation policy;
- the need for better understanding of interrelations and social dynamics of risk perception, preparedness, and impacts;
- disparities in wealth and socio-economic status;
- a realisation of the importance of the intangible impacts of natural hazards and disasters and the need for increased post-disaster support and recovery;
- and thus the increasing relevance of, and shift towards, responsibilitisation, resilience and social capacity building.

It has been the vulnerability of human beings *in the community* that has emerged as the least known element in the disaster literature as hazard-proof building structures and prediction of hazard impact and warning systems have been improved (King and MacGregor, 2000). Although the information explosion and proliferation of computers and software over the last decade or so has allowed more complex exploration of community vulnerability and its measurement, we still know little about the people of whom we have expectations, which makes strategic planning for

risk management policy implementation very difficult. Therefore ways need to be found to identify social vulnerability and resilience on the basis of a variety of factors, and at a range of scales e.g. individual, household, community, and region. There is therefore a need to determine: who or what are the elements of social vulnerability; how we can identify vulnerable social groups and which groups would benefit the most from having their resilience enhanced; and what attributes or capacities people posses that might reduce vulnerability and enhance resilience.

The ‘social vulnerability perspective’ aims at identifying and understanding which groups of people may be more sensitive and susceptible to the impacts of natural disasters and why. This knowledge base will enable more targeted ‘solutions’ and strategies and will therefore enhance the opportunity for effective mitigation and increasing future social capacity and resilience.

2 Social vulnerability: Concepts and definitions

'Vulnerability' has emerged as a central concept for understanding what it is about the condition of people that enables a hazard to become a disaster. However, almost every aspect of vulnerability conceptualisation and measurement is the subject of intense debate. Such debate is occurring in many different academic domains and it is recognized that the understanding and use of particular names for concepts may differ between them. Relevant to this work are the differences between the natural and social sciences (Gallopin, 2006). The following section sets out to inform the reader of the current state of interpretation of the concept of vulnerability and varied contested perspectives pertaining to, in particular, social vulnerability. In essence the following is a summary of a large area of research literature and academic discourse. Studies have already attempted, in part, to review theory and link theory with policy and practice (e.g.: Steinführer et al., 2009a/b; Environment Agency, unpublished; EC MOVE project). This account also draws on insights from two recent key EC research studies: FLOOD*site* (FP6 2004-2009) and ENSURE (enhancing resilience of communities and territories facing natural and na-tech hazards: FP7 2008-2011). Both projects have already tackled and reviewed the key conceptual issues which can be used as a starting point for further discussion. The following discussion will inform an understanding of what the differing perspectives are that characterise the concepts, the contested relationship with other concepts such as resilience and levels of complexity in interaction between attributes and other hazards. Emergent links with social capacity will only be highlighted at this stage in relation to these concepts.

2.1 Social vulnerability in context

Research literature has identified 'vulnerability' as essentially an umbrella term for a number of vulnerability-types. The FLOOD*site* project adopted a traditional systems perspective by formulating vulnerability as composed of two components:

Vulnerability = function (s, v)

The relationship is defined by the susceptibility (s) of the system in question to adverse consequences following hazard impact; thus incorporating the inherent characteristics of the composite elements of this system and the value (v) placed on the system by society. Susceptibility can be viewed as both dependent and independent of the hazard scenario (i.e. it implicates the nature and severity of the event, as well as the characteristics of the elements exposed), whereas societal value remains independent of the hazard (FLOOD*site* 2005). A relevant issue which will be developed later is the role of the hazard aetiology in affecting vulnerability to a hazard.

So vulnerability can be defined as the state of a system before an event triggers a disaster. Vulnerability can also be defined in terms of the likelihood of the outcome of the losses of a system measured in the form of economic or human life losses. Another view is that vulnerability is a combination of a particular state of that system with other factors such as capacity to cope and recover; the latter introducing the concepts of resilience and resistance. (Galderisi et al., 2010).

The ENSURE project visualizes vulnerability as multi-faceted concept and so a faceted diamond shape was adopted as one possible way to illustrate the varying characteristics or

dimensions of vulnerability. After reviewing literature, the project placed within each facet the key characteristics of vulnerability that emerged, Figure 2.1. The size of the facets and their position within the diagram are not representative of further relationship characteristics and the ENSURE project is still refining the vulnerability facets identified.

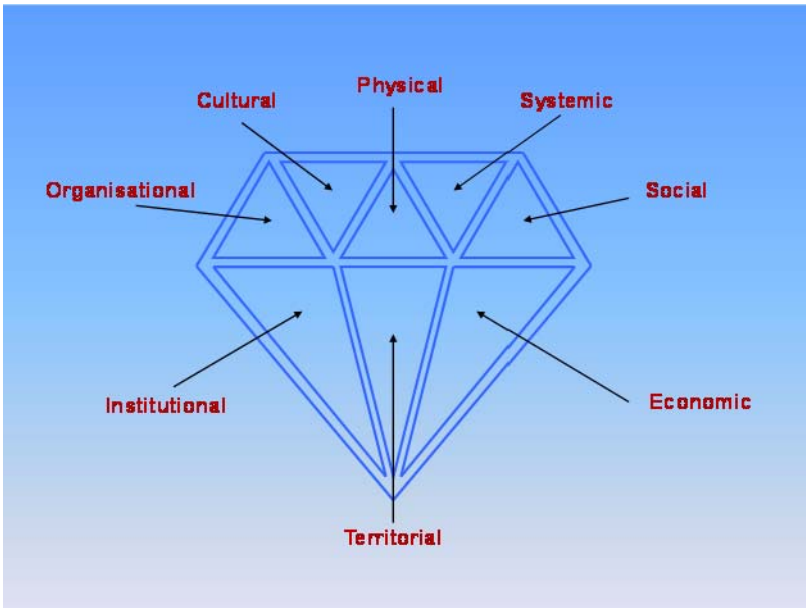


Figure 2.1: Diamond analogy: one illustration for conceptualising the multifaceted nature of vulnerability (Parker et al., 2009).

In the above diagram the 'physical' facet is viewed by ENSURE as the susceptibility to, or potential for, structural damage to buildings, vehicles, infrastructure and lifelines (heat, food, water). 'Systemic' vulnerability is associated with where and how an event might propagate through systems and their susceptibility to an inability to function (e.g. lifelines). The susceptibility to, or potential loss of, indigenous beliefs, customs, related artefacts and ways of life refers to the 'cultural' facet. This may include cultural independence and the superimposition of ideas and concepts from external sources. The 'organizational' facet might refer to the potential for loss and reduced ability to recover caused by the exposure of individuals, communities or local economies to the adverse consequences of an organization's critical shortcomings. The 'institutional' facet broadens the focus to institutional arrangements and the potential consequences of the critical shortcomings of institutions and institutional arrangements. In its most extreme case the breakdown of national governance could be an outcome signified in part by corruption (Wisner, 2000). 'Territorial' vulnerability, a contested concept within social and political science, implies a unit of space and territoriality. The ENSURE project views territoriality as a unique, dynamic assemblage of cultural, historical and present day beliefs, customs, attitudes, assets and capital which characterize, or even define, a specific space or territory and its linkages with other territories. 'Economic' vulnerability is viewed as the susceptibility to, or potential for, loss of economic assets and productivity. This includes the loss of the livelihoods such assets support and the wealth and economic independence they create together with financial deprivation and debt dependence and ability to recover from the losses. The definition of social vulnerability or the 'social' facet will be discussed in the next section 2.2. Although 'society' can be said to encompass all or many of these different facets of vulnerability, it was decided within the ENSURE project to consider each facet separately. For example, economic and social vulnerabilities should be considered separately because financial poverty and

financial deprivation are considered a component of economic vulnerability which underpins, and fundamentally contributes to the causes of, social vulnerability. However, the strong relationship between the different facets needs to be recognized.

The number of vulnerability facets is also debated. For example the European Floods Directive identifies four vulnerability assets of human health, economic activities, cultural heritage and environment. In the ENSURE project consideration was given to either drawing out concepts such as the 'psychological', 'environmental' and 'political' issues into separate facets or for them to remain within and inform individual facets. Psychological issues or psychological vulnerability refers not only to the consequences of an event on an individual but also the pre event attitudes and perception of individuals towards a hazard that may impact on their preparedness and recovery from an event. Issues of perception from a psychological perspective are explored in the Work Package 3 report on Risk Perception.

While the nature and sometimes direction of the relationship between each facet has not yet been clarified in the research literature, the diamond analogy recognises that relationships do exist. The strength of these relationships and bonds between the different dimensions of vulnerability vary across the face of vulnerability and also through space and time (Parker et al., 2009).

2.2 Working towards a 'crisp' definition of social vulnerability

Social vulnerability in itself can be treated as a distinct, multifaceted entity, a second diamond structure within the social vulnerability facet of the vulnerability diamond and characterised by the same attributes on a scale more closely focused on *the social*. Such attributes '*incorporate(ing) issues of livelihood, housing, security and gender among many others. Social norms and customs, international, national and private and public law may regulate these*' (Parker et al., 2009). It is clear that by focusing on *the social,* different forms of attributes are introduced in terms of ranges within attributes, relational attributes and activities associated with and between attributes at different social scales. As Fekete (2008) comments:

> '*Social vulnerability is often hidden, complex and nested in various human aspects and contingencies bound to different levels of society'.*

It is clear that by addressing the 'social' the focus is not just the characteristics of people (individuals) but also their relations within wider society, the nature of the relationships and the physical and societal environment they inhabit. How these various facets are incorporated into defining social vulnerability is in part informed by the perceived importance, ability and availability of measurement to address a particular scale of analysis (Cutter, 1996) or to enable a decision to be made. Section 4 on measuring social vulnerability will reveal some of these relationships. By way of example Table 2.1 provides some working definitions of social vulnerability revealed in the literature.

Table 2.1: Definitions of social vulnerability (adapted from van der Veen et al., 2009)

Working definition(s): Social Vulnerability	Exemplar reference source
A term used to define the susceptibility of social groups to potential losses from hazard events or society's resistance and resilience to hazard.	Blaikie *et al*., 1994 Hewitt, 1997
The characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist and recovery from the impact of a natural hazard … It involves a combination of factors that determine the degree to which someone's life, livelihood, property and other assets are put at risk by a discrete and identifiable event … in nature and in society.	Wisner *et al*., 2004
Social vulnerability derives from the activities and circumstances of everyday life or its transformations.	Hewitt, 1997
The condition of a given area with respect to hazard, exposure, preparedness, prevention, and response characteristics to cope with specific natural hazards. It is a measure of the capability of this set of elements to withstand events of a certain physical character.	Weichselgartner, 2001
The product of social inequalities 'it is defined as the susceptibility of social groups to the impacts of hazards, as well as their resiliency or ability to adequately recover from them …susceptibility is not only a function of demographic characteristics … but also more complex constructs such as health care provision, social capital and access to lifelines'.	Cutter and Emrich, 2006
Emanates from social factors that place people in highly exposed areas, affect the sensitivity of people to that exposure, and influence their capacity to respond and adapt.	Yarnal, 2007

Clearly, authors use the term social vulnerability with different meanings (Adger, 1999). Definitional perspectives can adopt broadly three approaches. First a focus on the characteristics or aetiology of the hazard and losses associated with location to it, second the event is viewed as a social construct rather than a biophysical condition, and finally where vulnerability is viewed both as a biophysical risk and a social response (Weichselgartner, 2001). Aligned with a social construction perspective, the use of a particular definition of vulnerability may also be informed by discourse or use of language with the focus of the purpose of attention or the intentions that underlie the discourse in which the definition is used (Green and McFadden, 2007). In Table 2.1 Wisner et al. closely link the hazard management lifecycle of preparation to recovery with measurable characteristics of the individual. Blaikie et al., Weichselgartner, Cutter and Emrich all look to broader societal drivers and processes. For Yarnal, the scale is people but how society places them in harms way and informs the character of the outcome. Blaikie et al. introduce concepts of resistance and resilience which will be commented on further into this chapter. As well as varying inclusion of hazard aetiology there is also the consideration of society (the term social can be ambiguous) at different scales and from different perspectives. Whilst it is acknowledged that the concept of society is debated, the idea of scale can be embraced within social vulnerability. Society can be viewed as constructed of many *social levels*; from the individual and household (micro society), the local community related to proximity of members (meso society), to the regional, national (macro society) and even global level (concerned with the relationships between different societies). It is certainly helpful to unpick how social vulnerability is differently defined at these different societal scales, and to consider in any one study whether the investigation is focused on different drivers and/or timescales.

In an attempt to pull together the various perspectives and scales one approach represented in Figure 2.2 draws on analysis from the ENSURE project to propose a broad conceptualisation of social vulnerability identifying its characteristics.

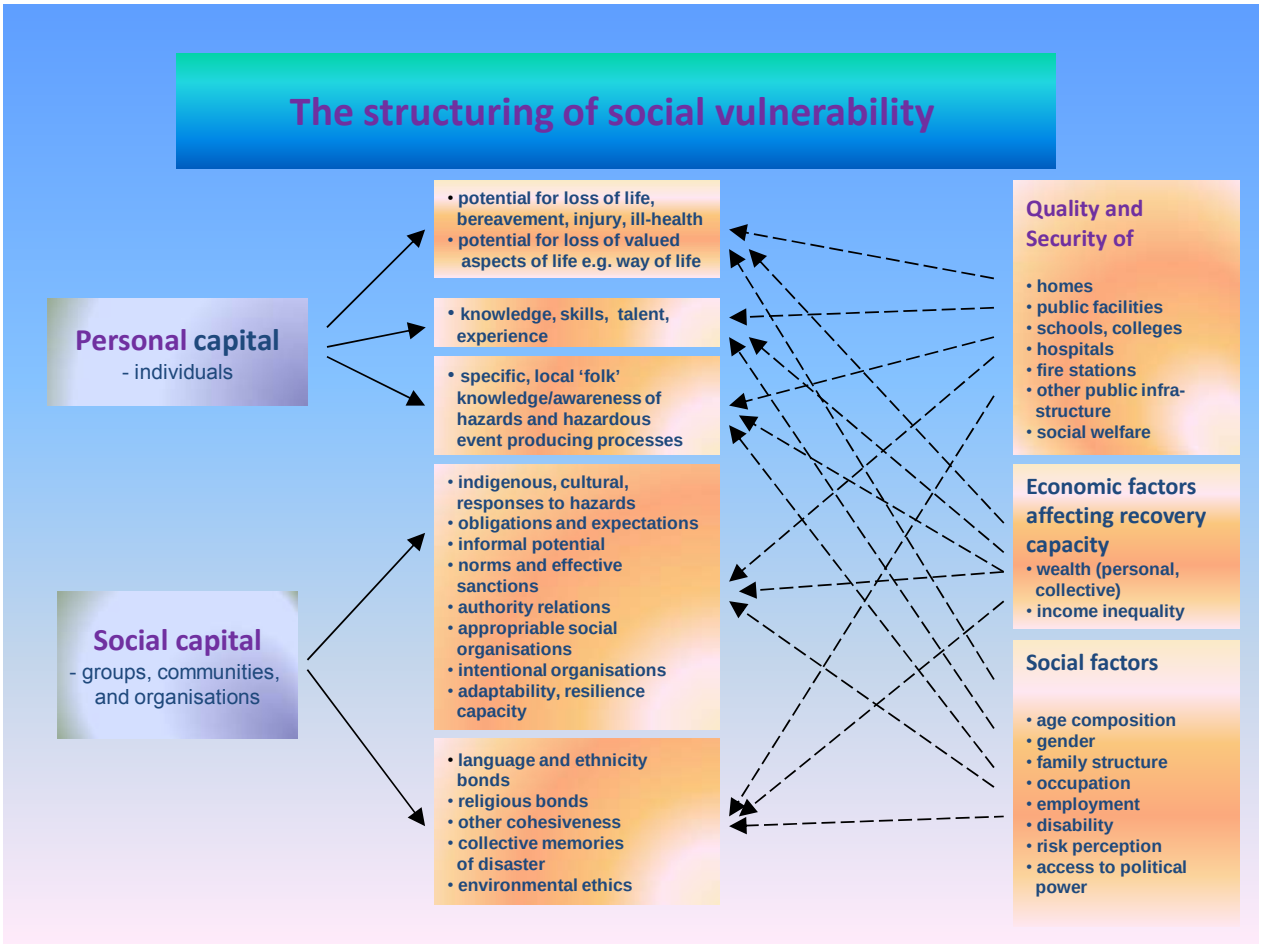


Figure 2.2: Adapted framework for approaching social vulnerability (Parker et al., 2009).

In this proposal social vulnerability is determined by the extent of personal and social capital (in themselves contested concepts) the associated attributes to which are listed in the middle column. The third column, categorises the elements of social vulnerability into 'security factors', 'economic factors' and 'social factors'.

Human capital can be simply defined as the 'stock of skills and knowledge' at the level of the individual (Smith, 1776 cited in Parker et al., 2009). This definition can be extended further to account for personal attitudes (effort, motivation, and commitment), competence and time and so it has been termed here 'Personal Capital'. In the context of natural hazards, these key components play a significant role in determining a person's ability to anticipate, respond, recover and adapt from a hazard event. Social capital refers to the role and value of social networks upon the productivity and capability of individuals and groups or the potential and actual personal relationships of an individual or a group of individuals and the resources which can be mobilized via such networks (Adger, 2000). This concept can further be viewed as a function of trust, social norms and participation (Nakagawa and Shaw, 2004). It is proposed that the cohesiveness of the community (Dynes, 2006), organisations, and responses and mechanisms in place to manage a hazard event, collectively contribute to the degree of social vulnerability transferred to the individual or group as a whole.

Table 2.2 provides a description of the three element categories in the framework. It is immediately apparent that a mixing of different measures and scales is taking place. Apart from introducing difficulties in undertaking vulnerability analysis, a broad catch-all framework as characterised here can be in danger of masking more complex relationships between concepts

and attributes represented within categories. Relationships may not be linear or even discrete. Nevertheless it provides a starting point for unpacking the complex attributes and processes influencing social vulnerability.

Table 2.2: Descriptions of elements of social vulnerability (Parker et al., 2009) with exemplar references.

Components of Social Vulnerability	Rationale	Exemplar references sources
Security	Issues of safety and longer-term stability; these factors incorporate the 'physical' impact of an event on the natural and built environment where people are located. Also considered is the ability for key institutions to respond and manage the event effectively to cause minimal disruption to exposed communities.	Parker et al., (2009): Cutter and Emrich (2006) Birkmann and Wisner (2006): Davis (2008, c.9); Lebel et al. (2006, c19); Barroca et al. (2006); Adger (2000), Zahran et al. (2008), Enders (2001).
Economic	Levels of vulnerability are highly dependent upon the economic status of individuals, communities and nations. Economic factors exert a profound influence upon social vulnerability, to the extent that the two can be difficult to untangle and thus we may see references to 'socio-economic vulnerability'. It is not the lack of wealth directly that makes an individual or community socially vulnerable; it is the provision and access to resources that 'money can buy' which is of interest. The economic vitality of an area in general has been shown to influence quality of life: conditions prior to a hazard event (e.g. out-migration, economic recession) are likely to continue post-hazard event (Cutter and Emrich, 2006).	Masozera et al., (2007): Yodmani (2001); Benson, (2008, c11): Fothergill and Peek (2004): Fielding (2007): Delica-Willison and Willison (2008): Blaikie et al., (1994)
Social	The characteristics of the at-risk individual or community which alter the degree of susceptibility and sensitivity to hazard impact. These may include demographic characteristics such as age, gender, family structure, health and disability, occupation and employment, as well as access to political power. With the exception of the latter, these characteristics typically reflect those employed in taxonomic classifications of social vulnerability.	Cutter et al. (1996: 2000: 2003: 2006): Cutter and Finch (2007): Wisner (2008, C.13): Pelling (2003, c3): Birkmann (2006); Enarson and Morrow (1998): Cupples (2007): Fordham (2008, c12); Fothergill et al., (1999); Elder et al., (2007): Tapsell et al., (2002); Dwyer et al., (2004); Haki et al., (2004); Eakin and Bojorquez-Tapia (2007); Rygel et al., (2006); Paton and Johnston (2001)

2.3 Confounding relationships: resilience and capacity

The contemporary academic discourse illustrates how in attempting to define social vulnerability a relatively new concept of resilience has developed. However, the relationship between the two concepts continues to be contested, highlighting the complexities that lie beneath broad categorisations. Again a number of definitions can be provided for the concept of resilience (Table 2.3).

Table 2.3: Definitions adapted from van der Veen et al. (2009).

Definition/concept	Working definition(s)	Exemplar reference source
Resilience	The capacity for renewal, reorganisation and development	Folke, 2006
Resilience	An intrinsic ability of a system, an element, or a community to resist the impact of a natural or social event.	Villagran, 2006
Resilience	The ability of a system, community, society, defence to react to and recover from the damaging effect of realised hazards.	FLOOD*site*, 2005
Social resilience	The capacity of a community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organising itself to increase its capacity for learning from past disasters for better future protection and to improve risk reduction measures.	FLOOD*site*, 2005
Adaptive capacity	The ability or capacity of a system to modify or change its characteristics or behaviour so as to cope better with existing or anticipated external stresses. Adaptive capacity represents potential rather than actual adaptation.	Adger *et al.,* 2004

As illustrated by these definitions, they represent a reaction to and recovery from an event which further develops, not so much back to the original state but towards an adaptation; such an ability for change is defined as adaptive capacity (developed by climate change researchers). For Galderisi et al. (2010) vulnerability researchers pursue two distinct relationships between vulnerability and resilience. The two approaches either treat vulnerability and resilience as opposites, the 'flip-side' of one another, or on the other hand there are some differences between them but the relationship is more complex.

The 'flip-side' approach, increasingly challenged by research, is a perspective taken by Villagran (2006) where high levels of vulnerability imply low levels of resilience, and visa versa. In a similar fashion to the concept of vulnerability, the concept of resilience is predictable and definable on the characteristics of a group (Cannon, 2008). Resilience also appears to have emerged from a desire to emphasise the positive, for example one enhances resilience but reduces vulnerability (Klein 2003). Researchers' attention to the definition of resilience has particularly taken place in the context of ecological systems where a distinction is made regarding the outcome of a resilient system. Either a system absorbs change and persists (and so is unstable) (Hollin, 1973) or the concept refers to the capacity to withstand and the rapidity of restoring equilibrium (a stable system) (Pimm, 1984).

In the second approach resilience is viewed as an integral component of vulnerability or vulnerability is considered a static component and resilience a dynamic propensity of a system (Galderisi et al. 2010). The dynamic nature of the relationship is a key component of this approach. The concept is linked more with the regenerative capacity of a system informed by attributes such as self-organisation, adaptation and learning capacity (Adger et al. 2005). But even within this group there are a range of approaches. If resilience is interpreted more as an outcome than a process then it is considered more incorporated within the concept of vulnerability (Manyena, 2006). But if a more process orientation is adopted in research informed by adaptive and learning capacity then vulnerability and resilience remain linked concepts but more separate. The relationships between the concepts of vulnerability, resilience and adaptive capacity are also contested (Cutter et al. 2008). Authors broaden vulnerability to highlight further components such as exposure introduced by Pelling (2003) together with resistance and resilience defining vulnerability. Villagran emphasises the temporal relationship between the exposure, resistance and resilience and McEntire (2001) developed an approach called

'invulnerable development' based on a wide ranging view of vulnerability that includes (Galderisi et al. 2010):

- risk, proximity or exposure to hazards, which affects the probability of adverse impact;
- susceptibility, proneness of individuals to adverse impacts of disasters, based on social, economic, political and cultural variables;
- resistance, the ability of physical systems to withstand the stress produced by hazards;
- resilience, the coping capacity and ability to recover quickly from impacts of disasters.

Hazard events *reveal* existing social vulnerabilities, as well as *create* social vulnerability and thus heighten an individual's/community's sensitivity towards the adverse impacts of future hazards. If social resilience is recognised as a component of social vulnerability, then we need to recognise a feedback loop in which resilience towards future events can in fact be enhanced by hazard impact i.e. reverse to the above (e.g. increased awareness, preparedness). However, this is perhaps a simplistic view of a complex relationship where reduction of vulnerability may equally enhance vulnerabilities in other areas perhaps to other hazards.

2.4 Social vulnerability and "proneness"

A component of social vulnerability highlighted here is that of the social proneness of individuals to adverse impacts of disasters. But this component can be viewed in two ways: '*Social vulnerability…a specific form of social inequality in the context of a so-called disaster*' (Steinführer et al., 2009b) or social inequalities govern to some extent the level of susceptibility of different societal groups. In this light, disasters can be viewed as a social construct (Morrow, 1999: Blaikie at el, 1994). Social inequality can be viewed as a process of feedbacks, which serve to further entrench and ingrain certain people/groups in a cycle of disadvantage. People are often coping with 'pre-existing disasters' (Erikson, 1994) which natural hazards events only serve to exacerbate. This process represents an often hidden driver of social vulnerability – indicators such as race and ethnicity are inferential proxies for the process of social inequality which creates marginalized groups in society, often neglected within disaster management plans (Cutter et al., 2003) (e.g. New Orleans evacuation plan based on middle-class assumptions that people will have access to a vehicle to evacuate themselves; when in fact this was only the case for 1 in 5 people in the city).

Entitlements-based explanations focus almost exclusively on the realm of institutions, well-being and on social class, social status and gender. On the other hand, natural hazards research has developed an integral knowledge of environmental risks, with human responses drawing on geographical and psychological perspectives in addition to social parameters of risk. This has driven current research on vulnerability as either an analysis of vulnerability as *lack of entitlements* and/or analysis of vulnerability to *natural hazards* (Adger, 2006). Both phenomena or approaches are not independent of each other.

Throughout this section it is apparent that the relationships between the concepts remain contested and their definition is informed by the nature of the research undertaken. Figure 2.2 has introduced personal and social capital as different scales of attributes and relations informing social vulnerability. Work Package 1 recognizes that social capacity is an integral component of vulnerability. An internal and external view of vulnerability is offered:

> '*Vulnerability thus has two sides: an external side of risk and stress to which an individual or household is subject; and an internal side which is defenselessness, meaning a lack of means to cope with damaging losses'* (Chambers, 1989. 38).

Social capacity building techniques can target both sides of social vulnerability: they may work to lessen the external side through influencing more over-arching risk governance (see WP2 report), emergency response or even targeting those areas of social inequality; on the internal side, the approach becomes a more *personalized* process focused on enhancing social resilience to *combat social vulnerability from within*: e.g. focused on educating, improving the level of perceived risk, building motivation and a sense of responsibility within individuals and communities to manage and mitigate their own risk (particularly a requirement for flood hazard).

It is clear that conceptually vulnerability (and social vulnerability) is a dynamic, challenging and diverse area of academic discourse. Whilst appearing as an area that lacks clarity of definition or consistent application, it appears this is resultant of the complex nature of social systems and the continued investigation and development of empirical direction.

The relationships between the concepts listed thus remain contested and authors use the term social vulnerability with different meanings (Adger, 1999). This can be for a variety of reasons: the scale at which the investigation is being conducted clearly affects the appropriate or inappropriateness of the variables selected and indicators developed. Alternatively, the functional purpose of the investigation and the time available may predetermine indicator choice. Or it may be because in some studies vulnerability is conceptualized as a pre-existing condition, and in other investigations as an outcome of an adverse event. In the latter case, vulnerability can be assessed in terms of the degree of loss (Few 2003, and see for instance Barroca et al. 2006; Granger et al.1999), which is an approach that has more in common with the entitlements arguments. On the other hand, the study of natural hazards has developed an integral knowledge of environmental risks, with human responses drawing on geographical and psychological perspectives in addition to social parameters of risk. This has driven current research on vulnerability as either an analysis of vulnerability as lack of entitlements and/or analysis of vulnerability to natural hazards. (Adger, 2006). The concept and characteristics of natural hazards will be explored in the next section.

3 Social vulnerability and natural hazards

Much of the literature summarized in the previous section suggests that social vulnerability is often a product of inequalities and causes external to natural hazards and unrelated to the type of hazard. Moreover, from a strategic point of view the hazard type could also be said to be irrelevant as the primary concerns for all hazards are to prevent loss of life, infrastructure damage, financial loss etc. and Wisner et al. (2004: 61) suggest that *"there is little value in confining attention mainly or exclusively to hazards in isolation from vulnerability and its causes".* However, in understanding some of the societal variations in vulnerability to hazards it is useful to have some understanding of the variety of hazards themselves, their causes and generation, and in what ways these may influence social vulnerabilities.

Smith (2004) argues that precise definition of natural hazards, like that of environmental health (Ball, 2006), is difficult. Burton and Kates (1964) and Burton et al (1993) emphasised the role of 'forces extraneous to Man' in their definition of natural hazards. However, contemporary thinking even in the natural sciences recognises that most hazards are hybrid, having natural and human components. Indeed Smith (2004) goes as far as including technological hazards in his definition. Here, both technological and geological hazards are excluded from our definition of natural hazards, which is *"… extreme hydrometeorological events which pose a threat to human life and can cause significant damage to goods and the environment".* The group includes: heat-related hazards such as wildfires, drought and heat waves; hurricanes; floods (both fluvial and pluvial, slow-rising and flash floods); and debris flows, landslides and other alpine hazards which involve melting snow (Table 3.1).

Table 3.1: Hewitt and Burton's (1971) classification of Natural Hazards (excluding geological and biological hazards).

1. Atmospheric	**2. Hydrologic**
Single elements	
Excess rainfall	Flood: freshwater from rivers/lakes/dam bursts
Freezing rain ('glaze')	Flood: coastal from marine storm surge/sea level rise
Hail	Wave action: coastal and lakeshore erosion
Heavy snowfalls	Drought: from rainfall deficit
High wind speeds	Rapid glacier advance (surges)
Extreme temperatures Heat/cold stress	
Combined/elements/events	
Hurricanes	
'Glaze' storms	
Blizzards	
Thunderstorms	
Tornadoes	

3.1 Does social vulnerability vary for different hazards?

In this section we consider whether the plethora of meanings for the term social vulnerability may have emerged because different investigations have been focused on hazards with different drivers (aetiological factors), and may have been undertaken with differing timescales in mind, or at different stages of the hazard/disaster cycle. This argument can be regarded as a physical science, risk-based view of vulnerability, and has a long history in the natural sciences. In Barroca et al.'s (2006) approach to defining vulnerability, the hazard itself is not unimportant in the definition: *Vulnerability [is the] susceptibility to degradation or damage from adverse factors or influences"* Barroca et al., 2006.

Barroca et al. (2006) recognise that the role of societies in both causing, reacting to and remediating the effect of natural hydrometeorological hazards is fundamental to an understanding of these complex events and experiences (Thomasella et al., 2006). But from such a technocentric viewpoint, the 'aetiology' of the hazard is strongly argued to affect our vulnerability to that hazard, whether as individuals, households or communities. This approach is further discussed in Faulkner and Ball (2007). Scientific understanding of hazards has dramatically increased since the middle of the last century. They are less often viewed as "acts of God", but also they are not always the fault of a problem that emerged within the extant social structures of the host community alone. The 'aetiology' of extreme events can now be much more successfully mapped (Table 3.2). Alexander (1993; 2000) for instance, has described in some detail how differing types of hazards have differing spatial and temporal 'shapes' that can be monitored, modelled, and at least partly anticipated and managed in advance. Research conducted according to this perspective tends to focus on the distribution of hazardous events or conditions, the human occupancy of identified hazard zones, and the degree of loss of life and property resulting from a given event (Rygel et al., 2006; Messner and Meyer, 2006; Simpson and Human, 2008).

It is also possible to argue that the social vulnerability of groups defined at different scales (individuals, communities, social systems) will also differ as any one particular hazard unfolds and as it is generated and impacts upon these social groupings. Just as one possibility, it can be hypothesised that anxiety and perceived (ontological) vulnerability (at least in relation to hazards) are likely to vary with the generation mode of the hazard, the rate of onset of the hazard, the velocities, the area affected and the hazard's temporal persistence in the environment. Some suggested variations in these aetiological characteristics of different natural hazards are indicated in Table 3.2, and this table is used to set the scene for the empirical examples that follow in Section 5. For example, it is recognized that different types of the same natural hazard can have different lead times e.g. in the case of floods there can be a short or a long lead time. These issues can help disaster managers to decide e.g. on either establishing a weather service (longer time scale) or an early warning system (shorter time scale). Similar issues are raised during the aftermath of a disaster between needs in the immediate aftermath or in the longer term.

The different "risk cultures" or "risk environments" which exist between and within regions also need to be examined to help understand social vulnerability in distinct national, local and cultural contexts and in relation to specific, and different, types of natural hazards. For example, quality of housing will be an important determinant to a community's vulnerability to a flood but is less likely to influence its vulnerability to drought. Moreover, people with very different backgrounds/occupations may be equally resilient in totally different situations in that a person may be vulnerable to a particular loss e.g. forest fire destroying a home, but may have resilience in terms of being insured, having skills to repair damage or personal networks to provide them with emotional support. In this case their resilience is independent of the potential for loss or vulnerability. This lack of contextual understanding thus often constrains the effective practice of emergency management and needs further examination (Buckle et al., 2000).

Table 3.2: Etiological characteristics of Hazards that may affect social vulnerability (Source: report authors).

Etiology of Climatically-driven hazards ↓	Fires	Droughts	Heatwaves	Hurricanes	Pluvial floods	Fluvial floods in large basins	Fluvial flood small basins (flashflood)	Alpine Hazards (debris flows)
Generation mode: •mixed	●							
•Source of Hazard geographically distinct from receptor				●		●	●	●
•source and receptor undifferentiated,		●	●		●			
Rate of onset: •Rapid (little lead-in time)	●		●	●	●		●	●
•Slow (long lead-in time)		●				●		
Flow-out characteristic: •Systematic, focussed, redictable and slow		●				●		
•Geographically and temporally diffuse and slow			●					
•Chaotic and rapid	●			●	●		●	●
•Chaotic and slow								
Area affected: •Point,focussed				●	●		●	●
• diffuse	●	●	●			●		
Persistence •long		●				●		
•short	●		●	●	●		●	●

3.2 The hazard (or 'emergency') cycle

Many have argued that hazards can be described as having a definite hazard, emergency or disaster cycle (Figure 3.1). Although being useful as an analytical tool, the disaster management cycle has been criticised for portraying disaster response in a circular fashion which is said to reinforce the perception of disasters as an aberration from normal conditions, and that these conditions will return to normal once the event has passed (White et al., 2003; Few, 2007). This assumes for example that certain conditions, e.g. social vulnerability, are not pre-existing in normal circumstances within affected societies, which is rarely the case. In reality, pre-flood conditions such as poverty and vulnerability may be simply recreated following flooding. The disaster cycle also fails to acknowledge that, in certain circumstances, and particularly in conditions of poverty, losses many lead to increased vulnerability, making people more susceptible to future flooding (White et al., 2003; Whittle et al., 2010). White et al. (2003) refer to this as a negative downward disaster 'spiral' rather than a cycle. Another criticism of the disaster cycle model is that the divisions of separate phases comprising mitigation/prevention, preparedness, response, and recovery do not always match the perceptions of individual local people who tend to regard their own responses as parts of a single personal coping strategy that integrates talents, capabilities, knowledge, skills, and technologies from many different sources (Weichselgartner & Obersteiner, 2002: 74). However, the disaster cycle also implies that lessons will be learned and that positive change will take place. In this sense White et al. (2003) promote the concept of the 'virtuous spiral' of risk reduction whereby lessons can be learned from a disaster which may result in positive adaptation and outcomes.

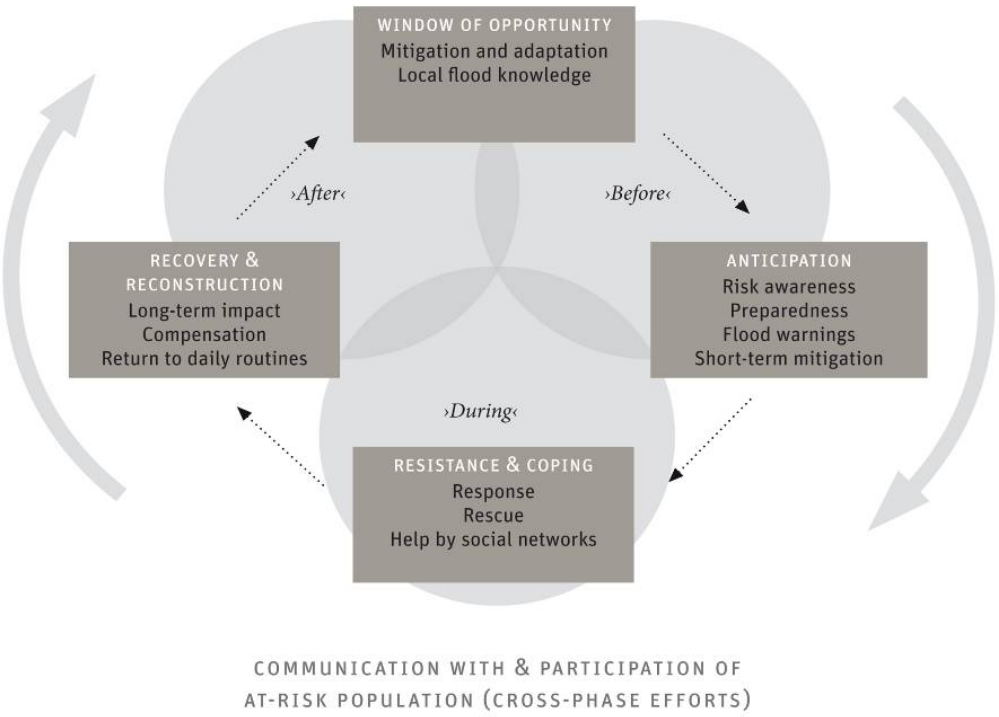


Figure 3.1: The hazard or disaster 'risk' cycle developed in the FLOOD*site* project (Steinführer et al. 2009b).

3.2.1 The 'socially vulnerable', the hazard cycle, and emergency management

Because we can anticipate some hazards, there are of course extensive possibilities of developing infrastructural responses, designing awareness-enhancement programmes and putting plans into place to mitigate the effects of the events once they have occurred or before they occur. But these plans may not be very sensitive to the characteristics of the residential communities involved, nor to the possibility that populations may vary in their vulnerability at different phases in the disaster cycle. In each phase, different characteristics of social groups may raise particular issues. How different vulnerability indicators may be used to aid decision-making and planning for disasters is discussed by Dunning (2009). One example is in relation to communication. People who do not speak the language of their host country, for instance, will have difficulty understanding and responding to warnings and evacuation orders in the preparation and response phases. The financially deprived will have more difficulty than the wealthy in repairing or replacing lost possessions in the recovery phase (Green et al., 1994). The very elderly are assumed to have difficulty at every stage in the disaster cycle; receiving a warning may be problematic for the elderly who may have impaired hearing or be easily confused. The various medical conditions associated with advanced age – lack of mobility, sensory impairment for instance – can also affect their ability to respond and recover from a disaster. For similar reasons, those with a limiting long-term illness are also assumed to be vulnerable at each disaster phase. The very young are primarily affected in the response and recovery phases (it is assumed that preparation in the form of receiving a warning would be the responsibility of a parent or guardian). The recovery phase can be especially distressing for people and has traditionally been ignored in literature on disaster management. Key problems are faced, for example: when families are evacuated, from the stress of coping with insurance claims and restoration of properties (Fordham and Ketteridge, 1995; Tapsell and Tunstall, 2001;

Whittle et al., 2010). The level of risk awareness or perception (WP3) may also affect ability to receive and respond to a hazard warning. Lack of trust in authority figures may undermine people's confidence in warnings, and hence their ability to respond. In relation to flooding, people who live in rented accommodation, especially if it is furnished, may not be motivated to either receive a flood warning or take action after one has been received. Lack of access to childcare facilities may severely impede a family's ability to recover from a flood, especially if it is a lone-parent household.

Some investigations do explore vulnerability at varying stages in the hazard cycle (in advance of the hazard, during, and after the hazard has occurred) for example see the extended discussion in Steinführer et al. (2007). Other investigations do not differentiate societal vulnerability by phase of the hazard cycle, nor are spatial variations in vulnerability linked very often to the hazard aetiological characteristics in Table 3.2. For instance, differences in reported vulnerability with variations in spatial patterns of intensity of the hazard do not feature very often in social science investigations of social vulnerability to a particular hazard but have emerged from findings in some studies e.g. Tunstall et al. (2007).

Considering the different phases of the disaster cycle may ultimately help to reduce vulnerability by advising policy makers and emergency managers where to take actions or to focus resources during a crisis and also how to identify different responsibilities for more effective hazard management. One question to ask is how much should we distinguish between different types of hazard managers? What knowledge do different disaster managers need to help them in their roles? Broadly speaking there are three classes of professionals that we need to consider. The first two classes are those that deal with preparedness and response. Each group will have different needs and requirements which need to be understood. One suggestion is that as scientists or advisors we need to start from the perspectives of disaster managers and ask what they are doing on a daily basis versus during a disaster, as most deal not only with disasters or their prevention. We therefore need to understand these differences. One suggestion from the Haigerloch workshop was the recognition of the varying social vulnerabilities which should form part of the preparedness training and management of natural hazards for the different groups of disaster managers.

A third group of professionals by virtue of their wider responsibilities are those who deal with disaster recovery. These are not technically disaster managers but they play a key role in recovery and reconstruction. Response, recovery and reconstruction after disasters have not yet been sufficiently used to promote and realise vulnerability reduction and climate change adaptation (Birkmann et al. 2009: 7). Yet social vulnerability can also be created by the ways in which the recovery process is handled and people may become vulnerable, or more vulnerable, as a direct consequence of an adverse event. This was recently illustrated in the UK following the 2007 floods in Hull (Whittle et al., 2010). For example, increased insurance premiums following a flood may make the insurance prohibitively expensive, or it may only be affordable at the expense of some other resource, thus compromising the quality of life of individuals or households. In Asia following the 2004 tsunami, and in the USA following Hurricane Katrina, developers moved in and took over land, thus increasing people's existing social vulnerability (Klein, 2007).

A further question is how can knowledge fit into the disaster cycle? One important issue is that of the knowledge gained by householders during relief and recovery being typically overlooked or devalued in traditional governance frameworks which emphasise expert to public

communications (e.g. see Whittle et al., 2010). A related issue relates to the lost knowledge of those people in responding agencies who return to their ‘normal’ jobs after the relief and initial recovery period. This was evidenced following severe coastal flooding in 1990 in Towyn, North Wales, where case workers were told to shred all of their documents and lessons were not passed on (Hill and O’Brien, 1999). This raises the question of how that knowledge can be harnessed and disseminated to others to help reduce future vulnerabilities and build capacity.

This section has looked at the characterisation of different natural hazards. We now turn in the next section to looking in more detail at the reasons for assessing and measuring social vulnerability to these hazards and at the different approaches that have been taken.

4 Analysing and measuring social vulnerability to natural hazards

4.1 What is the purpose of social vulnerability assessment?

The above question is a valid one and careful thought needs to be given to why we undertake social vulnerability assessments. What do we gain from them? Some authors have argued that everyone can be vulnerable (e.g. Handmer 2003) so do we need social vulnerability assessment at all? According to Fekete (2010), there can be no analysis of risk management, resilience and adaptation options without first *understanding* vulnerability. Vulnerability to natural hazards is a detector of the susceptibility and capacities of any system, be it physical or social. Social vulnerability is one part of disaster risk assessments and crucial information necessary for supplementing hazard and mitigation assessments. Improving risk reduction and disaster preparedness to natural hazards requires first and foremost the identification and assessment of various vulnerabilities of societies, economies, institutional structures and environmental resource bases through tools to measure vulnerability (Birkmann and Wisner, 2006).

The international community defines the measuring of vulnerability and risk as a key activity within the final document of the World Conference on Disaster Reduction, the Hyogo Framework for Action 2005-2015 (United Nations 2005, Hyogo Framework for Action 2005-2015). The Framework underlines the fact that the impacts of disasters on social, economic and environmental conditions should be examined through indicators or indicator systems to assess vulnerability. In this context, measuring vulnerability requires first and foremost a clear understanding and definition of the concept of vulnerability, although this in itself is contested, as discussed in Section 2.

The rationale behind measuring vulnerability and the use of vulnerability indicators has been summarized by Birkmann (2006) who discusses different definitions and conceptual frameworks used by the different schools of thought. At a broad level information on social vulnerability helps to:

- define where the greatest need is and set priorities e.g. by deriving knowledge about spatial distribution patterns
- determine actions e.g. by improving intervention tools
- monitor progress and analyse trends
- measure effectiveness of mitigation approaches
- anticipate undesirable states
- inform policymakers and practitioners
- alert the public and raise awareness
- stimulate discussion
- gain funding e.g. for poverty reduction initiatives
- represent social responsibility
- look at the social roots of vulnerability.

Different people may want to answer different questions regarding social vulnerability, depending upon their needs, roles and responsibilities. The questions that we want to answer also need to be discussed. There are many different ways to answer questions on vulnerability at different scales and using a variety of methods (see Section 4.3 below). Key questions to help clarify the choice of methods include (Birkmann and Wisner, 2006: 7):

- Who and what is vulnerable?
- Vulnerable to what?
- Who wants to know and why?
- What information do people need to reduce vulnerability and increase social capacity?
- What circumstances and contexts shape the daily lives of those affected?

The latter question suggests that there is a need to differentiate between everyday problems (e.g. emergencies) and disasters. Many people have little capacity to cope with everyday life generally due to inequalities e.g. in income, low skills base etc. Social inequalities and root causes of these are not necessarily social vulnerability leading to disaster, only leading to unequal social conditions generally. It is these inequalities that may also affect people's capacities to respond and recover from hazardous events. Gaillard, Wisner, Cannon et al. (2010) suggest that people's ability to face natural hazards depends upon the nature, resistance, diversity and sustainability of resources which enable them to satisfy their daily needs. For some people disasters are therefore situations that amplify the difficulties already encountered by them in their daily lives; situations which are often outside the remit of disaster managers.

These questions also imply the recognition of the horizontal and vertical multi-dimensionality and complexity of vulnerability and the diversity of stakeholders, decision-makers and interest groups at different levels who act according to their political mandate and material interests. These groups see vulnerability reduction in a specific context and from different perspectives. Moreover, some aspects of social vulnerability may be beyond measurement but this does not mean that they should escape an attempt at measurement, or at least assessment and systematization, altogether.

It can be argued that the vulnerability of communities should be approached from a multi-dimensional, process-oriented and holistic perspective. Vulnerability assessment should go beyond mere damage assessment to focus on susceptibility and coping capacity of the respective entity (e.g. people) as well as taking into account the potential intervention tools of governments or local communities (see Birkmann, 2006). For this, assessment of social vulnerability requires specific preconditions in governance and political will (see WP2). For the CapHaz-Net project it is clear that a better understanding of how to assess social vulnerability is necessary in order that social capacity to anticipate and cope with natural hazards across Europe can be increased.

4.2 Who decides who is vulnerable?

Much of the confusion of which definition of social vulnerability to select (see Section 2 above) and how to assess it can be solved by defining who are the vulnerable people we are referring to, which is the *target group* that is to be researched, and which is the potential *end-user group?* However, we also need to ask who it is that is defining these groups. For whom do we assess social vulnerability: is it for scientists, politicians, risk managers, citizens or other stakeholders? Vulnerability issues more often tend to be addressed from the top down. But how do (or do?) people and communities assess their own vulnerability? On what grounds are people categorized as vulnerable?

Vulnerability can be subjective and top-down disaster protection strategies tend to ignore social dynamics and, therefore, do not improve the situation because the at-risk people are not made visible, are not reached or not included in decision making processes. As a result, disaster

management, although specialized, can remain socially isolated (Weichselgartner & Kasperson, 2010; Weichselgartner & Obersteiner, 2002; Weichselgartner, 2003). Thus existing or potentially vulnerable populations are often institutionally and economically invisible but their participation in vulnerability assessments is crucial if these assessments are to be useful for decision makers. Cooperation across society is hindered when disaster schemes and programmes still treat people as 'clients' in disaster management processes, ignoring the experience of those most at risk, and where 'paternalistic' science and technology do things to them and for them, rather than together with them (Weichselgartner, 2003).

The above discussion raises the question of who is responsible for addressing social vulnerability and increasing social capacity. This question of *risk responsibility* was raised in the WP1 report on social capacity building for natural hazards where three overarching reasons were given for the necessity of building such social capacity: the observed increase in the occurrence of natural disasters as well as rising damages, which question established protection and management strategies; a changing distribution of responsibility between different state and non-state actors; and a lack of capacity on the side of state authorities. The issue thus needs to be addressed at a number of levels e.g. state, community and household. It raises the issue of the differentiation of ownership of capacity building at different scales. For example, at the state and regional levels who has the responsibilities and legal power to influence these activities? Do communities and individuals also accept such responsibility and, if so, how can they act to reduce their own vulnerability and increase their own social capacity? These issues are further discussed in the empirical examples in Section 5 but the reader should also refer to Annex 1 of the WP2 report on Risk Governance for some European examples of multi-level governance in managing the risk arising from natural hazards.

Evidence from the literature indicates that people need to be included in defining their own vulnerabilities (Heijmans, 2004; Delica-Willison and Willison, 2004) although the views of both scientists and other stakeholders also need to be reflected. People's vulnerability thus needs to be seen in light of their capacities and abilities to influence and define their own fortunes. Added to this is the role of *institutional* vulnerability in creating or re-creating social vulnerability, an issue raised following Hurricane Katrina in the USA.

4.3 Social vulnerability measurement and analysis for natural hazards

The development of indicators of social vulnerability to natural hazards and the development of approaches to measuring such vulnerability is a relatively small but growing area of research, particularly within applications to industrialised nations. Research on social vulnerability has traditionally focused on characteristics or attributes that contribute to specific aspects of such vulnerability in a subgroup of the total population at risk from a hazard, rather than an all inconclusive investigation of the relevant factors in the total population. While all people living in areas at risk from natural hazards can be vulnerable in terms of exposure (Handmer, 2003), there appears to be a general agreement in the literature that the impacts of natural hazards often fall disproportionately on the most vulnerable groups in society: the poor, minorities, the elderly, children, the disabled etc. Thus, certain social characteristics are more likely to be associated with vulnerability than others. Therefore, to date, the majority of approaches aimed at measuring vulnerability have been based on the use of *indicators* of vulnerability to represent key characteristics or attributes. Indicators are qualitative or quantitative parameters that

describe features of certain, often complex and ill-defined, phenomena and communicate an assessment of the phenomena involved (Dopheide and Martinez, 2000).

The use of social indicators to monitor the change in status of people and communities has a long history in social science research. European countries have been using social indicators to improve public health and social conditions since the 1830s. Indices of deprivation have been used in the UK in the fields of health, housing and welfare to differentiate between individuals and groups for resource allocation and other purposes (see Carstairs and Morris, 1991; Jarman, 1984; Townsend, Phillimore and Beattie, 1998). Importantly, vulnerability indicators can enhance the empowerment of local groups and communities if developed and used as part of community-based disaster management and self-assessment (Wisner et al., 2004), see Section 4.5.

There have been numerous initiatives to measure, qualify and/or assess social vulnerability which are well summarised and documented (e.g. Adger, 2000; Adger et al*.,* 2004; Birkmann, 2006). However, many of the initiatives for measuring vulnerability often lack a systematic and transparent approach (Birkmann, 2006). There is still no consistent set of metrics used to assess vulnerability to environmental hazards, although there have been calls for just such an index (Cutter et al., 2003). Research findings are fragmentary and there is still no consensus on a) the primary factors that influence social vulnerability, b) the methodology to assess social vulnerability, or c) an equation that incorporates quantitative estimates of social vulnerability into either overall vulnerability assessment or risk.

The particular characteristics of vulnerable populations are thought to have importance for the types of problems, needs and opportunities that risk managers and planners will confront, and for the range of measures needed to consider effective and acceptable solutions and mitigation strategies. However, there is a need for research on how to use and apply such indicators in decision-making processes at different levels, since determining useful indicators and the development of measuring approaches are not in themselves goals. Indicators can however be used to define more significant issues, such as broader social and economic inequalities, and can provide decision-makers with effective and influential tools (King et al., 2000; Birkmann, 2010).

Vulnerability is not static; because someone is deemed ‘vulnerable’ at the present time does not mean that they will remain so. The same applies to the non-vulnerable; people may become vulnerable due to forces or *processes* such as aging, illness or redundancy, which are independent of adverse events such as natural hazards. Vulnerability analysis can therefore be seen as a snapshot of a dynamic process.

There are a number of conceptual, methodological and practical challenges in developing vulnerability indicators. One challenge is that there are multiple interpretations, definitions and methods of what constitutes vulnerability and how to measure the concept ‘on the ground’ (AEA, 2008:15). As Downing (2004) emphasizes, *“the indiscriminate use of indicators—pick any that seem relevant and are available—must be avoided*”. Adger (2004) discusses three characteristics of vulnerability and vulnerability research that present particular problems when devising vulnerability indicators: complexity and limited understanding of the concept or phenomenon (i.e. the paradox as put forward by Birkmann (2006) *“We aim to measure vulnerability yet we cannot define it precisely*”); the issue of different scales; and the dynamism i.e. relationships between variables and over time. We will return to these last two issues later in the report, however the first point refers to the seemingly unending debate on what vulnerability *is,* making the operationalisation of vulnerability through indicators an even more difficult task.

One thing that most authors seem to agree on is the importance of developing a conceptual model as a basis for any indicator development for measuring social vulnerability.

4.3.1 Conceptual frameworks

Building upon discussion in Section 2.2, social vulnerability analysis is a way of describing who is likely to be especially at risk to the effects of hazards, both spatially and temporarily, and enables the special needs of so called 'vulnerable groups' to be taken into account as part of the risk management planning process (Dunning, 2009). Three distinct conceptual models have previously been put forward by researchers in vulnerability research on natural hazards:

- the identification of conditions that make people or places vulnerable to extreme natural events – an **exposure** or biophysical model (Burton, Kates and White, 1993; Anderson, 2000);
- the assumption that vulnerability is a **social** condition, a measure of societal resistance or resilience to hazards (Blaikie et al., 1994; Hewitt, 1997);
- the integration of potential exposures and societal resilience with a specific focus on particular **places** or regions (Kasperson, Kasperson and Turner, 1995; Cutter, Mitchell and Scott, 2000).

This third school has increasingly gained in significance in recent years in relation to hazards research, largely due to the work by Cutter et al. (2000; 2003) who use a conceptual model of vulnerability that incorporates both biophysical and social indicators to provide an all-hazards assessment of vulnerability at the local level (also see Appendix A).

Dunning (2009: 13) attempts to locate social vulnerability analysis in an emerging conceptual framework for flood risk management in the USA (Figure 4.1) to help improve the understanding of social vulnerabilities and consequences, however the framework could be equally applied to other natural hazards. The framework describes who is likely to be most vulnerable to threats, the kinds of consequences that can be expected for vulnerable populations, as well as the resilience of populations (i.e. influences on how rapidly and completely they are likely to recover.

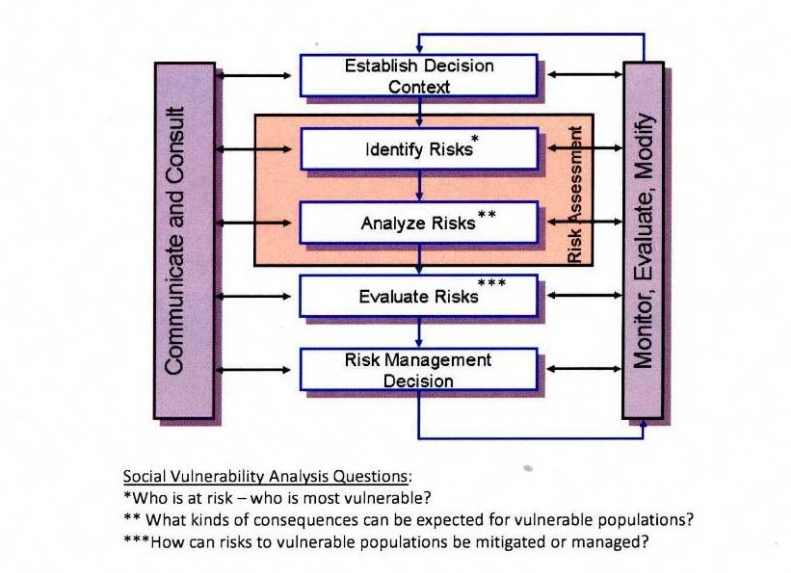


Figure 4.1: Social vulnerability analysis in a risk framework (Dunning, 2009).

Another theoretical concept, the 'BBC' framework developed by Bogardi, Birkmann and Cardona (see Birkmann 2006: 34), also combines hazard and vulnerability in a risk reduction perspective. The framework explicitly links vulnerability to the three spheres of sustainability: society, economy and environment and thus provides an entry point for the integration of coupled social-ecological systems analyses. It also permits the inclusion of more social perspective-driven research to identify the root causes of vulnerability, a point we will return to in Section 4.5. The BBC model shows the distinction of hazard analysis as being a different field from vulnerability analysis. The outcome of both hazard and vulnerability results in specific spheres of risk being created. Turner et al., (2003) also presented a vulnerability framework for the assessment of coupled human-environment systems to assess who or what are vulnerable to multiple environmental changes. They suggest that vulnerability is registered not by exposure to hazards alone but also resides in the sensitivity and resilience of the system experiencing such hazards. This recognition requires revisions and enlargements in the basic design of vulnerability assessments, including capacity to treat coupled human-environment systems and those linkages within the systems that affect their vulnerability. Such integration remains a challenge.

Finally, Wisner et al.'s (2004) Pressure and Release (PAR) model (Figure 4.2) is another framework for analysing how disasters occur when natural hazards affect vulnerable people. The PAR model attempts to assess the *progression* of vulnerability, as vulnerability is rooted in social processes and underlying causes which may be quite remote from the disaster event itself. The pressure aspect focuses on the processes generating the vulnerability and natural hazard event, while the Release aspect focuses on the reduction of the disaster to relieve the pressure and reduce vulnerability. This is more in line with White et al.'s (2003) suggestion of a disaster 'spiral' (see Section 3.2) rather than cycle, as the processes (possible spires) are more clearly depicted than for example in Dunning's (2009) model which fits the more 'conventional' approach of risk cycles.

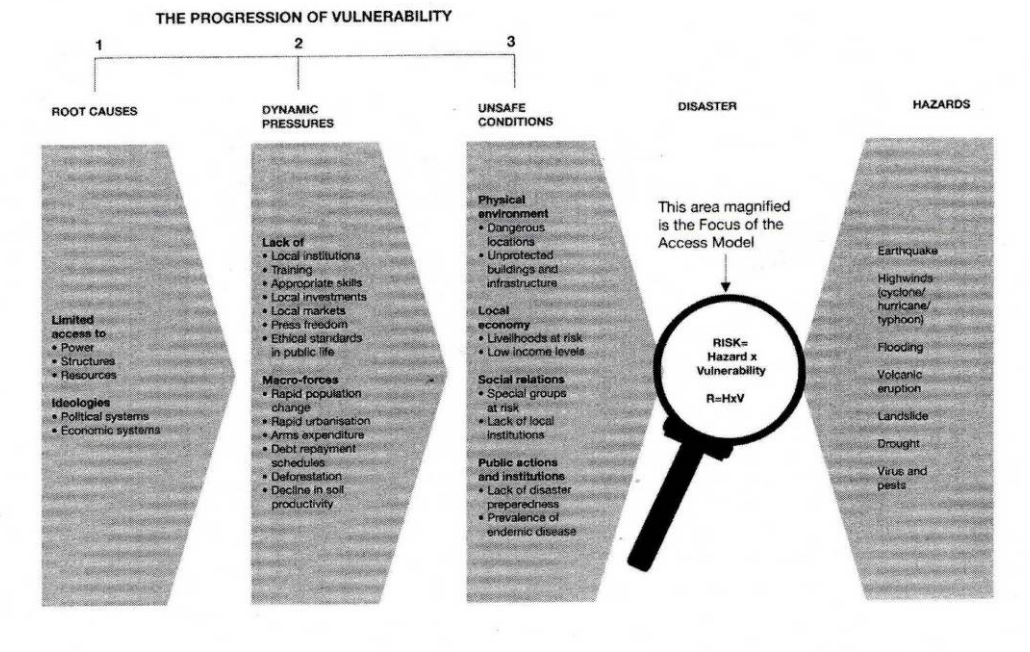


Figure 4.2: Pressure and Release (PAR) model: the progression of vulnerability (Wisner et al., 2004: 51).

4.3.2 What can we learn from the climate change community for disaster reduction?

There are obvious links between certain types of natural hazards (e.g. floods) and climate change. Climate change scientists have also been researching vulnerability, particularly in relation to adaptation and adaptive capacity, and it is useful to look at what can be learnt from this research. Ability to adapt is similar to coping capacity and resiliency, which is seen to be an important element of vulnerability. However, while climate change research has a stronger emphasis on gradual and creeping changes, such as sea level rise, the disaster risk community has a dominant focus on crises and disasters linked to sudden-onset hazards (Birkmann et al., 2009). The climate change community has conducted research on the development of vulnerability indicators but there is a diversity of opinion regarding the potential role of indicators in EU policy to climate change adaptation (AEA, 2008). One project to assess the feasibility of developing vulnerability indicators to help progression towards a European adaptation policy for climate change (see AEA, 2008) developed a process for the construction of such indicators following a review of them from a theoretical and methodological perspective. The main conclusion is that vulnerability indicators are best developed with a specific policy purpose in mind and this should determine the method and approach used in their development. AEA (2008) identify a strong link to adaptive capacity and the challenges to vulnerability assessment.

The literature on vulnerability to climate change makes a strong case that social factors are vital in determining actual vulnerability, although the literature does not provide an indicator or empirically-based set of variables to measure such social vulnerability. Adger et al. (2004, also see Brooks et al., 2005) developed a conceptual framework within which indicators representing vulnerability and adaptive capacity to climate change can be developed. A key objective of developing the framework was the reconciliation of different views and definitions of vulnerability. To do this they combined the approaches of the climate change and natural hazards and disaster management research communities, and developed a framework which related risk, vulnerability and adaptive capacity to one another, and which also addressed the problem of

timescale. Results suggest that health, education, and particularly governance indicators, provide a reasonable assessment of vulnerability to climate hazards, at least in terms of mortality related to discrete extreme events. These indicators are closely related to the themes of CapHaz-Net work packages, in particular social vulnerability (WP4), risk education (WP6) and risk governance (WP2).

Additional challenges and barriers identified in linking disaster risk reduction and climate change adaptation include: the scale dimension; normative dimension; and knowledge dimension (Birkmann et al., 2009: 29). For example, current national adaptation strategies for climate change may be too broad in order to be meaningful to local stakeholders for disaster risk reduction, leading to a mismatch of applied spatial scales. Different temporal scales are also a problem between the two schools: climate change adaptation is analysed at a global scale while disaster risk reduction is analysed at regional and local scales. Long, 'creeping' events do not conform to the conventional disaster cycle as there are less distinct transitions between phases, and vulnerability has a greater potential to change within this timeframe. Therefore the approaches taken by the two communities can be quite different, often top-down (climate change) vs bottom-up (disaster risk reduction). The problem of different languages and terminology used (for instance vulnerability is discussed as susceptibility by the climate change community versus sensitivity by the disasters community), can hamper effective cooperation. Nevertheless, we can identify synergies in the work that the climate change community is conducting on understanding and developing adaptive capacity with the aims of the disaster reduction community in building social capacity; the literature from the climate change community is thus drawn upon in the following sections of the report.

4.3.3 Scale of analysis

Let us return to the problem of scale in analyzing social vulnerability to natural hazards. It is necessary to consider the scale of analysis when embarking on any study. The level at which we can measure individual or social characteristics will then dictate how we can relate those characteristics in the form of some measure of vulnerability (Green and Penning-Rowsell, 2007). Research has clearly indicated that vulnerability is spatially and socially differentiated, and the scale of analysis is most important especially when multi-scale and cross-scale research is demanded (Fekete et al., 2009; Birkmann, 2007). One question is whether there are different characteristics of vulnerability at different scales.

The most detailed social vulnerability assessments are conducted at the local level, often of individuals or households. However, methodological decisions often mean sacrificing localised detailed case study approaches for more broadly based patterns and distributions (Cutter, 1996). National-level assessments, such as the use of census data, can result in loss of information and capturing local pockets of variability. The term 'social' can encompass either individuals, larger social groups, or society in general, and there is an argument for the need to 'unpack' the term to more clearly conceptualise social vulnerability at these different scales as discussed in Section 1, e.g. individual, community and nation, and how this may relate to social capacity building. For example, it is difficult to identify regional or national variables that can also capture the locally specific processes (AEA, 2008). Most studies take either a top-down macro perspective or bottom-up meso or micro perspective (see following Section), although a middle ground approach can also be taken which also allows the opportunity to include local knowledge and local coping capacities/practices (e.g. Hilhorst and Bankogg, 2004; Few, 2007).

In many conceptual vulnerability frameworks the allocation of scales and levels is missing or not explicitly described. Yet the literature indicates that vulnerability assessments and scale are highly intertwined, not only in application but also in conceptualisation, and needs more scientific development. Moreover, defining the time/space scale we need to look at should be part of the research question. Thus the purpose and the scale of the assessment will largely dictate the type of approach to be taken for assessing social vulnerability. There are also problems arising from up or down-scaling in multi and cross-scale assessments which can be related to the choice of spatial level for representation, the aggregation, and resulting variation in results and false assumptions of generalising from one spatial level to another. These can be especially important when dealing with census data on administrative units. Some examples of vulnerability studies in Europe and elsewhere at different scales are outlined in Appendix A.

4.4 Different approaches to assessing social vulnerability

Building on the challenge that there are multiple definitions, methods and scales of understanding social vulnerability, a related challenge is how to *measure* it once the system in question is defined (AEA, 2008). There are fundamental differences between the main types of assessment approaches. These are largely based on qualitative or quantitative research traditions and approaches which have important differences in their related paradigms. Procedures for the selection of indicators of vulnerability tend to follow two general approaches – a deductive approach based on a *theoretical* understanding of relationships, and an inductive approach based on *statistical* relationships, although conceptual understanding does have a role to play in both (Adger et al., 2004). Three broad approaches to indicator development are identified by AEA (2008: 17) along with the advantages and disadvantages of each approach. The authors include deductive and inductive approaches and also a third *normative* approach which involves the use of subjective preference criteria for developing indicators. The normative approach is often used in combination with other methodologies to select variables and some studies combine two of the above three methods.

The most important aspect of indicator development is to ensure that the indicators selected serve the needs of the research question and test the concepts to be operationalised. It is important to spend time clarifying exactly what is trying to be measured or the study may end up with indicators that measure something other than what was intended. The type of approach taken may be dictated by the required scale of the study or by whether the focus is upon analysing *attributes or processes* (see Section 4.3.1). For example, quantitative approaches based on statistical analysis may be more suitable for measuring attributes e.g. in larger scale studies, while more contextual and qualitative approaches will be appropriate for understanding processes and relationships e.g. in community level and bottom-up studies. However, both approaches may rely, to greater or lesser extents, on the use and development of indicators to measure social vulnerability.

4.4.1 Examples of vulnerability indicators and indices

Appendix A sets out some examples from a range of indices and frameworks developed to assess social vulnerability to natural hazards at spatial scales ranging from the global to individual. Many of the studies are based on measuring attributes or factors influencing vulnerability rather than understanding relationships or processes. For example, socio-economic and demographic characteristics of vulnerability have been identified by The United Nations

Universities Institute for Environment and Human Security (UNU-EHS) which has been active over the last decade to look into state-of-the-art vulnerability assessment, particularly in the field of hazards (e.g. Birkmann and Wisner, 2006; Birkman, 2006; Adger et al., 2004). Some of the key factors thought to influence social vulnerability are summarized below in Table 4.1 (see also Tierney, Lindell and Perry, 2001; Putnam, 2000). Many of these can also be termed resilience factors in that they affect people's management capacity (i.e. ability to meet their own needs): resource availability; cultural attitudes and values; access to services; and social isolation.

Cutter et al. (2003) conducted a comparative analysis of social vulnerability to natural hazards among US counties. The approach incorporates both biophysical and social indicators to provide an all-hazards assessment of vulnerability at the county level and may be particularly relevant for comparing results from diverse settings, as it incorporates the notion of 'place'. Cutter et al.'s Social Vulnerability Index (SoVI) is a comparative metric that provides a snapshot of an area's relative social vulnerability to hazard exposure (see Appendix 1). The variables used in the index were selected following extensive disaster and social science research (Dunning, 2009).

Table 4.1: Factors that influence social vulnerability (adapted from Cutter, Boruff et al. 2003).

Factor	Examples
Lack of access to resources	*Information* (e.g. of hazards, protective action decision options, etc); *knowledge* (i.e., this translates to more informed and prepared citizens and includes understanding of warning sources (environmental, informal and formal) and mitigation, preparedness and response actions); and *technology* (e.g. warning communication devices such as radios, cell phones, televisions)
Limited access to decision making	Political power and representation
Lack of social capital	Social networks and connections
Beliefs and customs	That neglect or ignore hazards or mitigation of hazards and their effects. Ethno-cultural differences, for example. Perception of hazards as 'Acts of God'
Building stock and age	Number, density and type of buildings and whether or not their age predates significant building design codes and enforcement
Frail and physically limited individuals	Those who are unable to take protective actions or require outside assistance to do so (e.g. very young or old, sick, disabled)
Weakness in infrastructure and lifelines	Type and density of infrastructure and lifelines
Population shifts	Population shifts which result in more people living in at risk areas
Increased mobility	More people live in new surroundings and are unfamiliar with the risks in their new areas, and how to respond to them

Research on flood hazard in the UK by Fielding et al. (2002) showed the following factors to *decrease* the level of flooding awareness (and hence risk perception), and therefore preparedness in areas at risk from flooding, thus increasing people's vulnerability (in order of impact):

- No experience of flooding
- Social class C, D, E (i.e. lower socio-economic groups)
- Renting accommodation
- New to area – resident within last year
- Not serviced by Environment Agency flood warning system
- Unemployed
- Aged under 45 or over 55

Table 4.2 shows common indicators for social vulnerability in relation to flooding identified by a review of literature for the FLOOD*site* project (Tapsell et al., 2005). These include indicators of elements at risk, exposure indicators and susceptibility and resilience indicators (Messner and Meyer, 2005). The symbols indicate whether the variable may be an indicator of increased or decreased social vulnerability (+ = increases vulnerability, - = decreases vulnerability). Further work was done on identifying indicators during the FLOOD*site* project (see empirical examples from Germany and Italy below) which has improved understanding of these factors. As the list in Table 4.2 is extensive it could be argued that most people will exhibit at least some of these indicators. In this sense the number and possible *combination* of applicable indicators may, in a certain population, indicate an increase or decrease in the potential for social vulnerability.

Table 4.2: Common social vulnerability indicators identified from literature reviewed for FLOOD*site* project (Tapsell et al. 2005).

Common indicators
• Age - children and very elderly (+) • Gender - women (+) • Employment (-) • Unemployment (+) • Occupation (depending upon whether skilled (-) or unskilled (+), also linked to income and financial status) • Education level (higher educational level -, low educational level +) • Family/household composition (large families +, single parents +, single person households +, home owner -, renter + etc.) • Nationality/ethnicity (minorities +, new migrants +) • Type of housing (single storey accommodation +, mobile housing +) • Number of rooms (low number indicates overcrowding +) • Rural/urban (low income rural +, high density urban +) • Levels of risk awareness and preparedness (high awareness -, low awareness +) • Previous flood experience (no experience +, high experience -) • Access to decision-making (increased access -, little access +) • Trust in authorities (no +, yes -) • Long-term-illness or disability (+) • Length of residence (linked to prior experience, short residence +) • Serviced by flood warning system (yes -, no +) • Type of flood (indicates potential damage levels) • Flood return period (indicates potential damage levels)

Advantages and disadvantages of the taxonomic approach

So how far can these taxonomic, attribute and hazards of place approaches account for social vulnerability to natural hazards? Such approaches can be advantageous if there is sufficient empirical knowledge and the aim is to compare the disaster risk between different areas. Such approaches also have the advantage that they may have the potential to put the issue of social vulnerability on the public agenda, as they may contribute to a very important aim of all vulnerability assessment, that is to sensitize administrations and politicians for the issue of social vulnerability at all (Benson 2004). Additionally, indicators and indices may be transferable to other contexts and allow for cross-regional or cross-national comparison.

However, according to Wisner (2005), the use of taxonomies of ‘vulnerable groups’ such as those outlined above e.g. women, children, the elderly, people living with disabilities, is not without problems. Although there is truth that these groups may often have ‘special needs’ and that there is empirical support for the use of such “check lists”, the taxonomic approach fails in that it produces too many ‘false positives’ e.g. not ALL women are equally vulnerable (Fordham, 1998; Morrow, 1999). Communities and even individuals in a household will vary in knowledge,

skills, culturally and socially determined rights to resources according to age and gender. Levine (2004) proposed that vulnerability should not therefore be seen as a 'group' characteristic since this deprives individuals of asserting their autonomy. This is an important consideration in terms of resource allocation because it could mean that resources are misdirected towards people who are regarded as vulnerable when they are not, whilst people who really are vulnerable are ignored.

Wisner et al., (2004: 15) suggest that there is a movement away from the use of simple taxonomies or checklists of 'vulnerable groups' to a concern with "*vulnerable situations"* which people move into and out of over time. To fully understand these vulnerable situations a more contextual approach for assessing vulnerability is necessary, one that also focuses on understanding the processes that contribute to vulnerability production and social capacity building, e.g. via use of the PAR model. Kuhlicke et al (2009), based upon the research for FLOOD*site*, suggest that a *local contextual approach* allows comparison of different spatial units since it is based on a common set of indicators whose individual components, however, are strictly understood as hypotheses to be tested. The approach is both sensitive to local contextual conditions and the temporal dimension of social vulnerability by differentiating indicators for the three phases of the disaster cycle. Such a contextual approach does not immediately refuse the use of indicators; it rather tries to test and evaluate their usefulness by applying them in a specific context. However, a clear limitation is that this method is quite resource and time demanding. Also transferability to other hazard situations, social contexts and types of risk governance is not assured.

As the CapHaz-Net WP1 report suggests, it has become increasingly clear that differences and variations in the vulnerability of groups and people cannot be sufficiently explained from a macro-perspective alone and by exclusively considering structural aspects. While indicator analysis, as outlined above, is useful and has its place, it is perhaps best used as input for interacting with populations themselves, or their surrogates, to obtain their input about potential measures (Dunning, 2009). A bottom-up meso or micro perspective which takes into account local knowledge and/or local coping capacities and examines processes and relationships is thus another approach to understanding, and addressing, social vulnerability. Many of these studies are based on more qualitative approaches for assessing vulnerability outlined in Section 4.5 below.

However, a number of other issues also need to be considered if choosing an indicator approach for assessing social vulnerability, some key ones outlined here are data availability, quality and validation, the issue of weighting, and evaluation – see Table 4.3. Availability of data is often the most crucial factor influencing indicator selection and can lead to reliance on easily measurable variables which may not be the most accurate indicators of vulnerability. Some measure of the *quality* of the data used is also necessary for analysing social vulnerability and it is equally important to look into the *quality of the process* of producing and communicating social vulnerability information (a topic for WP5). One question that could be asked is whether the quality of the process is more important than use of this or that indicator? Quality criteria are important points that should be considered when developing adaptation strategies as well as when evaluating their effectiveness and appropriateness. The selection process of indicators is thus key to ensure the quality of indicators (Briguglio 2003; Villagran 2006). Methodologies to *validate* the data gathered are also necessary, but generally lacking (AEA, 2008). Fekete (2010) attempted such a validation in research on German floods – see Box A on page 40).

Not all vulnerability indicators are necessarily equal, and the need to develop a defensible weighting scheme is also important (Cutter et al., 2003; Eakin and Bojoroquez-Tapia, 2008). Gall (2007) in an evaluation of selected indices of social vulnerability revealed significant shortcomings in the construction of most of the evaluated indices, with particular gaps in empirical validity and methodological robustness. She developed a framework for index evaluation that allows for the identification of methodologically robust approaches and the assessment of the overall quality of each index (Figure 4.3). To overcome these deficits, Gall suggests that the research community will need to advance conceptual frameworks, develop (social) vulnerability-relevant data sets, focus on evidencing index construction empirically, and pursue the validation of indices through proxy measures or other means. Also see Downing (2004) for suggestions of criteria for peer review of vulnerability assessments.

Table 4.3: Issues to consider in relation to use of quantitative data.

Issue	Comment
Data availability	Not all social data is nationally available in some European countries e.g census data. Need to consider the last date of data collection as this varies nationally – can be problem if comparative analysis required. Data compatibility is also an issue and a constraining factor e.g. in Germany each federal state applies different methods to calculate data sets Spatial resolution of data can also be a limitation for capturing certain social aspects The advent of internet and information technologies and increased availability of affordable computers has increased availability of secondary source data and a shift towards desktop analyses. Site surveys provide primary source data whose accuracy cannot be matched by secondary source data but they are time-consuming and expensive. Geographic Information Systems (GIS) and related information technologies have revolutionised the approach to vulnerability assessment, especially where a hazard has a spatial component
Data quality	The following criteria can be used as a guide for the selection of indicators (Cutter et al., 2003; Adger et al., 2004; Dwyer et al., 2004; Krumpe, undated). Indicators should be: reliable and verifiable; sensitive to change over time; simple and easily understood while reflecting complexity of concept; measurable via readily understood model; recognisable by others; objective; and ideally, comparable within and between communities
Validation	Validation is needed of the accuracy and robustness of criteria and the quality of data. Validation remains an often neglected activity in indicator development and for assessing whether the indicators are measuring what you want them to measure
Weighting of indicators	Most studies do not apply weights to vulnerability indicators and hence the indicators are generally considered to be independent and equally important variables. The standardization, weighting and aggregation of indicators is a subjective process and different methods of weighting and aggregation may lead to conflicting results. More recent development in multi-criteria analysis using statistical approaches (e.g. Haki et al., 2004; Meyer et al., 2007; Eakin and Bojoroquez-Tapia, 2008) have been attempting to allocate suitable weightings.
Evaluation	Four key issues contribute to variability and uncertainty embodied by current vulnerability indices: subjective interpretation of vulnerability concepts, ignorance of sound statistical practices, limited data availability, and absence of reliable approaches to calibrate social vulnerability indices (see Figure 4.2 and Gall, 2007).

Analytical framework for the evaluation of social vulnerability indices.

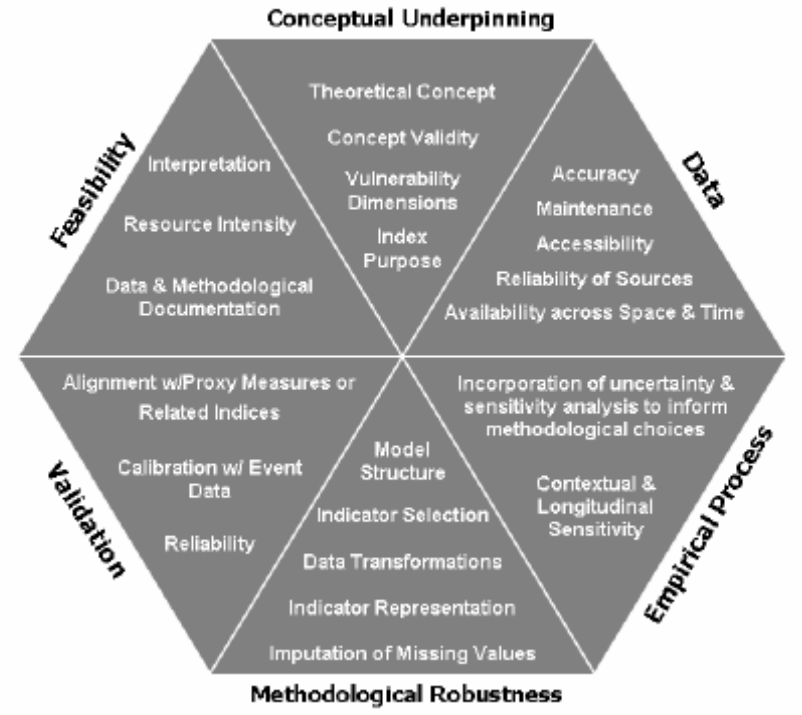


Figure 4.3: Framework for the evaluation of social vulnerability indicators (Source: Gall, 2007: 188).

4.4.2 Comparisons across time and space

According to Cutter et al. (2003), there has been little research effort focused on comparing the social vulnerability of one place to another. Vulnerability indicators are frequently location-dependent. So is it possible to develop a robust and consistent set of indicators for assessing social vulnerability that facilitates comparisons among diverse places? How well do such indicators differentiate places based on the level of social vulnerability? Cutter et al.'s SoVI methodology is said to allow for a robust and consistent set of variables that can be monitored through time to assess changes in vulnerability. The SoVI has also been tested for temporal consistency using decadal census data from 1960-2000 (Cutter and Finch, 2008) and to establish the robustness of downscaling to smaller geographical units (Schmidtlein et al., 2008). A major strength of the model is that the data are obtained from standard census studies performed by governments rather than expensive one-off surveys such as those often funded through scientific research. However, weaknesses of such approaches include the fact that they are often complex and use statistical procedures that are not easily communicated to non-specialists. Moreover, the relative nature of the values used can be difficult to appreciate, and results can be misinterpreted or misrepresented. Additionally, the model is not linked into a model of risk, but as the authors have explained, a logical next step is to integrate the model findings or outputs (GIS maps of vulnerable areas) with physical hazard maps.

4.4.3 Relational aspects of vulnerability

Another problem with vulnerability assessment is that although researchers are beginning to recognize the differential vulnerabilities of social groups, these analyses are often unidimensional, i.e. they focus on gender *or* race/ethnicity *or* age etc. but not on the *interactions*

and relations within and between several social groups. Although indicators may not in isolation make a person vulnerable, a combination of these indicators, or the relationship between indicators, may render an individual highly vulnerable (Dwyer et al., 2004). These effects of combinations of particular indicator values compared with other combinations tend not be explored. We therefore need to know how vulnerabilities are compounded to create the most vulnerable (Wisner, 1993). We also need to look more at the relationships between specific variables and social groups. One question that has been raised (first highlighted in Section 2.1) is whether we can truly differentiate between social and economic vulnerability?

A number of suspected *constant elements* in the relationships between the two facets of social and economic vulnerability have been highlighted by examining past natural hazard events in case studies developed for the EC ENSURE project (Parker et al., 2009). These 'constants' are elements which are likely to be found time and again when examining relationships between these two types of vulnerability, and suggest elements of predictability which may be built into our developing understanding of vulnerability as a whole. For example, most classical vulnerability indicators (age, income, gender etc.) are basically indicators of social inequality in general and not just in respect to natural hazards. Key constants identified from case studies of forest fires in Portugal, drought in Israel, floods in the UK and earthquakes in Italy include: levels of personal wealth, contracting local and regional economies (often largely rural), dependence of livelihoods on a narrow range of economic activities, a low skills base, low levels of education, lack of transferable skills and adaptive capacity, and lack of entrepreneurial knowledge and motivation. However, in these cases social vulnerability characterised by low income and underdeveloped human skills was often counter-balanced to some extent by social solidarity and cohesiveness within communities.

Findings from Parker et al., (2009) also indicate that it is clear that the socio-economic *characteristics* of a population exposed to a hazard are related in a complicated way to social and economic vulnerability of this population. In some circumstances this may make them poor predictors of social and economic vulnerability. It is therefore important that socio-economic *characteristics* are not used in a simplistic form to predict socio-economic *vulnerability*. Instead, it is important to examine more closely how socio-economic grouping *interacts* with vulnerability, including the existence of support groups which may affect recovery time, and elements such as insurance.

A number of practical attempts at *integrated* vulnerability studies have been identified, all of which focus on the construction of indices of various kinds as a vehicle for integration (see Parker et al., 2009). The inclusion of socio-economic vulnerability analyses within integrated hazard vulnerability analyses is becoming more central, yet to date few such analyses appear to have been carried out. One example is that of MacKendrick and Parkins (2005), who found it impossible to consider social and economic vulnerability without also including indicators of physical and institutional vulnerability when developing their socio-economic vulnerability index (see Appendix A). The current EC FP7 ENSURE and MOVE projects are also looking to develop generic new methodological frameworks for integrated multi-scale vulnerability assessment (see www.ENSUREproject.eu and www.move-fp7.eu).

4.5 Qualitative and bottom-up approaches to assessing social vulnerability

Much of the early work on assessing social vulnerability comes from the developing world where the socio-economic and political contexts can be quite different to those in Europe. One question

to ask is whether variables used for vulnerability assessment in less developed countries are appropriate in the European context and vice versa. It can be suggested that some synergies can be found with situations in Europe and it is worth examining some of the relevant literature. According to Wisner et al. (2004: 60) *"vulnerability can be assessed reasonably precisely for a specific group of people living and working at a specific time and place, and the 'unsafe conditions' that contribute to it have been the subject of a great deal of research reviewed in [their] book", At Risk*. Dynamic pressures and root causes of vulnerability (as raised above in previous sections) are reasonably well-understood in many situations, although treatments may be highly polemical and indeed political. The uncertainties and gaps in knowledge concerning how vulnerability is linked to underlying causes or pressures have some serious implications and the links can be dismissed, particularly by those who treat disasters as a technical issue. Policy and decision makers (restricted by scarce resources) address immediate pressures and unsafe conditions while neglecting both the social causes of vulnerability and more distant root causes. According to Wisner et al. (2004), where gaps in knowledge exist these are mainly because of a failure to ask the right sort of questions. A question for CapHaz-Net is how much should we or can we focus on these root causes of vulnerability? How far can disaster managers go in addressing such aspects of vulnerability? This brings us back to the question of 'Who is responsible for reducing vulnerability and increasing resilience and social capacity'?

Wisner et al. (2004:61) state that *"it is imperative to accept that reducing vulnerability involves something very different from simply dealing with hazards by attempts to control nature … or emergency preparedness, prediction or relief, important though these are".* Although it is useful to have an understanding of the aetiology of natural hazards (Section 3), dealing with disasters as though they are equivalent to the natural hazards that trigger them is not the only answer. Therefore *"… a deeper level of analysis is required which places moves to mitigate hazards within a comprehensive understanding of the vulnerabilities they are supposed to reduce".* Taking such an approach will often be more appropriate for mitigating hazards and will emerge within the supportive environment for implementation provided by the affected people themselves.

Examples of qualitative tools and bottom-up approaches for analysing social vulnerability

The PAR model developed by Wisner et al. (2004) as an approach for analysing social vulnerability was discussed in Section 4.3.1. The Access model (Figure 4.4 - also mentioned in the WP2 report on Risk Governance) is an expanded analysis of the principle factors in the PAR model that relate to human vulnerability and exposure to hazards; it focuses on the process by which the natural event impacts upon people *and their responses*. Only parts of the model will be relevant in each situation. Elements 3 to 5 of the model link back to Section 3 of this report which focuses on the nature of the hazard. Wisner et al., (2004) review both negative and positive examples of efforts to reduce vulnerability in various less developed countries in relation to floods and coastal storms, earthquakes and volcanos through the application of the PAR model.

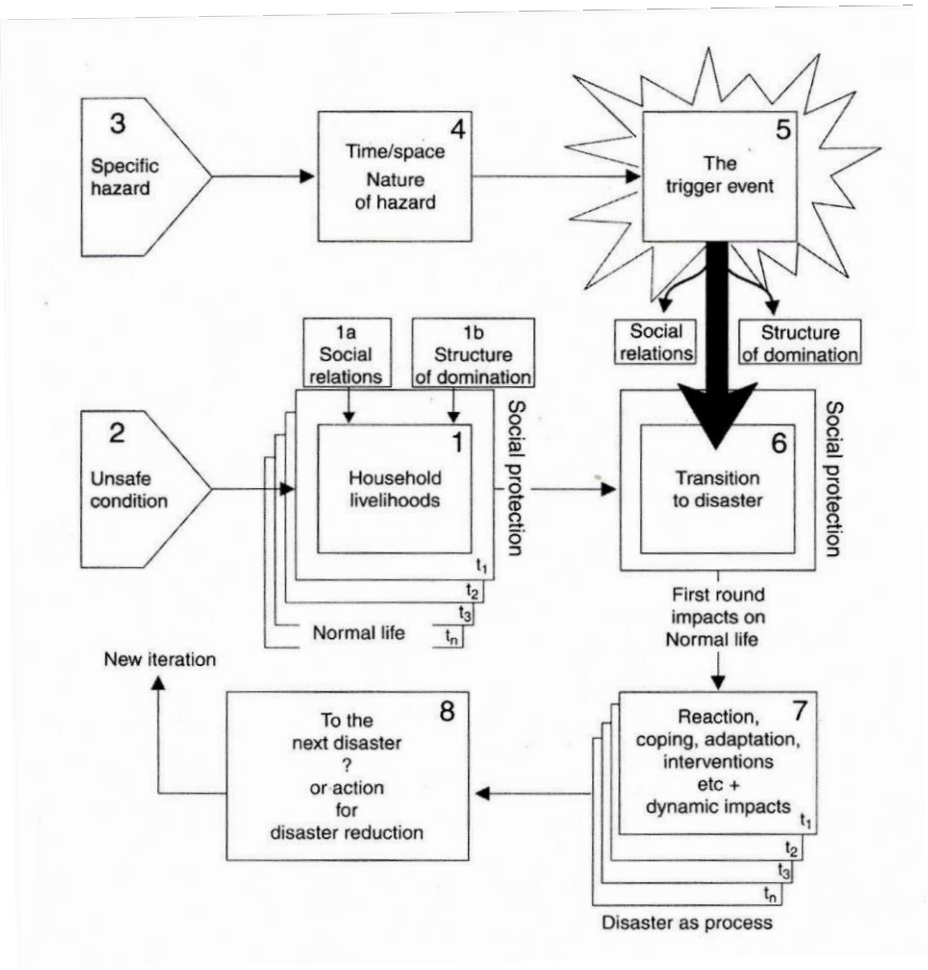


Figure 4.4: Wisner et al.'s (2004: 89) Access model.

Many other participatory assessment techniques such as Participatory Rural Appraisal (PRA), Participatory Action Research (PAR) and 'sustainable livelihoods' (SL) approaches have been developed within the context of research in less developed countries (e.g. Chambers, 1983; Chambers and Conway, 1992; Winchester, 1992; Moser, 1998; Cannon et al., 2003). These were often similar in approach to the Access model. Livelihood analysis seeks to explain how a person obtains a livelihood by drawing upon and combining five types of 'capital' which are similar to the assets that are involved in the Access model and in elements of Figure 2.2 from this report, namely: personal, social, physical, financial and natural capital.

Community or citizen-based risk assessments are another way of approaching social vulnerability assessment (Wisner, 2006). Such participatory models of research are where communities are actively engaged in the research process through partnerships e.g. with academic institutions or Non Governmental Organisations, often in relation to public health. Wisner (2006) discusses various qualitative and participatory approaches to assess vulnerability and coping capacity using such self-assessment tools.

Community-Based Participatory Research (CBPR) has been proposed as one approach that combines research methods and community capacity-building strategies to bridge the gap between knowledge produced through research and translation of this research into interventions and policies. CBPR's distinction from other community-based research approaches, which view 'community' as a setting or location, is the recognition of community as a *social entity* with a sense of identity and shared fate. CBPR actually emphasizes both

qualitative and quantitative research methods, researchers work *with* rather than *in* communities in an equal partnership and attempt to strengthen a community's problem-solving capacity through collective engagement in the research process. Communities can thus be involved in assessing their own vulnerability and addressing their own priorities for increasing their capacity to prepare for, cope with and mitigate the effects of disasters.

Much CMPR research has been in the area of public health (e.g. Israel et al., 1998; Hatch et al., 1993). Common themes are that the CBPR approach (a) recognizes the importance of social, political, cultural, and economic systems to health behaviours and outcomes; (b) engages community members in choosing research topics, developing projects, collecting data, and interpreting results; and (c) puts high priority on translation of the findings of basic, intervention, and applied research into changes in practice and policy. More difficult to prescribe, however, is the degree to which each of these criteria must be fulfilled to satisfy the elements of CBPR. However, CBPR should benefit community participants, practitioners, and researchers alike as it creates bridges between scientists and communities, allowing both to gain in knowledge and experience. This collaboration assists in developing culturally appropriate measurement instruments, thus making projects more effective and efficient.

Finally, CBPR establishes a level of trust that enhances both the quantity and the quality of data collected. The ultimate benefit is the prospect of examining the community's own unique circumstances to test and adapt best practices to its own needs. Such approaches offer significant potential for European countries to work with local communities in assessing their own vulnerability and in creating their own solutions with regard to natural hazards. As the equitable partnerships require the sharing of power and resources, this also has potential to improve risk governance (WP2).

Wisner et al., (2004: 30) thus emphasise the importance of taking a ‘bottom-up’ approach and document the importance of local knowledge and action as well as stressing the importance of the skills, capacities and political consciousness of ordinary people. They suggest seven objectives for risk reduction which are at the ‘heart’ or core of their message:

1. C = **Communicate** understanding of vulnerability
2. A = **Analyse** vulnerability
3. R = focus on **Reverse** of PAR model
4. D = emphasise sustainable **Development**
5. I = **Improve Livelihoods**
6. A = **Add Recovery**
7. C = extend to **Culture**

Emergency Management Australia, in a study on the assessment of personal and community resilience and vulnerability (adapted from ISDR, 2002:76 cf Wisner et al., 2004:337) suggest the following elements as necessary for increasing capacities and reducing vulnerability:

- Positive economic and social trends
- Access to productive livelihoods
- Sound family and social structures
- Good governance
- Established networks regionally/nationally
- Participatory community structures and management
- Suitable physical and service infrastructures

- Local plans and arrangements
- Reserve financial and material resources
- Shared community values/goals
- Environmental resilience

Examples of how social vulnerability assessment has been approached in Europe will now be discussed in the following section.

4.6 Social vulnerability assessment in Europe

A review of the literature revealed few specific studies related to social vulnerability to natural hazards in Europe. Appendix B lists studies that incorporate aspects of social vulnerability assessment. There are still many gaps in the table with only a few countries being represented. Other studies certainly exist which need to be added to the table over the course of the CapHaz-Net project e.g. from France and the Netherlands. For other countries, particularly in Eastern Europe, it is less clear how much social vulnerability to natural hazards features in government policy and practice.

A number of both qualitative and quantitative studies have been undertaken focusing on household and community impacts and responses to floods in Europe which include aspects of social vulnerability assessment, mainly on the social and economic impacts of floods and on the recovery process (e.g. Tapsell et al., 1999, 2003; Tapsell and Tunstall, 2001; Carroll et al., 2006; Tunstall et al., 2006; Werritty et al., 2007; Thieken et al., 2007; Whittle et al., 2010; Walker et al., 2010). Recent empirical studies on riverine and flash floods conducted in Italy, Germany and Great Britain for the EC FP6 FLOOD*site* project have provided some challenging insights a) on cross-country comparisons, and b) on the effectiveness of applying "classical" vulnerability indicators such as age, gender or income (see De Marchi et al. (2007; Steinführer and Kuhlicke, 2007; Tunstall et al., 2007). These findings indicate that such indicators are insufficient to explain social vulnerability. No individual, community or group was found to be *per se* highly vulnerable and no evidence for the vulnerability of certain social groups across all phases of a flood event was observed. Rather, different groups were identified as being more or less vulnerable at certain points in time within the disaster cycle, before or during the disaster or with higher damages and more psychological stress in the aftermath. Therefore the coping capacity of different groups in relation to a specific hazard needs to be considered in the different, and partially overlapping, phases of the event. One indicator which was shown to be context/location specific is that of renting property. In the UK renting is often associated with lower income social groups, while in other parts of Europe e.g. Germany, renting is common among all social groups. Thus in all the countries studied the local context was found to be very significant, and the importance of understanding this factor when analysing a natural hazard event and its impacts on individuals and communities is crucial. Two empirical examples from the FLOOD*site* project of these more contextual approaches to assessing social vulnerability are included in Section 5 below from the German and Italian studies.

In Italy, apart from the recent research by De Marchi et al. cited above and discussed in more detail in Section 5, few additional examples of social vulnerability analysis could be found. According to Maurizio Rozza (the person responsible for Agenda 21 in the province of Gorizia), *"In Italy....'risk' pertains only to physical phenomena and it is not considered to be determined also by social factors"* (Pers. Comm. 2010). Bruno (1985) evaluated the context of social

vulnerability to natural hazards by exploring the interactions between risk and vulnerability, and comparing this to the actual situation in the country. This work, and that of Pelanda (1982) identified a specific Italian sociological trend in the interpretation of natural hazards based around the perception that the pre-existing socio-systemic vulnerability of a community exacerbates 'risk'. Yet there is a general lack of contemporary literature in Italy on social aspects of vulnerability to natural hazards, and very little attention to it is paid in practice. In terms of delivery of services, in Italy it seems that risk culture and policy consider that natural risk itself causes vulnerability.

Local professional responsibilities and actions that impact on the vulnerability of communities in Italy are left to the initiative of municipal authority services such as local fire brigades, civil protection units, etc. Interestingly, although these are often the central capacity during emergencies, the label of 'reduction of social vulnerability' is rarely attached to such activities. So the notion of social vulnerability is not a mainstream concept in dealing with natural hazards in Italy. The term 'vulnerability' on the websites of the national and local units of civil protection is defined by 'identifying natural risks', instead of being seen as something that already exists in the social structure and could be mitigated in order to reduce the magnitude of the impact. From a monitoring of hydro-geological risk mitigation activities of several municipalities undertaken by a national environmental association (Legambiente, 2009), it emerges that the focus is mainly on territorial planning strategies, emergency plans and local organisation of the civil protection units i.e. on emergency capacities. No attention is paid to the underlying social conditions of the communities living in areas classified as 'risky'. However, there are local examples which show that actual steps can be taken in order to make the reduction of social vulnerability an operative task to enhance social capacity. After the earthquake of L'Aquila in 2009, the management of social issues in times of disaster has gained a new relevance. In much of the recent research (e.g. De Marchi et al. 2007; Ligi 2009) the importance of focusing on socio-cultural structures in order to fully understand the potential impact of a natural hazard is often highlighted.

The Scuola Superiore di Protezione Civile, founded in 2003, is an example of an operative application of the results of sociological research on hazards. The school, founded in 2003 with a law of the Lombardia region, provides training for volunteers and operators in the sector of civil protection, as well as certifying the validity of courses run by other institutions on the themes related to management of natural hazard. Prof. Marco Lombardi, scientific representative of the School, highlights the importance of dealing with the theme of 'risk' in an effort to reduce social vulnerability. In fact, creating specialised volunteer operators in the sector and providing them with guidelines for preventive and emergency behaviours enhances the development of individuals' responsibility towards the environment. This in turn contributes to communities that are more aware about natural hazard and therefore less vulnerable. This might fit the definition of social capacity building suggested in WP 1.

In Germany, apart from the studies mentioned above and discussed further in Box A and Section 5 below, there has also been little research focusing on social vulnerability to natural hazards. Although Birkmann (e.g. 2006, 2007) has discussed various approaches to measuring risk and vulnerability to hazards using indicators and indices, and has been influential in researching adaptation to climate change (see earlier discussion), these studies were not specifically related to Germany. However, more recently, Fekete (2010) has explored the

development of a social vulnerability index for riverine floods, and in particular upon a methodology to validate such studies - see Box A.

In the UK there have been a number of studies focusing on aspects of social vulnerability in relation to floods (e.g. Tapsell et al., 1999, 2002; 2003; Reacher et al., 2004; Carroll et al., 2006; Tunstall et al., 2006; Werrity et al., 2007; Whittle et al., 2010; Walker et al., 2010). The Environment Agency in England and Wales is currently developing a policy on vulnerability and has funded research on vulnerable or 'hard to reach' groups for the last ten years (e.g. Whittle et al. 2010; Burningham et al. 2005; Tapsell et al., 1999, 2001, 2003) in order to better understand the social impacts of flooding and recovery, to improve awareness of flood risk and flood preparedness, and for the provision of more targeted flood warnings. In the past, studies have also been carried out to assess the public perception of flooding, flood risk and structural flood alleviation schemes (see Tunstall et al., 1994) and findings have shown that flood experience is key to influencing risk awareness and response. A national database of receptors vulnerable to flooding has been produced using social flood vulnerability data based on the Social Flood Vulnerability Index (SFVI) (Tapsell et al., 2002) and census data. Information is assimilated into a GIS and query system which can be interrogated on a 100m by 100m grid scale.

The Environment Agency's nationwide Catchment Flood Management Plans and Shoreline Management Plans are required to include consideration of social vulnerability. Community and coastal Engagement Officers have recently been appointed at regional level with the express purpose of developing the Agency's capabilities and capacities for two-way collaborative engagement with external stakeholders in flood risk areas. A key element of their role is to work in partnership with local bodies and communities to help identify vulnerable social and economic groups in each community and to improve flood risk awareness and resilience among these populations. The Agency is also currently developing the Thames Estuary 2100 strategy which is likely to be the most comprehensive and integrated flood management strategy ever developed in the UK. This strategy involves many studies and analyses including ones which seek to integrate a wide range of very detailed data on flood exposure and on social and economic vulnerability throughout the Thames estuary area.

In France, according to Gaillard et al. (2010), more recent work on vulnerability has used a spatial-territorial approach (know in French as *'territoriale'*) and has tended to down play social considerations (e.g. D'Ercole et al., 2004 and Reghezza, 2006). Moreover, the presence of visible engineering structures has been said to be unrealistically reassuring of safety thus influencing people's perceptions of personal and community vulnerability, and thus increasing such vulnerability. 'Dyke risk red zones' have been reported on some of the French risk prevention plans, and this has partly contributed to why the State decided to strengthen civil security management policies with the 2004 law (Loi de modernisation de la sécurité civile) which allows the issue of municipal civil security plans (plans communaux de sauvegarde) – for a discussion see Vinet, 2007; Combe, 2007; Pigeon, 2005, 2007, 2009.

In the Eastern European states only one study was found from Romania (although others are likely to exist), where there has been little research to date on social vulnerability to natural hazards. Only one article has been published on social vulnerability to seismic risk in the city of Bucharest (see Box B below and Armas, 2008), although several other studies remain unpublished or are awaiting publication (Pers. Comm. I. Armas, 2010).

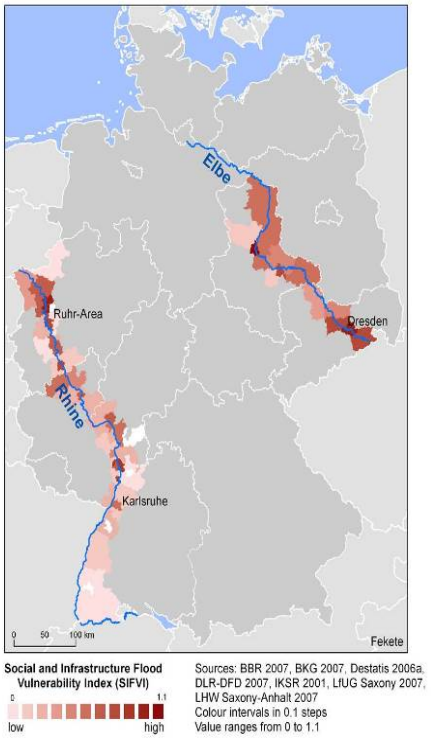
Despite the growing number of studies which are focusing on social vulnerability, a much better understanding is therefore still needed of how social vulnerability is conceptualized and

operationalised in different European countries and how these conceptualizations may underpin risk management strategies across Europe. Three empirical examples of studies from Europe are outlined in the next Section; these studies have attempted in some way to consider social vulnerability to different types of natural hazards in some detail: fluvial flooding, Alpine hazards and heat waves.

BOX A: SOCIAL AND INFRASTRUCTURE FLOOD VULNERABILITY INDEX (SIFVI)

Social Vulnerability was investigated in all counties along two rivers in Saxony, the Elbe and the Rhine.

Figure A (right): *In the study Dresden and the Ruhr area emerge as especially vulnerable areas because of population density, exposure levels and values of social susceptibility.*



A social and infrastructure flood vulnerability index (SIFVI) was developed by using demographic variables. It combines social status, location and flooding exposure. Data were aggregated at a range of scales. The validation set were 1700 households in the counties along the Elbe and the Rhine.

There were some difficulties in collection of data in a federal system. Another challenge lies in the choice of scale and which effects are specific on county level. The **relevancy and use of indicators** varied depending on the **scale of application of the methodology**.

It was argued that social inequalities are not in and of themselves indicators of vulnerability, and that therefore social vulnerability in this case study area needs a new perspective. It seemed important to the researcher to point out that the event probability is not vulnerability measure, and to differentiate between economic and social vulnerability

Other research by the UNITED NATIONS UNIVERSITY – Institute for Environment and Human Security (UNU-EHS) argues that **vulnerability assessment is a precondition for identifying adaptation measures**, especially to climate change. Bringing in another view on the study formerly conducted at UNU-EHS, the concept of **criticality** was explored. This brings into play physical vulnerability estimates, in which an emphasis was placed on the criticality of particular infrastructures which are defined as those with particular relevance to society in the face of outages of vital services. It was pointed out that the duration and timing of an outage could be important in identifying this threshold of criticality. Criticality viewed this way could be regarded as a new research area, and its value and meaning could form part of a vulnerability analysis in general. The contrasting approaches suggest that the differing approaches exposed some **interdisciplinary challenges between physical and social definitions of vulnerability**. The Federal Office of Civil Protection and Disaster Assistance (BBK) in Germany currently explores both concepts – criticality and vulnerability within the infrastructure-society nexus. The BBK also approaches proactive planning for emergencies using scenarios, emphasising these need to be plausible, and integrative so that the chain of unlucky events and interdependencies that might trigger a disaster could be identified. A need to streamline the perceptions of risk managers was also identified.

BOX B: PERCEPTION OF SEISMIC RISK EXPLAINED BY LEVELS OF VULNERABILITY TO SEISMIC HAZARD IN BUCHAREST

Armas (2008) studies the overall vulnerability, including social vulnerability, of the city of Bucharest, (Romania) to seismic events. Based on the building stock vulnerability criteria and the environmental vulnerability, in terms of level of seismic hazard, the historic city centre scores high. Frequently, brick buildings are in poor repair, and many of them are in total ruin today. A population of modest means now inhabits these buildings. Most of the buildings are included in categories of the greatest seismic vulnerability, and were built between 1875 and 1940.

The **total vulnerability** of the analysed urban space was calculated by dividing the total human vulnerability values by a composite "capacity" factor. For the latter, two indicators were used: *preparedness level* (expressed through distance to hospitals, fire stations and police stations) and *awareness level* (based on the literacy rate). An important finding was that the configuration of total vulnerability classes *(Figure A)* reveals a radial spatial pattern with values increasing from the central to the marginal areas.

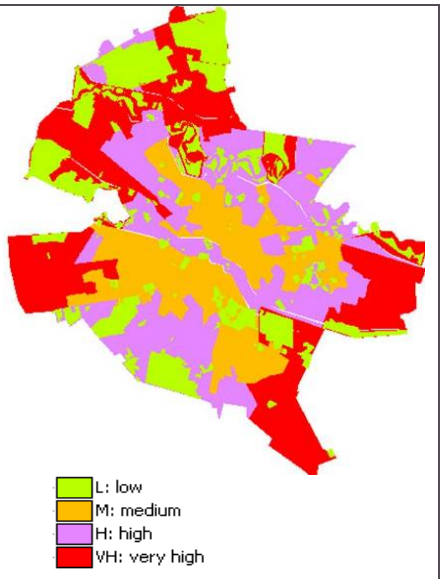


Figure A: *Total vulnerability in relation to composite "capacity", Bucharest City.*

The total vulnerability index map resulted from spatial composite indicators: *social, economic* and *building stock vulnerability criteria*, for describing human vulnerability, and by adding the *environmental vulnerability* into the spatial multi-criteria analysis (*Figure B*).

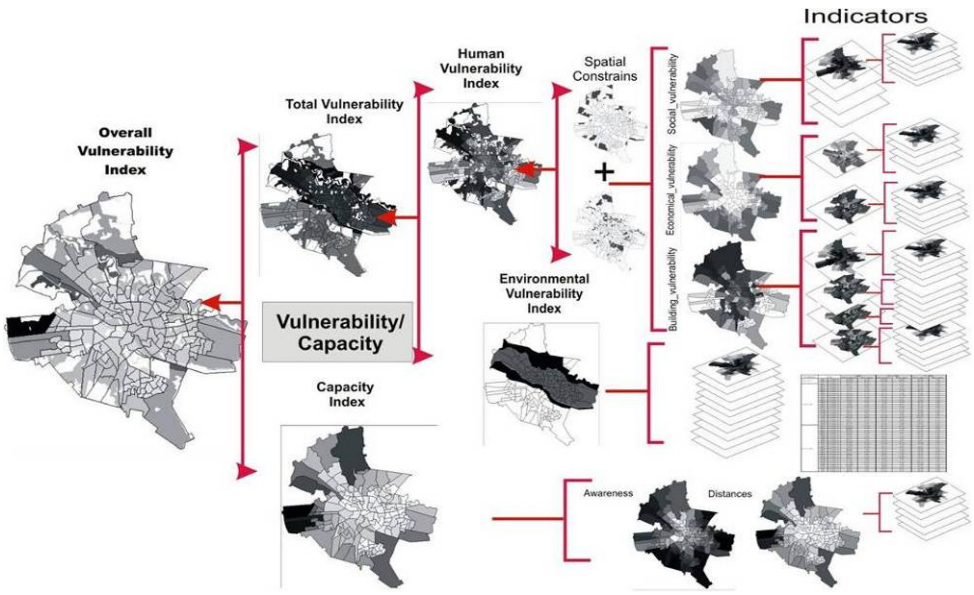


Figure B: *the multi-criteria methodology as a flowchart, showing social vulnerability as a subset of overall vulnerability.*

5 Empirical examples of social vulnerability in relation to natural hazards

5.1 Fluvial flooding in Germany (contribution from UFZ)

Table 3.2 suggests that slow rising fluvial floods can be regarded as having the following characteristics: predictable onset, generation apart from receptor sites, and relatively long-term persistence. These characteristics of fluvial floods mean that modelling of the hazard and predicting its onset before the flood hits are to various degrees possible. For hazards with this aetiology, proactive preparations and warnings are a realistic part of the capability of the institutional response which may contribute to reducing social vulnerability, although the realisation of this varies considerably with the sophistication of local technologies and governance structures. The ability to proactively model and manage these events distinguishes hydrological and geohazards in general from technological hazards, so that preparedness differs accordingly in many European countries, as discussed in WP1 report (Social Capacity Building). Figure 5.1 displays the hazard-related societal and professional activities during these types of hazards in a phase-sensitive way.

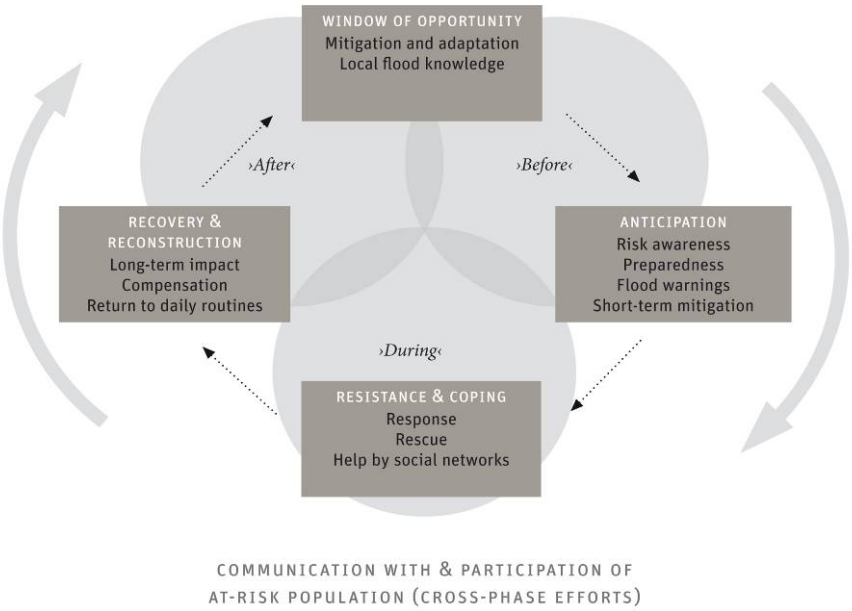


Figure 5.1: Temporal phases investigated in the Mulde study (Steinführer et al. 2009b).

5.1.1 Outline

Social dimensions of the Mulde 2002 flood were investigated within the frame of the FP6 Integrated Project FLOOD*site*[1]. In CapHaz-Net's WP2 report on Risk Governance the institutional framework through these stages in the Mulde region were described. However, the coping capacity of social groups in the overlapping phases of the event (anticipation, resistance and coping, recovery and reconstruction), were found to vary during the 'hazard cycle'. In this

[1] The work described in this section is based upon contribution to FLOODsite's Task 11 between 2004 and 2009 by researchers at UFZ. Comparative case studies were conducted in Germany, Italy and the U.K. (Steinführer et al. 2009). This work gained much inspiration from the cooperation with Bruna De Marchi and Anna Scolobig (ISIG) as well as with Sue Tapsell, Sylvia Tunstall, Amalia Fernandez-Bilbao and Colin Green (FHRC). FLOODsite – "Integrated Flood Risk Analysis and Management Methodologies" – was funded by the European Community's Sixth Framework Program (contract GOCE-CT-2004-505420; http://www.floodsite.net).

section of the report, the focus is on the empirical findings in relation to social vulnerability during those floods (for detailed analysis see Steinführer and Kuhlicke 2007 and, with a focus on surprise and ignorance: Kuhlicke 2008).

5.1.2 The Mulde flood 2002

In 2002, a major flood occurred in the Central European river basin of the Elbe and affected a number of tributaries and territories in Germany and the Czech Republic. It was the single most expensive flood in German history, amounting to economic losses of 11.6 billion Euros[2] (Schwarze and Wagner 2007). The Vereinigte Mulde was one of the worst affected tributaries. Although fluvial, the 1:250 r.i. flood in August 2002 had some characteristics of a flash flood, even in the flat areas of Saxony, having a fast onset and very high velocities.

The research was carried out in 2005/2006 in three locations in the Saxon section of Vereinigte Mulde. The village of Sermuth (population 600 in 2005) is divided by the Zwickauer Mulde, and both farm buildings and residential homes are to be found close to the river. Erlln (population 90 in 2005) is a village located at the end of a single one-way road just behind the dike and in close vicinity to the confluence of the Zwickauer and the Freiberger Mulde to the Vereinigte Mulde. Eilenburg is a small town with a population of around 17,500 in 2005. Several residential areas are close to the Vereinigte Mulde, and in all three areas the population affected needed to be evacuated.

5.1.3 Research approach

This study applied the definition of social vulnerability used by Blaikie et al. (1994), which is *"…the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist, and recover from the impact of a natural hazard"* (ibid., 9). Since an aim was to identify the main factors which influence residents' vulnerability before, during and after the flood events, this definition is selected because it appears to emphasise both the social and temporal dimensions of the hazard during the 'hazard cycle'. It was felt that to capture people's vulnerabilities to flooding at each single phase, different issues needed to be investigated.

First, the social and temporal contextual conditions of the flood in certain locations, and under specific conditions of risk governance, were explored by means of a standardized questionnaire survey and some additional techniques. Second, methodological issues were addressed by reviewing a wide range of indicators and indices for their efficacy in explaining people's vulnerability (Tapsell et al., 2005). This indicator work was paralleled by qualitative, participatory exploration to understand individual's own views on their vulnerability. Emergent themes were supplemented by evidence from previous work in other European settings (De Marchi et al., 2007; Tunstall et al., 2007; Steinführer et al. 2007).

5.1.4 Research design

To undertake the fieldwork, certain socio-economic and socio-demographic groups with a potentially higher vulnerability to flooding were identified based on sociological and geographical hazard research, but also on more general ideas of the sociology of social inequality (Steinführer et al. 2009a/b). For instance, factors such as age, dependency, educational qualification,

[2] However, when all of the private donations and governmental reimbursement payments are added together, it is suggested that more than 100% of the damages were compensated for (Mechler and Weichselgartner 2003).

employment and income were considered as characterizing social groups exhibiting a higher vulnerability than people without this specific feature. Some additional location/event specific indicators were also identified such as membership of local fire brigades/civil protection groups, depth of flood waters, and length of evacuation. A second category of potentially more vulnerable groups was derived from deliberations about the role of social networks in general, and especially through the course of a disaster. Specific focus was also paid to four varying classes of persons defined by having varying degrees of social integration.

A third group of tested variables focused around tenure and gender. Other factors, like level of personal or household preparedness, and degree of engagement or dissatisfaction with compensation for the 2002 flood damages, emerged from interviews ex-ante. Finally, related to the hazard aetiology, the effect of other factors were also considered, such as the obvious variation with engagement with the flood that emerges due to variations in property location and degree of onset of local flooding.

5.1.5 Research findings: variations by phase of the hazard flood cycle (see Figure 5.1).

In the **anticipation Phase**, the majority of the respondents felt by no means prepared for a flood on the scale of the 2002 flood. Moreover, when tested, none of the hypothesised variables strongly explained behavioural and attitudinal differences. But tenure plays a role, since owner-occupiers applied precautionary measures as well as insurance significantly more often than renters. Age mattered, but only because it was to a higher degree elderly people who were holding insurance policies before the flood[3]. Income also plays a part, since insurance was more often held by wealthier respondents. In the period shortly before the flood, it appears that ad-hoc activities are particularly important for reducing material vulnerability. However, the majority of people simply left their homes without taking any action. Again tenure was of importance, since home owners more often tried to secure as many things as possible during the early flood onset.

In spite of all activities before the water actually inundated the residents' homes, in the **resistance and coping phase,** the individual efforts to reduce material vulnerability did not have any influence on the economic damage. Neither long-term precautionary nor ad-hoc activities nor receiving a warning led to a significant damage decrease, and in some cases losses were even more substantial than for people who did not apply any measure, so the picture is somewhat contradictory. The only satisfactory explanatory factor is once more tenure: renters (in Eilenburg centre) were significantly less affected than owner-occupiers (in all other neighbourhoods), both with respect to buildings and to contents. Information emerges as crucial for coping with the immediate situation. Respondents aged over 60 years, as well as people with a low formal qualification, seem to have received less support. Networks were important, and the analysis showed that family members, friends and other informal networks emerged as the most important resources people relied upon.

In the **recovery and reconstruction phase** the flood's impact on the household most clearly varied with age and tenure: elderly people as well as home-owners perceive the impact as most severe and the physical and mental health impact on those over 60 years old appears particularly bad. However, the extensive degree of monetary compensation during the reimbursement process after the flood seems to have profoundly increased satisfaction with

[3] However, this finding may only be relevant to East Germany, as flooding there was formerly covered by normal household contents insurance until 1990

material compensation, which is uniformly very high, and variance is low. Although the level of awareness and also of preparedness increased after the flood, still the majority of the residents did not change anything in their homes in order to be more adequately prepared for any future flood, so there seems to be little evidence of social learning. Alternatively the high level of post-flood compensation can explain the lack of activity in improving preparedness for a future similar event. Tenure was explored again, and owner-occupiers reported being more inclined to pursue constructional changes in their buildings and to take up or improve their existing insurance policies than renters, whereas renters more often fitted the interior of their flats to a possible flood in the recovery and reconstruction phase.

Generally, although differences in behaviour and preparedness varied by stages in the hazard cycle, empirical analysis provided evidence that a strict ex-ante assumption concerning social vulnerability and behaviour at different stages based solely on socio-economic variables is not meaningful in the case of the 2002 Mulde flood.

5.1.6 Alternative interpretations: non-knowledge and surprise in relation to floods

Since the quantitative analysis by region or phase of the hazard cycle only poorly explained reported social vulnerability, in a further step of research, questions of non-knowledge, ignorance and surprise were explored (Kuhlicke, 2007 and 2008). In this, it was assumed that the 'normal' flood experience in the region under investigation is largely defined by regularly and relatively-often-occurring minor floods. Being thus used to a certain type of flooding, people developed specific mitigation and adaptation strategies in coping with the risk of being flooded at that level and no other. Yet this type of knowledge becomes problematical during a much more extreme flood like the 2002 Mulde event, which exceeded people's imagination. Prior to the flood an institutionalized space of experience and horizon of expectation existed, in which the possibility that the "stability" of the river is artificially created by engineering achievements to reduce its naturally given variability had not been recognized by the local population. Subsequently, an alternative understanding of vulnerability was proposed, which allows capturing the dynamics of surprise (Kuhlicke, 2008).

5.1.7 Implications

The empirical results of the Mulde flood research support the view that when the entire population lives on the floodplain literally everybody is vulnerable to a very extreme event such as occurred in 2002. The result is a local "risk society" (Beck 1992) that is always to some degree vulnerable. Given this observation, in areas where hazards regularly impact like in the study area, capturing vulnerability by exploring vulnerability-associated factors reveals a quite diverse picture from which it is a struggle to generalise. It was a help to take a the phase-oriented approach as discussed around Figure 5:1, as this provided valuable insights showing that at different points in time "performances" of different social groups and also of the actors in the single research locations varied. So the results emphasise the importance of applying a sensitive case-study-specific approach to capturing social vulnerability, one which not only relies on demography, but also one that captures important variations in vulnerability and risk perception that change during phases of the hazard cycle.

5.2 Alpine hazards (contribution from ISIG)

Natural hazards in alpine regions, such as flash floods, avalanches, debris flows, and landslides are generally characterised by short lead times and high levels of uncertainty, hitting receptor communities with limited possibility of forecasting and warning. Table 3.2 suggests relatively rapid generation which is also physically separated from receptor sites, and if sediment transfer due to debris flow is involved, there can be very long-term persistence of new debris and rubble on the ground in the receptor sites which influences recovery.

5.2.1 Outline

The case study presented here is focused on an Italian Alpine region, Trentino Alto Adige, which corresponds to the upper Adige/Sarca river basin. In this region the main types of hazard include both torrential processes (this includes flash floods and debris flows) and in some cases the flashier type of fluvial river floods. Before the year of study, the area already had a record of regular events – for instance in the autumn of 2000 totals for the three months locally exceeded 1000 mm. An exceptional rainfall of 150-250 mm fell in just five days in November 2000, and a series of subsequent flash floods affected several towns and villages in the region causing landslides and debris flows. Similar events happened in the year 2002.

5.2.2 Flash floods in an Italian alpine region

In the following discussion, the focus is on events in November 2000 and 2002 in four locations in the province of Trento: Romagnano, Roverè della Luna, Bocenago and Vermiglio. Long-lasting rains had brought the soil to saturation point and even minor rain events caused landslides, debris flows and flash floods. In Romagnano (population 1,272 in 2001) almost 500 people were evacuated. A huge, slowly evolving, landslide affected the uppermost portion of the village of Roverè della Luna, which generated a sequence of debris (hyper-concentrated) flows each characterised by a volume of around 1,500-2,000 m^3. A highly hazardous situation ensued in which debris filled a local creek, and the entire village had to be evacuated. In Bocenago (population 327 in 2001), a debris flow in November 2002 hit the village and several houses, forcing the evacuation of about 150 people for one week. The last site, Vermiglio (population 1856 in 2001), was hit by two consecutive debris flows in a short time interval, in 2000 and 2002. Both events caused damage and a stream broke its banks three times, destroying three bridges and only immediate interventions from the local voluntary fire brigade unit prevented further serious damage. In general, the events in the four communities had similar characteristics.

A long local tradition relates to risk and emergency management in the area; regional residents live with hydrological and geohazard risk and since these types of events are quite frequent in the area, residents are expected to be familiar with living with these risks. Not only local authorities and services, but also many citizens belonging to voluntary organisations are involved in risk prevention and mitigation activities. Every village has a local voluntary fire brigade corps, well trained in facing emergencies, and since provincial services cannot respond rapidly enough in high mountain areas, these brigades are often the most immediate hazard response service. The brigades have a deep knowledge of the territory, and have a recognised capacity to coordinate and manage emergencies.

However, variations in village and community identity and structure were identified in the research. Bocenago and Vermiglio are located in high mountains and provincial services of civil

protection do not intervene directly in almost all the emergencies. Roverè della Luna and Romagnano, being located not far from Trento, were more urbanised. In 2005 research was undertaken in these four locations within the FLOOD*site* project, focusing on the social components of vulnerability and the role of social capital. The research aimed to better understand both the dynamics of social vulnerability and the impacts of flash floods on households and local communities; communities that varied socially. Among other things the research hoped to critically address the conceptual and analytical traps and opportunities that social capital presents in social vulnerability assessment. One initial research hypothesis to be tested was that factors which reduce social capital are likely to increase social vulnerability.

5.2.3 Social vulnerability and social capital

As discussed in WP 1 (Social Capacity Building), social capital is essentially about *"…the value of social networks which affects the productivity and capability of individuals and groups."* Those factors and values which reduce individual and/or community ability to develop collective, structurally-organised ways of dealing with natural events are considered under this definition. The interest in social capital within social vulnerability studies represents a move towards a concern for the relations between agents, which act to reduce or improve individual and collective capacity to anticipate, cope with and recover from the impact of a natural hazard. From this perspective, attention can focus on the networks between individuals, social groups, organisations, authorities, according to their given and accepted roles and their ways of acting or operating. In this way, social vulnerability can be conceptualised in a more systemic way, rather than considering it as just the sum of properties or attributes of individuals. So in this context, this research explores the "operationalisation" of social capital. First the research design is presented followed by the main results.

5.2.4 Integration of research methods

The research design involved the triangulation of different methods and techniques for collecting information including both data amenable to statistical treatment and narratives subject to hermeneutical interpretation. The process was a recursive one, where each phase provided inputs for the next one and received feedback from it. The research involved an initial phase of semi-structured interviews and focus groups with local experts (e.g. officers from agencies in charge of civil protection or risk mitigation, officers from municipal services and members of the voluntary fire brigade, geologists, politicians, community leaders, etc.).

Participant observation in the selected sites was also undertaken alongside questionnaire surveys, with standardized questionnaires and face-to-face interviews with 100 local residents in each community. The sample included quotas according to such variables as gender, age, education, and level of risk exposure (De Marchi et al., 2007). The questionnaire aimed to examine residents' behaviour before, during and after the events, their changing attitudes towards risk and safety, their personal knowledge about hydro geological phenomena, the precautionary measures they adopted before and after the flash floods, and their opinions on risk mitigation measures. The role played by social capital in influencing the way people face a threat, and act to reduce their vulnerability was also a research topic

Social capital was operationalised in the questionnaire survey by means of six indicators and indices: an index of "*community embedding*" created by combining a number of variables related to the evaluations about the feeling of belonging, trust, friendship and solidarity among

people living in the village; respondents' *social networks type and location* (formality, quality, geographical range and strength); and *social advice* and *support networks* during the event. The respondents' reported *level of trust in local authorities* was also considered as an additional index of social capital.

5.2.5 Measuring social capital

Community "embedding" proved to be one of the most meaningful indexes of social capital in relation to residents' vulnerability[4]. In general, respondents with a high community embedding proved to be less vulnerable. They received more help during the events, showed a higher level of knowledge about hydro-geological phenomena, considered their communities more prepared to face future events and were also more aware of the available coping mechanisms. In particular, they were familiar with the functioning of the community support networks and knew whom to turn to, or not turn to, for help.

Research results suggest both social network type (kin, friend, mixed, no network) and location (local, external, mixed, no network) played a minimal role in influencing respondents' behaviours or attitudes in almost all the phases of the event, but advice networks in particular made the difference in residents' evaluations about the level of help received during the event, their preparedness and their trust in local authorities. In short, those relying on formal networks (i.e. local fire brigade corps and local authorities) for advice or support can be considered less vulnerable than the others (De Marchi et al., 2007). Results concerning the level of trust in local authorities varied, and further research is needed to better understand the influence of this index on social vulnerability. More precisely a high level of trust in local authorities seems to foster the residents' attitude of delegation of responsibility for safety to the services in charge. In its own turn, this delegation increases individual vulnerability by reducing the motivation for actions aimed at self protection.

5.2.6 Understanding the internal working of social capital

This section presents findings from focus groups and semi-structured interviews which were undertaken to explore some of the intangible and therefore possibly unmeasurable aspects of social capital which may contribute to increased social vulnerability at the local level.

The research explored the effect of three main processes related to changes in social capital through time: i) the progressive loss of local knowledge about risk mitigation practices, which was passed down through generations in the past; ii) the complexities of interactions between services and citizens, and more precisely the share of responsibility for preparedness and emergency management; and iii) governance issues: the complex relationships between provincial and municipal services whose competences often overlap for risk communication and emergency management issues.

The importance of local knowledge in relation to environmental hazards and disasters has already been highlighted in several studies (Dekens, 2007; Mitchell, 2006; Haynes, 2005; Cronin et al., 2004; Howell, 2003). Local information informs forecasting and warning, escape routes and safe places, key actors to contact in case of need, etc. In the view of many interviewees, the links which allowed the preservation of this knowledge in the past, have weakened or no longer

[4] Social embeddedness is defined as "… the extent to which an individual experiences solidarity, feelings of belonging, and friendship in a social setting" – De Marchi et al., 2007.

work at all mostly due to population and demographic change. For example, because of the depopulation of the mountain areas in the past decades, traditional keepers of the local knowledge are no longer present. This is more worrying in the urban sites because it is here that more frequent immigration phenomena take place, and people who move are often unaware of the risk and appropriate response.

Other crucial elements when analysing the influence of social capital on vulnerability are the networks between citizens and services/local authorities. Members of the fire brigade corps point out that, paradoxically, the good performance encourages residents' progressive disengagement with a culture of self-protection. At the same time these results need to be viewed with care, because the same officers of services and agencies sometimes give the message (more or less explicit) that "they are those in charge" and their mission is to guarantee a high standard of safety. Therefore it may seem quite contradictory to point out the residents' disengagement with self protection; why should people be responsible for taking care of their own safety and protection measures if it is someone else's task?

The last critical point regards governance issues (see WP2). More precisely, one of the problems underlined by local experts regards local governance and mixed ownership of responsibilities, which causes a lack of clarity on the issuing of warnings, the coordination and the management of emergencies, the planning of the territory, and the definition of risky areas.

5.2.7 Summary

The results presented underline how some dimensions of social capital play a key role in influencing vulnerability dynamics. A high level of community embedding, together with the reliance on civil protection and voluntary fire brigades for advice and support, considerably reduces residents' vulnerability. The ways these relations among residents and between them and the services are shaped and cultivated makes the difference in determining their level of vulnerability to alpine hazards and flash floods. This also means that what residents can do depends also on what the services do, and on the reciprocal expectations in terms of actions and responsibilities.

5.3 Heat waves in Europe (contribution from Lancaster University and UAB)

Table 3.2 suggests that heat waves can be regarded as having the following characteristics: rapid onset, generation and receptor sites not disjunct, and relatively long-term persistence. These characteristics of the heat wave in Europe in the summer of 2003 all affected the receiving population's ability to respond. But this hazard, the hazard of heat, is hard to define simply by temperature – for instance the spread of the heat wave problem is inherently one of relative heat difference (rather than absolute heat levels), or what is usual compared to what is 'extreme' in any one setting (Kalkstein and Davis, 1989). So more than any other type of natural hazard, this hazard has a physical definition that is hard to separate from its cultural context.

5.3.1 Introduction

If mortality can be regarded as symptomatic of heat wave intensity, this may be one of the most underestimated hazards, as they can cause increased mortality rates due to heatstroke for up to two years following the event (Robine et al., 2007). In the European heat wave of August 2003 (Kosatsky, 2005 – Figure 5.2, Map 1), over 50,000 excess deaths are now thought to have

occurred. Climate change predictions suggest that, in the future, events like that of August 2003 will increase in intensity, frequency and duration, with potentially serious implications for heat related mortality (Meehl et al., 2004; McGeehin et al., 2001;Brown et al., 2005; Schar et al., 2004).

Map 1: Daily death frequencies cumulated from August 3rd to 16th 2003, divided by fourteen times the daily reference median frequency for 1998-2002 summer period, sixteen European countries, NUTS 2.

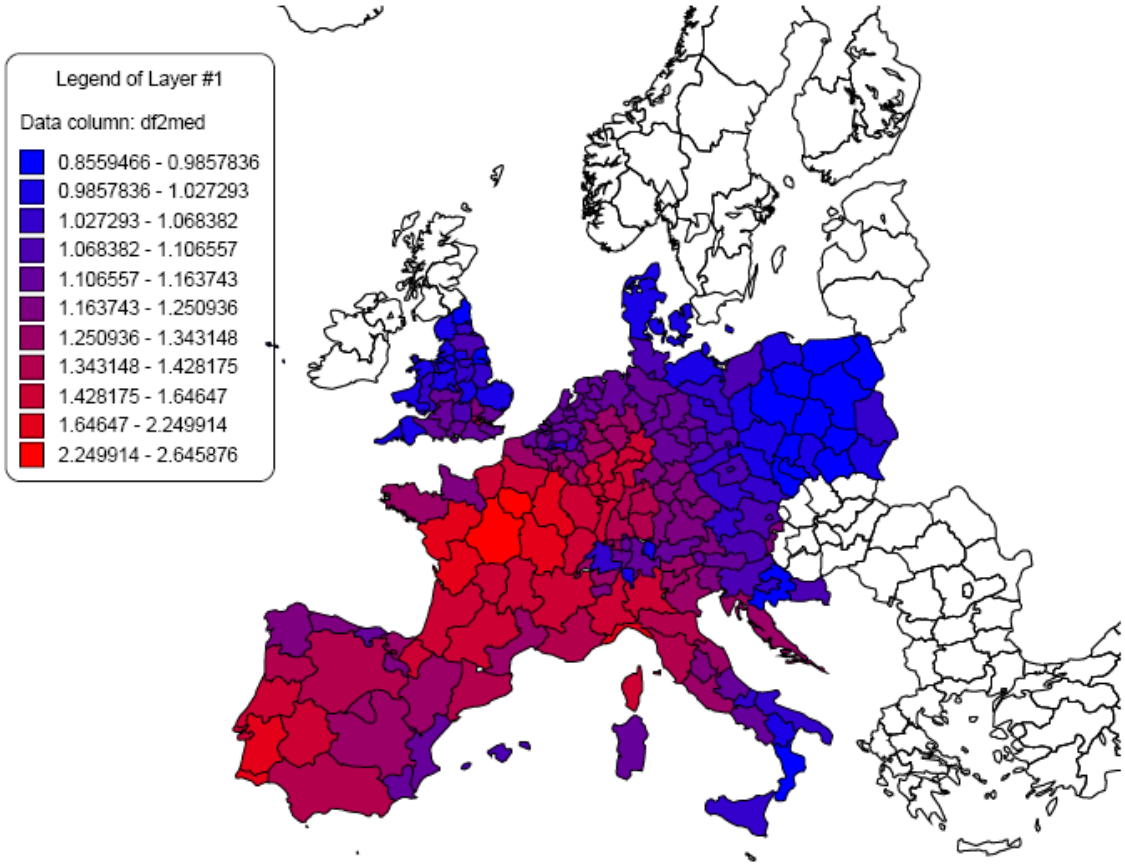


Figure 5.2: Frequency of daily deaths across Europe in August 2003.

The research literature on heat wave vulnerability has to-date largely concentrated on developing epidemiological evidence of mortality during heat waves, identifying certain demographic and social groups as more vulnerable to the effects of 'unusual heat' than others. However, beyond identifying older people as especially vulnerable, such evidence provides a mixed and inconsistent picture across geographical settings and scale, which suggests that the contextual and social dimensions may be hard to capture. Ethnographic and qualitative work is beginning to demonstrate some of this complexity.

To date, our understanding of vulnerability during heat waves is based largely on the epidemiological analysis of past mortality data. Such analysis, undertaken in different parts of the world and at different scales, has highlighted which demographic groups are most vulnerable to death during heat waves, and has revealed various patterns in mortality. These demographic studies have focused on the following factors most associated with vulnerability to heat waves; age, gender and income. Within Europe older people have been found to be the most vulnerable group, for example, in studies focused on Madrid (Diaz et al., 2002b), Italy (Conti et al., 2004),

France (Foulliet et al., 2006) and the Netherlands (Garssen et al., 2005) among others. The scale of the increase is made clear by Foulliet et al.'s (2006) analysis of the heat-related mortality during the 2003 heat wave in France. Of the 14,729 excess deaths that occurred in total 11,731 were amongst people aged 75 and over, while only 2,930 were younger than 75 (Figure 5.2). 45,000 of the deaths were recorded in August and the rest in between June and September 2003. However, not all old people appear to be equally vulnerable and, as discussed below, it is clear that patterns of variation in mortality cannot only be ascribed to matters of physiology.

In studies examining differences by gender, the pattern of vulnerability is less clear. Both men and women have been shown to be at heightened risk in studies undertaken in different locations. In Europe, women have comprised a higher percentage of the observed excess deaths in Rome (Michelozzi et al., 2004), Seville (Diaz et al., 2002a), London (Rooney at al., 1998), Vienna (Hutter et al., 2007), Birmingham, (Ellis et al., 1979), Barcelona (Borrell et al., 2006) England and Wales (Hajat et al., 2007), France (Fouillet et al., 2006) and the Czech Republic (Kysely and Huth, 2004). The spatial extent of the pattern within Europe and the period of time over which it has been observed again suggest that the findings are robust.

However, relying upon solely physiological explanations becomes more problematic as other parameters of difference are examined in the mortality data and other potential dimensions of vulnerability begin to emerge, for instance ethnicity as studied in several US papers. Outside the USA, in general researchers have found that the impact of socio-economic status on vulnerability to heat waves is less clear. Studies showed it to have no bearing on heat related deaths in Australia (Guest et al., 1999) and Sao Paulo (Gouveia et al., 2002), but a strong impact in Rome (Michelozzi et al., 2004).

Despite such complexities in the data it has become increasingly clear that it is a reduction in people's **capacity to adapt** in hot conditions and/or an **increased exposure** to the heat that is making them vulnerable. Exactly how these vulnerabilities are manifested seems to have some common themes in both Europe and the USA. In the USA, people's capacity to adapt was inhibited by their spending prolonged periods in bed, being unable to care for themselves, and by not leaving home every day, while living on the top floor of a building was a key way in which people were exposed to higher levels of heat than they otherwise might have been (Semenza et al., 1996). Research in France has similarly identified a lack of mobility, sleeping on the top floor of a building, and building characteristics such as a lack of thermal insulation as risk factors (Vandentorren, 2006). A key difference between the two countries seems to be the risk borne by older people living alone. In the USA the risk of heat related death increases (Semenza et al., 1996) but in France living alone was associated with no increased risk (Bouchama et al., 2007). The difference is further exemplified by studies focusing on where people lived at the time of death. As discussed further below, in both France and England research identified that in the 2003 heat wave mortality increased most in what are termed institutions and retirement homes in France (Foulliet et al., 2006) and residential and nursing homes in the UK (Kovats, 2006; Hajat et al. 2007), environments in which older people are rarely alone.

5.3.2 Spanish heat waves in 1991, 1995 and 2003

The numbers in Figure 5.2 clearly show the severity of the 2003 European heat wave hazard. In Spain, however, earlier heat waves of 1991 and 1995 had a higher impact on mortality (Diaz et al., 2004). Following the 2003 heat wave, however, media coverage was high and a surveillance

and warning system were discussed. The intensity of a heat wave (Ballenstar, 1997) can be assessed by the difference in the normal temperature in the region during that time of year and the current heat wave[5]. In a study of the city of Madrid (Diaz et al., 2004) by this criterion the 2003 heat wave was actually of a lower intensity and contributed to lower excess mortality than the two earlier heat waves (Table 5.1).

Table 5.1: Excess mortality attributable to the heat waves of various years in the municipality of Madrid. Taken and Translated from Diaz, et al. 2004.

	July- August 1991	July-August 1995	July-August 2003
Index of the Intensity of heat wave	23.8 º C	22.7 º C	8.2 º C
Excess mortality (IC95%)	408.9 (234.9 579.7).	400.0 (230.0 567.6)	140.9 (80.8 199.6).

5.3.3 Epidemiology of inequalities

Socio-economic inequalities produce health inequalities because economic position and the social circumstances of a social sector can determine to a great extent their living and working conditions, the quality of their housing and environment, the degree of education, access and use of services and resources, and their health and lifestyles (Lemkow, 2002; Borrell et al., 2004; Muntaner, 2004; Galobardes, et al., 2006). A discussion of the concept in Spain is given by Borrell & Pasarin (1999). Unemployment has both material and psychological factors on health, and occupation status can increase vulnerability towards heat waves, particularly working outdoors for prolonged periods (i.e. utility crews, construction crews) (State Emergency Management Agency, 2009).

Housing in cities brings with it new urban morphologies leading to new patterns of social and residential segregation, as well as new and deep social inequalities. The existence of socially vulnerable areas (often highly visible and easy identifiable) in the city, with problems of inequality and accumulation of risks (and interacting risks) has considerable implications for social policies and health and especially for what we call the epidemiology of inequalities. Some neighbourhoods accumulate more risks (both social and environmental) and from this reality distinct from the city one can begin to analyse in more detail the epidemiology of the inequalities that have an expression in the urban space (Lemkow, 2002). Deaths from heat waves seem to occur more frequently in urban areas (Arguad, et al., 2007; Rey et al., 2009), since a well insulated building will warm up slower than one with less insulation (Kovats & Jendritzky, 2006), and insulated buildings are typically associated with higher income areas.

In line with the ideas from health epidemiology that first began twenty years earlier and continued until the early 1970s, mortality rates in both men and women of 35 or more years old in Groups I and II[6] have been falling regularly while in Groups IV and V they have even deteriorated, but during heat waves they are still vulnerable. In a study of the elderly in Seville (Diaz, et al., 2004), 43 excess deaths were reported in 2003 and about 92.4 and 90.1 in 1991 and 1995, respectively (Table 5.2). The analyses were based on excess mortality in previous year to the current heat wave, using data between 1958 and 1997.

[5] Methodological details in Diaz et. al 2005 (English), Diaz et. al. (2004) Spanish

[6] Refers to the Registrar General of the UK categories, it has 6 categories and uses occupation as the basis for class, I being the highest and V the lowest.

Table 5.2: Excess mortality attributable to the heat waves in the municipality of Seville in the group of over 65 years. Taken and translated from Diaz, et. al. 2004.

	July- August 1991	July-August 1995	July-August 2003
Index of the Intensity of heat wave	26.9 º C	26.2 º C	12.5 º C
Excess mortality (IC95%)	92.4 (43.8 141.0)	90.1 (42.7 137.3)	43.0 (20.4 65.5).

Heat waves seem to be a hazard that identifies class. Studies statistically treating the excess mortality data during heat waves have found some association of lower socio-economic positions to increase mortality in Barcelona and France (a two-fold increase in the most deprived group - Borrell, 2006; Rey, et al., 2009). However, it may not be the same for ethnicity and socio-economic status. One complication in heat wave investigations in Spain is that heat tolerance is modulated by experience of outdoor temperature early in life (Vigotti et al., 2006). There are large immigrant areas in major cities like Barcelona who may typically be accustomed to higher temperatures, living in lower socio-economic sections of the city (Brucker, 2005). In some ways, since economic deprivation and immigrant communities are thus positively correlated, there may be an inverse relationship between vulnerability to heat and socio-economic status in some sectors of Spanish urban communities.

5.3.4 Institutional 'hot potatoes' – reporting deaths

There are still issues with allocating the death rates to heat waves, rather than other mixed causes when heat is merely a trigger. There are political issues here and governments do need to consider the effect of the communication of high death rates to the public; they seem even more pertinent in relation to the high death toll in previous heat waves in Spain (Diaz et al., 2004). According to these studies, the *difference* in temperature in 2003 was less, causing fewer deaths. Nevertheless it was the event that triggered a heat surveillance plan in Spain, perhaps due to the media coverage in the European region (Llasat-Botija et al.,, 2007). The change in the institutional reaction to heat waves in Spain is on-going. This brings in issues of risk communication, as discussed in WP5.

5.3.5 Implications

The effect of the heat waves in Spain or Europe is not just about mortality from the heat waves, nor about how heat waves exacerbate underlying health issues. In discussing groups vulnerable to the heat waves from a health inequality perspective, the view first expressed in the *Black Report* suggests that social variables cannot be seen in isolation but are grouped together, and in that grouping vulnerabilities are exacerbated. The continuous segregation of these groups within cities further polarizes them and deepens these inequalities. In referring to heat waves affecting the aged or those whose work depends on them working outdoors, or simply those who live in cramped housing conditions because they cannot afford anything better, we are referring to persons already affected by socio-economic vulnerabilities, which depresses their health, which the heat waves act upon. Additionally, those at risk from heat waves do not have mitigation capacities such as air conditioning, or the ability to move from their home to get help, nor for some the social networks that might provide them help. Added to these factors are the institutional variables, providing access to information and the physical effects of difference in ambient temperature. Yet we realise that the real work in healthcare needs to be prepared long

before the heat wave. Because the heat wave is the tip of the iceberg, we need to deal with the 90% of it which lies below the water (class/socio- economic vulnerabilities, access to healthcare, housing segregation, etc.) long before the heat waves hits. Perhaps part of building resilience is to rectify inequalities.

5.3.6 Alternative approaches and complexities

The epidemiological literature has successfully begun to set out who is most vulnerable during hot weather and has alluded to the social fault lines that heat-related mortality falls along. This takes vulnerability as an 'end point' (Kelly and Adger, 2000). Vulnerability is a consequence of the exposure of the system to the impact, the sensitivity of the system to that exposure, and then the capacity of the system to adapt (O'Brien et al., 2004). This conceptualisation of vulnerability is widely used throughout the epidemiology literature that forms the majority of the evidence base for heat-related mortality. In attempting to identify who is vulnerable, the starting point for analysis is mortality data, through which various constraints on adaptive capacity are identified (e.g. spending prolonged periods in bed), and vulnerability is ascribed. If viewed as a starting point though, a system's vulnerability governs its adaptive capacity, which in turn determines its exposure and sensitivity to a given impact (O'Brien et al., 2004). Here, vulnerability is inherent to the system and is not a product of the hazard, but is exacerbated by the hazard.

Klinenberg's insight into the construction of social isolation in 1995 Chicago is a seminal parallel case study (Klinenberg, 2002), but it does not fit so convincingly into the UK context in 2003. The most obvious inconsistency is that the highest increase in heat-related mortality in England and Wales was found in nursing and residential homes (Hajat et al., 2007). What makes residents of these homes so vulnerable is currently unclear. Intuitively the concentration of older people with their inherent physical frailties would seem a rational explanation, and, in the Netherlands, this is in part supported by data that suggests pre-existing physical illnesses are most consistently related to excess mortality (Mackenbach and Borst, 1997). However, research in France during the heat wave of August 2003 found that it was the *least* physically frail patients who were at greatest risk; it is argued that nursing staff directed their energies towards the physically ill patients who they perceived to be at greatest risk (Holstein et al., 2005). A study by Belmin et al. (2007) found that the degree to which residents in French institutions were dependent on others has a strong link with increased levels of mortality, but they were unable to clearly separate this effect out from the influence exerted by other variables. Governance may play a key role in this instance (see WP 2).

5.3.7 Vulnerability, context and sustainability during heat waves

The societal and economic understanding that need to be developed to manage and respond to heat waves have to be especially cognisant of the particularities of culture, built form, social organisation and social expectation that contribute to the production of vulnerability in context, rather than in the abstract. Existing quantitative research has begun to identify who, in demographic and social terms and in particular places, is vulnerable, but has shed far less light on why they are vulnerable and how that vulnerability is being produced in context, on an everyday basis. Understanding how vulnerability to heat is constructed through everyday routines and practice provides the potential for identifying alternative ways of managing heat through enabling people to modify their thermal environment without immediate recourse to air-conditioning. Focusing on adaptive behaviour and practices in this way is in line with the

adaptive model of achieving thermal comfort (Shove, 2003) emphasising the importance of adaptive measures, such as changing clothing, shifting patterns of food and drink intake, or enabling low-tech ventilation and cooling, and is a more sustainable prospect in the long-term.

5.4 Summary of findings from the three empirical examples

All three of the empirical examples above demonstrate that vulnerability conceptualisations are considered in terms of both the hazard and the social context. The studies also illustrate that how vulnerability is conceptualised varies. It varies of course with the aetiology of the hazard itself, as the hazard unfolds, persists and lingers, whether it leaves pollution, debris or sediment in its wake, and also by whether key governance structures are in place or not, whether hazard mitigations and anticipatory tools are available. Definitions of vulnerability are crucially linked to social perception of risk (Beck, 1992) (see WP3), and with variables such as age, gender, income, social organisation and education of the local population; such perception significantly increases with prior exposure to hazards of a similar type. Relationships are key in aiding understanding, not only between institutions but also individuals, as illustrated in the relationship between patients and carers in the heat wave example. We have also seen that householders develop social capacity not only by embedding themselves in community structures and having access to recovery and response services, but that their views change with the tenure of their home-associated factors during hazards. There is a possibility that where visible engineering structures are present, perceptions of personal and community vulnerability may be unrealistically reassuring, therefore increasing vulnerability.

6 Social vulnerability within CapHaz-Net

On reviewing the literature on social vulnerability to natural hazards outlined above, and based upon further discussion at the Haigerloch workshop, a number of initial observations and linkages can be made which relate to the other themes within the CapHaz-Net project. A number of these are outlined below in relation to the different work packages.

6.1 WP1 Social Capacity Building

- The WP1 draft report on social capacity building suggests that vulnerability has two sides: an external side of risk and stress to which an individual or household is subject, and an internal side which is defenselessness, meaning a lack of means to cope with damaging losses. While this paints a very negative view on the outcomes of a lack of capacity, it recognises capacity as an integral part to social vulnerability.
- As evidenced by the Alpine hazards example described above, social capacity building techniques can target both sides of social vulnerability: work to lessen the external side through influencing more over-arching risk governance, emergency response or even targeting those areas of social inequality; on the internal side, social capacity building becomes a more *personalized* process focused on enhancing social resilience to *combat social vulnerability from within*: e.g. focused on educating, improving the level of perceived risk, building motivation and a sense of responsibility within individuals and communities to manage and mitigate their own risk (particularly a requirement for flood hazard).
- The WP1 report begged the question: can exposure, vulnerability and capacity be viewed collectively or separately? The answer to this could be 'yes' to both providing that each concept is framed within the contexts of the others i.e. it would be too negative to only discuss the external (or exposure) side of social vulnerability without recognising and accounting for a degree of agency and control that people have in determining their level of vulnerability; conversely it would be too positive a perspective to merely focus on the internal (resilience and capacity) dimension of social vulnerability, without accounting for uncontrollable and potentially limiting factors of social vulnerability which stifle this. Any method said to reduce vulnerability can be said to enhance resilience: it is not however the reverse or flip-side, rather it is an inseparable dimension of social vulnerability (internal).
- A look at scientific literature on hazards has opened up the question of the role of 'local knowledges' vs. 'scientific knowledges' of hazards. In Europe, the latter strongly underpins the work of the emergency services, their infrastructural work, planning and preparedness. Capacity-building is often seen as focused around a technocentric view of hazards. This approach is fundamental to understanding and managing hazards, because the science allows modelling, monitoring, anticipation, targeting of infrastructure and so on. However, social capacity to respond to events could perhaps take local knowledges into account more. Specifically, should emergency services incorporate more knowledge about social vulnerability? If so how? As we have seen, appropriate adoption of vulnerability indicators varies with scale, event and hazard type and hazard cycle stage. The prevalence of the scientific paradigm, useful as it can be, may inadvertently be trying to reduce vulnerability issues simply by providing a broad 'panacea' of resilience measures.

6.2 WP2 Risk Governance

- Governance issues play a crucial role in influencing levels of social vulnerability e.g. through legal frameworks, institutional arrangements and levels of participation.
- Governance research on the mechanisms that mediate vulnerability and promote adaptive action and resilience is crucial.
- Risk governance functions on the external side of vulnerability when viewed from an institutional platform. The concept can however function internally as communities and individuals manage their own risk.
- Governance mechanisms may be too reliant on the scientific technocentric paradigm of hazards, although this situation may vary between European states.
- Research is needed to draw the social understanding of perceived risk and experiences of vulnerability into risk governance programmes, so they can be more sensitive to the social groups they serve.

6.3 WP3 Risk Perception

- Scientific models of hazards provide us with the potential to effectively reduce risk by being better prepared, by having improved models, improved pre-event planning and so on. But does improved knowledge lead to less anxiety, or more? By having very visible risk-reduction measures in place, does this lead to over-confidence, or enhanced risk awareness and anxiety? Does this then lead to behavioural change?
- Risk perception is closely connected to the notion of preparedness. Before an event, risk perception has great potential for vulnerability reduction, through the implementation of disaster awareness and preparedness education programmes and activation of mitigation measures. Social vulnerability thus relates to the behaviour and responses to risks as well as the resources and capacities to deal with them.
- The way that the public understands risk information is critically important in informing risk perceptions, determining behavioural responses during a flood event and, therefore, influencing hazard vulnerability at both an individual and a community level. The literature on vulnerability stresses the primacy of public risk perception and understanding in mediating the success of attempts to increase hazard resistance and resilience.
- Identifying the different dimensions of social vulnerability is indispensable for understanding the context within which different social groups develop risk perceptions (or socially construct risk), respond to communication and warning initiatives, and behave during hazardous events.
- Risk perception is hypothesised to be closely linked or even synonymous with an individual's perceived 'ontological vulnerability'.
- The basic concepts of risk perception are essential to the use of selected indicators in a vulnerability risk assessment. Conversely, a vulnerability perspective is becoming increasingly recognised as important in understanding environmental risk.
- Societal factors are known to affect perceptions of risk: this impacts upon the way in which an event is anticipated, responded to and subsequently managed in the aftermath.
- Risk perception can be influenced by belief systems, culture, experience and individual characteristics which can manifest in different understandings and subsequent responses and to preparedness – all of which can impact upon vulnerability. Thus the first essential

requirement for effective risk communication is an understanding of what people think and why.

- People with prior experience of flooding tend to be better informed and prepared and therefore more aware of flood risk, and possibly less vulnerable. Research evidence shows that the response and preparedness for floods improves with experience, including *access* and *willingness* to use warning communication technology. Experienced people could provide a useful resource to social capacity building measures.
- The trust of responsible agencies is also recognised as one of the most important influences upon risk perceptions and responses to official communication.
- There is a tendency to discuss the characteristics of the hazard in risk perception – the issue of 'am I vulnerable?' is often neglected in this process. Vulnerability perception is likely to feed into decision-making towards human behaviour (risk perception represents another driver in this process).

6.4 WP5 Risk Communication

- Risk communication within the field of natural hazards is under-researched. Without effective risk communication, communities cannot anticipate the oncoming hazard and thus social vulnerability is heightened.
- In order to achieve effective communication, there is a necessity to fully comprehend the *target audience* (i.e. their perspective, understanding and reasons behind this understanding and any underlying vulnerabilities). Communication therefore needs to be a two-way process.
- We need to consider the different levels of knowledge between the lay-person and professionals. The 'information deficit model' i.e. where we neglect the socially embedded and contextualised manner in which people make sense of the world, and onto which individual vulnerability is overlaid needs to be understood.
- Communication of risk does not necessarily reduce social vulnerabilities and increase socio-economic resilience to natural hazards (see WP5 report). Communication channels to give authorities feedback on their performance and to provide them with insights on what kind of support is needed in the aftermath of a hazard event are necessary if vulnerabilities are not to be reproduced.
- Vulnerability in communication practice seems to be understood mainly as a result of exposure to natural hazards rather than as a result of socio-economic-cultural characteristics that may constrain people's ability to receive communication and respond to it.
- A key concern is how messages are *interpreted* and the transition into motivation and inspiring action.
- There is a need to consider what communication tools/instruments already exist? What are the limitations of these? What are the constraints? How could the application of these instruments influence vulnerability? What information do stakeholders *need*?
- Risk maps identifying socially vulnerable areas and populations can facilitate discussions of vulnerability and can be a good communication tool. Such maps may also help provide valuable insights into the kind of preparedness and response measures needed to target selected areas of high social vulnerability for risk reduction professionals (see Haki et al., 2004). Maps are less useful where the population they cover is diverse, as they hide diversity

and can lead to stigmatisation of the ‘vulnerable’ i.e. they imply that all those living in the at risk area are vulnerable.

6.5 WP6 Risk Education

- Lower levels of formal education appear to be a contributing factor to social vulnerability, often linked to income levels and socio-economic grouping. Education is therefore required as a risk awareness-raising and risk communication tool.
- There should be better integration of and links between formal and ‘informal’ education and the utilisation of more community-based ‘local knowledge’ to help reduce social vulnerability and increase social resilience. This could then help to translate ‘expert knowledge’ into a more accessible form (see WP6 report).
- Education topics need to include the nature of the hazard and likely impacts, but perhaps more importantly, a positive and constructive outlook presenting the ‘solutions’ (to offer a sense of control to the situation as opposed to a learned-helplessness), and thus functions on the internal side of social vulnerability that is social resilience.
- To be truly useful, risk education needs to be a consistent part of risk governance.

7 Conclusions, future challenges and gaps in research

Despite the absence of an unequivocal definition of social vulnerability, we can conclude that a number of perspectives and methodological approaches provide valuable contributions to social vulnerability assessment. It was agreed that the CapHaz-Net project should map the different perspectives rather than agreeing on an overarching definition of social vulnerability. A number of relevant approaches and indicator initiatives have therefore been identified that have been, and can be, used to measure vulnerability in its different dimensions within Europe and for different natural hazards. However, it can be argued that while indicator analysis is useful, it is best used as input for interacting with populations themselves, or their surrogates, to obtain their input about potential vulnerability reduction measures. People's vulnerability thus needs to be seen in light of their capacities and abilities to influence and define their own fortunes. Indicators of vulnerability also need to be related to the specific contexts of European countries and case study areas and are best developed with a specific policy purpose in mind, which in turn should determine the scale, method and approach used in their development. The importance of developing a conceptual model as a basis for any indicator development for measuring social vulnerability has also been highlighted. Risk perception and local coping mechanisms are some examples of specific elements that need to be addressed as part of local social vulnerability assessment. A number of concluding points can be highlighted from the research.

It can be argued that social vulnerability varies with the aetiology of individual hazards but this has yet to be fully explored in the literature; studies that include both hazard aetiology and social variables appear to be more common in recent research. The literature also indicates that social vulnerabilities may change between the different stages of the disaster cycle, and that people can move in and out of vulnerability depending upon their position in the cycle. Importantly, the literature suggests that risk and vulnerability need to be examined within the wider context, in particular the social conditions in which risk-exposed people live, think and make choices. In terms of the way people think, investigation of the psychological aspects of social vulnerability is limited in current studies, although studies of risk perception to natural hazards do exist, as do social impact assessments.

We discovered a range of different approaches to assess and measure social vulnerability using different combinations of measures, both quantitative and qualitative, and of different attributes, relationships and processes. Again, no single common approach was found to be used by countries. There is no universal catalogue of vulnerability indicators: vulnerability is highly context-specific in terms of local/regional, socio-economic, demographic, legal, political and cultural contexts. However, it is suggested that qualitative approaches to vulnerability assessment need to be considered more frequently in order to better understand the processes and relationships contributing to social vulnerability and social capacity building; we therefore need more situational analysis.

There appear to be large differences in the extent of social vulnerability assessment between different European countries, with some having addressed the issue for a number of years while others are only now beginning to consider such issues. To date, there appears to be more data available and more studies on flood-related hazards than other types of natural hazards, although other studies may exist and this needs to be further explored. Social vulnerability assessments must measure the right things, at the right scale, with suitable conceptual underpinning. Studies must identify whether individual, community or systemic

vulnerability is being investigated, to avoid some of the confusion in the literature. There is still a need for a method of more finely assessing and assigning a priority to vulnerabilities. Related to this is the need for agreement over the weighting of variables/indicators, more research is needed on determining the quality of data and validating such data and evaluating the effectiveness of studies being conducted.

Given temporal and spatial changes in social vulnerability in the future, a one-size fits all approach to preparedness, response, recovery and mitigation may be least effective in reducing vulnerability or building local social capacity to hazards. Working with communities to help them assess their own vulnerabilities, priorities and solutions is crucial to improving social capacity. More work is necessary on exploring the issue of 'responsibility' in relation to the mitigation of natural hazards and the building of social capacity. One question is whether high levels of coping *capacity* always lead to successful coping? In addition, does risk perception affect whether coping is successful or even carried out?

Some discussion during the Haigerloch workshop suggested that social vulnerability research needs a totally new perspective, that the concept of social vulnerability is static and prone to be overtaken by other concepts. However, it can be argued that this happens to most concepts over time. One question is whether we need to step away from the demand to *measure* social vulnerability towards new assessment procedures? Birkmann et al. (2009: 13) have suggested that in the future it will be necessary to identify a basic generic framework of vulnerability, for example, by linking key components such as exposure, susceptibility and coping, with additional elements that reflect specific hazard or climate change features. Some key future challenges which can be identified for social vulnerability research are therefore:

- to develop robust, credible and appropriate assessment measures
- to incorporate such methods that include perception of risk and vulnerability
- to incorporate governance research on the mechanisms that mediate vulnerability and promote adaptive action and resilience, including the inclusion of communities in assessing their own vulnerability and in determining solutions to building future resilience.

In the mean time there are still a number of research gaps that need to be addressed.

Gaps in the research

A final question to be addressed by WP4 therefore is what is missing in social vulnerability research? Where are the gaps? In light of the findings from the research to date, a number of such gaps in data, knowledge and understanding can be identified, and more research is needed in order to try to fill some of these gaps in the future if we are to better understand how to build future social resilience to natural hazards. A number of knowledge and data gaps have been identified in relation to vulnerability indicators for climate change, most of which can also apply for social vulnerability assessment. These gaps include: conceptual gaps, methodological questions, application gaps, data concerns and data gaps.

Other key gaps identified in this report fall into different scales of analysis (e.g. from the local context to the individual at risk) and the application and role of vulnerability analysis more generally. At a contextual level gaps were identified in knowledge on the intensity and frequency of natural hazard events; how this may change in the future and how this may impact on risk perception and social vulnerability e.g. increased damages, impact on mobility, insurance etc. More research is necessary on the social vulnerability to different natural hazards, particularly

earthquakes, heat waves, droughts and volcanic eruptions as these appear to be under-researched. We also need to assess and address the needs of different types of disaster managers, professionals and end users who respond to natural disasters. Knowledge on future social/structural/institutional changes is also needed and how these may impact upon social vulnerability. We need more research particularly on how institutions consider and respond to risks and on the vulnerability of such institutions. This links to the need for more consideration of the aspect of adaptability and how this relates to social capacity building.

Another gap relates to analysis of the *relational* aspects of vulnerability and the relations and interaction of indicators. Little data is also available on inter- and trans-disciplinary small-scale projects and contextual research beyond the 'rural' community i.e. in high density urban areas. Particularly (but not exclusively) in these urban areas the question of how we address the issue of potentially socially vulnerable groups such as migrants and transients is of relevance, groups that are not easily represented by the census or other secondary source data. One question to be asked could be what can we learn from other organisations e.g. from those working in less developed countries and other charitable groups like the Red Cross?

At an individual level there appears to be little research on the *perception* of vulnerability, particularly on the part of those at risk. There is a gap in understanding how the perception of vulnerability affects people's reactions, to distinguish between risk and vulnerability perception explicitly and to understand how the two interact and shape people's decisions to respond. This includes actual and perceived responsibility for action, denial of the risk and also misperception or the cultural context limiting action. More linkages are thus needed between perceived social vulnerability and risk perception. If people think they *are* vulnerable what are their perceptions and behaviour? If people do not think they are vulnerable – why is this? There are additional gaps in terms of research specific to natural hazards on the issues of behaviour and trust. Moreover, how can knowledge of social vulnerability contribute to risk communication and education? More research is needed on communication instruments and how they can be improved by knowledge on social vulnerability.

Finally, but importantly, how does social vulnerability analysis 'fit' within societal constraints? What geopolitical aspects need to be considered? For example, vulnerability assessment depends on many political factors and political acceptance of such assessments e.g. social inequalities; which risk to whom? Thus we need to know what the links are between risk governance and local level activities and processes. Will or how will activities to mitigate social vulnerabilities today be relevant in the future? As Wisner et al. (2004:61) state, *"it is imperative to accept that reducing vulnerability involves something very different from simply dealing with hazards by attempts to control nature … or emergency preparedness, prediction or relief, important though these are".*

We can conclude with three overarching questions for future consideration that we consider to be relevant but yet not sufficiently covered by the scientific community. These questions are:

- Do current approaches to social vulnerability assessment actually contribute to social capacity building for natural hazards in a meaningful way? If not, how can they be improved?
- Does social capacity building contribute to a reduction in the consequences of natural hazard events, and if so, is this in both the long and the short term?
- What are the remaining social, economic, political, legal and institutional barriers to addressing social vulnerability and how does this change between countries and over time?

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9 Appendix A: Examples of indices and frameworks for assessing social vulnerability

Index or approaches	Scale of assessment	Hazard-Type	Key variables included	Details and methods for aggregation	Author(s)
Predictive indicators of vulnerability	National level – country comparison	Climate change	Indicators selected as outcome-based e.g. mortality data from EM-DAT (risk). Predictive indicators for vulnerability – health, education and governance indicators shown as reasonable assessments for vulnerability. Economic wellbeing, Health and nutrition, Education, Physical infrastructure, Institutions, governance, conflict and social capital, Geographical and demographic factors, Dependence on agriculture, Natural resources and ecosystems and Technical capacity. Proxies are correlated with 'outcomes' of risk.	Trials multiple methods, with the conclusion that disaggregated indices for different aspects of vulnerability are more effective than a combined, single value.	Adger et al. (2004)
Index to evaluate socio-economic vulnerability to drought.	National	Drought	Considers a) direct exposure to drought and b) socio-economic factors, operating at the national level	Utilises national level statistics proxy variables of a socio-economic nature	MEDROPLAN programme (Mediterranean Drought Preparedness and Mitigation Planning-05). See http:www.iamz.ciheam.org/medroplan
Hurricane Disaster Risk Index (HDRI)	Region/county-wide, USA	Hurricane	Four factors include hazard, exposure, vulnerability, emergency response and recovery.	Based on EDRI methodology though uses the analytical hierarchy process (AHP) for weighting indicators.	Lambert and Davidson (2001)

Index or approaches	Scale of assessment	Hazard-Type	Key variables included	Details and methods for aggregation	Author(s)
SoVI	National, county or city-wide, USA	Hazard-wide	Personal wealth, age, building density, single-sector economic dependence, housing stock and tenancy, race - African-American, race - Native American, race - Hispanic, race - Asian, Occupation and infrastructure dependence	11 key variables deduced from principal components analysis, normalised to a fixed scale and them computed into an additive model. Data source: U.S. Census. Has now been adapted for use at city level (Cutter et al., 2009). See SoVI website (http://webra.cas.sc.edu/hvri/products/soci.aspx)	Cutter et al. (2003): Furthermore, has been extended to assess the American 'hazardscape' through time (Cutter and Finch, 2007)
Social vulnerability profiling (SVP)	National to local, USA	Hazard-wide	Similar to SoVI but uses less variables	A SVP is performed by obtaining the relevant census information for each of the indicator variables for the project area at the appropriate level of spatial scale. Once the data has been assembled it can be summarised using basic percentages and proportions to compare and contrast areas. In contrast to the SoVI, does not employ a statistical procedure to generate vulnerability dimensions. Method provides a simpler and more straightforward way of characterising socially vulnerable populations than the SoVI. It also assembles basic social indicators of vulnerability from census data to draw inferences about the potential for the distribution and magnitude of social effects of exposure to a hazard.	NOAA's Coastal Services Centre's Risk and Vulnerability Tool provides an on-line guide for conducting SVP analysis. Also see http://training.fema.gov.emiweb/edu/sovul.asp
Earthquake Disaster Risk Index (EDRI)	Application to cities worldwide	Earthquake	5 factors contributing to overall risk; hazard, exposure, vulnerability, external context, emergency response and recovery planning. Indicators include population, per capita GDB, number of housing units, city development speed indicator (for physical infrastructure vulnerability); percentage population aged 0-4 or 65+ (population vulnerability) – amongst other hazard, economic and political indicators, and emergency planning and response capability.	Composite EDRI to determine relative risk between cities: Separate composite indices for each of the 5 factors, then combined for the overall EDRI. Explores multiple methods and the advantages and disadvantages of each.	Davidson and Shah 1997

Index or approaches	Scale of assessment	Hazard-Type	Key variables included	Details and methods for aggregation	Author(s)
Local Flood Vulnerability Index	Local (13 municipalities in Cantabria, Northern Spain)	Flood	Flood hazard, exposure, prevention, preparedness	Objective was to provide an applicable, intelligible tool for local decision makers, based on easy-to-determine factors and available data. The four variables are measured by means of 16 indicators (binary; yes/no): historical flood marks, flood prone area, slope stability, inhabitants/km2, industrial plants/km2, cattle/km2, annual income/inhabitant, key infrastructure, flood regulations, flood prevention measures, past flood experience, information material, early warning system, emergency plans, fire department, hospital. Integration of factors (no weights assigned) by means of a GIS to a vulnerability map with an ordinal scale: low to high vulnerability.	Weichselgartner, J. & Bertens, J. (2002
Social and Infrastructure Flood Vulnerability Index (SIFVI)	County level, Germany	Flood	Demographic data: fragility – persons over 65 years per total population; socio-economic condition – unemployment and graduates with basic education per total population, apartment living space per person; region – population density and number of apartments with 1-2 rooms per total number of apartments	Social Susceptibility Index (SSI) was developed at county level by selecting and aggregating demographic statistical data. Single variables are grouped by factor analysis to identify social profiles. These profiles are validated by analysis of an independent second data set for a real case flood event. The resulting social profiles at household level are compared with the county profiles, and a validated index is derived. A composite SSI is the main result of aggregating these single indicators. Data is combined with that from flood inundation maps. The result is a Social and Infrastructure Flood Vulnerability Index that combines the SSI with an exposure analysis.	Fekete, 2010;

Index or approaches	Scale of assessment	Hazard-Type	Key variables included	Details and methods for aggregation	Author(s)
Social Flood Vulnerability Index (SFVI)	Local Census Output Areas (Oas) ca. 125 households, UK	Flood	3 social variables - Lone parents, Age (75yrs+) and Long-term illness. 4 financial-deprivation indicators (Townsend Index for deprivation) - Unemployment, Overcrowding, Non-car ownership and Now-home ownership.	Variables deduced from thorough literature review. Crude values transformed and standardises as z-scores, aggregated into an additive model. Data source: UK Census	Tapsell et al. (2002)
Community vulnerability index (the Cities Project)	Community vulnerability: Relative risk rank determined for census districts, or local governments (ca. 200 households), Australia	Hazard-wide	Five 'S' categories: Setting, society, security, sustenance and shelter. Each is ranked separately, and then combined to show the relative position of a community. Indicators include, family structure, education of occupant, new residents, no religious adherence, age (and living alone), tenure (renters), un-employment, as well as further considerations to 'life lines'. 31 indicators in total.	Indicators are summed for each 'S' (no weights assigned), and ranked to determine overall and relative rank of each area. Data source: Australian Bureau of Statistics (ABS), 1996	Geoscience Australia Granger et al. (1999)
Neighbourhood social vulnerability	Neighbourhoods for the Pendik administrative district of Istanbul, Turkey	Earthquake	Employment status, reasons for not working, educational level, household size, being owner of dwelling, being the owner of any other dwelling, age and sex. {Income and education level shown to be most important factors in defining social vulnerability}	Mulit-criteria evaluation methods, based on Muliti attribute utility theory (MAUT). Also explorative spatial data analysis. Data source: 1990 Census	Haki et al. (2004)

Index or approaches	Scale of assessment	Hazard-Type	Key variables included	Details and methods for aggregation	Author(s)
Social vulnerability index	Census block-group level: The Hampton Road, Virginia Metropolitan region, USA	Hurricane-induced storm-surges	57 variables. Poverty', 'immigrants' and 'old age/disabilities' (component headings)	Variables subjected to PCA to identify 13 components; a scree-plot examination reduced these to just 3 components (accounting for 50.83% of variance) and described by raw variable which loaded most heaviliy on it. Pareto ranking is applied to organise the block-groups into ranks (in this case, 19) to determine the overall vulnerability- avoids the issue of assigning weights of importance between the components. Data source: US 2000 census	Rygel et al. (2006)
Socio-Economic Indexes for Areas (SEIFA)	Local, Australia	Hazard-wide	Census data	Based on data collected in the 2006 Census (ABS, 2008). The intention behind these indices is to measure socio-economic disadvantage which, may not be the same thing as socio-economic vulnerability. Even so it could be a development in the direction of a socio-economic vulnerability index as long as the relationship between disadvantage and vulnerability can be articulated and measured at some point.	Australian Bureau of Statistics (ABS)
Community vulnerability framework and index of socio-economic dimensions to the hazard of mountain pine beetle	Local, Canada	Pine beetle – but relevant to other hazards	Indicators of vulnerability included: current and future forest susceptibility, perceived impact, community risk awareness, evaluation of community leadership, economic diversity, forest dependence, long-term forecast forest resources available to community, community assessment of local economic resilience, human economic hardship/crime, health, education, children and youth at risk, perceived internal and external constraints, and perceived level of overall cooperation and coordination among organizations in the community.	Local social surveys and focus groups. Examines the vulnerability of Albertan forest region communities to attack by pine beetle. Constructed from a base of social science research in the areas of climate change, community capacity, hazards management and risk perception. Uses scoring methods for each indicator and then combines indicators into an integrated socio-economic vulnerability index. Determines capacities which are inherent (or lacking) within communities. Based on recognition that vulnerability of socio-economic systems is a function not only of damage susceptibility which causes economic loss but also a function of the coping and adaptive capacities of communities at risk.	Natural Resources Canada (see MacKendrick and Parkins, 2005)

Index or approaches	Scale of assessment	Hazard-Type	Key variables included	Details and methods for aggregation	Author(s)
Draft Coastal Resiliency Index: A Community Assessment	Local, USA	Hurricanes	The tool examines six categories of resilience factors in each community: critical infrastructure, transportation, community plans and agreements, mitigation measures, business plans, and social systems.	Studies factors that contribute to a community's resilience. Tool to engage communities in discussions on reducing vulnerability and increasing resilience. For use by community leaders, planners and engineers in coastal communities to test and assess their community's ability to recover from a disaster and to help identify needed actions that can increase community resiliency.	National Oceanic and Atmospheric Administration (NOAA) See Emmer et al. (2008)
'Pressure and Release model' (PAR) and 'Access model'.	Local, regional – used in developing countries	Hazard-wide	PAR presents the progression of vulnerability from *root causes* (limited access to power, structures and resources; Ideologies of political and economic systems), to *dynamic pressures* (e.g. lack of institutions, training etc; Macro-forces such as rapid population change) to *Unsafe conditions* – this is divided further into the *Physical Environment* (dangerous locations, unprotected buildings and infrastructure), *Local economy* (livelihoods at risk and low income levels), *Social relations* (specific groups at risk, lack of local institutions) and *Public actions and institutions* (lack of disaster preparedness, prevalence of endemic disease). Access model: household livelihoods – their resources and assets (e.g. land, labour, capital etc.as well as non-material sources such as specialist knowledge and skills: Collectively termed *household and individual access profile*). Also considers their structural position occupied in a society (gender,	The PAR model aims to show the pressure from both hazard and unsafe conditions that lead to disaster, and how changes in vulnerability can release people from being at risk. The Access model is an expanded analysis of the principle factors in the PAR model that relate to human vulnerability and exposure to physical hazard. It focuses on the process by which the natural event impacts upon people and their responses. The model complements the PAR. The two models function in a variety of time scales as root causes, dynamic pressures and unsafe conditions are all subject to change.	Wisner et al. (2004)

Index or approaches	Scale of assessment	Hazard-Type	Key variables included	Details and methods for aggregation	Author(s)
			membership) and personal attributes (social and human capital). *Income opportunities*, each with a set of *access qualifications* (defined by set of resources and social attributes) – provides opportunities and pay-offs. Importance of mechanisms or *structures of domination* which set pay-offs (e.g. markets). *Choices of household* concerning income opportunities and result of these constitutes *livelihood*. Household budget determined from livelihood contribution (deficit or surplus), *Decisions* are made on how to cope, invest, consumption – produces *Outcomes to decisions* which can change the access profile at a later time.		
Social Vulnerability Index (SVI) and Social and Infrastructure Flood Vulnerability Index (SIFVI)	County level, Germany	Floods	Fragility: elderly persons above 65 years per total population Socio-economic conditions: unemployed persons and graduates with only basic education per total population; apartment living space per person Region: degree of urbanity or rural area, measured by population density lower / higher than 150 persons per km² and the number of apartments with 1-2 rooms per total number of apartments	The SVI is an index that is aggregated by equal weighting and simple summation from three main indicators of social vulnerability listed in previous column. At the county level, the SVI is a pilot approach as to how to identify and compare social vulnerability for whole river-channels in Germany. The main outcome is a social vulnerability map of population characteristics towards river-floods covering all counties in Germany The SIFV uses a standardised procedure of data harmonisation, standardisation, equal weighting and ranking. The Index is open for additional vulnerability data e.g. environmental vulnerability, but also for additional hazard information such as flood depth, velocity, etc.	Fekete (2010)

Index or approaches	Scale of assessment	Hazard-Type	Key variables included	Details and methods for aggregation	Author(s)
Social-cognitive model	Local/individual	Hazard-wide	Key variables in this model are self-efficacy and outcome expectancy.	A model to predict factors that influence individuals' decision-making process in the context of preparing for natural hazards. Limitations to its use in social vulnerability studies are that the model has not been integrated into risk equations and that the model focuses on understanding the factors that predict why people do or do not undertake preparedness actions rather than how effective specific preparedness actions taken might be in reducing vulnerability.	Paton (2002) Paton (2008)
Household Vulnerability Index	Household and individual (distinguished as the 1st level of social vulnerability)	Hazard-wide	13 vulnerability indicators: age, income, gender, employment, residence type, household type, tenure type, health insurance, house insurance, car ownership, disability, English language skills and debt/saving. 2 hazard-indicators; residence damage and injuries chosen to link the above to the hazard context (specifically, to the recovery phase).	Social vulnerability model developed from indicators, risk perception questionnaire (to explore combination and importance of indicators – this is based on perception of 10 hypothetical individuals), decision tree analysis (applied to questionnaire data to assess contribution of attributes and 'decision rules') and synthetic estimation (apply decision tree rules to a real spatial area and community – Perth).	Dwyer et al. (2004)

10 Appendix B: Mapping research activities and practices in the field of social vulnerability to natural hazards in Europe

Country	Natural hazard	Scale national regional local households	Concrete event?	Research or practice?	Contact Details	Remark
0 Europe				research	satu.kumpulainen@saunalahti.fi (via Google)	Integrated Vulnerability assessment; part of the ESPON hazard project
1 Austria						
2 Belarus						
3 Belgium	flooding	Deuden/ Schelde River - river basin?		empirical research	Jochen Luther	social Vulnerability (also projection to 2050) http://dev.ulb.ac.be/ceese/ADAPT/public_section/Doc/Doc/Coninx_and_Bachus.pdf
4 Bosnia and Herzegovina						
5 Bulgaria						
6 Croatia						
7 Cyprus						
8 Czech Republic						
9 Denmark						
10 Estonia						
11 Finland						
12 France	flooding	Lyon/Narbonne		research	Thierry Coanus, Roland Nussbaum	
	flooding			practice/communication	Roland Nussbaum	social vulnerability assessment by floodplain managers and cities

Country	Natural hazard	Scale national regional local households	Concrete event?	Research or practice?	Contact Details	Remark
	flooding	Regional/local – Haut-Rhône		research/practice	Patrick Pigeon	vulnerability, structural measures, risk perception and uncertainty management. Pigeon and Dupont, 2008; Pigeon 2002 and 2005
	social vulnerability to earthquakes			research	(Google)	http://communicate.aag.org/eseries/aag_org/program/AbstractDetail.cfm?AbstractID=29805
	Climate change	All scales/coastal areas	No	Review and discussion paper which discusses the various elements and characteristics of societies which may help explain the vulnerability of a coastal territorial system, in this case to climate change	Alexandre Megnan, Institut du Développement Durable et des relations Internationals (iddri), Paris www.iddri.org	Includes, general discussion and review of literature on the concept of vulnerability; strategic adaptation; vulnerability as a process; six key factors influencing vulnerability: development constraints posed by the spatial configuration of a territory, the degree of social cohesion, the sensitivity of ecosystems, economic structure, political and institutional structure, and living conditions of the population.
	Climate change	All scales	No	Review and discussion paper	Alexandre Megnan, Institut du Développement Durable et des relations Internationals (iddri), Paris www.iddri.org	Adaptive capacity is not solely linked to economic and technological development.

Country	Natural hazard	Scale national regional local households	Concrete event?	Research or practice?	Contact Details	Remark
13 Germany	flooding	local	2002 Mulde flood	empirical research	Annett Steinführer, Christian Kuhlicke	Research for FLOODsite project. Steinführer et al., 2007
	flooding	Regional/county	2002 Elbe flood	research	Alexander Fekete	Social vulnerability index; study available as PDF at www.caphaz-net.org - WP 4 Social Vulnerability (intern)
14 Greece	All natural hazards	national	Post-event impact assessments for all major events	Practice	General Secretariat for Civil Protection	Vulnerability and capacity assessment is in infancy and not systematic. Systematic assessment of social impacts of disasters; vulnerability assessments carried out. and identification and mapping of risks for all key natural hazards – see www.oasp.gr
15 Hungary						
16 Ireland						
17 Iceland	volcanic hazard	local	none (last eruption 1918)	empirical research	Jóhannesdóttir and Gísladóttir 2010	http://www.nat-hazards-earth-syst-sci.net/10/407/2010/nhess-10-407-2010.pdf Risk perception AND SV!

Country	Natural hazard	Scale national regional local households	Concrete event?	Research or practice?	Contact Details	Remark
18 Italy	all	Regional – Lombardia region		Practice: High School for Civil Protection (Scuola Superiore di Protezione Civile)	Marco Lombardi, Scientific Representative of Scuola Superiore di Protezione Civile website of the school (in Italian) (http://www.irefonline.it/websites/iref/staging/home_sspc.nsf/index.htm)	The High School for Civil Protection provides training for volunteers; the courses offered are not only dealing with operative management of emergency, but are also focused on social aspects of a crisis. The reduction of social vulnerability is therefore dealt with in operative terms, as the school's activities are aimed at raising awareness about natural hazards and giving individual responsabilities in disaster prevention to the citizens.
	alpine hazards (debris flows, flash floods)	Regional/local	2000 and 2002	empirical research	ISIG: Anna Scolobig/Bruna De Marchi (FLOODsite)	Research for FLOODsite project. De Marchi et al., 2007
	heat waves (Alps)	Regional/local		research: test case study, stakeholder involved	Stefan.schneiderbauer@eurac.edu	
				research	Roberto.miniati@unifi.it	critical infrastructure
19 Latvia						
20 Lithuania						
21 Luxembourg						
22 Macedonia						
23 Malta						
24 Moldova						
25 Montenegro						
26 Netherlands	flooding					

Country	Natural hazard	Scale national regional local households	Concrete event?	Research or practice?	Contact Details	Remark
27 Norway				research	Ival Holland (Norwegian University of Science and Technology)	Social Vulnerability Index (SoVI)
28 Poland						
29 Portugal	wild fires	Regional/local	yes	research	www.ensureproject.eu	ENSURE project
30 Romania	flooding (Danube delta), earthquakes (Bucharest), landslides	Regional? City of Bucharest		empirical research	Iuliaarmas@yahoo.com Armas 2009	one paper available as PDF at www.caphaz-net.org – WP 3 (internal)
31 Serbia						
32 Slovakia						
33 Slovenia						
34 Spain	flood vulnerability assessment of 13 municipalities in Cantabria	Regional/local		research	J. Weichselgartner	PhD Thesis in German
35 Sweden						
36 Switzerland				research	WSL /Matthias Buchecker	perception of vulnerability
37 Turkey	earthquakes	Regional/local		research	Seda Kundak	perception of vulnerability
38 Ukraine						
39 United Kingdom	flooding	Household, community, region	various flood events: 1998, 2000, 2001, 2005, 2007	research and practice	S. Tapsell at Flood Hazard Research Centre s.tapsell@mdx.ac.uk	Some studies also incorporate aspects on risk perception/awareness and risk communication
	heat waves	national	2003	research	Lancaster University	