



Task 11 Social Indicator Set

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SUMMARY

The objectives of Activity 1, Action 1 are to produce an indicator set that will serve as a basis for the national Task 11 case studies and which will later be used to characterise the social resilience of different communities for the formulation of preparedness strategies in Sub-Theme 2.1. This report forms such an indicator set. It begins by reviewing some key and relevant literature on vulnerability and resilience to disasters relevant to the aims of Task 11. The literature suggests a range of indicators, and in some cases sources of data for these indicators, for use in determining community vulnerability and resilience.

‘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. Almost every aspect of vulnerability – including how to measure and gain estimates from it and how to reduce it – is the subject of intense debate. Floodsite’s Language of Risk document includes eight definitions of vulnerability, from which the following has been chosen for use: Vulnerability is “[c]haracteristic of a system that describes its potential to be harmed. This can be defined by the product of susceptibility and value”.

Until recently, flood defence policy was dominated by a technical world view. Much flood defence has been aimed at stopping or alleviating damage occurring through structural means (i.e. defence schemes). However, the socio-economic aspects of flood risk management have gained in importance in recent years. There is now a realisation that true flood prevention and mitigation will need to address not only the hydrological factors, but also the economic, social and political factors influencing wider society and underpinning the impact of damaging floods.

Several conceptual frameworks are outlined in the report and that from Cutter et al. (2000; 2003), which incorporates both biophysical and social indicators to provide an all-hazards assessment of vulnerability at the local level, may be particularly relevant for comparing results from the diverse case study locations as it incorporates the notion of ‘place’. Selection criteria for social indicators are discussed and outlined in the report along with examples of various sets of indicators relevant to the study.

In order to determine which national data is available in EU Member States to which vulnerability and/or resilience indices might be attached, a review was made via the Internet of national census data and sources and examples of available indicator data from a small selection of countries are listed. Despite some ongoing issues and problems with the taxonomic approach to classifying indicators, a number of common indicators can be identified that could be applied across European States.

There is now a level of concurrence within the social science community on the sorts of indicators that are appropriate to assess the vulnerability of communities and populations to natural hazards such as flooding. A number of key indicators are given, along with an indication of whether the variable may be an indicator of increased or decreased social vulnerability. These indicators should largely meet the selection criteria but will need to be finalised once the conceptual framework for the research is agreed.

This report is intended to serve as a background paper to stimulate discussion among Task 11 Floodsite partners before the final selection of suitable indicators can be finalised.

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1. Introduction

1.1 Background

The objectives of Floodsite Task 11, Activity 1, Action 1 are to produce an indicator set that will serve as a basis for the national case studies and which will later be used to characterise the social resilience of different communities for the formulation of preparedness strategies in Sub-Theme 2.1. The initial idea was to take the social resilience indicators developed by FHRC and make them compatible with other local and/or national contexts. This report therefore constitutes Deliverable 11.1 for Task 11.

The work for this Action has focused on two activities:

- a review of relevant literature on indicators relevant to hazard/disaster vulnerability assessment and resilience capacity;
- an Internet search across EU Member States for sources of data similar to or comparable with that used in FHRC's Social Flood Vulnerability Index.

2. Literature review

This section of the report reviews some key and most relevant literature on vulnerability/resilience to disasters relevant to the aims of Task 11 and suggests a range of indicators, and in some cases sources of data for these indicators, for use in determining community vulnerability and resilience.

2.1 The Policy Context

Until recently, flood defence policy was dominated by a technical world view. Much flood defence has been aimed at stopping or alleviating damage occurring through structural means (i.e. defence schemes). In addition, the response to hazards has been a "command and control" mentality that focused on clean-up and the rescue of survivors. However, the socio-economic aspects of flood risk management have gained in importance in recent years (Mileti, 1999). There is now a realisation that true flood prevention and mitigation will need to address not only the hydrological factors, but also the economic, social and political factors influencing wider society and underpinning the impact of damaging floods (White and Howe, 2002). Many factors can be identified as influencing a change in approach to hazard and disaster management and response, including:

- the increasing economic and financial cost of disasters and rising impact potentials in floodplain areas, particularly urban areas;
- the fact that hard engineering structures alone are no longer able to provide the most cost-effective protection for people;
- the perception that it is not possible to protect against all floods and other natural disasters;
- the density of infrastructure and sheer number of people living in riskier areas;
- expansive and intensified land use and increasing conflicts between socio-economic land use and flood protection policy;
- the need for better understanding of interrelations and social dynamics of flood risk perception, preparedness, impacts and flood management;
- disparities in wealth and socio-economic status;
- a realisation of the importance of the intangible impacts of floods and the need for increased post-flood support and recovery.

Flood defence is now evolving into flood risk management and the notion of sustainable floodplain development which focuses on the use of an integrated approach to flood-hazard mitigation and prevention. Non-structural measures of providing protection from flooding are now being encouraged

such as flood forecasting, warning and response systems; land use planning; flood insurance; and self-help strategies such as flood protection products. This means a wider range of flood mitigation strategies, and a 'juggling' of these to optimise in some way the degree of flood risk reduction for different areas, regions and catchments. Response to flooding has also changed to an emphasis on the reduction in loss of life and property through mitigation, preparedness, response and recovery (Cutter et al, 2000). Hazard-resistant building design standards also have the potential to reduce the chance of housing damage and the losses and stress experienced by people living in flood-prone locations.

Benefit cost analysis in option appraisals for flood protection is moving towards considering the more 'intangible' social aspects of flood impacts, such as that on people's health and well-being, as well as the more traditional economic impacts. Flood policy is therefore becoming more 'people oriented', rather than 'engineering oriented'. It is people who will determine flood risk standards, and people who will have to take many of the actions that are required to minimise risk, for example by buying insurance, flood proofing their homes, and reacting and responding to flood warnings when they come.

Brown and Damery (2002) suggest that despite the important link between assessments of exposure to flooding (hazard assessments) and issues of social vulnerability, the link has rarely been explored in detail and has often been reflected in policy terms by the highly technocratic approach to flood risk management mentioned above. 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). However, issues of resilience and vulnerability need to be expressed in terms that can be operationalised and dealt with in a practical way (Buckle et.al., 2001).

There are two goals in supporting resilience and reducing vulnerability: first, manage both so that resilience does not diminish and vulnerability does not increase. Second, positively work to increase resilience and reduce vulnerability (Buckle et.al., 2001). A number of implications for intervention can be drawn from the literature. Whether directed toward the community, family, or individual, the emphasis for interventions should be on empowerment, meaning they should draw upon and build strengths, capabilities, and self-sufficiency. However, Buckle et.al. (2000) state that the new approach to emergency management of assessing risk, evaluating a range of management options, and of directly involving the community in the process, rather than emphasising prevention and control of the hazard agent, is still developing.

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 flood risk management policy implementation very difficult. Therefore ways need to be found to identify vulnerability and resilience on the basis of a variety of factors or indicators, both at individual, household and community levels. There is a need to identify assets and characteristics that can be used to support resilience. If these can be identified and strengthened, it will be possible to improve the capacity of individuals, families and communities to prevent or reduce flood impacts. There is therefore a need to determine:

- who or what are the elements of social vulnerability;
- how we can identify vulnerable groups and which groups would benefit the most from having their resilience enhanced;
- what attributes or capacities people possess that might reduce vulnerability and enhance resilience.

However, there is still a limited understanding of what the terms vulnerability and resilience include. This lack of understanding often constrains the effective practice of emergency management (Buckle et.al., 2000). A clear understanding of the concepts and terms is therefore essential.

2.2 Definitions of key concepts

‘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. Almost every aspect of vulnerability – including how to measure and gain estimates from it and how to reduce it – is the subject of intense debate. Definitions of vulnerability are necessarily contested by different stakeholders (Green and Penning-Rowsell, 2005) and there remains a lack of consensus on the meaning of the concept and the methods of operationalising it (Cutter 1993; 1996). Within the hazards literature, vulnerability has many different connotations, depending on the research orientation and perspective (Dow, 1992; Cutter, 1996). Originally it was used in an engineering sense to refer to the vulnerability of built structures. A rigid and deterministic definition of vulnerability was often favoured that was in keeping with the wider technocratic paradigm pervading management institutions.

Much of the early work on vulnerability was formulated in developing countries where the most vulnerable groups tend to be those who do not have their fundamental needs, such as adequate, food, shelter and health care met. Vulnerability is therefore seen as a function of social and economic wellbeing and subsequently the term has been applied increasingly within a socio-economic framework. Latterly researchers have seen the value of transferring this knowledge base to developed world contexts (Blaikie et al 1994).

As Green (2005) states, whilst it may be possible to discuss vulnerability reasonably satisfactorily without defining or agreeing exactly what we mean by the term, we must define it in explicit terms for some specific purpose in order to measure it. The test of a definition of vulnerability is effectively the insights it gives into how vulnerability may be reduced. A range of definitions of vulnerability and associated concepts exist. Weichselgartner (2001) includes a table with 23 different definitions of vulnerability. Floodsite’s Language of Risk document includes eight definitions of vulnerability, from which the following has been chosen for use:

Vulnerability is “[c]haracteristic of a system that describes its potential to be harmed. This can be defined by the product of susceptibility and value”.

From a sociological point of view, the first sentence is acceptable, but the second is problematic. What does this mean when related to people? Table 21 lists some other common definitions of vulnerability and associated concepts from the literature. The majority of definitions largely conceive vulnerability as *a function of susceptibility to loss and the capacity to recover* – this capacity is termed ‘resilience’. The term ‘vulnerability’ has been said to have negative connotations and according to some authors should be turned around and approached positively as ‘resilience’, or as the capacity to cope with or adapt to change. This is broadly similar to the concept of adaptive capacity which has been used and developed by climate change researchers (Adger et al., 2004). Some writers prefer to use the term resilience in place of vulnerability because of these more positive connotations e.g. the United Nations International Strategy for Disaster Reduction which defines “capacities” as the opposite of “vulnerability”. However, according to Buckle et.al. (2001) it is not possible to divorce vulnerability and resilience from each other – they are linked in a double helix and are not necessarily opposite ends of a continuum.

Vulnerability is not understood simply by reference to geographical proximity to flood risk; rather it is determined by a complex range of social factors. Social vulnerability is a multi-faceted concept incorporating issues of livelihood, housing, security and gender among many others. Social norms and customs, international, national and private and public law may regulate these constituents of vulnerability. These may differ from country to country. We currently know least about the social aspects of vulnerability – partly due to the fact that it is not always easy to quantify socially created vulnerabilities. The nature of social vulnerability will depend on the nature of the hazard to which the human system in question is exposed. However, vulnerability to flooding is now broadly recognised as being a function of both the physical environment and of the socio-economic and political context (Parker, 2000).

Vulnerability is intimately related to social processes in disaster-prone areas and is usually related to the fragility, susceptibility or lack of resilience of the population when faced with different hazards. People or communities are resilient or vulnerable in the context of particular situations, especially their risk environments. 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. People with very different backgrounds/occupations may be equally resilient in totally different situations. For example, a person may be vulnerable to a particular loss e.g. flooding of their home, but they 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.

Table 2.1 Definitions from the literature

Definition	Author(s)
<i>Vulnerability</i> is here defined as being determined by the characteristics of a person or group in terms of their limited capacity to anticipate, cope with, resist and recover from the impact of a natural hazard.	Blaikie et.al., 1994
<i>Vulnerability</i> is ... 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
<i>Vulnerability</i> must, therefore, be defined as a combination of susceptibility and recovery or adaptation. In turn, susceptibility is defined as the degree to which a system would be affected by a disturbance or change in its environment.	de Bruijn et al., 2005
<i>Vulnerability</i> refers to the capacity of an element exposed during the impact of a hazard event. Definitions of vulnerability to natural hazards generally refer to the characteristics of an element exposed to a hazard that contributes to the capacity of that element to resist, cope with and recover from the impact of a natural hazard.	Dwyer et al., 2004
The term <i>social vulnerability</i> is 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
<i>Social vulnerability</i> derives from the activities and circumstances of everyday life or its transformations.	Hewitt, 1997
<i>Social vulnerability</i> is a condition rooted in historical, cultural social and economic processes that impinge on the individual's of society's ability to cope with disasters and adequately respond to them.	Weichselgartner, 2001
<i>Resilience</i> is "The ability of a system/community/society/defence to react to and recover from the damaging effect of realised hazards."	Floodsite, 2005
<i>Social resilience</i> is "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."	Floodsite, 2005
<i>Adaptive capacity</i> may be described as 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 <i>potential</i> rather than actual adaptation.	Adger et al., 2004

Key among those factors fostering coping capacity at various phases of the hazard cycle is social capital (Pelling, 1998; Cannon, 2000). Social capital is made up of the networks and relationships between individuals and social groups that facilitate economic well-being and security. In other words, disasters are socio-environmental by nature and their materialisation is the result of the social construction of risk (Inter-American Development Bank, 2005).

We are all vulnerable in one way or another. This complexity makes it very difficult to plan for simple 'fixes' to flood risk. No single investigation into vulnerability indicators will provide a holistic and comprehensive answer, however, there are aspects of vulnerability and resilience that can be explored and represented through the development and application of quantitative indicators.

2.3 The history of social indicators

Indicators are used to assess the change over time of processes or phenomena that are difficult to measure (Cob and Rixford, 1998). 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 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). Research on social indicators thrived in the 1960s and 1970s within the social sciences, with discussion on both methodological and theoretical issues as well as applications to policy formation (Cutter et al., 2003). The development of environmental indicators followed shortly thereafter, with quality of life studies emerging as an amalgum of the two.

Social and environmental indicators research is experiencing a renaissance at present, especially in the area of sustainability science. Social indicators provide a means of measuring social characteristics to provide decision-makers with an effective and influential tool. There are now many examples of the use of indicators to assess human and environmental security and vulnerability to various hazards and threats. However, the development of indicators of social vulnerability to natural hazards is a relatively small area of research, particularly within applications to industrialised nations.

The most important aspect of indicator development is to ensure the indicators selected serve the needs of the research question and test the concepts to be operationalised. Social indicators should therefore be grounded in a reasonable conceptual framework or model.

2.4 Conceptual frameworks

In recent years a perspective has emerged that views hazards as basic elements of environments and as constructed features of human systems, rather than as the extreme and unpredictable events they are traditionally perceived as (Wong and Zhao, 2001). In order to assess vulnerability and adaptive capacity to these hazards in a quantitative manner it is necessary to develop indicators to represent key variables. However to do this it is necessary to develop a coherent conceptual framework. The notion of vulnerability is used very differently in the literature. While social scientists tend to view vulnerability as representing the set of socio-economic factors that determine people's ability to cope with stress or change (Allen, 2003), climate scientists often view vulnerability in terms of the likelihood of occurrence and impacts of weather and climate related events (Nicholls et al., 1999).

Three distinct conceptual models have been put forward by researchers in vulnerability research:

- the identification of conditions that make people or places vulnerable to extreme natural events - an exposure or biophysical model (Burton, Kates and While, 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 the scientific community in recent years, largely due to the work by Cutter et al. (2000; 2003). They 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. To operationalise their conceptual model, Cutter et al (2000) focused on the three elements of biophysical (exposure), social (susceptibility) and place vulnerability (hazardness). Three outcome indicators were used to measure the relative hazardousness of Georgetown County, South Carolina: biophysical vulnerability (measured by event frequency and delineation of hazard), social (measured by socio-economic characteristics), and overall place vulnerability (the interchange of the two). This model could be of interest for Floodsite's Task 11 as it incorporates the notion of place which may be particularly relevant for comparing results from the diverse case study locations.

According to Cutter et al, (2003), to date, there has been little research effort focused on comparing the social vulnerability of one place to another. For example, is there a robust and consistent set of indicators for assessing social vulnerability that facilitates comparisons among diverse places? How well do these indicators differentiate places based on the level of social vulnerability and how well do they explain differences in economic losses from natural hazards? As outlined above, Cutter et al. (2003) examined these questions through a comparative analysis of social vulnerability to natural hazards among US counties.

The social vulnerability approach to hazard and disaster management argues that society also creates conditions in which people face disasters differently (Blaikie et.al., 1994). Social vulnerability is partially the product of social inequalities (those social factors that influence or shape the susceptibility of various groups to harm and that also govern their ability to respond), however, it also includes place inequalities – those characteristics of communities and the built environment, such as level of urbanization, growth rates and economic vitality, that contribute to the social vulnerability of places. Those who are most vulnerable socially are generally expected to be most vulnerable in flood events. Morrow (1999) refers to the social construction of disaster vulnerability and to the social exclusion of some groups in disaster response.

Adger et al. (2004) also 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. The authors state that the framework provides a context within which indicators may be developed. They thus developed simple indicators of risk measured in terms of the outcome of climate related disasters using data from the Emergency Events Database (EM-DAT), and developed predictive indicators of vulnerability using publicly available data relating to social, economic, political and environmental factors (see Appendix A). 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.

2.5 Risk perception, awareness and experience

The basic concepts of risk perception are essential to the use of the selected indicators in a vulnerability risk assessment. Conversely, a vulnerability perspective is becoming increasingly recognised as important in understanding environmental risk. Individual, group and societal factors are known to affect perceptions of risk (Petts et al., 2002). Responses to risk are intimately bound up with wider values. Risk is multidimensional with perceptions directly influenced by belief systems, experience, and individual characteristics. The notion of risk perception refers to the intuitive risk

judgements of individuals and social groups in the context of limited and uncertain information (Slovic 1987). These judgements will vary between individuals based upon many factors. As a consequence, individuals within a community may judge the risk of being flooded very differently, because they do not have the same information about the probability of flood events in their region and about measures to mitigate these events, and their effectiveness (Messner and Meyer, 2005).

Risk perception is also closely connected to the notion of preparedness. As Messner and Meyer (2005) state, if (average) flood risk perception is low in a region – perhaps due to the fact that flood events occur rarely or the level of flood protection in terms of dykes and levees is high – many people, experts and politicians do not perceive themselves to be at risk of flooding. As a consequence, these people will probably not take any actions to decrease the flood risk or to prepare for a flood event. As a rule of thumb, therefore, it can be stated that regions with low levels of flood risk perception and awareness and a low degree of being prepared to cope with flood events tend to experience flood damage levels above average – their vulnerability to flood events is usually higher.

The lower one's awareness of some kind of danger, the more one is vulnerable to it, and therefore variables identified associated with decreasing awareness could be measuring 'social vulnerability' (Fielding et al., 2002). Trust is also recognised as one of the most important influences upon risk perceptions and responses to official communication. The Environment Agency in England and Wales has since 1999 conducted annual flood awareness campaigns at the start of the flood season. It also commissions the British Market Research Bureau (BMRB) to conduct a series of annual reports documenting awareness and performance of flood warning systems. These surveys are able to inform the Agency about levels of awareness of flood risk and of actions taken upon receipt of a flood warning. The BMRB survey results provide evidence on both access to, and willingness to adopt, particular warning dissemination technologies. Notable recent findings (BMRB, 2004) include:

- 64% of those at risk from flooding (residents and businesses) were aware of the risk - this figure had increased from 51% in 2001;
- 83% were aware of precautions that could be taken if there was a risk of flooding – a slight increase from 2003 (79%);
- less encouraging was the finding that only 8% of those inhabiting 'at risk' addresses who could think of any special precautions or preparations that could be made had actually made them.

One factor shown to affect risk perception is previous experience of the hazard (Fielding et al, 2002). Those people with prior experience of flooding tend to be better informed and prepared and therefore more aware of flood risk, and consequently less vulnerable. Research evidence shows that the response and preparedness for floods improves with experience, including *access* and *willingness* to use warning communication technology (Tapsell et al., 2004). Findings in the UK from the BMRB surveys show that those with previous flood experience are more likely to take disruptive action upon receiving a warning than those who had not been previously flooded or were living in newer properties. Experience of previous floods is a recurring social factor in other studies, for example research in the Loire Valley of France for the OSIRIS project (Blancher, 2001).

There is evidence for the "innoculation hypothesis" that emphasises the advantage of being familiar or experienced with a stressor that is at hand (Norris and Murrell, 1988). An implication is that "experienced" victims could be a valuable resource in prevention efforts. However, Tunstall and Bossman-Aggrey (1988) reported that previous experience of flooding did not leave residents with knowledge about how to cope with a future flood, but with a feeling that there is little they can do.

The first essential requirement for effective risk communication is understanding what people think and why. It has been suggested that world views and culture are significant in explaining risk perception (Pidgeon & Beattie, 1997). Pidgeon & Beattie (1997) suggest that views towards risk vary systematically according to four cultural biases: individualist, fatalist, hierarchist and egalitarian. Each of these defend a particular set of institutional arrangements and ways of life. They define which

dangers should be accepted and avoided, how risks should be distributed and who should be blamed when things go wrong. Although these ideas are intuitively appealing, Petts et al (2002) suggest that the theory has so far received limited empirical support.

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 (Brown and Damery, 2002). Flood risk information is often framed using technical concepts and notions of statistical probability such as 'return periods'. These issues feed into public expectations about the role of flood management institutions and therefore the behaviour adopted when receiving communications regarding flood probability from 'official' sources. According to Brown and Damery (2002), the lay public have a fundamentally different intellectual standpoint from that of the experts, which should be taken into account when technical information about flood risk is disseminated. The 'information-deficit' model used in many countries is said to neglect the socially embedded and contextualised manner in which people make sense of the world, and onto which individual vulnerability is overlaid; this context needs to be understood.

Yet, despite the various efforts mentioned above, 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, and Cutter et al. (2003) talk of the need for redirecting social indicators research. It is possible, however, to identify certain criteria to aid indicator selection.

2.6 Selection criteria for indicators

The most important aspect of indicator development is to ensure the indicators selected serve the needs of the research question. The indicators selected for various studies depend upon the purpose of the study, the research discipline being explored and the final application. Moreover, different studies may use different indicators and produce different findings – with none likely to produce the ultimate and definitive answer. Any indicator set must be flexible enough to deal with both the individual case as well as various levels of aggregation depending on availability of resources, need and/or appropriateness. It needs to be simple enough to be practicable, yet sophisticated enough to give valid results. By ensuring that methods of indicator selection are transparent, both the methods and findings can meaningfully be compared and assessed and any weaknesses identified and addressed. It must be remembered that indicators only provide an 'indication' of much broader and complex social concepts, and therefore good indicators must have a clear conceptual basis in order to measure what is intended.

Vulnerability and resilience may be examined at a variety of levels or scales e.g. the individual, family group, household, community, local, national, regional or even global levels (Adger et al., 2004). It is necessary to consider these scales of analysis, as the level at which we can measure the individual characteristics will then dictate how we can relate those characteristics in the form of some measure of vulnerability (Green and Penning-Rowsell, 2005). However, vulnerability at the local level can be influenced by processes operating at the national scale. For example, national economic policy can have a strong influence on the economic well-being of vulnerable groups by determining the cost of basic needs such as food, education and healthcare.

Moreover, vulnerability is not static – processes are at work. Just because someone is vulnerable at the present time does not mean that they will be in the future, and vice versa. Vulnerability varies over time and space. It is increasingly recognised that vulnerability is a dynamic characteristic and a function of the constant evolution of a complex of interactive processes (Leichenko and O'Brien, 2002; Kasperson, 2001).

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. Moreover, a narrow range of indicators may often be more powerful than a long laundry list. 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
- Quantitative – measurable via readily understood model
- Recognisable by others
- Objective
- And ideally, comparable within and between communities.

The need to verify vulnerability assessments is particularly great given the complexity of vulnerability, the assumptions made, as well as variations in the definitions of vulnerability and the theoretical approaches applied. Procedures for the selection of indicators follow two general approaches – one based on a theoretical understanding of relationships and one based on statistical relationships. The first approach represents a *deductive* research approach and the second an *inductive* approach, although conceptual understanding does have a role to play in both (Adger et al., 2004). However, it is characteristic of many vulnerability indicator studies that they do not belong distinctly to either a deductive or an inductive approach.

The *deductive* approach involves proposing relationships derived from theory or a conceptual framework and selecting indicators on the basis of these relationships. For this it is necessary to understand the phenomenon being studied and the main processes involved and to identify the main processes to be included in the study and how they are related. Finally, it is necessary to select the best possible indicators for these factors and processes and assign them values and weights. During this procedure the research questions and hypotheses are stated. Concepts need to be operationalised in order to test variables empirically. This involves the specification of how theoretical concepts will be measured – or deciding which indicators will be used to measure the concept to produce data on it. In deductive research, a hypothesis is tested by operationalising the concepts in the hypothesis and collecting the appropriate data to explore the relationship between the measures of these concepts (Adger et al., 2004).

The *inductive* approach involves relating a large number of variables to vulnerability in order to identify the factors that are statistically significant. The observed statistical relationships are then used to build a model. The use of a conceptual framework and operationalisation is less rigorous in inductive research than in deductive methods, and the testing of hypothesis is less formal. Some concepts are often considered at the outset, however, in order to frame the collection of data. Inductive research often uses empirical generalisations: in other words the finding of patterns in data that can be generalised.

In Task 11 we need to have a clear understanding of which approach we are to use.

2.7 Examples of Indicator Sets

There has been discussion in the literature as to the purpose that indicators should serve. Cobb and Rixford (1998) ask if indicators should be prescriptive, providing guidance about what to do, or descriptive, simply highlighting conditions that might otherwise be overlooked. The answer to this is dependent upon the aim and context of each particular study. A review of social indicators by Fenton and MacGregor (1999) revealed five classes of indicators:

- Informative indicators
- Predictive indicators
- Problem-oriented indicators
- Program evaluation indicators
- Target delineation indicators

Many sets of indicators have been developed to examine highly context-specific processes. For example, the United Nations Development Program's Human Development Index (UNDP, 2000) provides a composite indicator of human wellbeing, as well as indicators of gender disparity and poverty among nations. The World Bank similarly provides annual data and indicators in its World Development Indicators Reports (e.g. World Bank, 2003). Some studies have investigated methodologies of vulnerability indicator development within a comprehensive risk assessment, such as the Earthquake Disaster Risk Index (Davidson, 1997) and the Australian Cities Project (Granger et al., 1999). A sophisticated database has been developed in Cairns in far North Queensland to predict vulnerability and manage mitigation. This culminated in the Australian Geological Survey Organisation's Multi Hazard Risk Assessment for Cairns (Granger et al., 1999). Other examples of national level indicator sets include:

- Index of Sustainable Economic Welfare
- Index of Human Insecurity
- Environmental Vulnerability Index
- Environmental Sustainability Index
- Environmental Performance Index
- Water Poverty Index
- Disaster Risk Index
- Disaster Deficit Index
- Local Disaster Index
- Risk Management Index
- Prevalent Vulnerability Index (PVI)

Not all of these indicators are relevant to Floodsite, and some are very issue specific. Of the above, the most relevant to Task 11 is the PVI which characterises prevailing vulnerability conditions reflected in: exposure in prone areas, socio-economic fragility, lack of social resilience; aspects that favour the direct impact and the indirect and intangible impact in case of the occurrence of a hazard event. The index is a composite indicator set that depicts comparatively a situation of pattern in a country.

Most of the above indicator sets aim at measuring vulnerability at the national level rather than the local community level, although some of the same indicators could be applied at either level assuming the relevant data was available. One such Index worth mentioning in more detail is the Social Vulnerability Index developed by Cutter et al. (2003).

2.7.1 Social Vulnerability Index (SoVI)

Cutter et al. (2003) constructed an index of social vulnerability to environmental hazards for all US counties - based on 1990 census data available at the county level. They used a factor analytic approach: 42 variables were reduced to 11 independent factors that accounted for about 76 percent of the variance. The factor scores were added to the original county file as 11 additional variables and then placed in an additive model to produce the composite Social Vulnerability Index score for each county. No weighting of variables was used. Table 2.2 shows the 11 composite factors that differentiated US counties according to their relative level of social vulnerability in 1990.

Results showed that those factors that contribute to the overall score are often different for each county, emphasising the interactive nature of social vulnerability; some components increase vulnerability while others moderate the effects. The factors demonstrate the geographic variability in social vulnerability and the range of the underlying causes of that vulnerability. However, the authors realise that the SoVI is not a perfect construct and that more refinements are necessary. They suggest that the SoVI can be coupled with hazard event frequency and economic loss data to further examine those individual factors that are the most important contributors to dollar (monetary) losses. This could be done on an individual hazard basis (e.g. floods) or by specific time period for all hazards. They

need to next look at whether those counties most exposed to biophysical risk are also the most socially vulnerable.

Table 2.2 Dimensions of Social Vulnerability (Cutter et al., 2003: 252)

Factor	Name	Percent Variation Explained	Dominant Variable	Correlation
1	Personal wealth	12.4	Per capita income - % households earning more than \$75,000 per year, median house values, and median rents	+0.87
2	Age	11.9	Median age	-0.90
3	Density of the built environment	11.2	No. of commercial establishments/mi ²	+0.98
4	Single-sector economic dependence	8.6	% employed in extractive industries	+0.80
5	Housing stock	7.0	% housing units that are mobile homes	-0.75
6	Race – African American	6.9	% African American	+0.80
7	Ethnicity – Hispanic	4.2	% Hispanic	+0.89
8	Ethnicity – Native American	4.1	% Native American	+0.75
9	Race - Asian	3.9	% Asian	+0.71
10	Occupation	3.2	% employed in service	+0.76
11	Infrastructure dependence	2.9	% employed in transportation, communication, and public utilities	+0.77

The authors conclude that the most biophysically vulnerable places do not always spatially intersect with the most vulnerable populations, reflecting the likely “social costs” of hazards on a region. The degree to which populations are vulnerable to hazards is not solely dependent on the proximity to the potential source of the threat. Social factors such as wealth and housing characteristics can also contribute to greater vulnerability. While economic losses might be large in areas of high biophysical risk, the resident population also may have greater safety nets (insurance, additional financial resources) to absorb and recover from the loss quickly. Conversely, it would only take a moderate hazard event to disrupt the wellbeing of the majority of residents who are more socially vulnerable – but who perhaps do not reside in the highest areas of biophysical risks – and retard their longer-term recovery.

2.7.2 The Social Flood Vulnerability Index (SFVI)

One Index developed by the Flood Hazard Research Centre (Tapsell et al., 2002) which does measure vulnerability at the local level is the Social Flood Vulnerability Index (SFVI). The SFVI was to be used as a guide to developing an indicator set for Task 11.

The Index was originally developed for use in production of the Environment Agency’s Catchment Flood Management Plans for the Development of a Modelling and Decision Support Framework (Defra/Environment Agency, 2002). The SFVI highlights the policy-shift away from purely economic assessments and engineering concerns to wider issues of sustainability, including sociological or

‘people’ issues. It is anticipated that the Index would be used in addition to knowledge of the potential flood damage impacts and losses that are more readily understood and modelled within benefit-cost analyses within investment appraisals.

Data for the Index is taken from the most recent Census in England and Wales in 2001 and indicates factors that lead people to be more vulnerable, and therefore less resilient to, exposure to flooding and the impacts from flooding. The choice of data was constrained by the need to (a) use data that is available for the whole of England and Wales and (b) use data that is available for small geographical areas. Census data was used because this data fits the above criteria, i.e. being available for England and Wales for the various Output Areas.

The SFVI is a composite additive index based on three social groups:

- the elderly aged 75 and over
- single parents
- the long-term sick

and four financial deprivation indicators:

- unemployment
- overcrowding in households
- non-car ownership
- non-home ownership.

It was the intention to target only those social groups which previous research has shown to be particularly vulnerable. The rationale for the selection of the social groups to be included in the Index is given in Table 2.3 below.

To identify the financially deprived, the Townsend Index was used because, unlike other deprivation indices, it focuses on deprivation outcomes (such as unemployment), rather than targeting predefined social groups. This enabled identification of our own social classification and is important because financial deprivation is only one of several factors that are said to contribute towards vulnerability to flood-effects.

The Townsend indicators are:

- Unemployment – unemployed residents aged 16 and over as a percentage of all economically active residents aged over 16.
- Overcrowding – households with more than one person per room as a percentage of all households.
- Non car ownership – households with no car as a percentage of all households.
- Non home ownership – households not owning their own home as a percentage of all households.

In order to prevent any undue bias in the SFVI towards financial deprivation, the four Townsend indicators were summed and multiplied by 0.25 before being added to the other variables i.e. data on the three social groups, each as a percentage of all residents:

The Index is categorised into a limited number of bands where category 1 represents low vulnerability to category 5 which represents high vulnerability. Once the data is processed the mapped, results give a clear indication of levels of vulnerability at the local level and between different locations. However, further research is needed to gauge how accurately actual vulnerability to flooding is predicted by the SFVI scores.

Table 2.3 Rationale for the selection social groups for the SFVI

Social groups	Rationale
Elderly (Over 75 years of age)	The age of 75 was chosen because epidemiological research has shown that after this age there is a sharp increase in the incidence and severity of arthritis (and other conditions) and this illness is sensitive to the damp, cold environmental conditions that would follow a flood event.
Lone parents	Previous FHRC research has shown that lone parents (of either sex) are more likely to be impacted by floods because they tend to have less income and must cope single-handedly with both children and the flood impacts, and with all the stress and trauma that this can bring.
Pre-existing health problems	Research by FHRC has shown that post-flood morbidity (and mortality) is significantly higher when the flood victims suffer from pre-existing health problems.
Financial deprivation	The financially deprived are less likely to have home contents insurance and would therefore have more difficulty (and take a longer time period) in replacing households items damaged by a flood event.

2.7.3 The Vulnerable Groups Project

Another local level study by researchers at the University of Surrey, UK, for the Environment Agency aimed to identify the vulnerability of discrete social groups to flooding, the reasons for their vulnerability, and to examine how the flood warning response of the most vulnerable of these groups can be enhanced, and the impacts of flooding reduced. The research was not just focusing on the 'vulnerable' socio-economic groupings but on the demographic variation of *all* socio-economic groupings (the social distribution of flood risk), including taking account of factors such as ethnicity, culture, housing type, car ownership etc. which may affect vulnerability (Fielding et al., 2004). The project is due to produce a vulnerability index but the report is not yet available.

The project addressed the concept of 'vulnerability' in three ways: in terms of certain groups being more likely than others to be flooded; in terms of certain groups being less likely to be aware of flood warnings; and in terms of certain groups being less able to respond to flood warnings. The Surrey University project attempted to measure vulnerability by using several conceptual models. One of these models was Openshaw's (1994) GB Profile classification (Table 2.4).

Using the GB Profiles of Enumeration Districts (EDs) from 1991 Census data within the one in a hundred year indicative floodplain, it was found that 34% of all EDs were at least partly included within the floodplain. Those EDs classified as 'rural farming communities' were three times as likely to be in the floodplain as not, and those EDs classified as 'prospering affluent achievers' were nearly two times as likely to be in the floodplain as not. This means that more people in these categories are more likely to be at risk from flooding. Those EDs classified as 'struggling' or 'aspiring' were more likely *not* to be in the flood plain.

Table 2.4 Openshaw's GB Profile of ten clusters

1. Struggling - multi-ethnic areas, pensioners and single parents, high unemployment, LA rented flats
2. Struggling - council tenants, blue collar families and single parents, LA rented terraces
3. Struggling - less prosperous pensioner areas, retired blue collar residents, LA rented semi's
4. Struggling - multi-ethnic areas, less prosperous private renters, young blue collar families with children, privately renting terraces and bedsits
5. Aspiring - academic centres and student areas, young educated white collar singles and couples, privately rented bedsits and flats
6. Aspiring - young married suburbia, young well-off blue collar couples and families, mixed tenure terraces
7. Climbing - well-off suburban areas, young white collar couples and families, buying semi's and detached houses
8. Established - rural farming communities, mature well-off self employed couples and pensioners, owning or privately renting large detached houses
9. Prospering - affluent achievers, mature educated professional families, owning and buying large detached houses
10. Established - comfortable middle-agers, mature white collar couples and families, owning and buying semi's

The Jarman index of deprivation was also considered as a good proxy for social vulnerability as it included several of the indicators identified in previous research. The standardised index ranges from -46 (low deprivation) to 66 (high deprivation) with a mean of zero. For each of the six sample sites identified, the Jarman index was mapped using the same classification for each site. Following this, each site was mapped using the GB Profiles classification, but only for EDs in flood warning areas. The maps indicated some levels of deprivation, and therefore levels of vulnerability, between and within each study site (Dept. of Sociology and Centre for Environmental Strategy, 2002). However, preliminary analysis did not reveal any systematic over representation of members of socially disadvantaged groups within floodplains in England and Wales, although the authors suggested that the issue requires more detailed investigation.

Two Environment Agency Regions were compared using the ED data and the GB Profile classifications: Thames and the North East. These demonstrate the difference in population characteristics between regions in England i.e. between north and south. For example, in Thames Region there are higher proportions of 'struggling multi-ethnic' populations, and 'aspiring academic' populations, while in the North East there are higher proportions of 'struggling less prosperous pensioner' areas and 'established rural farming communities'.

Certain categories of people emerged from the initial study as being considered particularly vulnerable to flooding (Thrush, 2002); these groups were:

- The elderly, particular the unsupported elderly and the frail and confused - although it was acknowledged that some elderly people cope very well.
- Families with young children, especially single parents.
- Minority ethnic populations.
- People without resources e.g. financial, physical, psychological and social - people with poor coping skills generally e.g. the disabled.
- People living in mobile homes.
- People new to an area and without previous flood experience.

- People who had become complacent about flood defence structures and who felt themselves to be protected from flooding in all eventualities.

What strongly emerged was the need to consider local issues and to use local information, and to retain (or reinstate) local action rather than adhere solely to a national initiative. The issue of local knowledge emerged as very important regarding the kinds of flood warnings issued, which should consider local situations and conditions. There were some suggestions of building up local trust and in giving local people a degree of control over their own warning systems.

2.7.4 Household vulnerability in Australia

In Australia, Dwyer et al. (2004) introduced a method for measuring the vulnerability of individuals within a household from the risk of natural hazards. The indicators used in the study explored social vulnerability at the individual and household level. Thirteen vulnerability indicators and two hazard indicators were selected based on those that were quantifiable and specific to people living in urbanised areas within an Australian city. Injuries sustained and damage to residence are indicators that relate to the impact of the hazard, while others are socio-economic variables that provide an insight into individual characteristics. The indicators are:

- Age
- Income
- Tenure type
- Employment
- English language skills
- Household type – family composition
- Disability
- House insurance
- Health insurance
- Debt/savings
- Car ownership
- Gender
- Residence type
- *Injuries sustained*
- *Damage to residence*

While not exhaustive of factors that contribute to a person's vulnerability, the combination was thought to provide an indication of which people are the most vulnerable within a community in the event of a natural hazard impact (Dwyer et al., 2004). In the study, financial indicators were the most significant after injury and residence damage and yet their role in vulnerability depends on other factors. For example, having a mortgage may only make you vulnerable if you are of retirement age and have no house insurance. Renting a home may only make you vulnerable if you are moderately injured and over 65. However, renting may lessen your vulnerability if you are younger than 43 and your house was destroyed, compared with those of the same age who owned their destroyed home but did not have insurance.

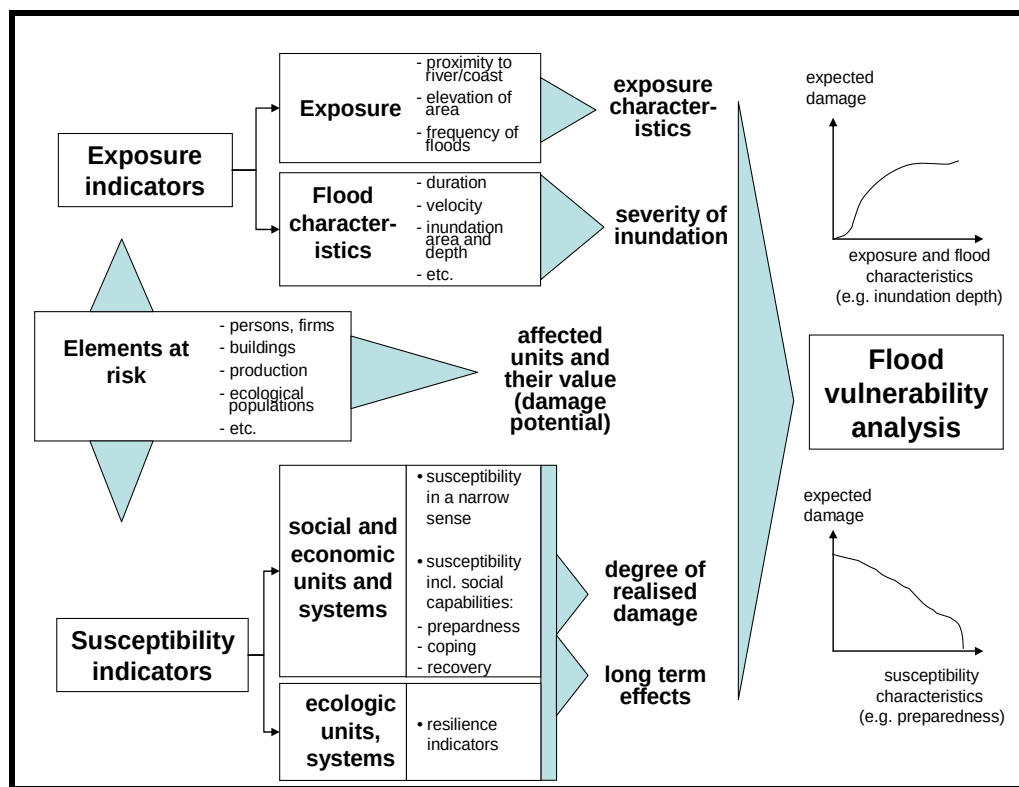
2.7.5 Taxonomies of indicators of vulnerability and resilience

Studies to date suggest that there is no single source of resilience or vulnerability, rather, many interacting factors come into play. However, for some time now, research has identified the differential experience and response of different social categories during various stages of the disaster process. In relation to this there has been much discussion in recent years on whether certain individuals or groups within communities are likely to be more vulnerable or resilient to the effects of hazards and disasters than the population in general (Enarson and Morrow, 1998; Morrow, 1999; Fordham, 1998; Buckle et.al., 2000; Tapsell et al., 2002). There is now a level of concurrence within the social science community on the sorts of indicators that are appropriate to assess the vulnerability

of communities and populations to natural hazards such as flooding, as illustrated in the examples cited above.

The subject matter of any analysis of social vulnerability to flooding is the group of elements that are at risk to be harmed by flood events. Generally speaking, an element at risk to be harmed is more vulnerable the more it is exposed to a hazard and the more susceptible it is to its forces and impacts. Therefore, any flood vulnerability analysis needs information about these aspects, which can be specified in terms of element-at-risk indicators, exposure indicators and susceptibility indicators (Messner and Meyer, 2005 - see Figure 2.1), reflecting the different conceptual models outlined above. In this regard natural *and* social science indicators are both of importance. These three sets of indicators are discussed below in more detail.

Figure 2.1 Categories of vulnerability indicators



Element-at-risk indicators specify the amount of social, economic or ecological units or systems which are at risk regarding all kinds of hazards in a specific area e.g. individual people, households, and communities. Properties and production may also be element-at-risk indicators for impacts (directly and indirectly) on people and communities.

Two categories of *exposure indicators* can be distinguished which indicate the severity of flooding as well as its distribution in space and time. The first typifies frequency of flooding and factors such as proximity to the hazard and level of elevation of the risk area/properties. These indicate the threat to the various elements at risk of being flooded. The second category of indicators include characteristics of the flood event such as like depth, duration, velocity etc. (Messner and Meyer, 2005).

The largest group of indicators comprise *susceptibility indicators* which measure the sensitivity of an element at risk to a particular kind of hazard. Messner and Meyer (2005) suggest that susceptibility indicators in a wider meaning also include the *social system context* of flood damage formation,

especially the awareness and preparedness of affected people regarding the risk they live with (before the flood), their capability to cope with the hazard (during a flood), and to withstand its consequences and to recover (after the flood event).

Awareness and preparedness indicators may include: the number of people aware of living in an at risk area; the number of households protected by means of structural flood defences and the quality of such measures; the effectiveness of disaster management organisation; and the number of people with flood insurance (both for buildings and contents) or individual flood protection measures for their properties. Research in the UK by the University of Surrey (Fielding et al, 2002) showed the following factors to *decrease* the level of flooding awareness, and therefore preparedness, in at risk areas and increasing vulnerability (in order of impact):

- Not been flooded before
- 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 warning system
- Unemployed
- Aged under 45 or over 55

Indicators relating to the ability of individuals and social systems to cope with the impact of floods are often correlated to general socio-economic indicators. Socio-economic and demographic characteristics of vulnerability have been identified by Adger et al. (2004); RPA, FHRC et al. (2004); Fielding et al. (2002); Thrush (2002); Drabek (2000); Fothergill et al. (1999); Blaikie et al. (1994); Fordham et al., 1994; Keys (1991); Drabek (1986) among others. The following social groups are therefore generally associated with high levels of vulnerability:

- The very young
- The very old
- Women
- The physically and mentally disabled
- Single parent households
- One person households
- Newcomers to the community and migrants
- Ethnic minorities
- People lacking communication and language skills
- Low income earners

Some studies have also identified other groups, such as:

- Households with children
- Those with no previous flood experience
- Those with low risk awareness
- People living in mobile homes.
- People who have become complacent about flood defence structures and who feel themselves to be protected from flooding in all eventualities.

Fundamental causes of human vulnerability outlined by many key authors include:

- a lack of access to resources, information and knowledge
- limited access to political power and representation
- certain beliefs and customs
- weak buildings or weak infrastructure and lifelines

- population shifts from rural to urban to suburban and exurban which result in more people living in unregulated floodplains and expose coastal locations.
- Increased mobility which means that more people live in new surroundings and are unfamiliar with the risks in their new areas, and how to respond to them
- resilience factors such as management capacity (i.e. people's ability to meet their own needs); resource availability; cultural attitudes and values; access to services; social isolation.

Recovery indicators relate to the capability of the people to overcome the consequences of flood impacts. Among others, these indicators refer to the financial reserves of affected households and communities, the substitutability of lost items, the cohesion of social systems, and the external support provided by family, friends, neighbours, local authorities, emergency services, the government, voluntary associations and private donors (Tapsell et al., 1999; Tapsell and Tunstall, 2001; Messner and Meyer, 2005). They also include not only the individual genetic predispositions that express themselves in terms of people's temperament, personality, and intelligence, but also qualities such as social skills and self-esteem. These in turn are shaped by a variety of environmental influences. Other factors that contribute to a person's ability to recover include spiritual, emotional and psychological capacity, as well as a sense of community and other less tangible factors, such as trust in authority figures, political climate, local government policy, emergency service capabilities and welfare services, capacity for change, preparedness and capabilities of Local Government (Dwyer et al., 2004).

The social impacts of floods also significantly relate to the susceptibility of basic infrastructure and lifelines, which support a population's basic needs and their ability to withstand the consequences of flood events. Coping and recovery indicators can also therefore include those on the technical susceptibility of these systems e.g. drinking water supply, wastewater treatment, communication systems and energy supply. They also indicate the potential of the systems to prevent the occurrence of damage or to reduce overall flood damage. Appendix A outlines the key indicators identified in selected literature.

2.7.6 Issues and problems with the taxonomic approach

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. It is important to differentiate between women of different social class (Fordham 1999) or ethnicity (Enarson and Fordham, 2001; Tapsell et al., 1999) or ableness (Abu-Habib, 1997). Buckle et al. (2000) and Brown and Damery (2002) see the use of taxonomies such as these to be a very limited view of vulnerability in that these categories have not been adequately explored and may give rise to a stereotyped and unenlightened view of risk and capacity for hazard response. Communities and even individuals in a household will vary in knowledge, skills, culturally and socially determined rights to resources according to age and gender.

Other research has revealed that the identification of vulnerability must be balanced by that of capacity (Anderson and Woodrow 1998). For example, although acknowledging women's tendency to vulnerability, Fothergill's reviews (1996; 1998) of the literature on gender and disaster found a number of examples (within warning communication and response) of women being generally more risk-aware, more likely to believe and act upon warnings, and more likely to relay them to others. Additionally, to have access to local community or family networks (social capital) can also counterbalance the negative effects of a lack of financial and other resources (Fordham, 1999; Tapsell et al., 1999; Cannon, 2000). Moreover, the same property type may indicate different levels of vulnerability according to the ownership status of the occupant. Tenure can affect the extent to which properties are kept in good repair (tenants may have less resources or motivation to repair than owner-occupiers).

Another problem 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 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 to be explored. For example, an elderly person may not be vulnerable just because of age, but when combined with living alone, not having a car, having a low income and disability, vulnerability may increase. Ethnic minorities may not be vulnerable because they are minorities but because they lack access to services and information, or because of language difficulties. Dwyer et al. (2004) challenge the notion that one personal attribute can determine vulnerability, except for a life-threatening injury. Therefore, we need to know how vulnerabilities are compounded to create the most vulnerable (Wisner 1993). Therefore the issue of identifying the functional form of the relationships between different indicators is important. Many of the indices outlined above apply additive models to produce their vulnerability scores. However, relationships of indicators can take many interactive forms, not all of which are additive, and which need to be considered.

Cutter et al. (2003) also conclude that not all indicators are necessarily equal, and the need to develop a defensible weighting scheme is important, for example the same property may be occupied by a two-salary couple, an elderly widow, or a lone-parent family – each requiring a different weighting on a vulnerability index. Most studies do not apply weights to the vulnerability indicators and hence the indicators are generally considered to be independent and equally important variables. However, what should determine these relative weights? Cutter et al. (2003) suggest that the analysis could be projected into the future (using latest census data) to develop realistic scenarios of potential future vulnerabilities in order to target mitigation efforts to the most vulnerable groups or areas.

3. Results of Internet Search

In order to determine which national data was available in EU Member States to which vulnerability and/or resilience indices might be attached, a review was made via the Internet of national census data and sources. EU member states are now requested to supply statistical data on their populations. The 2000 Round of Population and Housing Censuses covers the EU Member States, the European Free Trade Association Member States and countries that are presently Candidates for accession into the EU, as well as some of the remaining countries of the Western Balkans (University of Thessaly, 2004). Although it was possible to discover which countries do and do not hold census data, it was not possible in the time available to check the detailed data for all EU Member States. Appendix B therefore lists examples of available indicator data from a small selection of countries.

3.1 Constraints on the research

There are considerable complications and constraints surrounding the gathering and use of social indicators for measuring community vulnerability to natural hazards. A number of constraints were experienced in gathering census and statistical data for this Activity. The key constraint when searching for relevant data across Europe was the difference in nationally held data. First, some countries do not hold national Censuses (Germany, Sweden, Iceland). For countries where there is no Census data other alternative data sources are needed. Data is normally available on 'core' topics but some data is on 'non-core' topics which include optional variables that vary depending upon national priorities (University of Thessaly, 2004). Second, the last date of collection of national data varies e.g. from November 1995 (Malta) to May 2002 (Poland). Some countries also hold additional types of registers (e.g. Denmark for income, education, social security etc.). In the case of some Eastern European states, which historically developed under different socio-economic and political systems and administrative boundaries, comparative data is not always available.

It is also unclear at what level data is available for. For example, in the UK data is available at the very local level of Output Areas (average population per unit of 296 – divided by 2.4 for number of households). However, this does not appear to be the case for many countries and it may not be possible to distinguish regional variations.

Another constraint was the language barrier. While this was not a problem for many Western European countries, for many of the newer Member States data is only available (understandably) in the national language e.g. Hungary.

4. Suggested Indicator Set

In considering data from Appendix B, a number of common indicators could be applied across European States. These indicators should largely meet the criteria for selection outlined above but will need to be finalised once the conceptual framework for the research is agreed. We therefore suggest consideration of the following characteristics/indicators to determine vulnerability and resilience to flooding within European countries. These include elements at risk indicators, exposure indicators and susceptibility and resilience indicators. The symbols indicate whether the variable may be an indicator of increased or decreased social vulnerability (+ = increases vulnerability, - = decreases vulnerability). The indicators are:

- 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 (non-white +, 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 +)

It is not clear from considering the availability of Census data exactly what is the extent of data included under the 'households' category, nor is it clear in some cases if 'tenure' information is available or data on long-term illness or disability; some further verification might therefore be necessary. Only Estonia appears to include data on long-term illness or disability. More detailed research would be needed before a more definitive set of indicators could be suggested for comparability purposes across EU States.

In addition other key indicators that can be explored in questionnaire surveys would include:

- Levels of risk awareness and preparedness (high awareness -, low awareness +)
- Previous flood experience (no experience +)
- Access to decision-making (increased 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)

The following key issues will still need to be resolved:

- How do we deal with combinations of indicators and their functional form?
- How do we decide upon the weighting of indicators?

5. Conclusions

The literature review for this Activity has revealed a number of possible variables that can be considered as indicators for assessing vulnerability and resilience to flooding. It has also highlighted some of the problems associated with the use of social indicators. The Internet search helped to determine the availability of national data in EU Member States to which vulnerability and/or resilience indices might be attached. This report is intended to serve as a background paper to stimulate discussion among Task 11 Floodsite partners before the final selection of suitable indicators can be finalised. A few key points can be made in conclusion:

- good vulnerability assessments must measure the right things, at the right scale, with suitable conceptual underpinning;
- there is still a need for a method of more finely assessing and assigning a priority to vulnerabilities – not just for Floodsite;
- indicators of vulnerability will in some cases need to be related to the specific contexts of Floodsite countries and case study areas;
- there is still a need for agreement over the weighting of variables/indicators and their functional form.

6. References

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Appendix A Categorisations of indicators from key selected literature

Indicators	Research identified					
	Vulnerable groups identified in Australian studies (Buckle et.al., 2000)	Research from FHRC in England and Wales (e.g. Tapsell et al, 1999; Tapsell and Tunstall, 2001; Tapsell et al., 2003; RPA/FHRC et al., 2004)	The key indicators in North Queensland, Australia (King, D. (2000)	Dwyer et al (2004) Review of various literature.	Factors in UK seen as significantly affecting increased levels of awareness of flood risk (Fielding et al., 2002)	Adger et al. (2004) identify key groups of factors representing vulnerability to climate change
Socio-economic	Elderly (particularly the frail) Very young Disabled (physical and mentally) Poor/people with limited resources to meet essential needs (finances, accommodation) Non English speakers Socially isolated Seriously ill People dependent on technology-based life support systems Large families Single parent families New arrivals – refugees People on holiday and travelling Tourists from overseas	Population size and composition Age Gender Families with young children Single parents Size of household Race Ethnicity Disability (physical and mental) Pre-existing health problems Education levels Income levels Tenure - owner occupier/rented property Type of property Car ownership Length of residence in area Flood experience and recency Awareness of flood risk/risk perception	Total population Total number of households Unemployed Households with no car Aged 0 to 4 years or over 65 years Living in an institution Number of houses Population living in caravans Population living in flats Households with income under \$25,000 (Australian) a year Aboriginal and Torres Strait Islander population Lone person households Visitors	Age Income Tenure type Employment English language skills Household type – family composition Disability House insurance Health insurance Debt/savings Car ownership Gender Injuries sustained	Previous experience of flooding Being in socio-economic group A or B Being an owner-occupier. Being in full-time or part-time work. Being aged 45-54 Length of residence	Economic well-being Health and nutrition Education Physical infrastructure Demographic factors Technical capacity
Community		Level of community cohesiveness Membership of social/community groups and networks/Flood Action Groups				

		Presence of community groups/Flood Action Groups Level of community activism Level of trust in responsible authorities				
Political		Access to power and decision making Access to networks e.g. membership of political parties/trade unions Access to legal services/advice Access to welfare/insurance				Institutions, governance (including participation in a democratic system), conflict and “social capital”
Flood event		Type of flood (river/coastal/sewer/surface water; flash flood/slow rising) Return period/flood frequency Speed of onset Timing (day or night, holiday period) Depth Velocity Contaminants Warnings received Flood protection measures in place			Where flood severity was worse, awareness was higher.	
Exposure	Physically isolated People living close to the hazard e.g. floodplain residents	Type of hazard Location (urban/rural) Proximity to hazard Type of property Elevation Isolation	Number of timber houses Number of Fibro houses Average floor height Average ground height Average number of storeys Maximum ground height Minimum ground height	Residence type Damage to residence	Being in an area served by the Environment Agency Living in a pre-1970s property	Geographical factors Natural resources and ecosystems
Psychological		Personality traits Psycho-social resources				

Appendix B Census data from selected countries

COUNTRY	LAST CENSUS	HOW OFTEN	LEVEL OF DATA AVAILABLE	AVAILABLE DATA	ACCURACY/RELIABILITY
France	1999 (2004 results to be published in 2008)	Yearly from 2004 for communities over 10,000 people, every 5 years for communities of less than 10,000 people	National, regional, department, arrondissement, cantons and villes, communes	Population (age, sex, marital status, economically active or inactive, etc.); Activity (labor-force participation rate by sex, unemployment, employment conditions, etc.); Employment (payroll or non-payroll employment, part-time or full-time, etc.); Commuting ; Training (schooling and place of study, degrees, educational attainment, etc.); Migrations (place of birth, place of residence at 1/1/90); Nationality (nationality by age, sex, household size, etc.); Immigration (French citizens by birth or acquisition, foreigners, etc.); Households (sex, age, and activity of reference person, etc.); Dwellings (type, number of rooms, etc.); Principal residences (moving-in date, occupancy status, surface area, parking arrangements, amenities/heating, number of automobiles, etc.); Buildings (completion date, number of stories, number of dwellings, public housing or not, central heating, sanitation, electronic access code, superintendent, etc.).	Based on complete enumeration
Spain	2001	Every 10 years	National, regional (Comunidad Autónoma), provinces (provincias), counties (municipios) Based on complete enumeration	Population (age, sex, marital status, number of children, place of birth, place of residency 1 year/10 years ago, moving-in date, education level, area of education, place of education, occupation/employment details) Households (home ownership/renting, number of years in home, 2 nd home ownership, car ownership) Dwellings (type of property, number of rooms, utilities, m ²) Buildings (age of building, number of floors, flats, shops, etc., type of building, owner, condition, utilities)	Based on complete enumeration
The Netherlands	2001	Every 10 years	National, COROP (?), and municipal. Also at sub-city level for ten large	• Sex • Age • Country of birth	Data from different sources ('virtual census'). Last

			cities: Amsterdam, Rotterdam, The Hague, Utrecht, Eindhoven, Tilburg, Groningen, Enschede, Arnhem and Heerlen.	• Country of citizenship • Country of residence a year prior to census • Region of residence • Marital status • Family status • Family situation • Family nucleus type • Private household composition • Household status • Household size • Number of children • Other persons in household (outside the family nucleus) • Employee • Branch of economic activity • Gross wage before deduction of social insurance premiums (auxiliary variable) • Time usually worked • Place of work • Pensions / life insurance benefits (retired persons) • Educational attainment level • Occupation • Unemployment • Attendance at educational institutions	census based on complete enumeration was held in 1971. In order to obtain consistent estimates an estimation method developed at Statistics Netherlands was used: repeated weighting. It is based on the repeated application of a regression method.
Czech Republic	2001		National, municipalities	▪ Population: by population and housing census results ▪ Population: by age, sex and municipality size group ▪ Population: by age, sex and region ▪ Population aged 15+: by highest educational attainment and municipality size group ▪ Population: by nationality and municipality size group ▪ Population: by nationality and region ▪ Population: by denomination and municipality size group ▪ Population: by denomination and region ▪ Population: by economic activity and municipality size group ▪ Population: by economic activity and region ▪ Foreigners: by municipality size group ▪ Foreigners: by region	Complete enumeration

				▪ Housing and dwelling stock: by population and housing census results ▪ Housing and dwelling stock: by municipality size group ▪ Housing and dwelling stock: by region ▪ Unoccupied dwellings: by region ▪ Population: by region and district ▪ Housing and dwelling stock: by region and district	
Estonia	2000	First census	National?	▪ Age ▪ Buildings containing dwellings ▪ Citizenship ▪ Distribution of the population. Temporary presence and absence ▪ Dwellings ▪ Economically active population ▪ Education ▪ Ethnic nationality. Mother tongue. Command of foreign languages ▪ Families ▪ Households. Population in households ▪ Living conditions of the population and households ▪ Marital status ▪ Place of birth. Parents' place of birth ▪ Place of residence at the time of the 1989 Population Census ▪ Population with long-term illness or disability ▪ Religious affiliation ▪ Sources of subsistence. Employment and socio-economic status ▪ Women's number of children	Complete enumeration A survey was carried out to evaluate the coverage of the census and the quality of the data It covered about 1% of the population and showed that the under coverage of the Census was on an average 1.2%.

Sources:

France:
http://www.insee.fr/en/home/home_page.asp

Spain:
<http://www.ine.es/censo2001/index.html>

The Netherlands:

<http://www.cbs.nl/en/publications/recent/census-2001/b-57-2001.htm>

Linder, F. (2004) 'The Dutch Virtual Census 2001: A new approach by combining administrative registers and household sample surveys'. Austrian Journal of Statistics Volume 33 (2004), Number 1&2, 69-88. <http://www.stat.tugraz.at/AJS/ausg041+2/041+2Linder.pdf>

Czech Republic:

http://www.czso.cz/eng/redakce.nsf/i/population_and_housing_census

Estonia:

<http://www.stat.ee/index.aw/section=70475>