2006 ECI Conference on Geohazards
Lillehammer, Norway
Editors: Farrokh Nadim, Rudolf Pöttler, Herbert Einstein, Herbert Klapperich, and Steven Kramer

Year 2006 *Paper* 33

Disasters and Decision Processes

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http://services.bepress.com/eci/geohazards/33

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One of the most important topics in hazard and disaster related research is the effective reduction of vulnerability. Despite the fact that our knowledge about several physical and human dimensions of disasters has grown rapidly in recent decades, there is ample evidence that casualties and damages due to natural disasters have grown even faster. Apparently, there is no such formula like 'more data = better knowledge = less casualties and damages'.

Purpose of this paper is the identification of some potential reasons for this obvious dilemma. After briefly addressing selected social science concepts of hazards, disasters, and risks, it is argued that good research leads to – scientifically – good models and predictions, but not necessarily to 'good' decision-making meant to reduce vulnerability to hazards. Both physical and human factors need to be brought together. Furthermore, research should focus on those most vulnerable to hazards and disasters as real target beneficiaries.

The identification of practical ways to enable decision makers to make more sense of information will belong to the fundamental challenges of future hazard research.

Disasters and decision processes

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Abstract

One of the most important topics in hazard and disaster related research is the effective reduction of vulnerability. Despite the fact that our knowledge about several physical and human dimensions of disasters has grown rapidly in recent decades, there is ample evidence that casualties and damages due to natural disasters have grown even faster. Apparently, there is no such formula like 'more data = better knowledge = less casualties and damages'.

Purpose of this paper is the identification of some potential reasons for this obvious dilemma. After briefly addressing selected social science concepts of hazards, disasters, and risks, it is argued that good research leads to – scientifically – good models and predictions, but not necessarily to 'good' decision-making meant to reduce vulnerability to hazards. Both physical and human factors need to be brought together. Furthermore, research should focus on those most vulnerable to hazards and disasters as real target beneficiaries.

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Introduction

Without doubt, the field of disasters, risks, and hazard studies fascinates a fast growing academic community. Each disaster seemingly testifies again that there is a problem we have not yet fixed properly. Within this community, a rich variety of approaches can be found: some scholars want to reconstruct, others to predict; some want to observe and 'understand' (Verstehen'), others to intervene. At least with reference to geohazards or 'natural' hazards and disasters in general, the fascination of the object of research – in one way or another – does not derive solely from its awfulness. Many are allured by the concept that the research object includes both nature *and* society, man *and* environment. Society usually does not belong to the 'classical' research objects of engineers, geologists, hydrologists, geo-morphologists or specialists in volcanoes and earthquakes. V*ice versa*, current social and cultural perspectives are not designed to comprehend nature 'as it really is', but rather semantic fields of the term 'nature'.

The field of hazards and disasters is rich in ironies. Funding for prevention and mitigation is much easier to receive after a disaster – although evident that the returns would have been higher if efforts in prevention and mitigation had started already *before* the last disaster. The history of recovery and reconstruction after a

disaster is rich in examples where people did the same as they did before. However, does the return to the *status quo ante* not mean that the same calamity will occur again, one day or another? Some refer to this as the "disaster-damage-repair-cycle" (Tobin and Montz 1997). Into the same direction points the notion of the so called „hydro-illogical cycle" (National Drought Mitigation Center 1998). Since more than sixty years, we have written testimony that efforts meant to minimise losses due to natural events might, in the end, increase the total sum of such losses instead. In 1937, when he was a young officer of the National Resources Planning Board, Gilbert White made clear: Floods exceeding the design limits of dykes will cause greater damage than would have occurred in the absence of such protective structures (Platt 1986: 48-49). This contiguity does mean not less than: By intending to make the flood plain a safer place we stimulate investments which, one day, will show up in the loss figures. Without such structural means, fewer investments had had been made in the flood plain in question.

Everybody involved in the hazard- and disaster scene knows such examples. They show: If the aim of research on hazards, risk and disasters was the effective reduction of the number of casualties and losses, we must admit that we failed – at least, on the global level.

Many have argued that the problem's complexity exceeds the capacity of a single discipline and that interdisciplinary work is a necessity. Unfortunately, there are massive hindrances to a true and honest interdisciplinary success. Still basic terms like 'disaster' and 'risk', 'natural event' and 'hazard' are used as if referring to age-old empirical realities that are self-evident (Hewitt 1998: 76). Eric Waddell (1983: 38) referred to hazard research as an "ideological battlefield" already in 1983, and since then the rifts between the manifold paradigms have appeared to be widened – no matter of IDNDR or similar programs. To make things worse, behind these terms and their manifold meanings lay, mostly implicitly, world-views, underlying assumptions and over-simplifications.

The traditional formulation of the problem is quite close to commonplace perspectives: Disasters are discrete phenomena, believed to be external to social systems upon which they impinge. This approach holds that disasters and society are related to each other in a cause-and-effect-manner (Blaikie et al. 1994). Perspectives like that are challenged increasingly, mainly by social scientists.

'Natural Disasters'?

April this year saw the 30th anniversary of a paper published in Nature by Phil O'Keefe, Ken Westgate, and Ben Wisner (1976), celebrated in modesty by the Radix website (http://www.radixonline.org). The title of the paper in question is "Taking the Natural Out of 'Natural Disasters'". Possibly this was the first peer-reviewed paper decidedly refusing the idea of "Natural Disasters". The authors argue that such a distinction between natural and technological hazards was misleading. Even more, this taxonomy is accused to perpetuate the ideology of a nature separate from society and encouraging a belief in natural disasters as inevitability. As opposed to natural events, hazards and disasters are, from such a perspective, by definition social:

> "The time is ripe for some form of precautionary planning which considers vulnerability of the population as the real cause of disaster – a vulnerability that is induced by socio-economic conditions that can be modified by man, and is not just an act of God. Precautionary planning must commence with the removal of concepts of naturalness from natural disasters." (O'Keefe et al. 1976: 567)

By closer examination, earlier examples of the argument can be found. Exactly 400 years before O'Keefe, Westgate and Wisner published the paper mentioned, a man in Cairo was deeply impressed by the great earthquake in Cairo early in the morning of the April 2nd, 1576. Ibn Al-Jazzar was his name. Since he was not satisfied by the standard explanations of that time, he elaborated the idea of building houses in a way that they would not collapse when the ground shakes (Taher 1979, quoted from Schulze 2004: 111). He suggested that earthquakes were god's will, and man should keep silence about their possible objects. To him it was unambiguous that earthquakes meant ordeals for humans. Nevertheless, he argued, that the fatal consequences of earthquakes can be minimized by – first – the right moral conduct and – second – by better building techniques (Schulze 2004: 104). We can read this early scholar as an example for the idea that calamities do not just result from fate, and a deity's will but from human behaviour, values, and decisions.

In the year of 1932, a social scientist published a similar argument in the United States:

> "Not every windstorm, earth-tremor, or rush of water is a catastrophe. A catastrophe is known by its works; that is, to say, by the occurrence of disaster. So long as the ship rides out the storm, so long as the city resists the earth-shocks, so long as the levees hold, there is no disaster. It is the collapse of the cultural protections that constitutes the disaster proper." (Carr 1932: 211; quoted from Dombrowsky 1998: 24)

At least in geographical thought, from the outset of modern hazard research it was conceived as axiomatic that features of the environment can only be regarded as a hazard as long as it does (or could) affect man and his possessions. An earthquake in the desert affecting not a single person might be an extreme and extraordinary event, but neither a hazard nor a disaster (White 1974).

Interestingly, at least in Germany the affected parts of the public are very sensitive to the question of causation of disasters. The 1997 deluge of the Odra River was identified by politicians and by media as once-in-a-millennium-flood, as 'natural disaster'. Interviews with people affected by this flood showed that they hardly felt as 'victims of nature'. Nobody challenged the idea of naturalness of high water levels. However, what, from their perspective, needed an explanation, was: Why did the dyke did not protect them this time, if it did so for so many years? Many were believed to be responsible for their calamities: Why did the authorities neglect the dyke's maintenance? Why this contradictory early warnings, why this overall incompetence in initial emergency response management, why this inconsistent evacuation appeals? Looking upstream, many felt as victims of forest dieback and omitted reforestations, of ongoing sealing due to construction, of river regulation and wrong management of retention basins and so on (Felgentreff 2000; 2003). No matter if a decision-maker is identifiable or not: Important is that people ascribe their

calamities to decisions (Pohl 1998) – usually to decisions made by third parties, but not oneself.

While some researchers interested in hazards and disasters conceptualise all kinds of disasters regardless of their assumed (man-made or so-called natural) trigger as problems of purely corporate integration, others keep to the idea of critical relations between man and environment. However, for social scientists the focus of interest does not lie in the analysis of environmental problems as such, but in the question how they are treated; in this case on how societies and their subgroups deal with hazards and disasters.

> "Since about fifteen years ago, however, a new perspective has emerged that views hazards as basic elements of environments and as constructed features of human systems rather than extreme and unpredictable events, as they were traditionally perceived. When hazards and disasters are viewed as integral parts of environmental and human systems, they become a formidable test of societal adaptation and sustainability. In effect, if a society cannot withstand without major damage and disruption a predictable feature of its environment, that society has not developed in a sustainable way." (Oliver-Smith 1996: 304)

Because of such arguments, many social scientists refrain from the usage of the term 'natural disaster' (Pelling 2001). From a social perspective it is structural and systemic – but nonetheless man-made – causes that generate disasters (Blaikie et al. 1994: 11). In fact, one can hardly think of disasters that are not linked to human presence, action and decision-making, in one way or another.

All this reasoning about the social causes of disasters is similarly applicable to the hazard concept. To most natural scientists and engineers, hazard refers to a feature of environment, to a natural event. The International Strategy for Disaster Reduction (ISDR) defines a 'Geological hazard' as…

> "Natural earth processes or phenomena that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.
>
> Geological hazard includes internal earth processes or tectonic origin, such as earthquakes, geological fault activity, tsunamis, volcanic activity and emissions as well as external processes such as mass movements: landslides, rockslides, rock falls or avalanches, surfaces collapses, expansive soils and debris or mud flows.
>
> Geological hazards can be single, sequential or combined in their origin and effects." (ISDR n.d.)

Again, the counter-argument is that not the process *itself* is the hazard, but only in relation to material assets, values or lives exposed to the process or phenomenon in question. That means, the concept of hazard includes two dimensions, the physical/environmental *and* the human/social. Neglecting the social context can provide not more than incomplete knowledge (Sarewitz and Pielke n.d.: 3).

On Vulnerability

In engineering terms, it is the combination of the vulnerability of the built environment and the hazard that creates the risk specific to a hazard, e.g. the earthquake risk (Somerville and Leith 2006). In this sense, vulnerability "…means the degree of loss to a given element at risk or set of such elements resulting from the occurrence of a natural phenomenon of a given magnitude" (Granger 2000: 3). Following such an understanding of the term vulnerability, it is often measured on a scale from 0 to 1.

What appears almost as monolithic in the sphere of natural sciences and engineering (Glade 2004) is a contested field in the realm of social sciences, where dozens of different concepts of *social* vulnerability compete (e.g. the overview provided by Weichselgartner 2002). At least for social geographers influential was and still is the definition that Ben Wisner and his co-authors suggested:

> "By vulnerability we mean *the characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard* (an extreme natural event or process)." (Wisner et al., 2004, p. 11; italics in original)

It is clear that such a concept of vulnerability is difficult to handle empirically. For instance, how a person or a group will recover *after* a calamity is hardly predictable in detail and can be analysed only in retrospect. Although rare and restricted to material dimensions, there are cases where households were much better off after a destructive 'natural disaster' – can we call them as 'vulnerable'? Examples can be found in the German Odra River valley where formerly small and sub-standard houses badly affected by the 1997 Odra River flood soon got retrofitted and modernized with the assistance of insurers, donations made by the public and by state compensation schemes. Observers like neighbours assume, many houses are much more luxury since then (Felgentreff 2000).

Since the 1970s, many studies indicated the crucial significance of societal conditions in disasters:

> "Material losses were often disproportionately concentrated according to age, gender, occupation, social position and, above all, lack of wealth and political voice. Even the effectiveness of risk assessment, warnings and emergency preparedness, depended most on whether or how they are (least) available to those most in need of them." (Hewitt 1998: 77)

Cases illustrating the relationship between socio-economic status and the distribution of human casualties are numerous – see the consequences of Hurricane Katrina (SSRC 2005). Although not applicable to each societal context, it remains a truism that it is generally the poor who suffer more than the rich do. Vulnerability is not identical with poverty, but often highly correlated (Wisner et al. 2004: 12).

Colin Green (2004) makes an interesting point in stressing that most versions of the term vulnerability constitute a conjunction …

> "… relating something or someone who is vulnerable to something else as a source of potential harm because of some property of the subject or the object.

> Vulnerability implies something therefore about the relationship between the subject and the object as well as the relevant characteristics of either or both the object and the subject of the argument. The meaning of 'vulnerability' may thus be context specific rather than being a universal concept. What we mean by 'vulnerability' may consequently depend upon the nature of the decision that must be made and what the decision involves." (Green 2004: 323-324)

Following this understanding, at the start the desired state sought to achieve or maintain needs definition. Consequently, what the hazard is follows from the definition of desirability, but is not objectively present (Green 2004: 324).

There are good reasons to regard vulnerability as the basic problem. From a social science perspective, it appears as being a social problem, which cannot be fixed just by technical means. Even if one argues that the problem with hazards and disasters was many people's lack of problem-solving capacities due to a lack of technical fixes, the question "Who is responsible for such a lacking" would remain. "Instead of answering that question, it is much easier to turn causality toward the overwhelming forces coming from outside." (Dombrowsky 1998: 24)

Decisions and decision-makers

Provided that decisions are 'good', they can bring about effective reduction of vulnerability (Sarewitz and Pielke n.d.: 13), whereby their capacity to reduce vulnerability is difficult to measure.

Not just professional decision-makers like politicians make decisions relevant to the creation and reduction of vulnerability. The decision of how to allocate money, time and energy must be made each day by everybody and each household. Each decision implies risks, not least because failure might be accredited to the person held responsible for the decision. A homeowner in an earthquake-prone region deciding to completely rebuild and upgrade his home according to earthquake safety regulations acts exemplary in the light of disaster prevention. Socially and culturally, he might fail to meet basic standards when this investment means he cannot afford to pay his children's tuition fee anymore.

In many places worldwide, the likelihood of car theft, crop failure, unemployment or burglary is much higher as compared to losses related to storms, flooding or landslides. Although being very different types of extreme events, their consequences and outcomes are similarly unwanted (Sarewitz and Pielke n.d.: 4). Since resources are always limited, decision-makers face the problem of how to allocate these resources properly between the different hazards (Green 2004: 326).
This problem applies not just to households but also to other levels of decision-making. As Philip H. Berke observed:

> "Natural hazard issues are usually given low priority on local government agendas. Low priority, however, is not necessarily due to a lack of awareness. Research findings from surveys of risk perception indicate that the general citizenry and key decision-makers (planners, building officials, public works engineers, and so forth) are aware of hazards, but put a low priority on taking action, and have little concern for doing so." (Berke 1998: 79)

What – with reference to the reduction of vulnerability to one particular type of unwanted event – appears as questionable and is sometimes labelled as bounded rationality might in real world terms be the result of the necessity to minimize over-complexity. Generally, knowledge about single risks has proven to be only a weak predictor for their individual assessment (Wildavsky 1993: 194).

Often people do neither know nor believe what could happen to them. In Germany, apparently only a small portion of floodplain dwellers is aware that a flood exceeding the design of the structural protection will affect their house. Even more, if there is a dyke between the house and the water, from a legal point of view in Germany, this house is not at risk of flooding at all and no specific building standards are mandatory. In other context, many groups and individuals do not have any leeway for alternative decisions at all; they can hardly be blamed for 'bad' decisions.

Decision makers – including ‚ordinary people' – should have access to all sort of relevant knowledge and information. The questions are, what exactly means relevant, how should information be formatted in order to become useful, and what can be done to make sure they end up in 'good' decisions in the above-mentioned sense? Answers to these questions will be difficult to obtain, but Sarewitz and Pielke (n.d.) have made worthwhile suggestions for a framework for research and policy. The basic requirement is that useable and appropriate knowledge can be generated. In this respect, we might witness progress in future.

Grasping the 'big picture'?

On another level, another problem arises. It is systemic and structural in nature and cannot be abolished just by better practice: It is widely accepted that reduction of vulnerability is achievable through several ways and the combination of different measures – before and after the impact, avoidance of 'hazardous' terrain or by manipulation and hopefully preventing of the triggering process. Who can rightfully claim to have the definite answer to the question, which combination of measures in which dose was the appropriate in a given context, for presence and future?

Having the ongoing academic disputes about environmental controversies in mind, Daniel Sarewitz recently argued against the "… old-fashioned idea that scientific facts build the appropriate foundation for knowing how to act in the world." (Sarewitz 2004: 385) The same argument has been raised with reference to ecosystem management:

> "More information provides an ever-larger pool out of which interested parties can fish differing positions on the history of what has led to current circumstances, on what is now happening, on what needs to be done, and on what the consequences will be. And more information often stimulates the creation of more options, resulting in the creation of still more information" (Michael 1995: 473, quoted from Sarewitz 2004: 389).

Further options to reduce vulnerability will develop with further information and insights that are more penetrating than today. The more measures available, the greater the chance to fail by recommending some and neglecting other options. As scientists, we can never rely on eternal validity of our knowledge. Each such

recommendation implies the risk of turning out to be wrong, since each casualty, and even damage, will count as counter-evidence difficult to justify. We can keep this risk low by different strategies; e.g., conducting 'good' science according to our profession's standards and keeping our horizon restricted to the process in question, blinding out practical issues of vulnerability reduction and potential research beneficiaries.

On this road, we will not come that far in respect to vulnerability reduction. We should aim to do something about *all* floods and not about some, *all* earthquakes and not just the minor. The residual risk is not identical with the so-called accepted risk, but both are perfect prerequisites for the disasters of tomorrow.

Future will always be uncertain in that sense that nobody ever can exclude everything unwanted and negative occurring to him in future. However, this overall uncertainty appears as only a minor portion of the problem. Global population development is an instructive example provided by James Jackson: In twenty years, the cities of developing countries will have about two billion more residents. It can be taken for granted that a large proportion of these additional city dwellers will reside in regions known to be notoriously earthquake-prone. One thing is certain, good buildings save lives in earthquake-prone terrain. If only little can be done to retrofit all already existing buildings in these cities, was it not a good idea to at least make sure that construction of the houses to be built is adequate (Jackson 2006)? What exactly will happen when the next massive earthquake rocks the Teheran region with its 14 millions inhabitants (Anonymous 2005: 7) is unthinkable and far beyond our imagination. Nevertheless, what appears as unthinkable in terms of its awfulness is, according to tectonic expertise and likelihood, very likely to happen one day, eventually.

Carefully considered, Green's above-mentioned argument (what the hazard is, is the consequence of the definition of desirability) demands for all-embracing visions. They would not only include answers to questions like what desirable living conditions mean for whom and touch on concepts of quality of life, but also on ethical issues like justice and human rights. Apart from attempts like the Federal Emergency Management Agency website "Ready Kids" (FEMA n.d.), hazard texts remain remarkable silent in this respect. Instead, the stock of literature ties up to implicit and commonsense value judgements (e.g. alive is better than dead, sane is better than sick, functional better than smashed and broken). Surely, strong arguments can be positioned against the formulation of such ample visions, e.g. that it would overstrain the professional domain of perhaps all single academic disciplines. On the other hand, the call for action is plain to see. Although it is clear that the results will always remain unsatisfactory, second-best solutions are better than completely neglecting of disasters ahead.

Such research would require changes in science policy. So far, 'best' science is defined primarily by criteria inherent to the research system. In most cases, merits derived from 'good' models and predictions will outdo those for research successfully enabling decision-makers to make 'good' decisions. Public value of science would benefit from research programs considering additional criteria and incentives. As Sarewitz and Pielke (n.d.: 13) suggested, the understanding of the

decision contexts in the realm of vulnerability reduction in face of extreme events could provide a promising framework.

Conclusion

As demonstrated, from a social perspective, origins of disasters can be seen in crushing of human relations and social vulnerability instead of natural and external agents beyond society. Seemingly, terms like ‘disaster’, ‘hazard’, and ‘vulnerability’ are intrinsically contextual. They refer not just to physical and ‘objective’ events but also to human perception of consequences. Studying solely the physical dimensions and letting the respective social context aside can never produce more than fragmentary knowledge.

This is not to say that it should become an assigned task for engineers to solve problems, which, as pointed out, can be comprehended as being social problems. The decision-making process tackling with options to reduce vulnerability should be rigorously paid tribute to. Decisions are not yet understood to be central research issues in the field of hazards, disasters, and vulnerability.

Although difficult to achieve and perform, interdisciplinary work could be a cure against attempts to hide unaware or knowingly societal aspects in ‘black boxes’. Supplementary to meeting disciplinary standards for ‘good’ scientific conduct, studies dealing with vulnerability should take those into account who are most at risk. They are not the ordering party for scientific expertise, but they should belong to its first beneficiaries.

What people do or fail to do about features of their environment identified as dangerous will be a reflection of how they choose among competing values. And the more knowledge and options become available, the more decisions have to be made – decisions which always include the possibility of failure.

Making such choices for other people is not what scientists are expected to do. Instead, it is the job of democratic politics and of the people themselves. Science can at most direct attention to problems and help to understand how to achieve goals – for instance, the goal to reduce social vulnerability. To accomplish the goal of a disaster-resistant society is a continual task that will never be finally accomplished, and the avenues to reach it often collide with other goals.

In the end, we face multiple uncertainties. Not just that future is always contingent and uncertain. To make things worse, as scientist we can never be certain that our knowledge is ‘good’ in terms of vulnerability reduction. Nor will there be ever something as certainty, whether or not decision-makers will derive ‘good’ decisions from this knowledge. The implications of these interactively entailing uncertainties are hardly to overlook. Nevertheless, these implications might be very close to the root of the problem – that globally we lose increasingly in the context of so-called ‘natural disasters’, while more and more data, information, and knowledge is accumulated.

Acknowledgement: Comments on an earlier version of this paper by Christian Kuhlicke (UFZ Leipzig) are gratefully acknowledged.

References

Blaikie, P., Cannon, T., Davis, I., and Wisner B. (1984). *At Risk: Natural Hazards, People's Vulnerability and Disasters.* Routledge, London.

Anonymous (2005). "*Tehran, Iran. Disaster Management Profile."* http://emi.pdc.org/cities/CP-Tehran-08-05.pdf (March 16, 2006).

Berke, P.H. (1998). "Reducing Natural Hazard Risks Through State Growth Management." *Journal of the American Planning Association* 64(1), 76-87.

Carr, L. (1932). "Disasters and the sequence-pattern concept of social change." *American Journal of Sociology* 38, 207-218.

Dombrowsky, W. (1998). "Again and again. Is a disaster what we call a "Disaster"?" Quarantelli, E.L. (ed.), *What is a disaster? Perspectives on the question*, Routledge, London, 19-30.

Felgentreff, C. (2000). "Impact of the 1997 Odra Flood on Flood Protection in Brandenburg (FRG): The dyke broke, but the local people's trust in technical solutions remained unbroken." Bronstert, A., Bismuth, C., and Menzel, L. (eds.) *European Conference on Advances in Flood Research. Proceedings*, Vol. 2, Potsdam Institute for Climate Impact Research, Potsdam, 614-626.

Felgentreff, C. (2003). "Post-Disaster Situations as 'Windows of Opportunity'? Post-Flood Perceptions and Changes in the German Odra River Region after the 1997 Flood." *Die Erde* 134(2), 163-180.

FEMA (Federal Emergency Agency) (n.d.), "Ready Kids. Be prepared in every situation." http://www.ready.gov/kids/home.html (May 28, 2006).

Glade, T. (2004). "Vulnerability assessment in landslide risk analysis." *Die Erde* 134(2), 121-138.

Granger, K. (2000). "Chapter 1: Urban Geohazard Risk Assessment." Middelmann, M. and Granger, K. (eds.), *Community Risk in Mackay. A Multi-Hazard Risk Assessment*. http://www.ga.gov.au/servlet/BigObjFileManager?bigobjid=GA4178 (May 20, 2006).

Green, C. (2004). "The evaluation of vulnerability to flooding." *Disaster Prevention and Management,* 13(4), 323-329.

Hewitt, K. (1998). "Excluded perspectives in the social construction of disaster", Quarantelli, E.L. (ed.), *What is a disaster? Perspectives on the question*, Routledge, London, 75-91.

ISDR (n.d.). *"Terminology: Basic terms of disaster risk reduction."* http://www.unisdr.org/eng/library/lib-terminology-eng%20home.htm (May 11, 2006).

Jackson, J. (2006). "Oases with a loud tick, tick ringing through the air." *Times Higher Education Supplement*, February 17, 2006.

Michael, D.N. (1995). "Barriers and Bridges to learning in a turbulent human ecology." Gunderson, L., Holling, C., and Light, S. (eds.), *Barriers and Bridges to the Renewal of Ecosystems and Institutions*. Columbia University Press, New York, 461-485.

National Drought Mitigation Center (1998). *"The hydro-illogical cycle."* University of Nebraska, Lincoln http://enso.unl.edu/ndmc/plan/illogic.htm (May 24, 2000).

O'Keefe, P., Westgate, K. and Wisner, B. (1976). "Taking the Natural Out of 'Natural Disaster." *Nature* 260 (April 15), 566-567.

Pelling, M. (2001). "Natural Disasters?." Castree, N., and Braun, B. (eds.), *Social Nature. Theory, Practice, and Politics*, Blackwell, Malden (Mass.), Oxford, 170-188.

Pfister, C. (2004). „Von Goldau nach Gondo – Naturkatastrophen als identitäts-stiftende Ereignisse in der Schweiz des 19. Jahrhunderts, Pfister", C. and Summermatter, S. (eds.) *Katastrophen und ihre Bewältigung. Perspektiven und Positionen*, Haupt, Bern, Stuttgart, Wien, 53-78.

Platt R.H. (1986). "Floods and man: A geographers agenda." Kates, R.W. and Burton, I. (eds.), *Geography, resources, and environment Vol. 2: Themes from the work of Gilbert F. White*, University of Chicago Press, Chicago, 28-68.

Pohl, J. (1998). „Die Wahrnehmung von Naturrisiken in der 'Risikogesellschaft.'" Heinritz, G., Wiessner, R., and Winiger, M. (eds.), *Europa in einer Welt im Wandel: 51. Deutscher Geographentag, Vol 2, Nachhaltigkeit als Leitbild der Umwelt- und Raumentwicklung in Europa*, Steiner, Bonn, 153-163.

Quarantelli, E.L. (1998). "Epilogue: Where we have been and where we might go." Quarantelli, E.L. (ed.) *What is a disaster? Perspectives on the question*, Routledge, London, 234-273.

Sarewitz, D. (2004). "How science makes environmental controversies worse." *Environmental Science and Policy* 7, 385-403.

Sarewitz, D. and Pielke, R. (n.d.). "*Extreme Events: A Research and Policy Framework for Disasters in Context."* (Draft) http://www.cspo.org/products/articles/xepaperfinal.pdf (May 26, 2006).

Schulze, R. (2004). „Islamische Deutungen von Erdbeben und anderen Naturkatastrophen.“ Pfister, C. and Summermatter, S. (eds.) *Katastrophen und ihre Bewältigung. Perspektiven und Positionen*, Haupt, Bern, Stuttgart, Wien, 101-117.

Somerville, P. and Leith, W. (2006) “Reduced earthquake risk and losses as consequences of improved monitoring.” Geophysical Research abstracts 8, 09212 http://www.cosis.net/abstracts/EGU06/09212/EGU06-J-09212.pdf?PHPSESSID=ff8453756cd19dc5d3f22cf8768499ca (May 15, 2006).

SSRC (Social Sciences Research Council) (2005). “*Understanding Katrina: Perspectives from the Social Sciences.”* http://understandingkatrina.ssrc.org/ (May 26, 2006).

Taher, M. A. (1979). unpubl. Thèse de doctorat d’état Univ. Paris 1.

Tobin, G.A. and Montz, B.E. (1997). *Natural hazards: explanation and integration*. Guilford Press, New York, London.

Waddell, E. (1983). “Coping with Frosts, Government and Disaster Experts: Some Reflections based on a New Guinea Experience and a Perusal of the relevant literature”. Hewitt, K. (ed.), *Interpretation of Calamity: From the Viewpoint of Human Ecology,* Allen & Unwin, Boston, 33-42.

Weichselgartner, J. (2002). “Disaster mitigation: the concept of vulnerability revisited.” *Disaster Prevention and Management* 10(2), 85-94.

White, G.F. (1974). *Natural Hazards – Local, National, Global*. Oxford University Press, New York, London, Toronto.

White, G.F., Kates, R.W., Burton, I. (2001). “Knowing better and losing even more: the use of knowledge in hazard management.” *Environmental Hazards* 3, 81-92.

Wildavsky, A. (1993). „Vergleichende Untersuchungen zur Risikowahrnehmung. Ein Anfang.“ Bayerische Rück (ed.), *Risiko ist ein Konstrukt*. Knesebeck u. Schuler, München, 191-211.

Wisner B., Blaikie, P., Cannon, T., Davis, I. (2004). *At Risk – Natural hazards, people’s vulnerability, and disasters*. 2nd edition, Routledge, London, http://www.unisdr.org/eng/library/Literature/7235.pdf (May 15, 2006).