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Is the World Becoming A More Risky Place?
- Trends in Disasters and Vulnerability to Them -

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Torsten Feldbrügge and Joachim von Braun

Abstract

Numerous publications about disasters are implying that disaster vulnerability is growing. The main reasons given for this are growing populations, climate change and increasing poverty. However, maybe the current perception of vulnerability to disasters rests primarily on a perspective focusing on the present and neglecting long-term trends. Moreover, a changed understanding of the term "disaster" perhaps reflects a changed perception of its scope. An intention of this study is the examination of the hypothesis that vulnerability to disasters has increased. To accomplish this, clarification is needed about what is, and what determines vulnerability. As a concept, "Vulnerability" to disasters is relevant for a world that changes rapidly in technological and settlement structures. Vulnerability can be manifested at different levels of analysis, from the individual to the household to the region and state. Apart from this, vulnerability differs according to the type of disaster. Because of the problems involved with the availability of data, the empirical part of this study primarily examines trends at the aggregate country and global level.

The results show that on the whole, the number of registered disasters is rising. The monetary value of damage is also increasing. And the results show that people in developing countries suffer the most from disasters. However, - more importantly - the number of disaster-related deaths has declined and the mortality risk induced by disasters has declined as well in the last two decades. In these crude terms, the world does not seem to become a more risky place. Improved organizational response and emergency aid contribute to that positive development.

Kurzfassung

In Publikationen zu Katastrophen wird häufig von einer steigenden Katastrophenanfälligkeit gesprochen. Hierbei werden steigende globale Bevölkerungszahl und -dichte, Klimawandel und zunehmende Armut als wichtige Begründungen genannt. Es stellt sich jedoch die Frage, welche Argumente und empirischen Belege für und welche eventuell gegen diese These einer steigenden Katastrophenanfälligkeit sprechen. Vielleicht beruht die akut wahrgenommene Katastrophenanfälligkeit vor allem auf einem auf die Gegenwart bezogenen, langfristige Trends vernachlässigenden, Blickwinkel. Außerdem kann sich eventuell ein verändertes Verständnis des Begriffs Katastrophe in einer veränderten Wahrnehmung des Ausmaßes von Katastrophen widerspiegeln.

Es wird zunächst geklärt, was unter Katastrophenanfälligkeit verstanden wird und was sie determiniert. Der Begriff der Katastrophenanfälligkeit ist grundsätzlich relevant für die sich technologisch und in der Siedlungsstruktur rasch wandelnde Welt. Vulnerabilität kann sich auf verschiedenen Analyseebenen manifestieren, vom Individuum über Haushalte bis hin zur Regionen- und Staatsebene. Aufgrund von Problemen der Datenverfügbarkeit wird in der vorliegenden Untersuchung überwiegend die aggregierte Länderebene betrachtet.

Die Ergebnisse zeigen eine unterschiedliche Vulnerabilität nach Katastrophentypen. Insgesamt ist die Zahl der registrierten Katastrophen ansteigend. Die Ergebnisse unterstreichen, dass Entwicklungsländer besonders stark von Katastrophen betroffen sind. Die Zahl der Katastrophentoten ist aber in den vergangenen zwei Jahrzehnten gesunken und das Mortalitätsrisiko, das von Katastrophen ausgeht, hat ebenfalls abgenommen. Aufgrund dieser groben Angaben kann die Welt nicht als zunehmend riskanter Ort bezeichnet werden. Verbesserte Organisation, Technologie, Reaktionsfähigkeit und Hilfsmaßnahmen leisten dazu ihren erfolgreichen Beitrag.

1 Introduction

Increasingly, publications about disasters are discussing that disaster vulnerability is growing (e.g., Blaikie et al., 1994; Münchener Rück, 2000a; Abramovitz, 2001).[1] The main reasons given for this are rising global population numbers, climate changes and increasing poverty. As illuminating as these reasons appear to be in light of the reports and pictures of recent disasters, one must ask which arguments and empirical evidence speak for and perhaps against them. For as strongly as they point to an increasing vulnerability to disasters, there are also hypotheses that suggest a declining susceptibility, at least for a part of the world population, as the result of improved protection structures. One must ask if the current perception of vulnerability to disasters rests primarily on a perspective focusing on the present and neglecting the long-term trends. Also, a changed understanding of the term disaster perhaps reflects a changed perception of its scope. The purpose of this study is not to qualify disasters and the necessity for immediate assistance, but rather to classify disasters also in a long-term context. Finally, the monitoring and the evaluation of vulnerability to disasters need to be included to measure progress in this area.

Therefore, the intention of this study is the examination of the hypothesis that vulnerability to disasters has increased. To accomplish this, clarification is needed about what is understood by and what determines vulnerability. Also, the level of analysis must be considered. The levels of analysis of vulnerability to disasters can range from the countries, the sub-regions and the groups of the population to the individuals. Because of the problems involved with the availability of data, the empirical part of this pilot study primarily will examine the aggregate level. Another equally important decision involves selecting the indicators to be used to determine vulnerability, for example, the generally-used, monetary damages figures or the number of victims. As will be shown, the indicators can only present an approximation of the concept of vulnerability to disasters.

The study is structured as follows:

- a clarification of the basic definitional aspects of disasters, followed by
- a description of different concepts of vulnerability to disasters, and

[1] See the following quotation from the year 1994: "There is general consensus in research that the number of natural hazard events (earthquakes, eruptions, floods, or cyclones) has not increased in recent decades. If this is valid, then we need to look at social factors that increase vulnerability (including, but not only, rising population) to explain the apparent increases in the number of disasters, in the value of losses and numbers of victims...Some of the increase may be a result of better reporting and improved communications, or the incentive for governments to declare a disaster to try and win foreign aid. But the rising trends seems to be too rapid for these explanations alone, with a doubling time of around ten years." (Blaikie et al., 1994, p. 31).

- a description and criticism of the data bases for disasters, which present the basis for
- an observation of trends in the subsequent chapter.

The starting point here is a description of the limiting factors, which leads to a criticism of the existing statistics for disasters. These problems complicate the interpretation of statements concerning vulnerability to disasters. In spite of the difficult data situation, in the following chapter trends are noted based on secondary statistics for the frequency of disasters and for how the numbers of dead and injured as well as material damages are reached. Possible differences in the susceptibility to disasters in industrial and developing countries will be discussed. Two case studies clarify the necessary long-term perspectives concerning vulnerability. These are based on the examples of its reduction in India and its increase in Peru. A discussion and a conclusion of the insights gained, including a view of further research needs, close the study.

2 Definitions and Concepts

2.1 Disasters

Different definitions and classifications of disasters can lead to varying interpretations of trends in their frequency.[2] Definitions of disasters range from the engineering-technical to the sociological perspectives. This study will not attempt to propose a new definition or give an overview of the current ones as this has already been covered in the existing literature more thoroughly than is possible here (e.g., Quarantelli, 1998a; Dombrowsky, 1995; Plate, 1993; Westgate and O'Keefe, 1976). It is here sufficient to note that there are a multitude of definitions and concepts of disasters. In the following, therefore, the meaning of disaster typologies will be dealt with only with respect to their meaning for the recording of events.

Traditionally, there has been – and continues to be - a differentiation between **natural** and **anthropogenic** disasters. Some classifications divide the latter into **technical** disasters (industrial disasters, such as the chemical accident in Bophal, India) and military conflicts (IFRC, 1993; IDNDR, 1996). In the English-speaking world, a differentiation is sometimes made between "disasters" and "catastrophes." In the latter, most or all people living in a community are affected, as are the basic supply centres, so that help from neighbours is largely impossible (the affected people helping each other is a general phenomenon in "disasters" with a lower degree of severity) (Quarantelli, 1998a). This shows that the organization of disasters by size is relevant for their registration.

The onset's speed of disaster is another relevant factor for investigating vulnerability trends. The differentiation here is between **sudden-onset** and **slow-onset** disasters, examples for the latter being droughts and desertification (Albala-Bertrand, 1993, p. 9). Kent (1987, p. 2) describes **sudden-onset**, **creeping** and **chronic** disasters. The characteristics of sudden-onset disasters, such as earthquakes or cyclones, are fast development and a generally short warning period. Creeping disasters, such as plagues of insects or droughts, tend to be more predictable. Chronic disasters are connected with such factors as land erosion and deforestation. The

[2] There is as well an immediate *operational* consequence resulting from the definition of catastrophe: Each catastrophe intervention as well as its financing is based among other things on the perception of the catastrophe. For this reason, the decision to intervene in a catastrophe is dependent on how it is defined or understood. Oxfam UK describes this in a handbook: "The Overseas Development Administration ...of the British government fund NGOs emergency programmes, provided that these fall within its established criteria for assistance. These mainly concern [Overseas Development Administration's] technical definitions of what constitutes emergency relief, as opposed to 'rehabilitation' inputs, which would normally be dealt with by a separate department." (Eade and Williams, 1995, p. 954). If the number of disaster interventions is to be taken as an indicator for trends in catastrophe vulnerability, then possible changes in the perceptions of catastrophes must be considered.

beginnings of both creeping and chronic disasters can be difficult to determine, which complicates the recording of statistics and thus the analysis of trends (see also chapter 3).

Natural disasters can be divided by at least seven criteria, which likewise can give an indication of vulnerability: strength, frequency,[3] duration, geographical expansion, speed of entry, spatial expansion and regularity (Albala-Bertrand, 1993, pp. 9-11). All of these characteristics can change in principle with the passage of time and thus signal an increase or a reduction in vulnerability.

Albala-Bertrand (1993, pp. 8-9) criticized that all definitions suffer the same deficit: they do not consider the coping strategies, which as reactions to the catastrophic events are also components of them. Definitions, according to Albala-Bertrand, only relate to analytically divided components of disasters. In his opinion, a disaster situation has two components: the "impact" and the "response of society," with the corresponding, and on the whole possibly also positive, effects. He continues: the "final outcome of a disaster situation is the net effect of largely negative impact effects and generally positive response effects" (ibid., p. 10). According to this definition, not only the short-term but also the middle-term economic damage must be considered, which through adjustment mechanisms could actually turn out to be less severe. Kent (1987, p. 4) criticized that most definitions of catastrophic events present them as something unusual, deviating extremely from the "normal." In this view, natural threats are not understood as integral parts of the spectrum of humans and nature (Hewitt, 1986, p. 312). However, disasters should be understood as events that are part of the "normal" ways of life (Kent, 1987, p. 4). Similarly, Clausen (1983, p. 43) concludes that disasters should be analyzed as extreme cases of possible social relationships, but still as something "normal." Moreover, a further point of criticism is that disasters are not singular, independent events on the time line. Under certain circumstances, disasters first create the conditions for the emergence of following ones. This also complicates the analysis of vulnerability trends.

For this study, a pragmatic approach was chosen in reference to the definition of disasters; in the description of disaster trends coming later in this work, the definitions of the respective data bases are referred to (for some points of criticism of the pragmatic definition of disasters, see Dombrowsky, 1995, pp. 242-244).[4] The following definition comes from the International Federation of the Red Cross and Half Moon (IFRC) and presents a compromise between analytical- and operational-based approaches. Moreover, it already refers to the factor of social "vulnerability":

[3] The determination of the recurrence of disasters is difficult and dependent on the horizon of time. Insurance companies face the problem of estimating the frequency and recurrence of partially very rare natural threats. This is investigated on the basis of historical and current data, e.g., return periods and, for example, recurrence periods and extent of damage schedules (Münchener Rück, 2000a, p. 120).

[4] Examples of definitions from aid organizations call everything that requires their intervention a catastrophe; insurance companies interpret them on the basis of excessive insurance damage (Dombrowsky, 1995, p. 242).

"Disasters combine two elements: events and vulnerable people. A disaster occurs when a disaster agent (the event) exposes the vulnerability of individuals and communities in such a way that their lives are directly threatened or sufficient harm has been done to their community's economic and social structures to undermine their ability to survive. A disaster is fundamentally a socio-economic phenomenon. It is an extreme but not necessarily abnormal state of everyday life in which the continuity of community structures and processes temporarily fails. Social disruption may typify a disaster but not social disintegration" (IFRC, 1993, pp. 12-13).

In summary, it can be determined that there is a problem of definition which affects the interpretation of vulnerability to disasters. Therefore, a list of important questions often cannot be answered clearly: When does a disaster begin? Who decides about shortcomings in the coping capacity of a society? When does the disaster end? What are the appropriate indicators for disasters? In addition, many definitions do not take differing vulnerabilities of population groups into account.

2.2 Concepts and Determinants of Vulnerability to Disasters

The concept of vulnerability to disasters comprises a variety of components, allowing for different possible interpretations,[5] and therefore it deserves attention here. There has been heightened scientific interest in this concept since the 1970s and especially the mid-1980s. Nevertheless, its meaning remains vague.[6]

As mentioned before in the chapter about the definition of disasters, in the last decades there has been a change in the focus on disasters and susceptibility to them. Today, more attention is given to the connection between political, economic, social and technical factors as the primary causes than before when natural causes and technical solutions were emphasized. New factors such as ecological problems are being identified but without sufficient understanding about the exact interrelations. An example of this is climate changes. Besides physical proximity to a disaster's trigger, lower social and economic status is increasingly recognized as a contributing factor. Nevertheless, poverty by itself is not a sufficient measure of vulnerability.

Recent models and the concepts of disaster's origins and vulnerability seem to lead to a changed view of their endogenous and exogenous natures. The concepts of causality and the views of vulnerability have become much more complex and integrate a multitude of participants and causes. However, even though there is an improved understanding that external and natural factors are not the only determinants for the formation of and vulnerability to disasters, the analysis of economic and social factors should not lead to the neglect of the external factors. Disasters are not the products of chance/bad luck; they result rather from the *interaction* of

[5] The terms susceptibility and vulnerability will be used interchangeably in this study.
[6] For overviews of the development of the concept of disaster vulnerability, see Winchester, 1992, pp. 37-42; Blaikie et al., 1994; Varley, 1994, pp. 4-6; Cannon, 1994, pp. 13-30; Anderson 1995, pp. 43-46.

political, economic, social, technological and natural conditions. Knowledge about these determining factors is necessary for a solid understanding of disaster vulnerability, because the so-called external factors could have changed (e.g., the increased frequency of extreme events such as heavy storms) as well as the social susceptibility. Therefore, vulnerability to disasters must be examined on the level of the event and on the level of the economic, political and social structures, which cannot prevent the event from resulting in a disaster.[7]

The increased responsibility of society for the occurrence of disasters is therefore meaningful in relation to vulnerability. A strengthened recognition of these anthropogenic influences could lead to a growing awareness of the problem and thus to a reduction of susceptibility to disasters through improved security measures and protection mechanisms. On the other hand, Clausen (1983) raises the consideration that the increasing "professionalisation" of protection from disasters could lead to an only unprofessional understanding of disasters and thus increased vulnerability for the total population in the industrial nations.

2.2.1 Natural Science / Technically Oriented Concepts

A scientific or technically oriented understanding of vulnerability usually refers to the susceptibility of tangible assets or nature to a natural hazard. According to the former UNDRO (1991), vulnerability is a function of the intensity of an extreme event (*hazard)*. Here, two elements are "at risk": structure and infrastructure. The term structure includes, for example, the way a house is built (clay, wood, stone, etc.), while infrastructure indicates communications, energy and information connections. A ranking can be established on the basis of an inventory of structures and infrastructures ranging from the lowest to the highest vulnerability. The definition of vulnerability unfolds as follows: *"Vulnerability is expressed as the degree of expected damage (i.e., the cost of repair divided by the cost of replacement) given on a scale of 0 to 1, as a function of hazard intensity (or magnitude, depending on the convention used)."* (UNDRO, 1991, p. 79). However, this definition neglects the decisive factor of "time" for the repair of the damage. In a training program for disaster management, vulnerability was described as "the propensity of things to be damaged by a hazard," and more exactly, "the degree of loss to a given element at risk (or set of elements) resulting from a given hazard at a given severity level" (UNDP/UNDHA, 1994, pp. 38-39; see also UNDHA, 1992). In contrast to the concept of risk, here the probability of the occurrence of a hazard is not considered. Thus, vulnerability is to be understood as separate from risk. *"Risk, as defined here, means the sum of all losses that can be expected from the occurrence of a particular natural phenomenon"* (UNDRO, 1991, p. 91). This includes the occurrence probability of a natural event and encompasses the expected number of dead and injured, damages to material goods and the interruption of economic activities. The Münchener Rück (2000b) also perceives susceptibility as the possible "damages at the entry of

[7] See also BMZ Scientific Advisory Board, 1997.

an event, that is, the vulnerability of a system (building, complex, state, businesses, etc.) to external damaging effects."

2.2.2 Socio-Economic Concepts

In the last decades, a change took place in the paradigms having to do with the understanding of disasters and vulnerability to them. The first paradigm, the 'hazard paradigm,' focuses on an external, destructive trigger. In the late 1970s and the beginning of the 1980s, a second paradigm emerged, which abandoned the focus on events. Disasters were seen as social vulnerability. The third and most recent paradigm comes from these two earlier, opposing ones. Disasters were seen as crises and as times of extreme uncertainty, thus as social situations. More and more disasters are only a form of varying crisis phenomena (Blaikie et al., 1994, p. 11; Gilbert, 1998).

2.2.2.1 Traditional Concepts

Traditional concepts about disasters show a limited space-time understanding, generally short-term perspectives, simple causalities, a focus on natural events and some technological dangers and a perception of an only short-term interruption of an otherwise continuing development process (Rosenthal, 1998, p. 150).[8] According to Rosenthal, however, present disasters should be understood more as being complex, interconnected processes. The identification of vulnerability is correspondingly difficult because no threshold value for its originating process can often be defined.

An example of the simplified and too narrow perceptions of vulnerability can be observed in the case of food emergencies. Analyses of carrying capacity, which clarify how much food can be produced sustainably (e.g., Ehrlich et al., 1993; Brown and Kane, 1994), are the examples of simple extrapolations into the future and of simplified concepts about the origins of famines. For a long time, population growth was connected with the development of, the occurrence of and the vulnerability to famines. Malthus was one of the first to conceptualize the connection between population growth and a given resource base, which serves for food production. According to his assumption, a balance was achieved between population and available food through "shocks," which led to a "regulating" reduction of the population numbers through famine deaths. In her classic work, Ester Boserup (1965) argued in the other direction: population growth could have been the driving force for technological innovations and agricultural progress. The necessary technical change can be caused by the existing relative shortage of factors (compare to Hayami and Ruttan, 1985). Carrying capacity analyses (in the

[8] Traditional models describe a world of " 'un'-ness": they are "unmanaged," "unexpected," "unprecedented," "uncertain," "unaware," "unready" and "unscheduled."(Hewitt, 1983, p. 10).

form of person-to-land ratio) ignore the dynamic of economic development because they overlook potential resource substitutions, view technological progress too pessimistically and underestimate the prospects of trade (von Braun and Qaim, 1997). Linear causalities are too simple to clarify the multidimensional connections between poverty, population pressure, politics and famines (von Braun et al., 1999, pp. 56-61). This shows clearly the complexity of the multidimensional concept of vulnerability.

2.2.2.2 Further Developments in the Concept of Vulnerability and Its Determinants

As an explanation for disasters, the concept of vulnerability (at the household level), which has been heavily developed since the 1970s,[9] was partially expanded to include the aspect of capacities to resist the respective catastrophic event (Anderson and Woodrow, 1989). It was recognized that the severity of the natural events contributed only partially to the destruction caused by catastrophes (Winchester, 1992). Other areas of vulnerability are individual behavior and social and organizational structures of society (Anderson and Woodrow, 1989, p. 11; Anderson, 1995).

Especially in developing countries lower social and economic status has increasingly been recognized as a further variable along with the physical proximity to a natural disaster. Blaikie et al. (1994, p. 11), however, reject concepts that equate vulnerability with poverty; the same holds true for approaches that exclusively judge the capability of systems by how they avoid risks and losses. The latter approach is considered as advanced environmental determinism, which cannot explain "how one gets from very *widespread conditions* such as 'poverty' to very *particular vulnerabilities* that link the political economy to the actual hazards people face" (Blaikie et al., 1994, p. 12).[10] Their simplified basic model consists of two opposing forces. On the one hand, the processes that cause vulnerability can be observed;[11] on the other hand, there is physical exposure to hazards (earthquakes, storms, floods, etc.). Vulnerability develops then from underlying reasons in the economic, demographic and political spheres into insecure conditions (fragile physical environment, instable local economy, vulnerable groups, lack of state or private precautions) through the so-called dynamic processes (e.g., lack of local

[9] An overview of the development of recent social-scientific *vulnerability*-research is given by Winchester 1992, pp. 37-42; Blaikie et al. 1994; Varley 1994, pp. 4-6; Cannon 1994, pp. 13-30; Anderson 1995, pp. 43-46

[10] Blaikie et al. (1994, p. 30) emphasize: "There is a serious lack of analysis of the linkages between vulnerability and major global processes as root causes. For example, it is not possible to identify the precise manner in which urbanization increases hazard impact. This situation reflects the preoccupation of most disaster work with the hazards themselves, and we propose that the IDNDR should collect and analyze data to determine the nature of such links." The authors continue: "Despite the shortage of firm evidence, there is a consensus that, for example, urbanization has contributed considerably to the severe losses of certain urban earthquakes of recent years, that population increase is one of the reasons for rapidly rising casualty statistics as a result of droughts and flooding, and that deforestation increases flooding and landslide risk. We cannot make any proper claims that vulnerability produced by a range of social processes has been increasing along with these factors. But we consider that the analysis and discussion of this book strongly supports such a view." (Blaikie et al., 1994, p. 30).

[11] According to Blaikie et al. (1994, p. 9) vulnerability is "*the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist, and recover from the impact of a natural hazard*".

institutions, under-developed markets, population growth, and urbanization) (Blaikie et al., 1994, pp. 21-26).

As these and many other formulas emphasize, there are clear differences in how individuals and groups are affected. Indeed, vulnerability has long been understood as above all the connection between risks and (natural) dangers, without including differentiations in individual susceptibility (Winchester 1992, p. 39). Winchester (1992), on the other hand, emphasizes these individual variances (differential vulnerability). His statements refer above all to areas affected by cyclones. His simple concept considers internal as well as external processes that influence the balance between the stability or instability of a household or individual. The externals are climate, physiography, production conditions and developmental-political measures. Based on the work of Sen and Swift, these externals can be expanded to include the relationships between production, exchange and consumption. These factors influence the "assets" of households, which in turn affect risk-reducing and risk-distributing strategies. The analysis of shocks, losses and household characteristics and their interaction with adaptability mechanisms help to foresee vulnerability. Winchester (ibid.) examined tornado vulnerability in south India and found serious differences in vulnerability among different groups. Often, but not always, the poorest have been the most vulnerable.

This relationship between poverty and vulnerability to disasters is not always clear. In the famine of 1988-90 in Sudan, for example, animal owners, who were considered wealthier by the local population, were as affected as the "poorer" groups. Wealthier wandering shepherds had greater problems with converting their possessions (animals) into available income or with trading them because the animals could not be divided or were kept far away. They thus suffered from reduced liquidity. Moral demands to help the poor may have been a contributing factor (Jaspars and Young, 1995, pp. 210-212). If all shepherds sell their animals at the same time, the price per animal sinks, and their previous "wealth" is diminished. The price relation between animals and grain sank from 6:1 to 2:1 in the famines in the Sudan and Ethiopia (Webb and von Braun, 1994; von Braun et al., 1999).

According to Webb and Harinarayan (1999), vulnerability is not a static concept, but rather is changeable because of the activities of those affected. According to this interpretation, vulnerability can be seen as follows:

Vulnerability (V) = Hazard – Coping

with: Hazard = H (Probability of the hazard or process; shock value; predictability; prevalence; intensity/strength); and
Coping = C (Perception of risk and potential of an activity; possibilities for trade; private trade, open trade).

Longhurst (1994) combines the multitude of vulnerability and other related concepts and criticizes that their meaning remains vague. Table 1 shows the different concepts and terms concerning vulnerability on the household level; their combination here illustrates the overlaps and unclear dividing lines.

Table 1: Conceptional approaches to the explanation of vulnerability and household conditions in disasters

Event/ Process	Household condition	Determinants of possible impact	Result after the event
Extreme event (Hazard)	Capacity (Sen, Anderson and Woodrow)	Vulnerability (Chambers, Anderson and Woodrow, Winchester)	1. Winners (Duffield) 2. Enduring households, which are not affected (Oshaug) 3. Resilient households , which return to their original positions (Oshaug, Chambers, Davies etc.) 4. Fragile households, whose positions are worse (Oshaug, Chambers, Davies)
Shock	Entitlements (Sen, Swift)	Exposure (Watts and Bohle)	
Stress	Net assets (Chambers)	Resilience (Oshaug, Bayliss-Smith)	
Risk	Insurance strategy (Phillips and Taylor)	Sensitivity (Bayliss-Smith)	
	Coping ability (Corbett, Longhurst, Frankenberger)		
	Capability (Watts and Bohle)	Potential (Watts and Bohle)	

Source: slightly changed from Richard Longhurst, 1994: Conceptual Frameworks for Linking Relief and Development. IDS Bulletin 25 (4), p. 20.

In this table the terms often cannot be clearly separated from each other. Alongside the affliction of the possibly larger part of the population, in some estimations there are also "winners," in other words, households that are in better positions than before at the end of a catastrophe. Here, it is also clear that the concept vulnerability (on the household level) has a process character and is not static.

The recognition that people are responsible for the origins of disasters introduces the possibility for an active reduction in vulnerability through a series of decisions and actions (Anderson and Woodrow, 1989; Anderson 1995). The responsibility for disasters moves

therefore to the organizational and systematic levels - "deficient safety culture and lack of effective counter-disaster management" (Rosenthal, 1998, p. 152).

(Global) systems approaches expand the concept of vulnerability. For example, the German Scientific Advisory Council for Global Environmental Changes overcomes the classical, one-dimensional perspective with its systems approach and syndrome concepts. It establishes the hypothesis that some functional patterns (syndromes) are symptomatic for unwanted combinations of natural and civilization-based trends. These syndromes can be observed in different areas of the world. For example, the "Sahel syndrome" stands for the overuse of border areas, or the "disaster syndrome" represents singular, anthropogenic environmental catastrophes. Integrative analyses of these syndromes could contribute to a better understanding of catastrophic events and their characteristics along with their interactions with social and economic factors (WBGU, 1996; see also Lass et al., 1998).

Lass et al. (1998, p. 14) emphasize that an indicator system for disasters that is limited to "the moment of the event or its consequences – deaths and monetary damages" - is insufficient. For example, the same number of dead could be the result of a middle-strength event with good precautionary measures or of a weak event with only limited precautions. For this and other reasons, the authors prefer the application of "*integrative indicators*" for disaster vulnerability. These include the frequency and intensity of the events, the number of endangered people, the material capital and the ecological resources as well as the preventative abilities and/or reaction capacities of the affected people and regions (ibid., p. 15). Lass et al. (1998, pp. 18-19) see susceptibility to disasters as a triad between event, potential damage and reaction potential.

As will be shown later, disasters occur more often in developing countries. Along with possible regional differences, per-person income growth and social security systems seem to lead to improved technological and institutional security systems. In this respect “good” institutions, meaning those that support the values, norms and rights of a society, should prevent extreme events from becoming catastrophic. They are an important influence factor in disaster vulnerability. The examination of institutions relevant to disasters can reveal information about changed trends in disaster susceptibility because these formal and informal institutions are placed under great pressure by these catastrophic events (von Braun and Feldbrügge, 1998). Examples of formal and informal institutions as indicators of disaster vulnerability in the agricultural area of developing countries on the micro-level are:

- **formal institutions**: rights of ownership, e.g., land and water rights, credit markets, insurance markets, cooperatives;
- **informal institutions**: traditional value systems, family support, community support, common property, cooperatives.

In crises, institutional collapse hits different institutions in various ways and sequences: the formal or official institutions usually fall first; with the consequence that an intensified

reversal for the informal institutions follows. Indicators for advanced institutional collapse and concurrent vulnerability to famine are, for example:

- increased exchange of goods instead of money;
- selling of goods not normally for sale;
- collapse of the market;
- dissolving of households, flight and migration; and
- the breaking of laws (in extreme cases, robbery and murder).

At the same time, new substitutes for fallen institutions can appear ad hoc, e.g., the rise in community actions after the collapse of formal institutions. This can also be observed in industrial countries ("emergent norms") (Neal and Philipps, 1995).[12]

In summary, the following potential *determinants of disaster vulnerability* can be identified from the analysis:

- demographic factors: population growth, urbanization, settlements near coastal areas, etc.,
- the state of economic development: poverty, modernization processes,
- environmental changes: climate changes, degradation and depletion of resources (straightening the courses of rivers, deforestation, etc.)
- political factors,
- an increase in tangible assets, which leads to an increase in damages,
- effects of disaster protection structures and research, and
- the interactions of the causes of disasters.

In this pilot study, each determinant will not be discussed individually. However, in the following section, hypotheses will be presented that relate to the above-mentioned determinants.

[12] "Emergent norms are 'a set of new behavior guidelines' that develop during new, uninstitutionalized events."(Neal and Philipps, 1995, p. 329).

3 Database

3.1. The Importance of Disaster Statistics

3.1.1 Limiting Factors

Several factors considerably reduce the meaningfulness of disaster statistics. These are related primarily to the collection area (survey framework), reliability and meaningfulness as well as the comparability of the data. At least seven critical areas can be cited in relation to disaster statistics (see also Sapir and Misson, 1991; Sapir and Misson, 1992):

- **limits of disaster definitions**: a lot of organizations use different definitions of disasters; these depend in part on the intervention capability of the organization. In the case of insurance companies, certain monetary thresholds must be crossed in order to earn consideration. In other words, on the whole there is only a low level of standardization.
- **ambiguity in the typology of disasters**: the limiting use of pre-defined types leads to simplification and does not correspond to the diversity of actual disasters. Classification into categories of disasters does not consider causes. An example for this is famine, the causes of which range from natural to political catalysts.
- **discrepancies in dates and data**: in many instances, exact dates and times for the onset of disasters cannot be determined; often, two or more initiation dates can be found. The number of dead, affected and homeless individuals as well as the loss of valuables are sometimes especially difficult to ascertain. An example of this is the determination of the number of dead, where all confirmed cases are considered without looking at the causes of death, which may not necessarily be connected with the disaster. Without exactly specifying the kind of injuries, they usually range from minor ones to cases for hospitalization. The category for affected people remains imprecise and leaves room for many possible interpretations.
- **insufficient consideration of indirect effects**: in assessing damages, and thus identifying trends, usually at most the direct costs in the form of material damages are considered; indirect and long-term effects of disasters are not;
- **discrepancies in relation to the utilized numerical units**: these especially affect statements about the extent of damages. The data are given in the local currency or in US dollars and are either nominal or real values. On the whole, it remains unclear whether the evaluation of damages rests on the current (depreciated) or the resale values. Especially in this area the data and the quality of the statements are not reliable. Although

reinsurance companies collect data about damages, this frequently relates only to insured rather than to the actual damages. This last point also holds true more for developing countries with reduced rates of insurance coverage than for industrial countries. In addition to this, indirect costs and damages from disasters as a rule are not taken into consideration. However, these can cause a large part of the total damages and thus costs;

- **assessment of damages (lack of 'baseline data'):** this leads not only to difficulties in the classification of damages and losses, but also to problems in correctly assessing the numbers of dead and injured persons; especially in developing countries. For example, the exact size of a population is often not known, even before a disaster strikes;
- **no consideration of reciprocal effects:** existing statistics do not reflect the reciprocal and interdependency effects of various disasters striking within a single region. The focus is still on the singularity of each disaster, which is also a result of too much emphasis resting on disaster relief instead of prevention;
- **serious problems concerning the reliability of information sources:** for instance, information can be politically motivated and under- or overcalculated;[13]
- **exclusion of qualitative differences:** because of different coping capabilities, such as health provision, there is a qualitative difference regarding the number of injured in developing and developed countries;
- **insufficient sub-regional data**: these complicate the analysis of different vulnerabilities within countries.

3.1.2 Is the Quantitative Increase in Disasters a Result of Improved Statistics?

With the foundation of the US Office of Foreign Disaster Assistance (OFDA) in 1964 a worldwide systematic collection of disaster data began. In addition to this, the United Nations Disaster Relief Organization (UNDRO) was established in 1971/72 (CRED 1994, pp. 4-5). Therefore, it is assumed that data compiled since the mid-1960s are more reliable. The Center for Research on Epidemiology of Disasters (CRED) was created in 1973; since 1988, an Emergency Events Bank has been managed there. In addition, reinsurance companies, such as the Munich Re and Swiss Re, have systematically collected data on disasters for the past 25 years.

The trend curves (see below) show a plausible influence of improved statistics since the mid-1960s. How strong this influence is, however, cannot be determined. Presumably, more of the "smaller" disasters in particular have been recorded with the improved statistics. There are fewer uncertainties about the number of major events in the 20th century. According to the Munich Re (2000a, p. 5), the major events of the last 50 years are more accurately recorded and thus allow for better analyses of trends.

[13] Albala-Bertrand (1993, p.43) is of the opinion that the economic losses in industrialized countries are overvalued twofold regarding the actual damage, and even more so in developing countries. Overvaluation is higher in rural than in urban areas.

3.2 Global Disaster Data Bases

The following numbers are mostly based on the data banks of OFDA/CRED (released via the Internet and regularly published in the World Disaster Reports of the IFRC), of the Munich Re and Swiss Re.

3.2.1 OFDA/CRED International Disaster Database EM-DAT

Many of the following data are taken from the CRED data bank, which was established in 1988 at the University of Leuwen, Belgium. The data bank has cooperated with the US Office of Foreign Disaster Assistance (OFDA) since 1999.[14] To be called a disaster, the following criteria must apply:

- 10 deaths, and/or
- 100 persons affected, and/or
- an international request for assistance and /or
- the declaration of a national emergency.

Date, type and country of origin of each new event is recorded in the data bank. In case of inconsistent data, government information about the affected country has precedence over that of the United Nations [via the United Nations Office for Humanitarian Affairs (OCHA)]. This in turn takes precedence over OFDA. Consistent information from two sources is preferred over a single source. The following disaster categories apply: avalanches, technical accidents, heat and cold waves, chemical incidents, droughts, fire, earthquakes, epidemics, famines, floods, storms and tropical storms, tsunamis and volcanoes (CRED 1994, pp. 3-5). Since data on famines are often inconsistent, CRED´s analyses only rely on them partially.

3.2.2 Munich Re

For more than 25 years, Munich Re´s research team for geo-sciences has worked on establishing its own disaster data bank, which also includes a historical survey. The team defines a major disaster or event as follows: "a natural disaster is regarded as 'major' if it exceeds the affected region's capability for self-help and requires inter-regional and international assistance. This is usually the case if the number of dead reaches into the thousands, or the number of homeless into the hundred thousands or if substantial economic damage – according to the relevant economic situation of the country affected – is caused" (Münchner Rück 2000a, p. 41, own translation).

[14] Since September 1999, the OFDA/CRED International Disaster Database, which includes over 12,000 entries, can be contacted on the internet under http://www.md.ucl.ac.be/cred.

3.2.3 Swiss Re

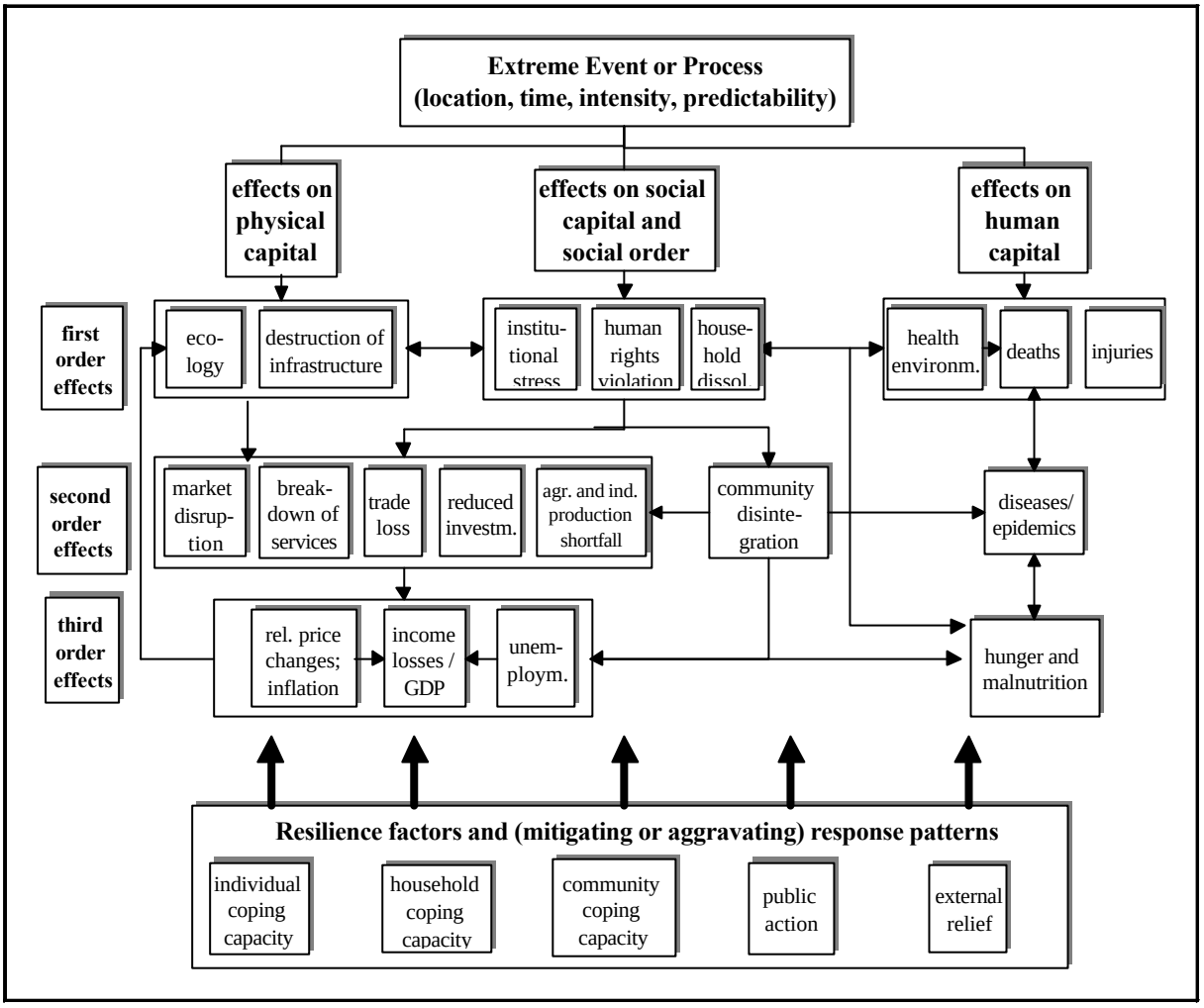
Since 1970, the Swiss Re also has established a "record of major damages," adding technical incidents. The amount of the minimum damages required to be included in their list is adjusted to the annual US rate of inflation. In 1998, the following criteria were applied to natural and technical disasters: insured losses of at least US$ 12.8 million (shipwrecks), US$ 25.7 million (airplane crashes), US$ 32.3 million (other damages) *or* total damages in the amount of US$ 64.6 million *or* leaving at least 20 dead or missing, 50 injured or 2,000 homeless (Swiss Re 1999, pp. 4-5). Here is of special interest, for example, the minimum threshold of dead persons, which is different from that of the OFDA/CRED or Munich Re definitions.

3.2.4 Synthesis: Criticism of Existing Disaster Statistics

The inconsistent definitions of disaster (see above) result in an uncertain statistical information base, particularly where developing countries are concerned. So far, not enough money has been invested in this field (see also IFRC, 2000).[15] Individual countries have little incentive and insufficient means to invest in surveys of disasters. Further difficulties are inherent to catastrophic events. Figure 1 shows the direct and indirect effects and costs of a disaster and illustrates how inaccurately its dimensions are projected by appraisals of the amount of insured damages and losses in the national product. Monetary values are usually not attached to the indirect effects, which makes their assessment extremely difficult. The long-term negative nutritional effects caused by a disaster are just one example. The correlation between the material damages assessed and the indirect damages is uncertain and presumably dependent on the type of disaster. The following table also presents factors that mitigate or aggravate vulnerability. They include coping capacities on individual, household, community and national levels as well as disaster assistance.

[15] To some extent, there are considerable differences in the number of casualties compiled in the various data banks; these differences often reach several thousand. In observing global trends, however, these differences do not result in different assessments, since the deviations from trends are still of similar size.

Figure 1: Direct and indirect effects of disasters



Source: authors

Lacking alternatives, in the following damages are expressed in numbers and used as indicators for disaster trends irrespective of these problems.

In addition, disasters are still regarded as solitary and independent events. The actual survey methods employed are not sufficient to integrate these events regionally or historically. Past disasters, however, may lay the foundations for future ones. That is true especially for developing countries with their limited resources.

4 Long-Term Global Trends in Disasters

In view of the difficulties concerning the collection of data in times of disaster, the following presentation of figures regarding their frequency, number of casualties or otherwise affected people can only indicate tendencies and are not exact values. The trends presented here are based on analyses of organizations and institutions that collect data and are familiar with the issue of trend analysis. A more comprehensive analysis would exceed the framework of this pilot study.

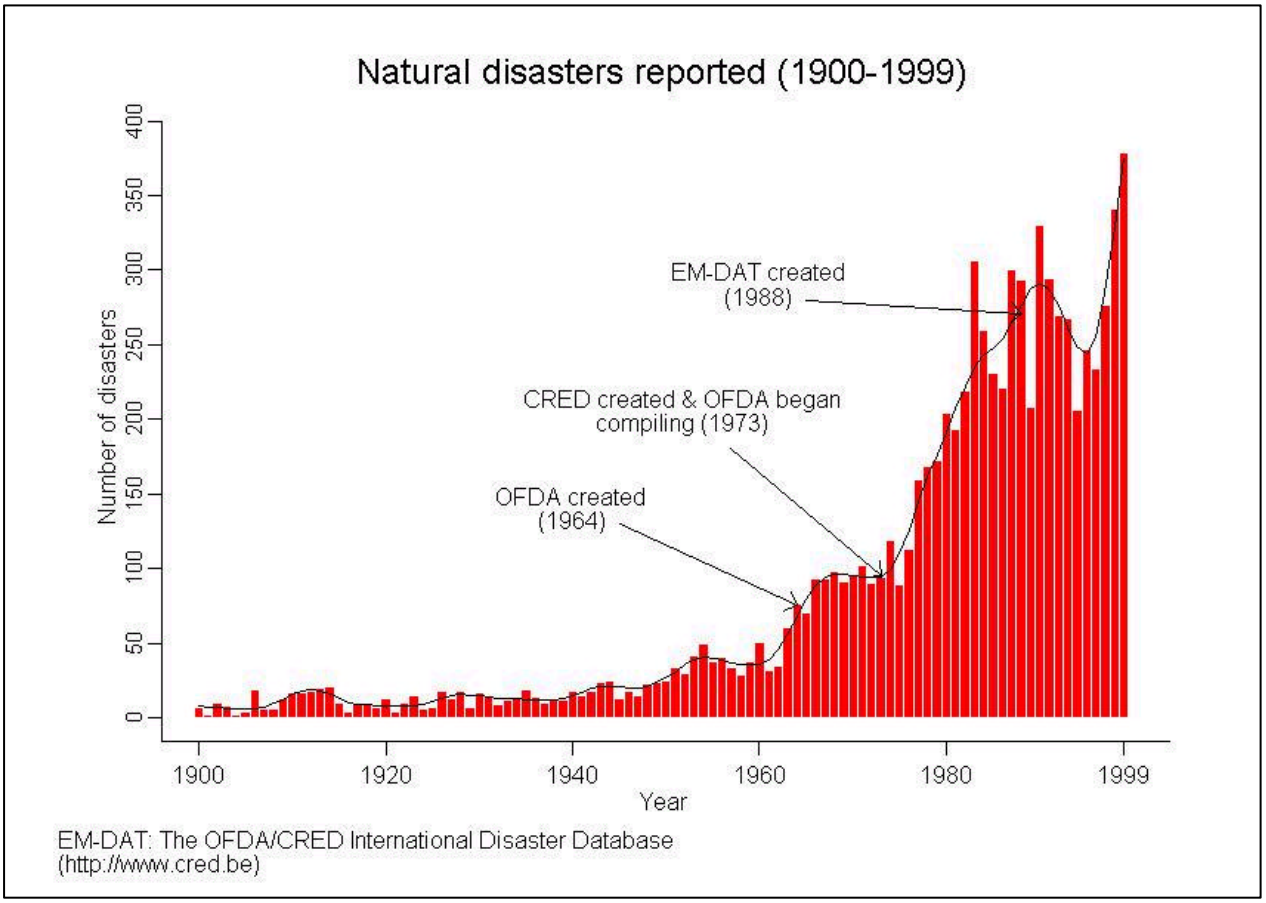
4.1 Global Frequency of Disasters: Historical Insights and Trends in the Last Decades

The older the data, the less accurate and reliable they become. Therefore, only the approximate trends in the 20th century are considered at this point. Older data are too inaccurate to be included in an observation of trends.

4.1.1 Trends in the 20th Century

As can be gathered from the following figure, there has been a considerable increase in the number of recorded natural disasters since the beginning of the 20th century. Figure 2 shows the number of disasters together with the years in which data collection improved as a result of the founding of institutions to study disasters. According to data collection which has been improved since the mid-1970s, there has been a slight increase in the number of disasters according to OFDA/CRED data bank.

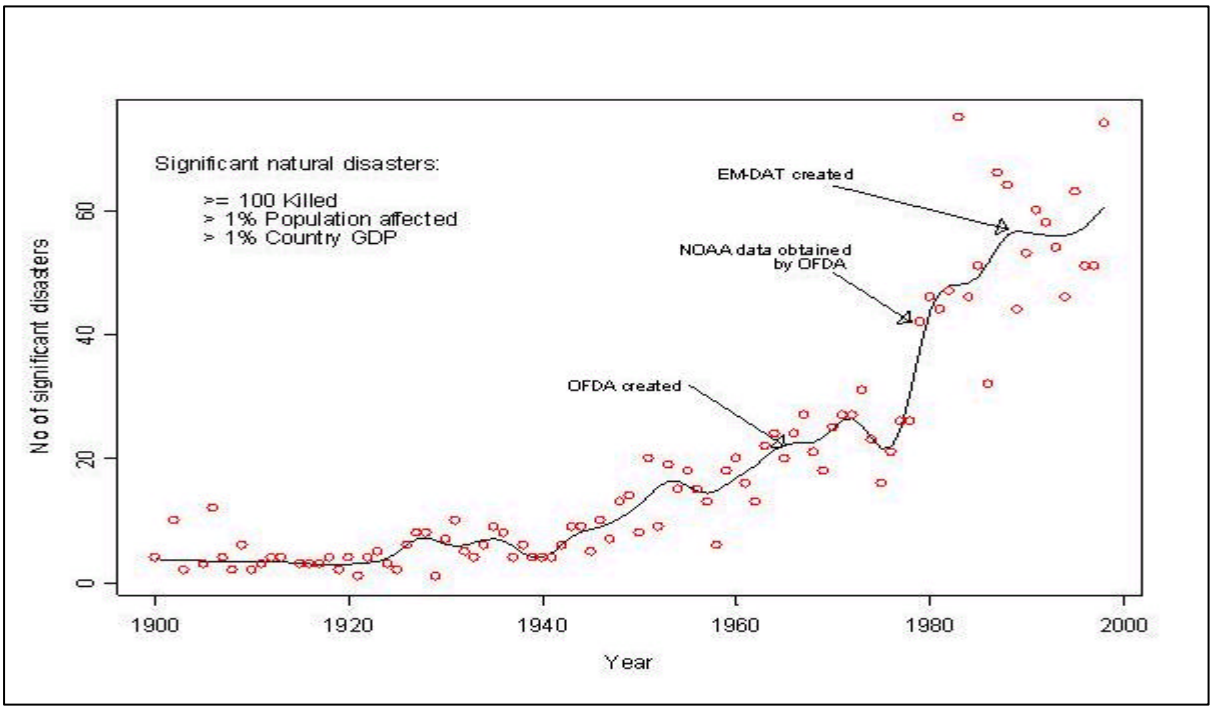
Figure 2: Number of natural disasters reported, 1900-1999



In addition, figure 3 shows a rise in the number of major disasters during that period.[16] Data on major disasters are probably more accurate.

[16] The trends are confirmed by Nussbaumer and Winkler (1997) with the help of another, but very anecdotal data bank (Nussbaumer, 1996). In his data bank, Nussbauer included randomly selected and unverified figures on droughts, floods, earthquakes, tropical and other storms, volcano eruptions, tsunamis, avalanches and landslides, blizzards, heat and cold waves, hailstorms and forest fires that leave at a minimum one hundred persons dead according to a least one source. Both authors also conclude that the frequency of natural disasters reporting at least one hundred dead has increased during the last hundred years (Nussbaumer and Winkler, 1997, p. 547). The occurrence of droughts and earthquakes was, in relative terms, evenly spread over the century. In the second half of the last century events such as storms (62% of storms took place in the second half), floods (72%), and other natural disasters (68%) accumulated (ibid., p. 548). A significant difference, however, is established by the authors (ibid., pp. 549-550) between high- and low-income countries. Whereas the number of disasters has decreased in high-income countries during the last hundred years, it has risen the most in low-income and less so in middle-income countries. The influence of improved information cannot be separated from an actual rise in the number of disasters in the developing world. Nussbaumer and Winkler (1997, pp. 558-559) indicate in their study that there could be a difference in the development of smaller and major disasters and that smaller disasters could become more significant to the extent that major ones become less so. In addition, small disasters are more probable to be protected against by various safety measures than are bigger disasters (personal communication by Research Group Geo Sciences of Munich Re).

Figure 3: Number of significant natural disasters, 1900-1999



Source: EM-DAT: The OFDA/CRED International Disaster Database; http://www.cred.be

4.1.2 Overview of Trends in the Last Decades

Table 2 gives an overview of the number of natural disasters according to the CRED definition (see above the various definitions of disaster). The table does not yet represent a period of time, but shows first the relative frequency of various disasters by continents. It shows the different time horizons in which certain types of disasters occur and that must be included in an observation of trends (the considered period of 11 years is rather short).

The occurrence of certain types of disaster can vary: earthquakes and volcano eruptions take place randomly and rarely, while floods and storms are the dominant types. They include 60% of the disasters that happened between 1988 and 1997. Some countries, such as Bangladesh, experience such disasters almost annually. In comparison, the number of droughts and famines is rather small, and they are concentrated in Africa. Asia is clearly the continent with the highest average number of disasters, followed by the American continent.

Table 2: Average annual number of natural disasters, 1988-1997

	Africa	America	Asia	Europe	Oceania	Total
Earthquakes	2	6	11	4	2	**25**
Droughts and famines	8	2	3	1	1	**15**
Floods	13	22	34	9	4	**82**
Land slides	1	4	7	1	1	**14**
Storms	4	28	34	10	7	**83**
Volcano eruptions	0	2	2	0	1	**5**
Other	14	10	14	7	1	**46**
Total	**42**	**74**	**105**	**32**	**17**	**270**

Source: International Federation of Red Cross and Red Crescent Societies, 1999: World Disasters Report 1999. Geneva, IFRC, p. 147.

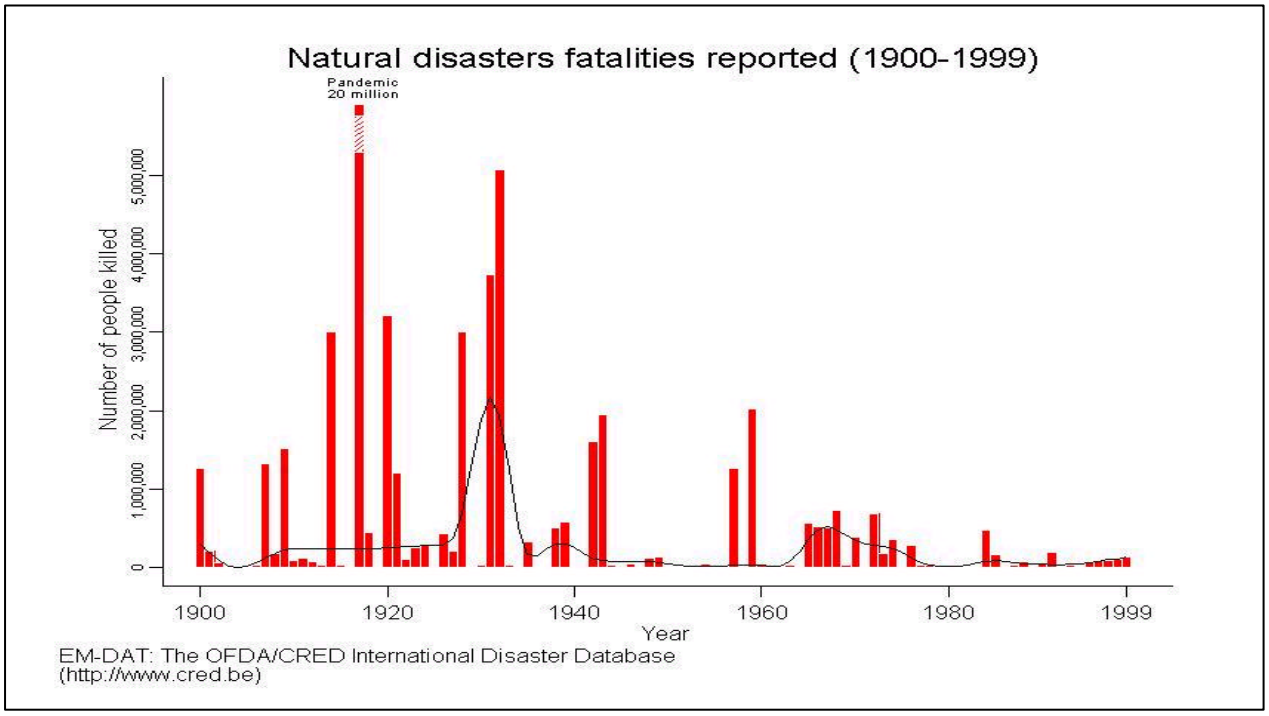
Statistics compiled by the Swiss Re show that since 1970 there has been an increase in the number and extent of natural and technological disasters. According to the Swiss Re, the reasons are growing population density, a rising amount of insured tangible assets located in endangered areas and a higher concentration of property values in industrialized countries. The number of technological disasters (70-100) remained relatively stable between 1970 and 1986, but strongly increased to 160-200 between 1987 and 1998. The number of natural disasters has continuously grown from 40 events per year to 120 per year today. One of the reasons for this is an improved information capacity (Swiss Re, 1999, p. 8).

4.2 Global Trends in the Number of Dead and Injured

The number of disasters does not entirely reflect vulnerability, because it does not include any qualitative components that express the severity of a disaster. Among others, these can be seen in the number of dead and injured. However, over time the number of disasters shows a much stronger increasing trend than does the number of fatalities. Here, there seems to have been a decreasing tendency, e.g., a divergent development (Figure 4). Presumably, the decrease in the number of drought victims contributed to this. The composition of a data bank needs to be taken into account; for example, the worldwide pandemic of 1917 was responsible for an extreme deviation in the CRED database. As the study by Devereux (1999) shows, famines in the 20th century have caused fewer fatalities and have shifted their occurrence, with a few exceptions, from the north (e.g., Russia) and Asia to Sub-Saharan Africa. In addition, mortality has been reduced significantly. Previous famines in Russia, China and India, in part because of their large populations, resulted in more fatalities than the more recent ones in Africa, even though these

left up to one million people dead. Also, the causes of some famines connected with droughts lie in government failures and conflicts. In the case of droughts, it is extremely difficult and very inaccurate, to estimate the number of fatalities. Therefore, the Munich Re usually refuses to list droughts as disasters. This fact should not be ignored when interpreting the data.

Figure 4: Number of disaster fatalities, 1900-1999



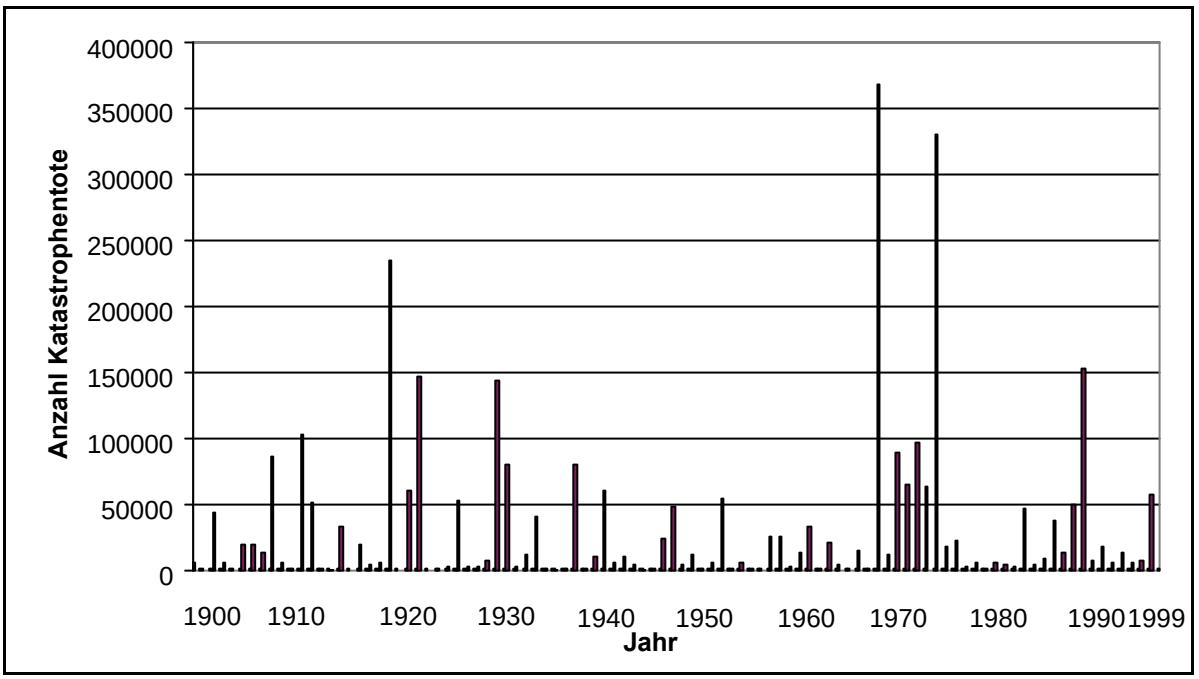
A record of fatalities over time, beginning in 1900 and based on the data bank of the Munich Re (Münchner Rück, 2000b),[17] also shows divergent tendencies. An increase during the 1920s is followed by a notable decline during the period of the Second World War up to the mid-1960s. This period is followed by another rise from the beginning to the middle of the 1970s. If 5 or 10 year moving averages are considered, the phases of low disaster occurrence are more significant.

Major deviations usually result from a few extreme catastrophic events, for example: an earthquake in Italy with ca. 90,000 dead in 1908, an earthquake in China leaving 290,000 dead in 1920, an earthquake in Japan killing 123,000 in 1923, cyclones in Bangladesh with 61,000 killed in 1942 and 300,000 killed in 1970, an earthquake in Peru leaving 70,000 dead in 1970, a drought in the Sahel claiming 250,000 lives in 1972-1975, an earthquake in China with a death

[17] All major events on the CD-Rom were taken into consideration with the exceptions both of a drought in India (1965-1967), which supposedly killed 1.5 million people, and a rupture of a dam in China in 1938, which was caused by an intended blow up. The results were reached by basic analyses and need more processing. Significant events were chosen, since in these cases the retrospective analysis is more reliable than the inclusion of less significant events.

toll of 290,000 in 1976, and a cyclone in Bangladesh with 139,000 fatalities in 1991.[18] Therefore, the fluctuating numbers of fatalities in the course of the 20th century do not allow for the determination of a clear trend.

Figure 5: The number of dead from disasters (major events), 1900-1999 *



*without China in 1938 (dam rupture) and India in 1965-67 (drought)
Source: author's calculations on the basis of data from Munich Re, 2000b

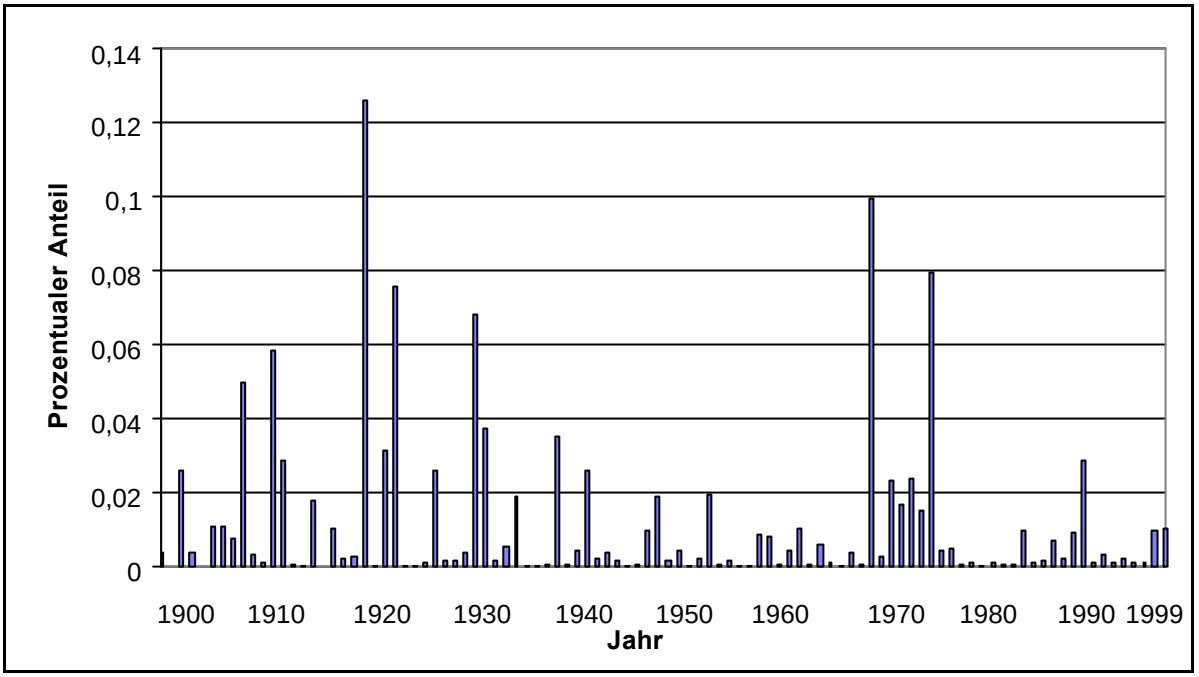
For a more exact assessment, it is necessary to include both the death toll and its percentage of the world population, which has grown tremendously during the 20th century (from about 1.65 billion people in 1900 to about 2.5 billion in 1950 to 6 billion in 1999). Figure 6 shows a similar trend. This is also a rough calculation; a more detailed analysis should cover the trends of individual countries and the death toll relative to each country affected.[19] As specified in the conceptual section of this study, analyzing some characteristics of extreme catastrophic events, such as frequency and duration, could lead to more detailed results. In this case, social coping capacities would then be neglected.[20]

[18] For more on the number and scale of natural hazards, see also Worldwtach Institute, 2001

[19] In a historical study, Nussbaumer (1996) tried to compile material on natural disasters into a chronicle of catastrophic events starting in 1500. Besides describing the difficulties of gathering reliable data in general, he states: "Historically, an increase in the number of catastrophic events cannot easily and clearly be proven. A rise in the number of recorded catastrophic events rather indicates improved reporting than clear evidence of a more violent nature....In spite of all prophecies the relative death toll per event has considerably declined... (p. 11, own translation).

[20] Looking at hurricanes in the United States, the Swiss Re (Swiss Re, 1999, pp. 10-13) demonstrates that cyclical, that is "periodically recurring factors in the realm of natural climate variability," have supposedly been responsible for a rise in the number of hurricanes since 1995. It is assumed that precipitation in the western Sahel, stronger ocean circulation as well as the El Nino phenomenon contributed to the increase. From 1944 to 1967, a total of 16 hurricanes of category three to five occurred, but only six from 1968 to 1994. Hurricanes in the US have not shown any tendency to continuously increase since the middle of the 20th century.

Figure 6: Relative number of dead from major disasters as a percentage of the global population, 1900-1999*



* without China: in 1938 (dam rupture) and India: in 1965-67 (drought)

Source: authors´ calculation on the basis of data from Münchner Rück, 2000b; United Nations, 1998. World Population Prospects: The 1998 Revision. New York.

As table 3 shows, based on the CRED data bank, if the number of deaths are considered, no clear confirmations are possible concerning a rising or declining vulnerability to disasters during the last four decades.

Table 3: Annual average number of fatalities* by region and in 5-year periods, 1973-1997

	Africa	America	Asia	Europe	Oceania	Total (and as % of the population)
1973-1977	84,413 [1]	8,519	68,454[2]	2,318	107	**163,811 (0,0040)**
1978-1982	1,436	3,172	16,529	1,406	35	**22,579 (0,0005)**
1983-1987	115,269[3]	10,853	17,073	2,302	189	**145,686 (0,0030)**
1988-1992	12,272	5,248	63,435[4]	2,352	138	**83,445 (0,0015)**
1993-1997	7,919	3,065	19,078	1,996	149	**32,206 (0,0006)**
1973-1997	**44,262**	**6,171**	**36,914**	**2,075**	**124**	**89,546**

* all confirmed dead and missing

Main causes of death:

[1] Drought in Ethiopia 1974: 200,000 dead

[2] Earthquake in China 1976: 242,000 dead

[3] Drought in Ethiopia 1986: 300,000 dead

[4] Cyclone in Bangladesh 1991: 139,000 dead

Source: according to the International Federation of Red Cross and Red Crescent Societies, 1999: World Disasters Report 1999. Geneva, IFRC, p. 139; concerning the death tolls in Ethiopia, China, Bangladesh see OFDA/CRED, 2000: International Disaster Database EM-DAT; http://www.md.ucl.ac.be/cred/wdr1999.htm; United Nations, 1998: World Population Prospects: The 1998 Revision. New York.

The analysis of average annual death toll shows that during the last decades fewer people died than in the mid-1980s. This holds true especially for Africa, probably because of improved national and international assistance in times of drought, at least where former droughts are compared to the drought in sub-Saharan Africa at the beginning of the 1990s (the high death toll in Africa in the 1970s and 1980s was due in large part to the famines in Ethiopia).This may also result from fatalities caused by disasters being erroneously attributed to the war-like conflicts in Africa, which are occurring more frequently. In Asia, the trend is less clear. Between 1988 and 1993, a cyclone hit Bangladesh (1991), leaving 139,000 persons dead. This pushed the number of deaths above the average (IFRC 1999, p.139). In general, the trend curve, influenced by a few but very deadly events, shows extreme and divergent deviations, which are not sufficient for drawing clear conclusions.

If differentiated by types of disaster, droughts, famines and earthquakes emerge as the deadliest catastrophic events during the 1970s and 1980s (see table 4; differences between tables 3 and 4 are probably due to aggregating differently). During the 1990s, these events seem to have killed fewer people, possibly because of improved disaster assistance or prevention. As to other types of disasters, no clear trends can be found regarding the number of dead; the number of dead because of floods remained more or less constant. The category of storms, however, is strongly influenced by a single extreme event (i.e. a cyclone in Bangladesh in 1991 leaving 139,000 dead).

Table 4: Average annual death toll* by type of disaster and per 5-year period, 1973-1997

	Earth-quake	Drought and Famine	Floods	Storms	Land Slides	Volcanic eruption	Other	Total
1973-1977	61,752	83,800	7,236	6,949	999	34	1,750	**162,520**
1978-1982	6,920	115	5,550	4,388	369	129	2,702	**20,174**
1983-1987	3,775	112,062	5,120	6,411	696	4,714	6,172	**138,951**
1988-1992	15,037	2,128	8,642	32,486	1,094	151	14,943	**74,481**
1993-1997	4,596	186	7,671	4,331	792	66	6,401	**24,043**
1973-1997	**18,416**	**39,658**	**6,844**	**10,913**	**790**	**1,019**	**6,394**	**84,034**

*included are all confirmed dead, missing and presumed dead.

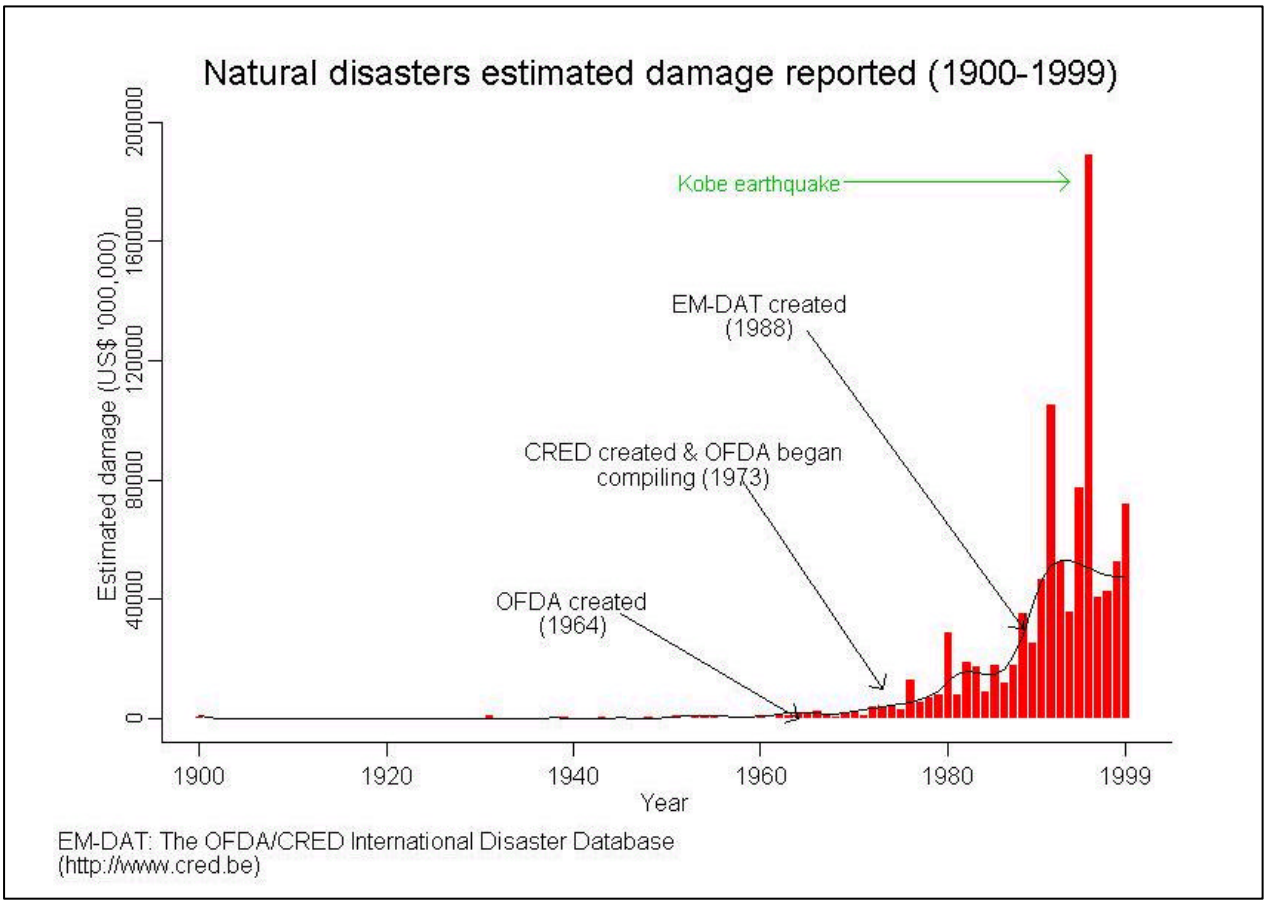
Source: International Federation of Red Cross and Red Crescent Societies, 1999: World Disasters Report 1999. Geneva, IFRC, p. 143.

Similar to the analysis of developments of the last century, population growth should be taken into account when analyzing the last three decades

4.3 Global Trends in Damages in Relation to Total Tangible Assets

As a first overview, figure 7 graphically illustrates the development of damages since the beginning of the 20th century. It shows a significant increase in damages, which is connected to an improvement in disaster assessment. The numbers shown are not adjusted for inflation.

Figure 7: Economic value of disaster damages in million US$, 1900-1999



In addition to the difficulties of ascertaining the economic value of disaster damages discussed above, another problem of interpretation emerges. The property damages experienced, rising in absolute terms and expressed in monetary units, may reflect a real growth of damages, a rising living standard with mounting property values or an inflation-induced increase. To take this into account, the Munich Re has calculated both the inflation-induced increase and the increase in property values owing to rising standards of living since the early 1970s. To roughly approach the changed standard of living, the Munich Re chose the gross domestic product (GDP). This proved to be a more realistic indicator than liabilities for damage incurred or "fixed reproducible tangible wealth," since the data are not available for all countries. The GDPs of Germany and the United States correlate relatively well with the mean sum insured of the homeowners´ insurance. Consequently, the Munich Re adjusted the increase in values to the difference of the GDPs between the year the disaster occurred and 1999 ("GDP-adjusted total damages"). The Munich Re concludes that regarding the increase of losses triggered by major natural events, inflation and a general accretion of value during the years 1970 to 1998 play an important role. But the insurance company further reasons that damages are clearly on the rise in real terms. According to the Munich Re, the GDP-adjusted economic damage amounted to US$ 315 billion in 1970-79, US$ 283 billion in 1980-1989 and US$ 636 billion in 1990-1999. The damage figures provide clear evidence of an increase in the 1990s compared to the 1980s.

According to the Munich Re (1998, p.19), the economic losses are distributed relatively evenly: storms, floods and earthquakes each make up 30% of the recorded losses; other hazards accounted for the remaining 10%. Storms lead the statistics of insured recorded losses (two-thirds of all recorded insured losses), "because there is maximum insurance density for this natural hazard all over the world." Earthquakes account for 20% and floods for 8% of the recorded insured losses.

During the observation period of 1970-1998, the Swiss Re records a total of 34 major disasters with damages reaching billions. Twenty-four of them occurred between 1989 and 1998 and 11 between 1970 and 1988 (inflation-adjusted, but not adjusted to tangible wealth). The year 1997 presents an exception in a "series of record-hitting years starting from 1989" in so far as El Nino led to decreased hurricane occurrence in the US. (Swiss Re, 1999, p.9)

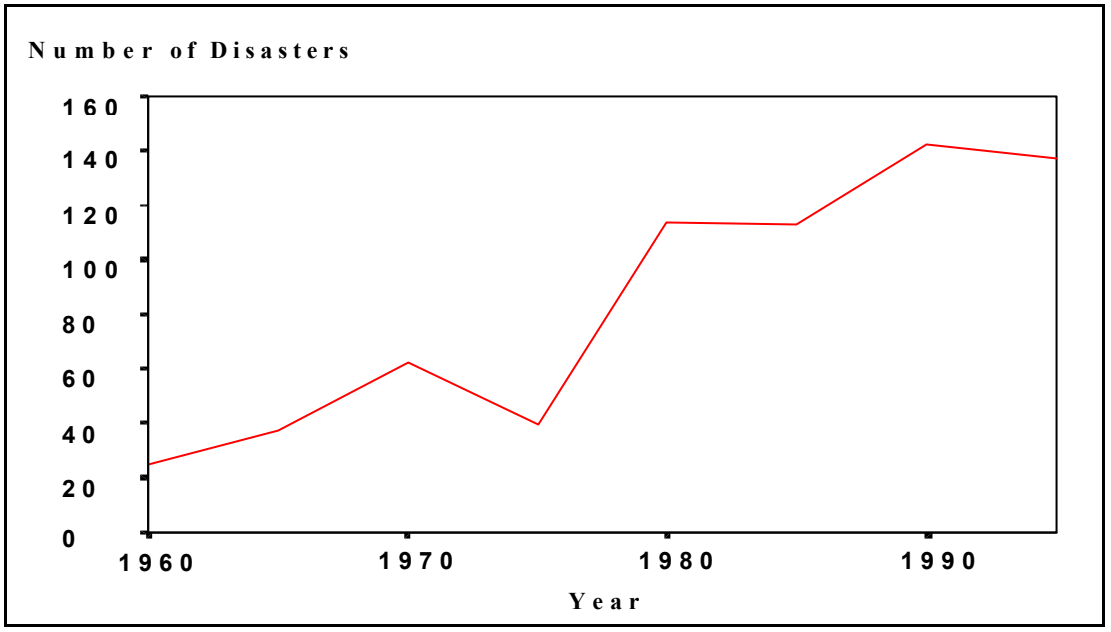
4.4 Industrial and Developing Countries: Are There Basic Differences in Vulnerability to Disasters?

Clausen and Dombrowsky (1987, p. 264) have already earlier pointed out that "most victims are not found in places where disasters are most frequent, but where people are the poorest." Although based on older statistics, this observation continues to hold true according to the recent World Development Report (World Bank 2000) where, for the first time, disasters are presented as impediments to development.

To explore possible differences in vulnerability to disasters between developing and developed nations, the following issues should be considered:

1. countries' numbers and densities of population differ; therefore, a correct examination must adjust for these differences;
2. the number of extreme events in developing countries can be very high as a result of geographical locations and corresponding climatic conditions;
3. different degrees of urbanization and population densities near coastal areas are important (Shah 1983);
4. in developing countries, the indirect or secondary losses are probably much higher than the direct losses; a comparison would show that losses are underestimated in developing countries.
5. differences in vulnerability to disasters also exist because of different prevention mechanisms. For example, earthquake-proof buildings are more prevalent in the cities of the industrialized than in developing countries

Figure 8: Number of disasters in 90 developing countries, 1960-1995*



* All countries are developing countries with more than 3 million inhabitants

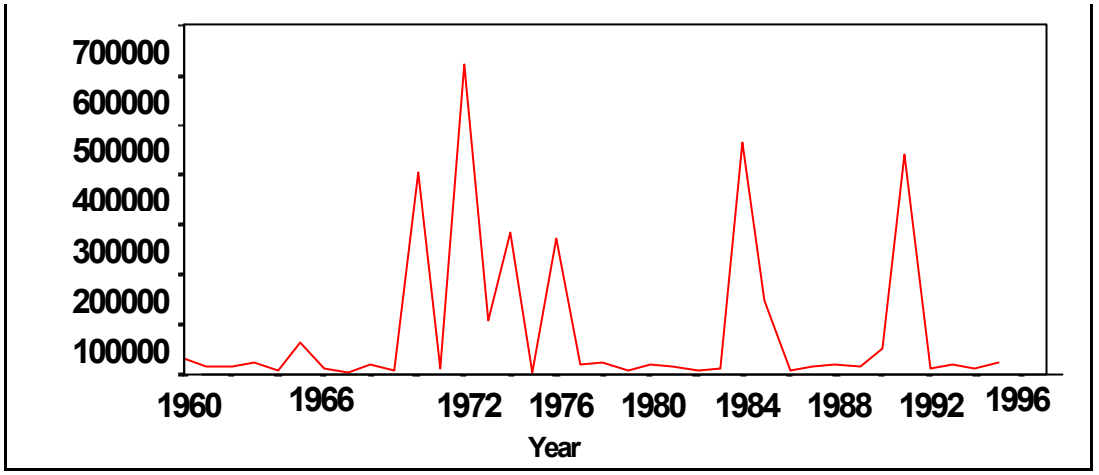
Source: author's calculation on the basis of data from CRED from 1995

Figure 8 shows an increase in the number of disasters. However, interpreting this data is difficult. It is not clear whether this increase is indeed a trend or is caused by improved recording of data in developing countries.

Figure 9 illustrates the death tolls in 90 developing countries between 1960 and 1995. Apparently, except for a high fluctuation rate, there is no pattern to be discerned. Single disasters dominate the picture. In some years, over 600,000 people were killed by disasters. According to the CRED data bank, the following disasters are the most significant to have occurred in developing countries during the last four decades (until 1995): Ethiopia (famine 1972: 600,000 dead); Bangladesh (cyclone 1970: 300,000 dead); Ethiopia (drought 1984: 300,000 dead); China (earthquake 1976: 242,000 dead); Ethiopia (drought 1974: 200,000 dead); Bangladesh (cyclone 1991: 139,000 dead); Ethiopia (drought 1973: 100,000 dead); Mozambique (drought 1985: 100,000 dead); Peru (earthquake 1970: 67,000 dead); Iran (earthquake 1990: 36,000 dead).[21]

[21] These figures provided by CRED partly differ from those of Munich Re presented earlier in chapter 4.2.

Figure 9: Number of deaths from disasters in 90 developing countries, 1960-1995*



* All countries are developing countries with more than three million inhabitants
Source: authors´ calculations on the basis of data from CRED from 1995

Notably, during this period all 40 disasters with the highest death tolls took place in developing countries, with the exception of an earthquake in Italy, which left 4,800 persons dead (Swiss Re, 1999, p. 38). This development may be caused by a growing number of natural hazards or by a lack of protection systems in developing countries. The most recent World Development Report published by the World Bank states that between 1990 and 1998 developing countries sustained 94% of all 568 of the more severe natural disasters worldwide and over 97 % of all fatalities (World Bank 2000, p. 170). Further, the report indicates that poverty and economic underdevelopment aggravate the negative effects of disasters. Developing countries are especially vulnerable as they have only limited possibilities to prevent and absorb hazardous events. It is estimated that people in low-income countries have a four-times higher chance of being killed by a disaster than people in high-income countries (IFRC 1993). Other publications also refer to this vulnerability. Although sharing a similar pattern of disasters annually, 2,900 people die on average per year in these events in Peru, while in Japan the number is only 63 (Anderson and Woodrow, 1989). Average costs per event as a share of the GDP is estimated to be about 20% higher in developing than in developed countries (Funaro-Curtis 1982; quoted in World Bank 2000, p. 171).

On the whole, only a few studies consider the impact of disasters on poverty. These show that the effects can be severe. In Ecuador, it is thought that El Nino increased the incidence of poverty by more than 10% (Vos et al., 1999; quoted in World Bank, 2000, p. 171).

4.5 Vulnerability to Disasters in a Historical Perspective: Two Case Studies

The trends presented above demonstrate the difficulties in interpreting the long-term development of disasters. In the following paragraphs, two historical case studies illustrating vulnerability to disasters are presented to exemplify the long-term development of prevention systems and vulnerability.

4.5.1 Reduced Vulnerability to Hunger Crises

India serves as an example of a country that has reduced its vulnerability to natural disasters, specifically famines, despite considerable population growth.[22] In reaction to Indian hunger crises, *famine codes* have been developed. After a long process, these codes finally have been established as institutional innovations. The public fight against hunger has a long tradition in India; this provides a background against which to consider the political actions of the 19th and 20th centuries. The resulting programs and projects after recurring famines led over time to a synthesis of experiences, which were incorporated into a legal framework. In 1880, these experiences were included in the recommendations of the Famine Commission, which prepared region-specific regulations (Famine Codes) to be applied by local administrations in the case of an imminent famine. When a famine has been determined, a pre-determined program is initiated and can be adjusted to the particular situation. The program does not run ad hoc, but has a legal base. The stages of the program include: first, the release of public stocks and the increased distribution of food to so-called "ration shops;" second, an intensification of public works programs (including investigating the impact of food aid on prices, etc., in test markets); third, the free distribution of food aid. In federal states such as Maharashtra, public works programs are legally guaranteed in times of crises (Dev, 1995). Two qualities of the Indian state played a decisive role in implementing the program. First, it has a well-organized administration with the ability to take action, and second, it has a functioning political system to implement the actions. The stable political conditions, including freedom of speech, etc., were decisive factors in sustaining the Famine Codes. The implementation of labor-intensive public works programs, which pay wages in money or in kind, as well as the free distribution of food to people who are unable to work are still used today (Drèze and Sen 1989; von Braun 1995). In the 1990s, it was discussed as a measure to be extended to the whole of India. The shaping of the public works programs is thereby adjusted to the extent and the characteristics of a crisis with respect to chronological sequence, regional concentration, technologies and choice of actions. In the framework of the public works programs, crises and the institutional reactions as part of the Famine Codes affect each other.

[22] Whether or not to include famines in the category of natural disasters is open to debate. In his list of major famines in the 20th century, Devereux (1999, p. 6) shows that only a small number of them are drought-induced; usually conflicts, failed government policies, etc., are also responsible.

Coping strategies to prevent hunger do not always lead to more positive results. Sometimes the reverse occurs. For example, in Sudan the existing laws and regulations to reduce hunger lost their effectiveness because of wars and socio-political upheavals during the 1980s and 1990s. From the 1920s until India's independence in 1956, the British administration built on its experiences there and introduced policies to avoid famines. The basic principles consisted of offering fast assistance to persons in need, including public works programs, and of freely distributing food to persons unable to work. Giving up this hunger emergency policy after 1956 resulted in a stronger dependence on informal institutions (family assistance) and traditional coping strategies (e.g., the Islamic system of zakat). However, the famines of the 1980s exposed the weaknesses of these systems (Teklu et al, 1991).

Similarly, at the time of the famine of 1984, Ethiopia benefited from relatively effective regulations and a principally effective organization called the Relief and Rehabilitation Commission (RRC). Unfortunately, political dirigisme weakened the power of the commission during the crisis, and the existing conflict and war situation further hindered the fight against hunger. This serves as another example of the impact of politics on vulnerability to disaster.

Crises of poverty also lead to the development of nongovernmental coping strategies with positive long-term effects. (Micro-) finance systems and cooperatives are significant examples. The famines of the 19th century in the German region of Westerwald, for example, led to local consumers´ cooperatives (called bread associations) and finally to the foundation of the Raiffeisen Cooperative.

Initiated by Friedrich Wilhelm Raiffeisen, charities were founded that later turned into self-help organizations and mutual loan societies. Other regions such as the Odenwald experienced similar developments. Today, the Grameen Bank in Bangladesh is a well-known example of a successfully established program that began at the local level and then developed into an institution that could offer better protection from existing crises. In case of floods, for example, the Grameen Bank permits savings bank depositors and borrowers to raise loans to tide them over in a time of emergency. So far, these compensations in difficult times have been very successful. The Grameen Bank was conceived as an instrument to fight structural poverty and especially to strengthen the position of the poor in the rural finance systems. Meanwhile, it has proved to be a reliable instrument to prevent transitory poverty crises on the household level (Zeller et al., 1997).

4.5.2 *The Long-Term Evolution of Vulnerability, Exemplified by the Peruvian Earthquake in 1970*

Oliver-Smith (1994, pp. 31-48) illustrates the long-term evolution of vulnerability with the example of the Peruvian earthquake in 1970. According to his analysis, the genesis of the severe earthquake that killed 70,000 persons lies in the Spanish colonization, which began 500 years ago. Originally, the indigenous population used five mechanisms to adjust to the multiple natural events in Peru (freezing temperatures, cold waves, avalanches, El Nino, earthquakes, floods occurring after snow melts, volcano eruptions). These mechanisms were: 1) risk aversion by using different ecological sites, 2) an emphasis on small towns as the prevailing form of settlement, 3) a construction method adapted to earthquake-prone areas, 4) taking precautions such as storing provisions for emergencies, and 5) handing down the experiences of disasters in the form of myths from generation to generation. The arrival of the Spanish changed the method of constructing houses to two-story buildings with overhanging roofs on narrow streets. Ignorant of local knowledge, the Spanish resettled the indigenous population in regions prone to disasters, such as floods. Also, within a few decades the storage buildings were given up because of compulsory levies imposed by the Spanish. In total, the changed mode of settlement and construction as well as the modified building materials resulted in increased vulnerability to hazardous events in the Callejón valley. In 1970, an earthquake-induced avalanche buried several larger villages. The earthquake also caused the collapse of the houses that were not built with the earthquake-proof method. About 10,000 people died in the departmental capital Huaráz alone. The Peruvian society's strong concentration on the nation's capital, Lima, caused additional difficulties, which greatly obstructed the coordination of assistance in the provinces.

This example demonstrates that there can be a considerable time lag between the evolution of vulnerability and its manifestation in a disaster. At the same time, it shows the difficulties in determining trends in vulnerability based on quantitative analyses exclusively referring to the present situation

5 Summarizing Conclusions

The following conclusions can be drawn from this study.

1. The term "vulnerability" to disasters is relevant for a world changing in technological and settlement structures. However, the term is vague, which complicates its analysis. If the interaction between natural events and social mechanisms of protection are included when considering vulnerability, trends could be affected by changes in either of these two factors. The interactions could have intensifying or conflicting effects.

2. The total sum of natural hazard events does not seem to have increased (Blaikie et al., 1994), but this is probably not true for all types of disasters. Independent of the still unanswered questions about natural or anthropogenic causes, the frequency and duration of some types of disasters (extreme weather conditions, e.g., storm tides in the Baltic Sea area, see Beckmann and Tetzlaff, 1998, cited in Plate et al., 1999) probably did increase.

3. To assess vulnerability, not only disaster events but also protection structures and coping mechanisms must be considered. These do not develop uniformly. Here, aggregated observations yield little helpful information. Vulnerability can be manifested on different levels of analysis, from the individual to the household to the region and state. As exemplified in two case studies, vulnerability must be assessed in dynamic contexts and not only as a condition.

4. The present disaster statistics provide only a limited basis for a comprehensive understanding. There are no sufficient and long-term comparative data, at least not for a disaggregated analysis. This unfortunate situation provides opportunities for playing with public perceptions and exaggerations on the one hand, and lack of policy action on the other hand. The data problem clearly hinders the understanding of vulnerability considerably.

5. Vulnerability differs according to the type of disaster. Some forms of disaster such as famines seem to be less serious today (measured by the number of dead) than at the beginning to the middle of the twentieth century. Apart from this, there are changes in regional occurrences.

6. In spite of the above mentioned limitations of more detailed analyses, the following trends emerge:

- on the whole, the number of registered disasters is rising, but the effect of improved data collection on this may play a role;
- people in developing countries suffer the most from disasters;
- a most relevant statistic, the number of disaster-related deaths and the probability of death from disasters have declined in the last two decades, which may be counter general perceptions in industrialized countries;
- the economic costs - according to existing statistics - are rising. This increase seems to exceed the general increase in economic wealth. Whether this also means an increase or decrease in vulnerability depends on the level of analysis and context of livelihood conditions (e.g., households, countries, types of disasters, etc.); no broad generalizations are possible based on existing data.
- some determinants of vulnerability (such as urbanization) indicate that it is reasonable to expect a future rise in the number of disasters and in the economic damage but probably not in the disaster related mortality.
- To reduce vulnerability, progress in technical, economic and social protection structures and institutions are necessary. While this is partly a function of economic development, it requires strategic investments in organizations, knowledge, and research to strengthen capabilities of protection against vulnerabilities.

7. Among the implications for research, the following are highlighted:

- Indications about how to reduce vulnerability should be derived from the analyses of strategies and best practices, that have proven successful in avoiding and mitigating disasters in different environments.
- Systematic and detailed regional and comparative studies are recommended. These need to draw on comparable data bases in order to identify tendencies in the causes of disaster related vulnerability. The resulting findings then could be integrated into vulnerability mapping and policy responses.
- Along with aspects of technical vulnerability, social, economic, and political factors should be examined.
- The recording of economic damages should be based on comparable, standardized registers. Here too, research efforts could make a valuable contribution in order to strengthen the information base for broadly defined risk-markets.

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