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Vulnerability x Hazard = Disaster?

An Overview of Different Vulnerability Approaches and Definitions

Martin Cassel-Gintz

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1 Introduction

1.1 Vulnerability in the NCCR North-South

The purpose of the present paper is to provide an overview of the development of the concept of vulnerability and related concepts for discussion in the NCCR North-South. It draws on various activities related to concepts of vulnerability during Phase 1 of the NCCR North-South, and attempts to provide ideas for a usable framework for Phase II.

Vulnerability is one of the overarching concepts used in the NCCR North-South. The fact that it is used by different researchers in different Individual Projects (IP), and therefore by different disciplines, already suggests that there is no single vulnerability concept but a multitude of different approaches and concepts dealing with vulnerability. This situation in the NCCR North-South reflects the overall fact that vulnerability is used in different ways by different disciplines.

The various activities in the NCCR North-South related to vulnerability concepts began with an overview discussion paper for the Scientific Forum of the NCCR North-South (Brutschin and Wiesmann 2002). As a result of this discussion a special session at the 2nd International Training Course (ITC 2003) of the NCCR North-South was organised. To gain an overview of the different vulnerability concepts used in the NCCR North-South and at the same time raise awareness about the multitude of different understandings of these concepts, the participants in the ITC 2003 were presented with several different definitions of vulnerability and related concepts, based on 27 important publications on the subject. The task for the ITC participants was to identify which definition suited the topic and the concept of their individual research, and secondly, what was suitable for an interdisciplinary and inter-culturally mixed group. The different definitions were provided without references, so as to avoid identification of important researchers in one's own discipline and focus on the actual content of the definition.

As a result of these activities, an interdisciplinary group of NCCR North-South researchers created a Transversal Topic Project with the aim of exchanging different ideas and developing an overall framework to provide common ground and connections to individual approaches. This group had several internal meetings integrating researchers from the South which cumulated in a workshop with international experts in the field, where very fruitful contributions were made and discussions held.

The present paper gives a summary of these developments related to vulnerability in the NCCR North-South, and tries to identify the shape of a possible vulnerability framework for Phase II of the programme.

1.2 Basic understandings of vulnerability

As mentioned above, the concept of vulnerability is currently widely used inside and outside the NCCR North-South by researchers from many different disciplines, who are eagerly discussing conceptual frameworks and analytical approaches.

One way to begin a discussion about a common understanding of the term is to go back to its roots. The origin of this word can be traced to the Latin vulnus, meaning "a wound," and vulnerare, "to wound." Specifically, the word vulnerable derives from the Late Latin vulnerabilis, the term used by the Romans to describe the state of a soldier lying wounded on the battlefield, i.e. already injured and therefore at risk from further attack. In this sense, vulnerability indicates a state that predisposes people or places to risk (Brutschin and Wiesmann 2002).

Over the last decades, the basic notion of vulnerability has been transformed into various concepts and approaches in many different scientific fields, including:

- Natural hazards
- Impact Assessment
- Food Security
- Entitlement
- Psychology
- Health
- Global Climate Change
- Global Change
- Sustainability Science

Vulnerability, in the context of sustainable development and global change, is far more than a purely human or social problem. It is too often equated with poverty; yet vulnerability is a broader concept in a multitude of different scientific traditions. It is also often coupled with notions of "risk", "hazard", "resilience" and "coping". All these key concepts have no common definitions in their various fields of application. They also still lack a common and scientifically consistent conceptual framework. Therefore, the concepts can mean different things to different people, depending on their scientific, disciplinary and cultural backgrounds. They are normative concepts, representing the values and goals of those who define them, and they are embedded in larger social, economic and political contexts. Their meanings must be negotiated, not only in inter-disciplinary but also in trans-disciplinary debates involving scientists, the general public, politicians and practitioners.

1.3 Definitions of vulnerability and related concepts

The definition of vulnerability and statements about it and its related concepts (section 1.3.1) were taken from a list of 27 important publications[1] about vulnerability, based on an extended list of publications used for an exercise at the ITC in 2003. Participants had the task of identifying a definition that best fit their research setup and goals, and also of identifying missing issues. This task was first to be performed individually and later, in a second step, in an interdisciplinary and inter-cultural group. The goals of this session were to gain knowledge about the different strands in the vulnerability discussion and its development, to critically reflect on concepts of vulnerability in one's own problem setting, and to contribute to discussion within the NCCR North-South on the concept of vulnerability and its application in development-oriented syndrome mitigation research. In the first step the various definitions were provided without any reference to focusing the attention of participants on the content of the definitions, and also in an attempt to avoid an "automatic" decision by important representatives of one's own discipline or background. The references were eventually provided during the closing discussion of the session.

1.3.1 Definitions of vulnerability

Vulnerability is not the same as poverty. It does not means lack or want, but defencelessness, insecurity, and exposure to risk, shock and stress. Here, vulnerability refers to exposure to contingencies and stress, and difficulty in coping with them. Vulnerability thus has two sides: an external side of risk, shock, and stress, to which an individual or household is subject; and an internal side of defencelessness, meaning a lack of means to cope without damaging loss. Loss can take many forms – becoming or being physically weaker, economically impoverished, socially dependent, humiliated or psychologically harmed. (Chambers 1989)

Vulnerability: There are three basic co-ordinates of vulnerability: the risk of exposure to crises, stress and shock; the risk of inadequate capacities to cope with stress, crises and shock; and the risk of severe consequences from, and the attendant risks of slow or limited poverty (resiliency) from, crises, risk and shock. From this vantage point, the most vulnerable individuals, groups, classes and regions are those most exposed to perturbations, those who have the most limited coping capability, who suffer the most from crisis impact and who are endowed with the most circumscribed capacity for recovery. Vulnerability can be, in other words, defined in terms of exposure, capacity and potentiality. (Watts and Bohle 1993)

Vulnerability: The urban study defines vulnerability as insecurity and sensitivity in the well-being of individuals, households and communities in the face of a changing environment and implicit in this, their responsiveness and resilience to risks that they face during such negative changes. (Moser 1998)

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[1] Again, the term "important" is biased by the background of the author.

Vulnerability is an interactive process between the social contexts in which a young person lives and a set of underlying factors that, when present, place the young person "at risk" for negative outcomes (e.g. school failure, unanticipated pregnancy, injury). … Counter balancing such vulnerabilities are resources (…), assets (…), protective factors (…) and resilience (…) that likewise arise from the individual, familial, and social environments in which a young person lives. As a conceptual model, vulnerability and resilience has captured the imagination of researchers and program planners over the past decade. As an interactive process between context and harm-inducing/harm minimizing factors, this research questions why some who are reared under extremely adverse circumstances appear to live healthy and productive lives, while others faced with what appears to be minimal challenges never appear to overcome the adversities experienced in early life. (Blum et al. 2002)

Vulnerability is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity. (IPCC Working Group II 2001)

Vulnerability is the degree to which a system is susceptible to injury, damage, or harm (one part the problematic or detrimental part of sensitivity). (Smit et al. 1999.)

Vulnerability has two principal components: an external source of stress or shock, and an internal component addressing the social relationships that shape an individual's or group's exposure and capacity to respond to and cope with the damaging consequences of external stress. (Sanchez-Rodriguez 2002)

Vulnerability represents the interface between exposure to the physical threats to human well-being and the capacity of people and communities to cope with such threats. Threats may arise from a combination of social and physical processes. Human vulnerability thus integrates many environmental concerns. Since everyone is vulnerable to environmental threats, in some way, the issue cuts across rich and poor, urban and rural, North and South, and may undermine the entire sustainable development process in developing countries. (UNEP 2002)

Vulnerability to global environmental change has been conceptualized as the risk of adverse outcomes to receptors or exposure units (human groups, ecosystems, and communities) in the face of relevant changes in climate, other environmental variables, and social conditions. (Clark et al. 2000)

Vulnerability is emerging as a multidimensional concept involving at least exposure – the degree to which a human group or ecosystem comes into contact with particular stresses; sensitivity – the degree to which an exposure unit is affected by exposure to any set of stresses; and resilience – the ability of the exposure unit to resist or recover from the damage associated with the convergence of multiple stresses. The concepts of preparedness, coping reserve, and adaptive capacity are clearly important – but as yet under-theorized – underlying determinants of the sensitivity and resilience of an exposure unit. Vulnerability can increase through cumulative events or when multiple

stresses weaken the ability of a human group or ecosystem to buffer itself against future adverse events, often through a reduction in coping resources and adaptive capacities. (Clark et al. 2000)

Vulnerability is the degree to which an exposure unit and its attendant human-environment system are harmed due to exposure to a perturbation or stress. (Turner et al. 2002)

Vulnerability is a quality that resides within the condition or make-up of the system in question (or a designated exposure unit in the system)

≠ the hazard (perturbation or stressor)

≠ solely the risk of exposure to the hazard. (Turner et al. 2002)

Vulnerability integrates across the elements of exposure and processes of risk, and across scales. (Downing and Lüdeke 2002)

Vulnerability in the sense of assessment methods may be defined as a set of relationships between exposure to an external threat (e.g., extended drought) and its consequences (e.g., human mortality due to starvation), or proxies may be combined or aggregated to form indices of relative vulnerability. In this sense, vulnerability assessment is a way of quantifying specific analyses. (Downing and Lüdeke 2002)

Vulnerability is far more than a purely human or social problem. And it is too often equated with poverty, but vulnerability is a broader concept. Since vulnerability is a multi-scale process, it is important to determine how global change cascades down across lower scales, and through what filters (or amplifiers and attenuators). (Kasperson and Kasperson 2001)

Vulnerability is registered not by exposure to hazards (perturbations and stresses) alone but also resides in the sensitivity and resilience of the system experiencing such hazards. This recognition requires revisions and enlargements in the basic design of vulnerability assessments, including the capacity to treat coupled human–environment systems and those linkages within and outside of the systems that affect their vulnerability. The vulnerability and sustainability coupled human–environment systems which are predicated on synergy between the human and biophysical subsystems are affected by processes operating at different spatiotemporal (as well as functional) scales. (Turner et al. 2003)

Vulnerability is the degree to which a system, subsystem, or system component is likely to experience harm due to exposure to a hazard, either a perturbation or stress/stressor. (White 1974)

Vulnerability is typically described to be a function of three overlapping characteristics: exposure, sensitivity, and adaptive capacity. (Polsky et al. 2003)

Vulnerability: Global change vulnerability is the likelihood that a specific coupled human-environment system may experience harm from exposure to stresses associated with alterations of societies and the biosphere, accounting for the process of adaptation. The term coupled human-environment system is used to highlight the fact that human

and environmental systems are not separable entities but part of an integrated whole. Global change vulnerability assessments include not only the analysis of vulnerability but also the identification of specific options for stakeholders to reduce that vulnerability. The general objective of global change vulnerability assessments is to inform the decision-making of specific stakeholders about options for adapting to the effects of global change. (Polsky et al. 2003)

Vulnerability to disasters is a function of human action and behaviour. It describes the degree to which a socio-economic system or physical assets are either susceptible or resilient to the impact of natural hazards. It is determined by a combination of several factors, including awareness of hazards, the condition of human settlements and infrastructure, public policy and administration, the wealth of a given society, and organized abilities in all fields of disaster and risk management.

The specific dimensions of social, economic and political vulnerability are also related to inequalities, and often related to gender relations, economic patterns, and ethnic or racial divisions. Vulnerability is also largely dependent on development practices that do not take into account the susceptibility to natural hazards. (UNISDR 2002)

Vulnerability is an aggregate measure of human welfare that integrates environmental, social, economic and political exposure to a range of harmful perturbations. (Bohle, Downing and Watts 1994)

Table 1: Vulnerability

Steps	Risk Approach	Vulnerability Approach
1.	Absolute Risk	Exposure
2.	Relative Risk	Capacity
3.	Attributable Risks	Potential
4.	Costing of Intervention	Variability (intra- and inter households)
5.	Define and choose an intervention	Achieve a specific, adapted and acceptable transformation

(Obrist and Tanner 2002)

Vulnerability is the degree to which an exposure unit is susceptible to harm due to exposure to a perturbation or stress, and the ability (or lack thereof) of the exposure unit to cope, recover, or fundamentally adapt (become a new system or become extinct). (Research and Assessment Systems for Sustainability Program 2001)

Vulnerability is the likelihood of injury, death, loss, disruption of livelihood, or other harm in an extreme event, and/or unusual difficulties in recovering from such effects. (Wisner 2002)

Vulnerability is a set of conditions and processes resulting from physical, social, economic, and environmental factors, which increase the susceptibility of a community to the impact of hazards. (UNISDR 2004)

1.3.2 Definitions of related concepts

Acceptable risk: The level of loss a society or community considers acceptable given existing social, economic, political, cultural, technical and environmental conditions. In engineering terms, acceptable risk is also used to describe structural and non-structural measures undertaken to reduce possible damage at a level which does not harm people and property, according to codes or "accepted practice" based, among other issues, on a known probability of hazard. (UNISDR 2004)

Adaptability: The ability, competence, or capacity of a system to adapt to (to alter to better suit) climatic stimuli (essentially synonymous with adaptive capacity). (Smit et al. 1999).

Adaptation: A system response to perturbation or stress that is sufficiently fundamental to alter the system itself, usually shifting the system to a new state. Adaptations are commonly but not necessarily long-term in their development and implications. Contrast with "adjustment" below. Adaptation and adjustment are commonly fused in the literature and do not have standard definitions. (Research and Assessment Systems for Sustainability Program 2001)

Adaptive capacity is the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damage, to take advantage of opportunities, or to cope with the consequences. (IPCC Working Group II 2001)

Adaptive capacity is the potential or capability of a system to adapt to (to alter to better suit) climatic stimuli or their effects or impacts. (Smit et al. 1999)

Adaptive capacity relates to increased options for re-organisation following change. Systems with high adaptive capacity are more able to maintain resilience and avoid significant disruption of critical functions after a disturbance. (Quinlan 2003)

Adjustment: A system response to exposures that does not fundamentally alter the system itself. Adjustments are commonly but not necessarily short-term and involve relatively minor system modifications. (Research and Assessment Systems for Sustainability Program 2001)

Biological hazard: Processes of organic origin or those conveyed by biological vectors, including exposure to pathogenic micro-organisms, toxins and bioactive substances, which may cause loss of life or injury, property damage, social and economic disruption, or environmental degradation. Examples of biological hazards include outbreaks of epidemic diseases, plant or animal contagion, insect plagues and extensive infestations. (UNISDR 2004)

Capacities: Positive factors that increase the ability of people and the society they live in to cope effectively with hazards and can reduce their susceptibility are often designated as "capacities." (UNISDR 2004)

Capacity building: Efforts aimed at developing human skills within a community or organization needed to reduce the level of risk. In extended understanding, capacity

building also includes development of institutional, financial, political and other resources, such as technology at different levels and sectors of the society. (UNISDR 2004)

Capacity: A combination of all the strengths and resources available within a community, society or organization that can reduce the level of risk, or the effects of a disaster. Capacity may include physical, institutional, social or economic means as well as skilled personal or collective attributes such as leadership and management. Capacity may also be described as capability. (UNISDR 2004)

Coping Ability: Degree to which a system can successfully grapple with a stimulus (similar to adaptability, but includes more than adaptive means of "grappling"). (Smit et al. 1999)

Coping capacity: Social units have different coping capacities, which enable them to respond to registered harm as well as to avert the potential harm of a hazard. In one sense, entitlement and endowment link to these capacities, and either concept can be expanded to include a large array of social institutions. (Turner et al. 2003)

Coping capacity: The manner in which people or organizations use existing resources and abilities to face adverse consequences that could lead to a disaster. In general, this involves managing resources, both in normal times, as well as during adverse conditions. The strengthening of coping capacities usually builds resilience to withstand the effects of natural and other hazards. (UNISDR 2004)

Coping/response capacity: The potential of a system to reduce impacts from stresses or perturbations, not necessarily the actual coping actions taken in response to a stress. Actual coping can be markedly less than the capacity for coping, depending on system goals and priorities, institutional and informational obstacles, and timely access to coping resources, all of which vary across the human and ecological components of the system. (Research and Assessment Systems for Sustainability Program 2001)

Coping/response: The wide-ranging set of mechanisms used or actions taken (by ecosystems or people) in reaction to threats or impacts. Coping/response includes preemptive measures, as well as more reactive adjustments and adaptations. (Research and Assessment Systems for Sustainability Program 2001)

Counter measures: All measures taken to counter and reduce disaster risk. This most commonly refers to engineering (structural) measures but can also include non-structural measures and tools designed and employed to avoid or limit the adverse impact of natural hazards and related environmental and technological disasters. (UNISDR 2004)

Coupled human-environment system: A system composed of interacting and partially integrated social and ecological elements and processes, usually coalescing in a particular place. (Research and Assessment Systems for Sustainability Program 2001)

Damage potential is the sum of all possible forms of damage that may be caused by an activity or event. (WBGU 2000)

Disaster: A serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources. A disaster is a function of the risk process. It results from the combination of hazards, conditions of vulnerability and insufficient capacity or measures to reduce the potential negative consequences of risk. (UNISDR 2004)

Disaster: A disaster is defined in this context as a serious disruption of the functioning of society, causing widespread human, material or environmental losses which exceed the ability of the affected society to cope using its own resources. While this is also a broad definition it shows clearly that a disaster coincides with the exposure of vulnerability. (Bogardi 2004)

Disaster risk management: The systematic process of using administrative decisions, organization, operational skills and abilities to implement policies, strategies and coping capacities of the society and communities to lessen the impacts of natural hazards and related environmental and technological disasters. This comprises all forms of activities, including structural and non-structural measures to avoid (prevention) or to limit (mitigation and preparedness) adverse effects of hazards. (UNISDR 2004)

Disaster risk reduction (disaster reduction): The conceptual framework of elements considered with the possibilities to minimize vulnerabilities and disaster risks throughout a society, to avoid (prevention) or to limit (mitigation and preparedness) the adverse impacts of hazards, within the broad context of sustainable development. The disaster risk reduction framework is composed of the following fields of action, as described in ISDR's publication 2002 "Living with Risk: a global review of disaster reduction initiatives",

- Risk awareness and assessment including hazard analysis and vulnerability/ capacity analysis;
- Knowledge development including education, training, research and information;
- Public commitment and institutional frameworks, including organisational, policy, legislation and community action;
- Application of measures including environmental management, land-use and urban planning, protection of critical facilities, application of science and technology, partnership and networking, and financial instruments;
- Early warning systems including forecasting, dissemination of warnings, preparedness measures and reaction capacities. (UNISDR 2002)

Early warning: The provision of timely and effective information, through identified institutions, that allow individuals exposed to a hazard, to take action to avoid or reduce their risk and prepare for effective response. Early warning systems include three primary elements (i) forecasting of impending events, (ii) processing and dissemination of warnings to political authorities and population, and (iii) undertaking appropriate and timely actions. (UNISDR 2004)

Emergency management: The organization and management of resources and responsibilities for dealing with all aspects of emergencies, in particularly preparedness, response and rehabilitation. Emergency management involves plans, structures and arrangements established to engage the normal endeavours of government, voluntary and private agencies in a comprehensive and coordinated way to respond to the whole spectrum of emergency needs. This is also known as disaster management. (UNISDR 2004)

Endowments: The assets, resources, and qualities, both human and ecological, that determine system capacities for and constraints on responding to stresses and perturbations. These qualities for ecosystems include soil characteristics, species diversity, landscape connectivity, and nutrient cycling, among others; for humans, they include rights, resources (land, skills), information, opportunities, and so forth. (Research and Assessment Systems for Sustainability Program 2001)

Entitlements are determined by the units' endowments, especially what they have to sell, their ability to sell, and the price received; the cost of food relative to endowments; and access to markets and resources. Entitlement helps to explain why certain social units are differentially at risk. (Turner et al. 2003)

Entitlements: The totality of rights and arrangements (both formal and informal) an individual or group in society can draw upon to establish command over sets of resources and commodities. Entitlements result from endowments, and reside at critical points in the chain of creation or avoidance of social vulnerabilities. (Research and Assessment Systems for Sustainability Program 2001)

Environmental degradation: The reduction of the capacity of the environment to meet social objectives and needs. Potential effects are varied and may contribute to an increase in vulnerability and the frequency and intensity of natural hazards. Some examples: land degradation, deforestation, desertification, wildland fires, loss of biodiversity, land, water and air pollution, climate change, sea level rise, ozone depletion. (UNISDR 2004)

Environmental impact assessment (EIA): Study undertaken in order to assess the effect on a specified environment of the introduction of any new factor, which may upset the ecological balance. EIA is a policy-making tool that serves to provide evidence and analysis of environmental impacts of activities from conception to decision-making. It is utilised extensively in national programming and for international development assistance projects. An EIA must include a detailed risk assessment and provide alternative solutions. (UNISDR 2004)

Exposure unit: Any system or part of a system that comes into contact with a perturbation or stress. In practice these units include individuals, groups, economic sectors, places, and various parts of ecosystems. (Research and Assessment Systems for Sustainability Program 2001)

Exposure: The contact between a system, or system component, and a perturbation or stress. Exposure is a function of both the magnitude and scope of the perturbation, and of the system with which it comes into contact (e.g., its location). (Research and Assessment Systems for Sustainability Program 2001)

Flexibility: Degree to which a system is pliable or compliant (similar to adaptability, but more absolute than relative). (Smit et al. 1999)

Geological hazard: Natural earth processes or phenomena, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. Geological hazards include 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, and debris and mud flows. Geological hazards can be single, sequential or combined in their origin and effects. (UNISDR 2004)

Hazard is the circumstance of an objective threat posed by a future damaging event that will occur under certain conditions. In contrast, a risk is a mental construct by which to characterize hazards more precisely. Risk assessments must always remain approximations of the objective hazard, as the latter can only be known with certainty after the damage has occurred. (WBGU 2000)

Hazard is the threat of a stress or perturbation faced by a system. (Research and Assessment Systems for Sustainability Program 2001)

Hazard: A potentially damaging physical event, phenomenon and/or human activity, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. Hazards can include latent conditions that may represent future threats and can have different origins: natural (geological, hydrometeorological and biological) and/or induced by human processes (environmental degradation and technological hazards). Hazards can be single, sequential or combined in their origin and effects. Each hazard is characterised by its location, intensity, frequency and probability. (UNISDR 2004)

Hazard analysis: Identification, studies and monitoring of any hazard to determine its potential, origin, characteristics and behaviour. (UNISDR 2004)

Human security fruitfully supplements the expansionist perspective of human development by directly paying attention to what are sometimes called “downside risks.” The insecurities that threaten human survival or the safety of daily life, or imperil the natural dignity of men and women, or expose human beings to the uncertainty of disease and pestilence, or subject vulnerable people to abrupt penury related to economic downturns demand that special attention be paid to the dangers of sudden deprivation. Human security demands protection from these dangers and the empowerment of people so that they can cope with and when possible overcome these hazards. (Commission on Human Security 2003)

Human security means safety for people from both violent and non-violent threats. It is a condition or state of being characterized by freedom from pervasive threats to people’s rights, their safety, or even their lives. From a foreign policy perspective, human security is perhaps best understood as a shift in perspective or orientation. It is an alternative way of seeing the world, taking people as its point of reference, rather than focusing exclusively on the security of territory or governments. Like other security concepts – national security, economic security, food security – it is about protection.

Human security entails taking preventive measures to reduce vulnerability and minimize risk, and taking remedial action where prevention fails. (Govt. of Canada 1999)

Hydro-meteorological hazards: Natural processes or phenomena of atmospheric, hydrological or oceanographic nature, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. Examples of hydro-meteorological hazards are: floods, debris and mud floods; tropical cyclones, storm surges, thunder/hailstorms, rain and wind storms, blizzards and other severe storms; drought, desertification, wildland fires, temperature extremes, sand or dust storms; permafrost and snow or ice avalanches. Hydro-meteorological hazards can be single, sequential or combined in their origin and effects. (UNISDR 2004)

Impact: The consequence(s) of exposure to a perturbation or stress on a system. System consequences can refer either to the risk of impact or the actual impact experienced. (Research and Assessment Systems for Sustainability Program 2001)

Impact Potential: Degree to which a system is sensitive or susceptible to climate stimuli (essentially synonymous with sensitivity). (Smit et al. 1999)

Mitigation: A type of coping mechanism utilized or action taken to reduce exposure or sensitivity, or to reduce the harm resulting from such exposure. Mitigation is often used to mean an anticipatory action. Alternatively, mitigation can be used to mean a coping strategy or mechanism (e.g., insurance systems) used after immediate harm or impact has occurred, designed to ameliorate longer-term consequences. (Research and Assessment Systems for Sustainability Program 2001)

Mitigation: Structural and non-structural measures undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards. (UNISDR 2004)

Natural hazards: Natural processes or phenomena occurring in the biosphere that may constitute a damaging event. Natural hazards can be classified by origin, namely: geological, hydro-meteorological or biological. (UNISDR 2004)

Persistency expresses the temporal scope of the damage or of the damage potential. The persistency of damage is an important criterion of intergenerational equity. (WBGU 2000)

Perturbation: A disturbance to a system resulting from a sudden shock with a magnitude outside the normal range of variability. Perturbations may arise from human driving forces, ecological (natural) events, or combinations of the two. Furthermore, perturbations may arise from within or outside of the exposure unit. (UNISDR 2004)

Pre-emptive measure: A type of coping mechanism utilized or action taken (by ecosystems or people) to reduce exposure or sensitivity to a stress. Pre-emptive measures in human systems are anticipatory or preparedness actions. (UNISDR 2004)

Preparedness: Activities and measures taken in advance to ensure effective response to the impact of hazards, including the issuance of timely and effective early warnings

and the temporary removal of people and property from a threatened location. (Research and Assessment Systems for Sustainability Program 2001)

Prevention: Activities to provide outright avoidance of the adverse impact of hazards and means to minimize related environmental, technological and biological disasters. Depending on social and technical feasibility and cost/benefit considerations, investing in preventive measures is justified in areas frequently affected by disasters. In the context of public awareness and education related to disaster risk reduction,n changing attitudes and behaviour contribute to promoting a "culture of prevention." (Research and Assessment Systems for Sustainability Program 2001)

Probability of occurrence is one of the two prime categories of risk, the other being extent of damage. It denotes the probability of occurrence of an event that will lead to damage. (WBGU 2000)

Public awareness: The processes of informing the general population, increasing levels of consciousness about risks and how people can act to reduce their exposure to hazards. This is particularly important for public officials in fulfilling their responsibilities to save lives and property in the event of a disaster. Public awareness activities support changes in behaviour leading towards a culture of prevention. This involves public information, dissemination, education, radio or television broadcasts and the use of printed media, as well as the establishment of information centres and networks. (Research and Assessment Systems for Sustainability Program 2001)

Public information: Information, facts and knowledge provided or learned as a result of research or study, available to be disseminated to the public. (Research and Assessment Systems for Sustainability Program 2001)

Recovery: Decisions and actions taken after a disaster with a view to restoring the living conditions of the stricken community, while encouraging and facilitating necessary adjustments to reduce disaster risk. Recovery (rehabilitation and reconstruction) is an opportunity to develop and apply disaster risk reduction measures. (Research and Assessment Systems for Sustainability Program 2001)

Relief / response: The provision of assistance or intervention during or immediately after a disaster to meet the life preservation and basic subsistence needs of those people affected. It can be of an immediate, short-term, or protracted duration. (Research and Assessment Systems for Sustainability Program 2001)

Resilience is the capability of a system to return after deflection or perturbation to a stable overall or local state of equilibrium (also termed elasticity). (WBGU 2000)

Resilience is the degree to which a system rebounds, recoups, or recovers from a stimulus. (Smit et al. 1999)

Resilience is the ability to persist and the ability to adapt. (Adger 2003)

Resilience: The resilience of social-ecological systems has three defining characteristics: i) the amount of change the system can undergo and still retain essentially the same structure, function, identity, and feedbacks on function and structure, ii) the de-

gree to which the system is capable of self-organisation, and iii) the degree to which the system expresses capacity for learning and adaptation. (Quinlan 2003)

Resilience is how systems respond [adjustments and adaptability]. (Turner et al. 2002)

Resilience enters vulnerability analysis from ecology. It characterizes a system's ability to bounce back to a reference state after a disturbance and the capacity of a system to maintain certain structures and functions despite disturbance. (Turner et al. 2003)

Resilience: The ability of a system to absorb perturbations or stresses without changes in its fundamental structure and function that would drive the system into a different state (or extinction). (Research and Assessment Systems for Sustainability Program 2001)

Resilience / resilient: The capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organizing itself to increase its capacity for learning from past disasters for better future protection and improve prevention measures. (UNISDR 2004)

Resistance is the degree to which a system opposes or prevents the effect of a stimulus. (Smit et al. 1999)

Responsiveness is the degree to which a system reacts to stimuli (broader than coping ability and adaptability because responses need not be "successful"). (Smit et al. 1999)

Risk refers, in a technical perspective, primarily to two variables – the probability of occurrence of a specific instance of damage, and the extent of that damage. The social science perspective focuses on the aspects of societal and psychological risk. (WBGU 2000)

Risk is the conditional probability of harm attendant on exposure to a perturbation or stress. (Research and Assessment Systems for Sustainability Program 2001)

Risk: The probability of harmful consequences, or expected losses (deaths, injuries, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human-induced hazards and vulnerable conditions. Conventionally risk is expressed by the notation Risk = Hazards x Vulnerability. Beyond expressing a possibility of physical harm, it is crucial to appreciate that risks are always created or exist within social systems. It is important to consider the social contexts in which risks occur, and that people therefore do not necessarily share the same perceptions of risk and their underlying causes. (UNISDR 2004)

Risk analysis is based on measures and aims at establishing the absolute risks (the risk that an exposed or unexposed group faces), relative risks (the ration of the absolute risks that illustrates the magnitude of the difference) and attributable risks (the risk associated with one specific factor / situation of exposure). (Obrist and Tanner 2002)

Risk assessment/analysis: A process to determine the nature and extent of risk by analysing potential hazards and evaluating existing conditions of vulnerability that

could pose a potential threat or harm to people, property, livelihoods and the environment on which they depend. The process of conducting a risk assessment is based on a review of both the technical features of hazards such as their location, intensity, frequency and probability; and also analysis of the physical, social, economic and environmental dimensions of vulnerability, while taking particular account of the coping capabilities pertinent to the risk scenarios. (UNISDR 2004)

Risk vulnerability is an attribute of regions or of individual groups in society, referring to whether they are more or less vulnerable than others to a certain risk aggregate in terms of probability or magnitude of damage. (WBGU 2000)

Robustness/Strength = degree to which a system is not given to influence (Smit et al. 1999)

Sensitivity is the degree to which a system is affected, either adversely or beneficially, by climate-related stimuli. Climate-related stimuli encompass all the elements of climate change, including mean climate characteristics, climate variability, and the frequency and magnitude of extremes. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea-level rise). (IPCC Working Group II 2001)

Sensitivity is the degree to which a system is affected by or responsive to climate stimuli (note that sensitivity includes responsiveness to both problematic and beneficial stimuli). (Smit et al. 1999)

Sensitivity is how exposure is registered. (Turner et al. 2002)

Sensitivity is the extent to which a system or its components are likely to experience harm due to an exposure to perturbations or stress. (Research and Assessment Systems for Sustainability Program 2001)

Stability is the degree to which a system is not easily moved or modified. (Smit et al. 1999)

Stress is the cumulating pressure on a system resulting from processes within the normal range of variability, but which over time may result in disturbances causing the system to adjust, to adapt, or to be harmed. (Research and Assessment Systems for Sustainability Program 2001)

Stressor is an agent and process – human or ecological (and arising either internally or externally to the system) – that creates stresses or perturbations on an exposed system. (Research and Assessment Systems for Sustainability Program 2001)

Structural measures: Engineering measures and construction of hazard-resistant and/or protective structures and infrastructure UNISDR 2004)

Susceptibility is the degree to which a system is open, liable, or sensitive to climate stimuli (similar to sensitivity, with some connotations toward damage). (Smit et al. 1999)

Sustainable development: Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains

within it two key concepts: the concept of "needs", in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and the future needs. (Brundtland Commission, 1987). Sustainable development is based on socio-cultural development, political stability and decorum, economic growth and ecosystem protection, which all relate to disaster risk reduction. (UNISDR 2004)

Technological hazards: Danger originating from technological or industrial accidents, dangerous procedures, infrastructure failures or certain human activities, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. Some examples: industrial pollution, nuclear activities and radioactivity, toxic wastes, dam failures; transport, industrial or technological accidents (explosions, fires, spills). (UNISDR 2004)

1.3.3 Results of the 2003 ITC exercise

The feedback from the participants showed that the session enhanced the understanding of vulnerability and its links to different related concepts (risk, security, resilience, sustainability, etc.). It helped to identify a first common understanding of vulnerability for the NCCR North-South, and to point towards some common elements which could be identified as important for most of the vulnerability-related projects in the NCCR North-South.

The discussion indicated that it seems to be essential to treat both the external side (involving exposure to risks & shocks) and the internal side (defencelessness and insecurity, the capacity to anticipate, cope with, resist, and recover from impacts of a hazard) of vulnerability, following the notions of Chambers (1989). Vulnerability was identified as a multi-layered and multi-dimensional social space defined by the political, economic, and institutional capabilities of people in specific places at specific times. Since all actions and events concerning vulnerability are influenced by the cascading effects of Global Change[2] (GC), vulnerability and its related concepts similarly have to be defined in a GC context.

> **GC vulnerability** can be defined as the likelihood that a specific coupled human-environment system may experience harm from exposure to stresses associated with alterations in societies and the ecosphere, accounting for the process of adaptation.

Based on a review of important research developments in the field of vulnerability, the specific options and potentials for an incorporation of the syndrome mitigation concept of the NCCR North-South (Cassel-Gintz 2003) into an overall, systemic, multi-scale, GC vulnerability framework will be demonstrated in what follows.

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[2] GC encompasses more than purely global warming. It must be understood as environmental, social and cultural processes of change on different spatial and temporal scales.

2 The Development of a Global Change Vulnerability Approach

2.1 Global change risk

The development of the different vulnerability approaches was stimulated by research about risk. Risk can be defined in several ways but is broadly understood as a combination of the likelihood of an outcome or event and some quantitative measure of the consequences of that outcome or event (Manning et al. 2004). Depending on the discipline and research school, the relation between risk and vulnerability ranges from 'vulnerability as one aspect of risk' (Natural Hazards), to "vulnerability includes different aspects of risk" (Food aid and Famine), "risk is closely tied to vulnerability" (Sustainability Science), "risk and vulnerability complement each other" (Health), and "risk behaviour is a source of vulnerability" (Psychology). For the aspects of Global Change Risk, the following definition of UNISDR will be used here:

> **Risk:** The probability of harmful consequences or expected losses (deaths, injuries, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human-induced hazards and vulnerable conditions. Conventionally, risk is expressed by the notation
> *Risk = Hazards x Vulnerability*. (UNISDR 2004)

Beyond expressing a possibility of physical harm, it is important to note that risks are always created or exist within social systems. Therefore we have to consider the social contexts in which risks occur and the resulting varying perceptions of risk and its underlying causes (UNISDR 2004).

When examining risk from GC, different forms of risk have to be differentiated. On the one side there is a *systemic risk* involved in the human-induced alteration of the geo-biophysical cycles. The other form of risk is a cumulative risk made up of the risk associated with the accumulation of regional and localized changes in the coupled human-environment system (Kasperson et al. 1995).

Both these forms of GC risk present distinctive challenges and problems in their analysis and identification of appropriate societal responses. The systemic risks are often related to complex, nonlinear processes, whereas the cumulative risks raise the challenge of dealing with multiple temporal, spatial and – for the responses – organisational scales. Considering these aspects, we can define

> **GC Risk:** The probability of threats to human beings and their valuables resulting from human-induced systemic and cumulative environmental changes ranging from the local to the global scale. In the long term perspective, the systemic aspects of GC risk, specifically the alteration of bio-geophysical cycles, pose the ultimate threat by potentially endangering the survival of human civilisation. As increases in extreme events over the last decades related to Global Climate Change (GCC) show (BMU 2002, Brooks and Adger 2003), even the seemingly invulnerable become increasingly vulnerable to GC risks (Kasperson et al. 2001).

2.2 Global change vulnerability

As previously pointed out, vulnerability can be seen as an element of risk. Analogously, GC vulnerability, as an integral part of GC risk, can also be differentiated into two fundamental aspects, a systemic vulnerability towards GC processes and a more intrinsic, cumulative aspect arising from the specific setup of the coupled human-environment system where it takes place. In this coupled system the environmental and societal aspects have to be treated not as separable entities but as part of an integrated whole. There are some difficulties arising in this multi-scale coupled human-environment system.

One important aspect leading to an inherent uncertainty is the disproportional relationship between cause and effect in the different subsystems (Schellnhuber 2001). This implies that by analysing vulnerability in a coupled human-environment system we face different forms of complexity and nonlinearity producing non-predictable outcomes. Another difficulty arises from the fact that risk, vulnerability, their responses and the related negotiations are bound to a specific context.

In assessing GC vulnerability in a sustainable development context, it is important to include not only the analysis of vulnerability but also the identification of specific options for stakeholders to reduce that vulnerability. In identifying pathways towards the mitigation of vulnerabilities, a look at the capacities and resilience of the people affected is essential. The human (singular and societal) responses have to deal with the unknowable and inherently indeterminable (Kasperson et al. 2001), by being able to incorporate all possibilities for response, ranging from anticipation to adaptation, resilience and social learning.

Vulnerability in a GC and sustainable development context is a broad concept with a multitude of different scientific traditions. International research over the last decade has reached some realisations, stimulating research in some new directions:

- Vulnerability is registered not by exposure to risk or hazards alone. It resides in the sensitivity and resilience of the system experiencing such hazards. The basic design of vulnerability assessments has to be expanded to comprise coupled human-environment systems incorporating all the linkages that affect their vulnerability and resilience.
- A focus limited to mainly perturbations and stressors proves insufficient for understanding the impacts on and responses of the affected system or its components (Turner et al. 2003, Folke et al 2002b, Wisner et al. 2004), which makes it necessary to go from a purely pathogenic towards a more salutogenic view.
- Due to the multi-scale nature of the human-environment system, multiple protection mechanisms become possible, adding to the overall resilience of different elements (e.g. households, districts, cities, regions). This necessitates the explicit incorporation of differential, multi-layered resilience into an open, systemic approach, incorporating feedback mechanisms.

- The insufficient treatment of the multi-scale environment incorporates the danger of underemphasizing the various feedback mechanisms beyond the system of analysis (Turner et al. 2003).

In what follows, the development of important vulnerability research strands related to GC and sustainable development is sketched, culminating in a list of requirements for a GC vulnerability framework for syndrome mitigation.

2.3 Review of the development of important vulnerability approaches

As previously stated, vulnerability is a concept used in many different sciences. The aspects concerning the research foci of the NCCR North-South have their roots mainly in the social sciences. Vulnerability has a particularly long history in the geographical literature concerning risk and hazards, where it was mainly defined as the degree to which a system, subsystem, or system component is likely to experience harm due to exposure to a hazard, either a perturbation, stresses or stressors (White 1974). Research focused mainly on developing scientific methods for identifying and describing hazards and for assessing the probability of associated adverse outcome events and their consequences. In the 1980s, risk analysis evolved into risk assessment and risk management, as more attention was given to how hazards or risk factors could be controlled at both the individual level and by society as a whole. By the early 1990s, it became apparent that relying mainly on approaches to risk assessment and management was not always achieving the expected results (Hewitt 1997, Kasperson et al. 1995).

In the last two decades, the focus on risk has been more and more complemented by vulnerability and resilience, which are conceptually linked to the risk concept. A specific focus on socio-economic and political structures and processes which make people vulnerable came to the foreground (Bohle et al. 1994; Cutter 1996; Ribot 1996, Wisner et al. 2004). In a general, systemic definition, vulnerability can be described as the degree to which a system, subsystem, or system component is likely to experience harm due to exposure to a hazard or risk (Turner et al. 2003). It is important to note that in this definition, vulnerability is registered not by exposure to risk or hazards alone but also resides in the sensitivity and resilience of the system experiencing such hazards. The capacity to anticipate, cope with, resist and recover from natural hazards, and the consequences of stresses became increasingly important aspects of analysis and assessments (Watts and Bohle 1993; Blaikie et al. 1994).

Another important step in the methodological development of a vulnerability approach was Chambers's (1989) distinction between an internal and an external dimension of vulnerability which both have to be addressed. The internal dimension refers to defencelessness and insecurity, the capacity to anticipate, cope with, resist, and recover from impacts of a hazard. The external dimension involves exposure to risks and shocks. In this notion, vulnerability can be understood as a multilayered and multidimensional social space defined by the political, economical and institutional capabilities of people in specific places at specific times (Kasperson and Kasperson 2001).

Watts and Bohle (1993) describe vulnerability as a multilayered and multidimensional social space defined by the political, economic, and institutional capabilities of people in specific places at specific times. Bohle et al. (1994) defined vulnerability as made of three dimensions, the ecology of production, the exchange of entitlements, and political economy – the Bohle-Watts-Downing triangle (Figure 1a). Taking up Chambers notions to treat both the external and internal sides of vulnerability, Bohle (2001) expanded this view into an external side of exposure and an internal side of coping, as depicted in Figure 1b.

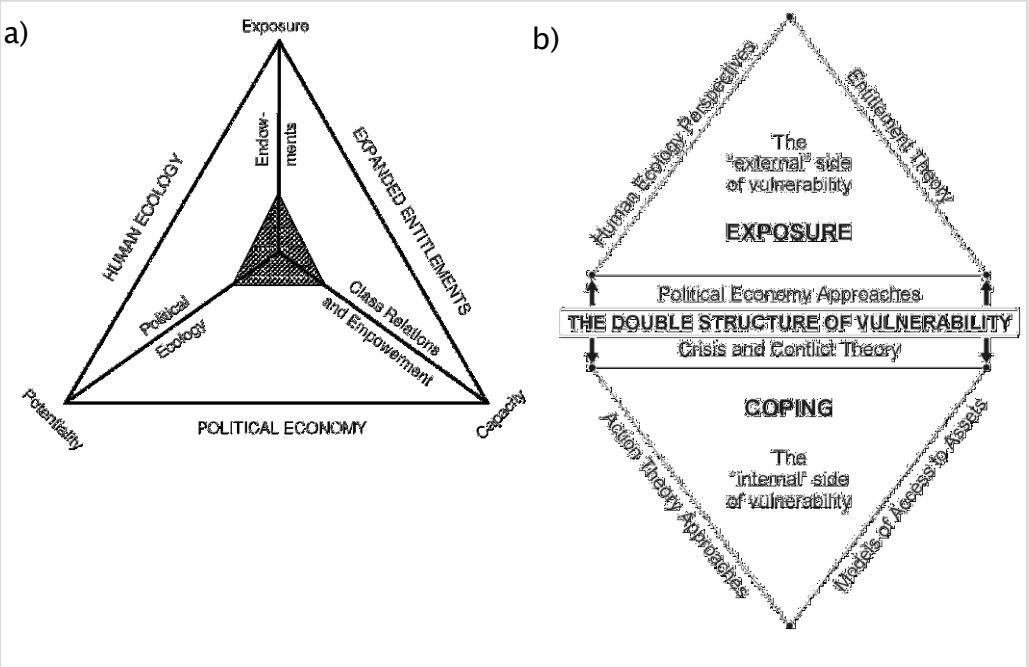

Figure 1: a) The three dimensions of vulnerability – The Bohle-Watts-Downing Triangle (Bohle et al. 1994); b) A new conceptual model for vulnerability analysis (Bohle 2001, taken from Kasperson and Kasperson 2001).

Bohle argues that the external side focuses on exposure to stresses as well as human ecology perspectives and entitlement theory (Kasperson and Kasperson 2001). When shifting the focus from exposure to coping, three important approaches have to be supplemented:

1. Action-oriented approaches treating the interactions between the external and internal sides
2. Access to assets, particularly those that allow people to mitigate their vulnerability and strengthen their resilience towards economic and ecological risk
3. Conflict and crisis theory, particularly control over resources and assets and the capacity to manage crisis situations and to resolve conflicts

2.3.1 The pressure and release model

Another important step in the development of vulnerability approaches was the realisation that far more people are vulnerable to their "normal" living conditions then to extraordinary events. This led to the recognition that a focus limited to mainly perturbations and stressors, as in the previous risk and hazard concepts, is insufficient for understanding the impacts on and responses of the affected system or its components (Wisner et al. 2004, Cannon 2005). This realization influenced the development of the pressure and release model (PAR model - Figure 2), in which risk is explicitly defined as a function of the perturbation, stressor, or stress and the vulnerability of the exposed unit. Here, the focus is directed towards the conditions that make exposure unsafe, leading to vulnerability and to the causes creating these conditions.

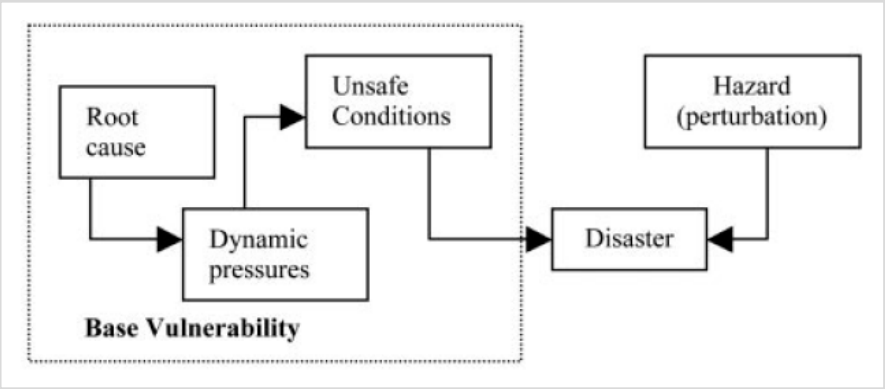

Figure 2: The PAR framework is the common approach in risk research with an emphasis on "social" conditions of exposure (Turner et al. 2003).

Combining the PAR model with Chambers's distinction (1989) between the external and internal sides influenced further developments in vulnerability research. In the PAR model a disaster can be defined as the product of hazard and vulnerability. Therefore, reducing disaster means mitigating the hazard AND/OR dealing with the vulnerability or the capacity of the people involved. In this understanding, immediate factors that lead to vulnerability are caused by processes involving power (political, social and economic factors). Therefore, a main lever to reduce vulnerability is to be found in the social vulnerability components (Figure 3) and the livelihood assets. With its focus on the social dimension, the PAR model can be seen as the underlying model of the livelihood approaches to vulnerability.

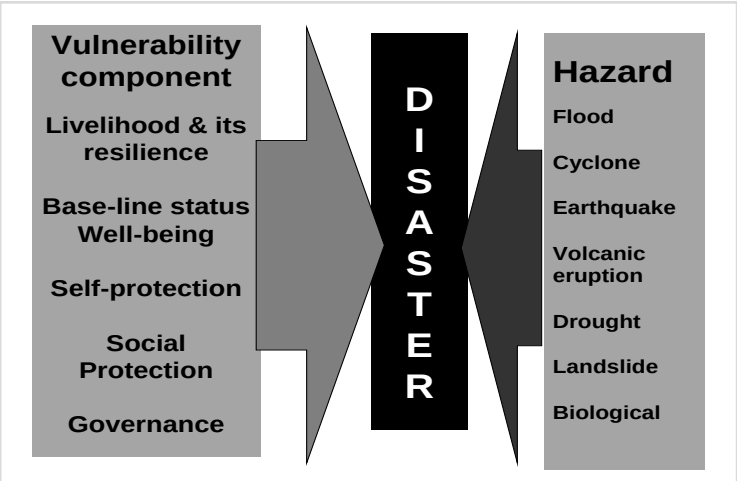

Figure 3: The vulnerability components of the PAR model.

2.3.2 The resilience approach

In the last several years, vulnerability research has undergone a paradigm shift. As stated by (Turner II et al. 2003), the three major concepts of entitlement, coping through diversity, and resilience are explicitly embedded within the understanding of vulnerability in the PAR model. These concepts are more concerned with the capabilities of people than with their deficits. The focus has shifted more towards elements of stability. This stability approach is borrowed from ecology, where concepts like resilience, resistance and persistence appear implicitly and explicitly throughout the vulnerability literature. These ecological concepts deal with the ability of a set of mutually reinforcing structures and processes to persist in the presence of disturbance and stresses. They are particularly prominent within the discourse of the global change vulnerability community (Carpenter et al. 2001; Folke et al. 2002a).

An important element of the resilience concept is its shift from the more passive position of people resigned to their vulnerability towards more active options for avoiding terminally disastrous experiences. In an analogy to ecology, the analytical focus is not so much on what threatens a system but on the elements of a system's ability to bounce back to a reference state after a disturbance, and its capacity to maintain certain structures and functions despite the disturbances or stresses exhibited on the system (Turner et al 2003). This general shift towards a more salutogenic focus corresponds with the NCCR methodology of not only looking at problems of development and environment (Syndromes of Global Change) but also at the processes strengthening potential which might be identified, underlining the active role of the people affected.

2.3.3 The sustainable livelihood framework

The sustainable livelihood framework (SLF) provides an instrument for the investigation of livelihoods, while at the same time visualising their main factors of influence. The model developed by the British Department for International Development (DFID) gives a framework (Figure 4) in which stakeholders are operating in a context of vul-

nerability, within which they have access to certain assets (labour, human capital, productive assets). Vulnerability in this framework depends on these assets of a household, the entitlements to food that it possesses, and the extent to which people, given the assets at their disposal, can adapt (Kasperson and Kasperson 2001).

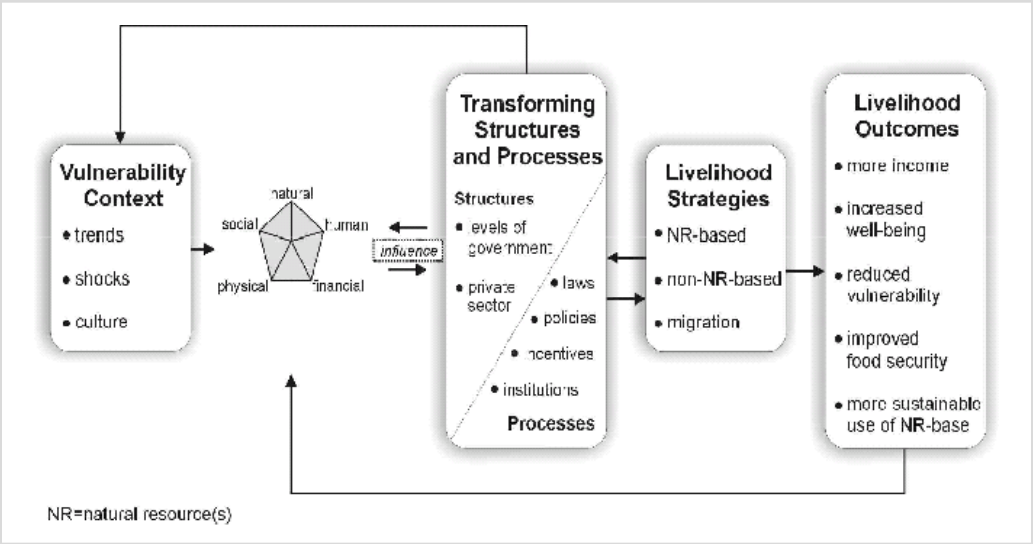

Figure 4: The Sustainable Rural Livelihoods Framework – SLF (Carney 1998, cited in Kasperson and Kasperson 2001).

The PAR model and the SLF served as the core for the model utilised by Wisner et al. (2004) in their book At Risk. Besides the basic vulnerability components, a set of other influencing elements on different functional, spatial and temporal scales determine vulnerability, as depicted in Figure 5. These different scales add different coping elements and strengthen different forms of resilience for vulnerable or disaster-prone people and households (Figure 6).

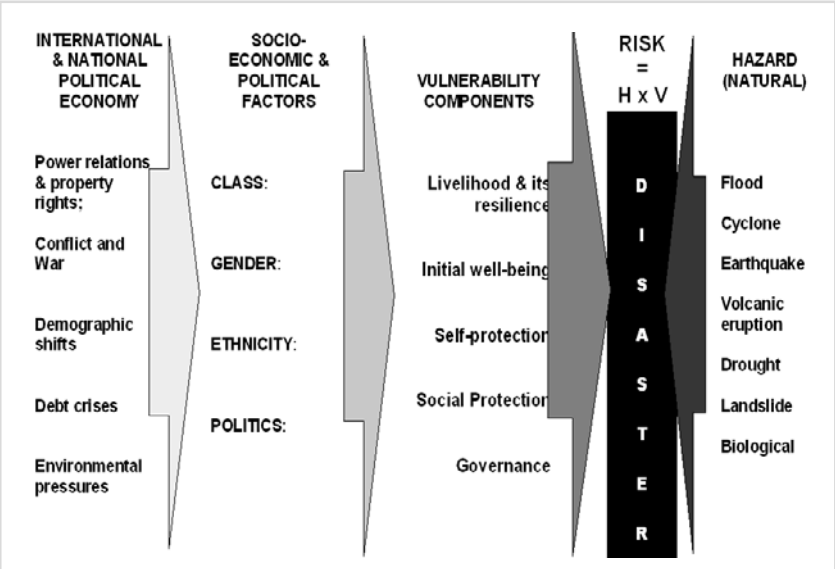

Figure 5: Different elements and scales of the PAR model centred around a livelihood approach (Cannon 2005).

Due to the multi-scale nature of the PAR livelihood approach, multiple protection mechanisms that add to the overall resilience of a household can be identified (Figure 6). The different layers of protection and the various coping mechanisms form the concept of a multi-layered resilience. Resilience and its related concepts influence a variety of interdisciplinary research focused on coupled human–environment systems (Berkes and Folke 1998), especially through the key component of adaptive capacity, the flexibility of ecosystems, and the ability of social systems to learn in response to disturbances (Turner et al. 2003). Because different systems differ in their resilience characteristics, the explicit incorporation of differential, multi-layered resilience has become a critical element of analysis in vulnerability research on human–environment systems.

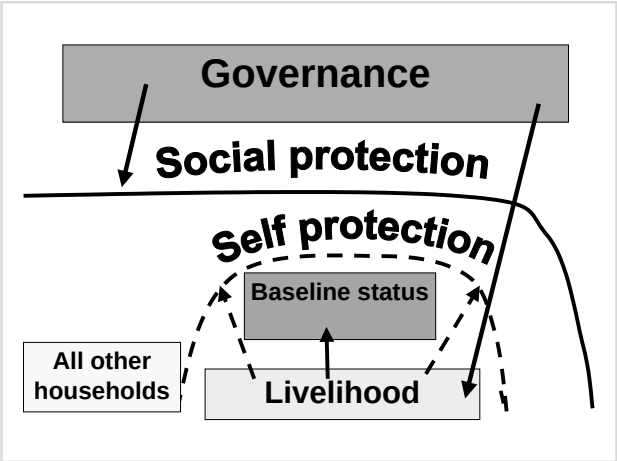

Figure 6: Different protecting mechanisms on various functional scales adding to the resilience of a household (Cannon 2005).

Besides its advantages, the PAR model and a singular focus on resilience does have its shortcomings. First of all, the PAR model does not address the coupled human–environment system in the sense of considering the vulnerability of biophysical subsystems (Kasperson and Kasperson 2001) and the potential influence of the active mechanisms of GC on the different bio-physical and socio-political realms. Furthermore, a singular focus on resilience provides only a limited insight into the complex causal structure of a hazard's sequence, including the nested scales of interactions. This limited view incorporates the danger of underemphasizing the various feedback mechanisms beyond the system of analysis (Turner et al. 2003).

In summary, vulnerability must be understood:

- as a complex of various controlling and enhancing feedback mechanisms
- a multi-scale process (as in syndromes and regional studies)
- involving coupled human-environment systems, which is exposed to
- the cascading effects of GC
- the dynamic nature of the processes leading to a changing vulnerability
- as a human institution (embedded in how humans run the world)
- including the various individual and societal socio-political mechanisms of resilience.

2.3.4 The multi-dimensional framework for vulnerability analysis of sustainability science

Pursing an ambition to link the field of vulnerability analysis with research on sustainable development, interdisciplinary research teams have begun in recent years to explore the vulnerability of linked human–environmental systems, including cascading scales and the option to investigate feedback mechanisms (e.g. Turner et al. 2003, Folke et al. 2002a). The Research and Assessment Systems or Sustainability Program proposed a multi-dimensional framework for vulnerability analysis that finds vulnerability, which is defined as a function of exposure, sensitivity, and adaptive capacity, manifested within the interactions of social and ecological systems (Turner et al. 2002, 2003, Polsky et al. 2003). In this general vulnerability framework (Figure 7), vulnerability is composed of the multiple interactions between exposure, sensitivity, and resilience (Figure 8).

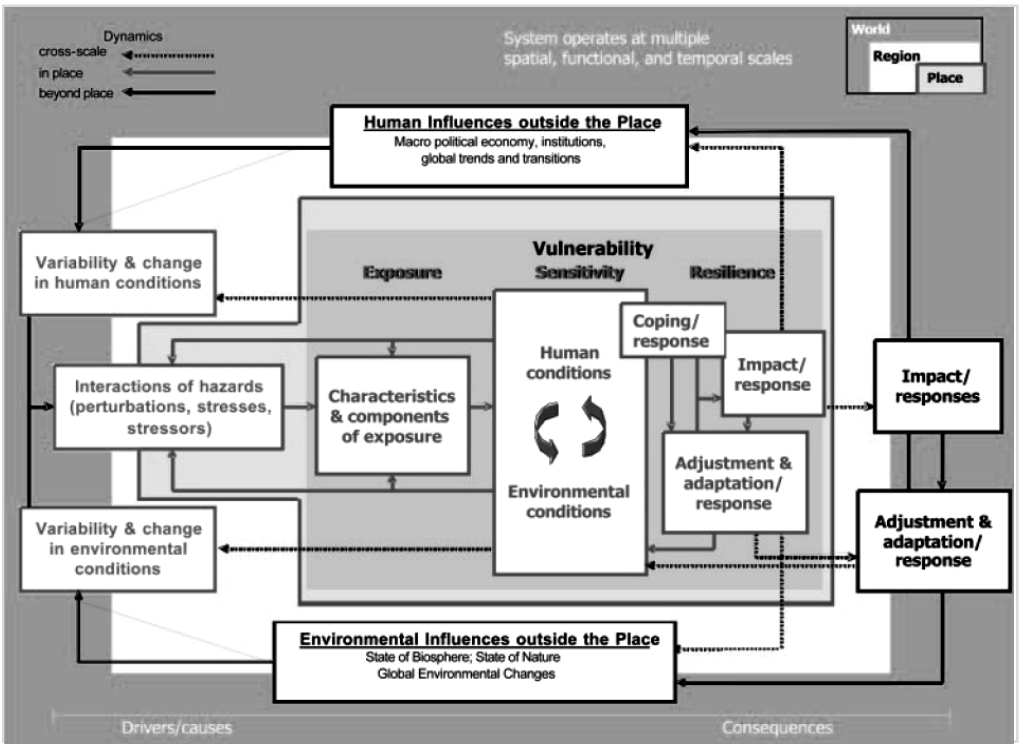

Figure 7: Vulnerability framework of the sustainability science community. Components of vulnerability identified and linked to factors beyond the system of study and operating at various scales (Turner et al 2003).

This general vulnerability framework tries to represent the multiple systemic interactions defining vulnerability and capacity across different scales, thus allowing for the consideration of the diverse effects and impacts of GC. Based on the ideas expressed in this framework, the vulnerability research group of the sustainability science community identified several basic criteria for vulnerability analysis which should be considered in all attempts to analyse vulnerability and or capacity (adapted from Polsky et al. 2003):

1. The knowledge base engaged for the analysis should be transdisciplinary, varied, and flexible.
2. The research should be place-based (encompassing all relationships within a study area and important relationships involving other scales).
3. The stresses and disturbances examined should be recognized as multiple & interacting (instead or unique or multiple and independent)
4. The analysis should allow for differential adaptive capacity contributing to the multi-scale and multi-process nature of resilience (taking into account the heterogeneous situations of affected people, and the different mechanisms on different socio-political scales).
5. Information should be both prospective and historical.

These criteria correspond in parts with the experience of the vulnerability group of the NCCR North-South. Points illustrating the general improvement of vulnerability approaches in the NCCR North-South are the shift in focus from singular events towards multiple and/or chronic disturbances and stresses, the consideration of multiple scales and processes, and the utilisation of scenario techniques for hind- and fore-casting.

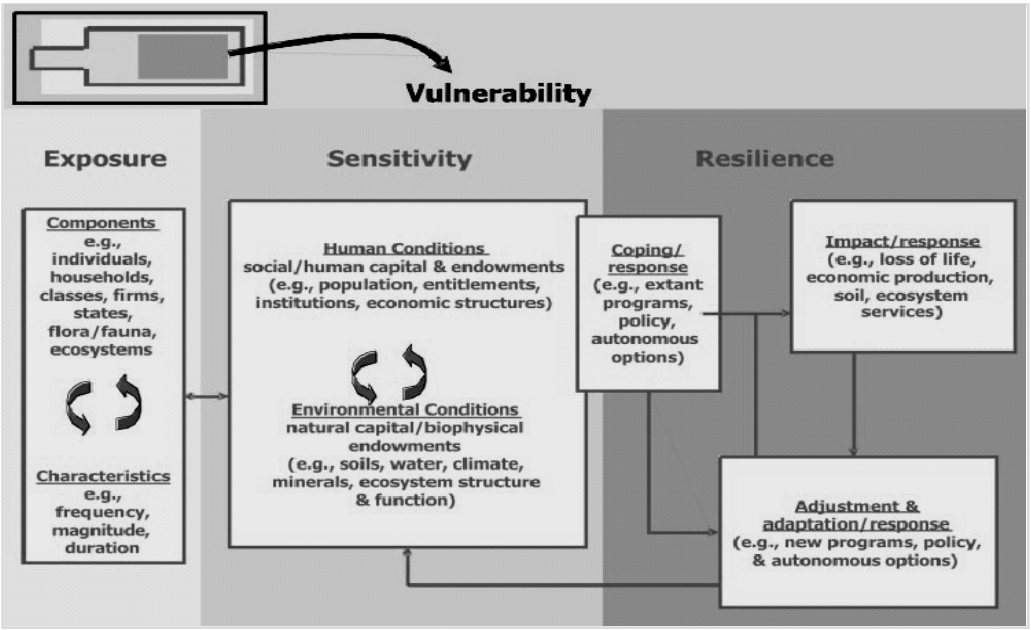

Figure 8: Details of the exposure, sensitivity, and resilience components in the general vulnerability framework of the sustainability science community. The figure at the top left refers to the full framework illustrated in Figure 7 (Turner et al 2003).

The general tools and elements of the syndrome mitigation approach of the NCCR North-South (Cassel-Gintz 2003) provide the capabilities for dealing with these weak points in vulnerability research. By combining the syndrome approach with the 8-step methodology for vulnerability research by the sustainability science community (Polsky et al. 2003; Figure 9), options for contributing to the void in research and literature identified in Figure 10 will crop up.

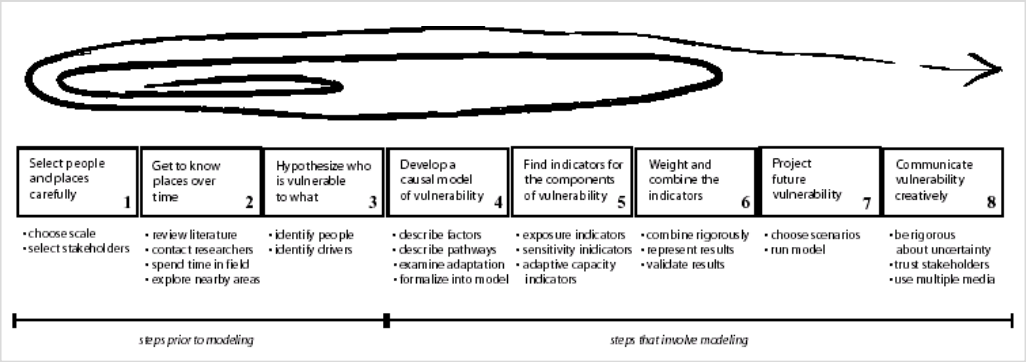

Figure 9: Eight-step methodology for vulnerability research of the sustainability science community (Polsky et al. 2003).

The vulnerability research group in the sustainability science community (Polsky et al. 2003; Figure 9) identified an 8-step methodology for successful vulnerability research. The steps are:

1. Define study area in tandem with stakeholders
2. Get to know places over time
3. Hypothesize (who is vulnerable to what?)
4. Develop a causal model of vulnerability
5. Find indicators for the components of vulnerability
6. Weight and combine the indicators (exposure, sensitivity and adaptive capacity □ overall measures of vulnerability
7. Project future vulnerabilities → scenario building
8. Communicate vulnerability creatively

This methodology follows an iterative design, trying constantly to improve understanding of the situation and reflect the previous steps after each consecutive step. The methodology rests on a modelling approach, allowing for scenario building to identify future developments and the possible effects of mitigation actions.

This methodology follows an iterative design, trying constantly to improve understanding of the situation and reflect the previous steps after each consecutive step. The methodology rests on a modelling approach, allowing for scenario building to identify future developments and the possible effects of mitigation actions.

3 Conclusion

3.1 The potential for an NCCR North-South vulnerability framework

Over the last several years, a trend toward uniting the different strands of vulnerability research into a more general, integrated framework can be seen among a group in the sustainability science community. The aim is to overcome confusion about the various meanings and definitions of the term “vulnerability” and other related concepts, as well as to provide an overall framework which allows for the integration of the different traditions. A challenge in this integrated framework is posed by the incorporation and adequate representation of global change (GC) processes and the multi-scale and dynamic nature of vulnerability.

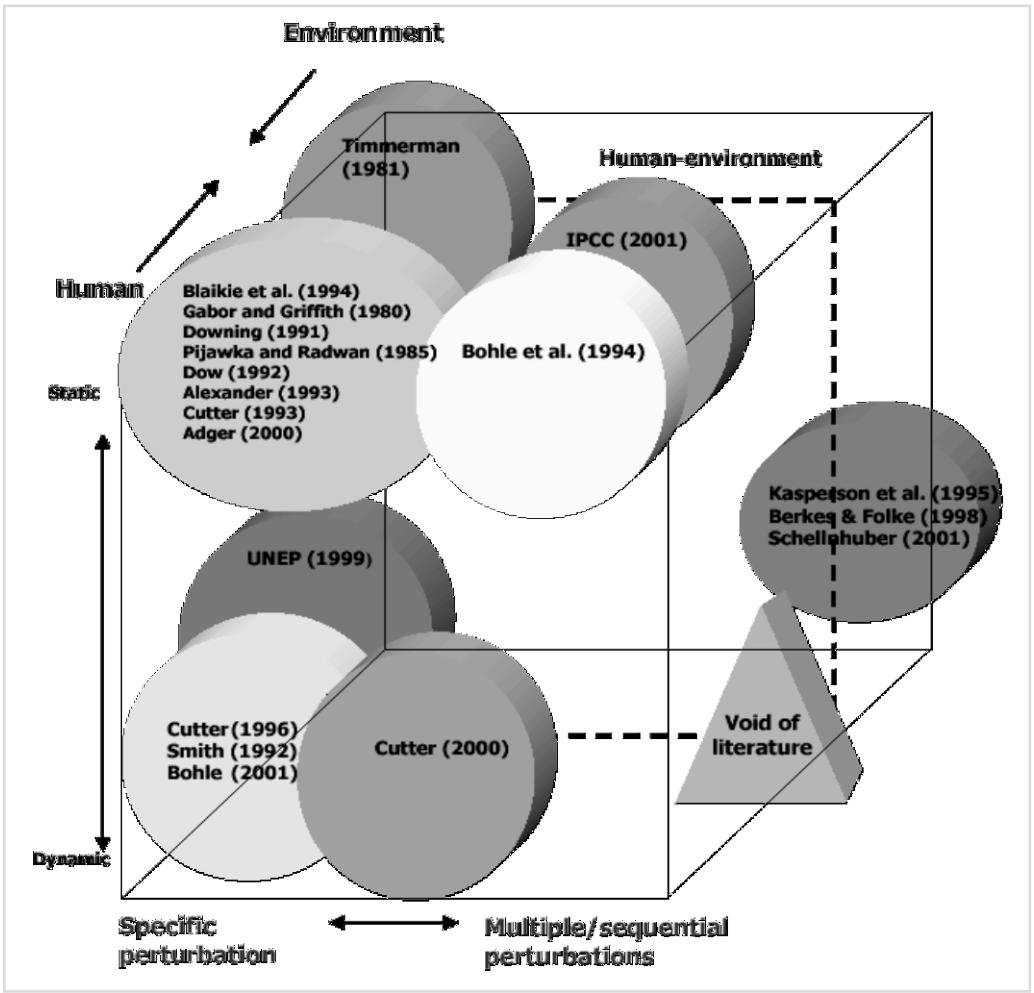

Figure 10: Dimensions of vulnerability research (modified from Research and Assessment Systems for Sustainability Program, 2001)

Based on the analysis of current literature in the field, the Sustainability Science Group on Vulnerability proposed the classification scheme in Figure 10. The coordinate system is defined along a human-environment axis, a static-dynamic axis, and an axis taking account of specific and multiple perturbations.

The void in literature and research noted in Figure 10 is located at the interaction between humans and the environment, where the dynamic behaviour of multiple or sequential perturbations is to be analysed. This also defines the potential location for NCCR North-South contributions, following the argumentation that the NCCR North-South:

- Approaches issues of development and environment interaction in a transdisciplinary, integrated way
- Analyses problematic developments at the human-environment interface with a system dynamical approach, and
- Focuses on patterns, i.e. the multiple and recursive aspects of the problematic developments observed in human-environment systems.

Therefore, the NCCR North-South is in an ideal position to meet this identified research need. The syndrome concept used by projects in the NCCR North-South provides a structure closely related to general notions of vulnerability. The syndrome concept provides a set of methods describing coupled human-environment interactions and their possible deteriorating and strengthening effects in an overall vulnerability framework. The concept focuses on dynamic, multi-scale processes (as in syndromes and regional studies) in the context of GC and sustainable development. In these respects, the syndrome concept offers a suitable environment for the analysis of global change vulnerability.

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About the Author

Martin Cassel-Gintz coordinated Work Package 4 of the NCCR North-South and a transversal package project entitled “From vulnerability to resilience” from 2002 to 2007. His areas of research within the NCCR North-South were “Methods and Concepts for inter- and transdisciplinary research”, the “Syndrome Approach” (which he is very familiar with, having worked before at the Potsdam Institute for Climate Impact Research where the original concept was developed), “Vulnerability and Resilience Research”, “Sustainability Science”, and “System Dynamics Approaches in Global Change”. Further areas of professional interest are integrated assessments, global change, biodiversity assessments and deforestation.

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This paper provides an overview of the development of the concept of vulnerability and related concepts for discussion in the NCCR North-South. It draws on various activities related to concepts of vulnerability during the first phase of the NCCR North-South programme (2001-2004), and attempts to provide ideas for a usable framework for the second phase.

Vulnerability is one of the overarching concepts used in the programme. The fact that it is used by different researchers in different projects, and therefore by different disciplines, already suggests that there is no single vulnerability concept but a multitude of different approaches and concepts dealing with vulnerability in circulation among members of the programme. The paper introduces those concepts that were discussed in depth by a group of researchers on the occasion of several workshops and other programme-related activities, and that have thus been singled out as important for the programme.

The NCCR North-South Dialogue Series presents reflections on research topics of concern to programme members throughout the world.

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