



UNITED NATIONS
UNIVERSITY

UNU-EHS

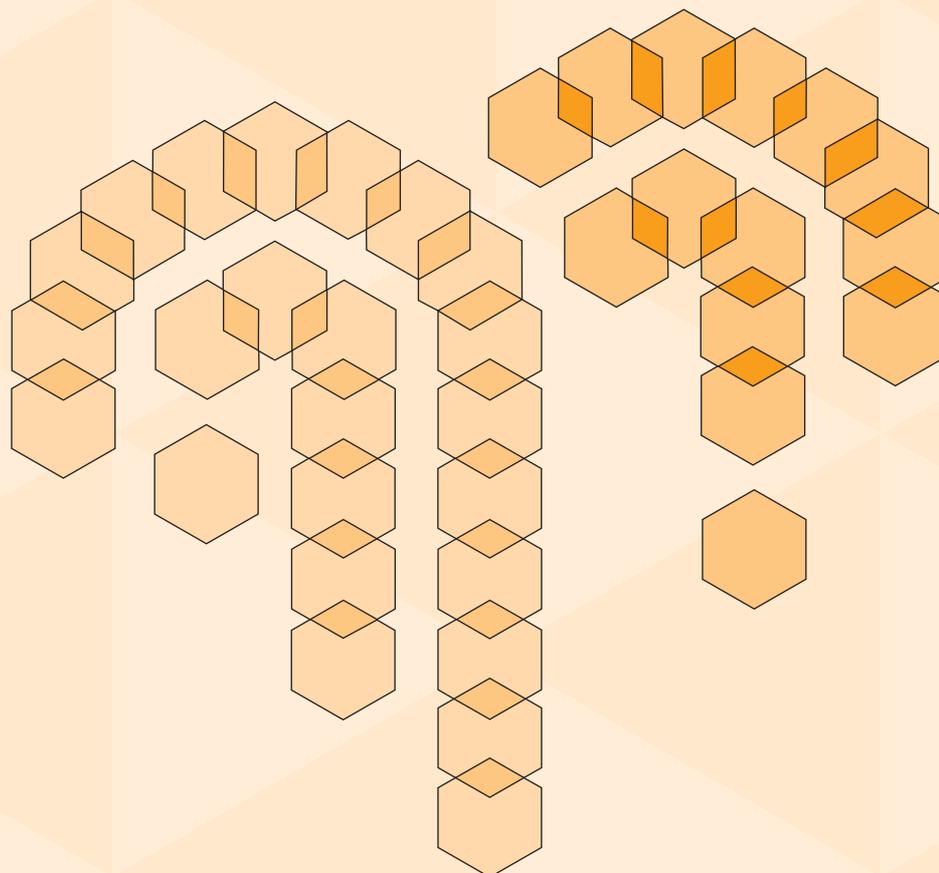
Institute for Environment
and Human Security



**Munich Re
Foundation**
From Knowledge
to Action

Perspectives on Social Vulnerability

Edited by Koko Warner



SOURCE

'Studies Of the University: Research, Counsel,
Education' - Publication Series of UNU-EHS

No. 6/2007

UNU Institute for Environment and Human Security (UNU-EHS)
UN Campus
Hermann-Ehlers-Str. 10
D-53113 Bonn, Germany

Copyright UNU-EHS 2007

Cover design by Gerd Zschäbitz
Copy editor: Ilona Roberts, Vilma Liaukonyte
Printed at Paffenholz, Bornheim, Germany
1. edition, 1000 copies, February 2007

The views expressed in this publication are those of the author(s).
Publication does not imply endorsement by the UNU-EHS or
the United Nations University of any of the views expressed.

ISBN: 978-3-939923-00-8 (printed version)
ISBN: 978-3-939923-01-5 (electronic version)
ISSN: 1816-1154

SOURCE

**'Studies of the University:
Research, Counsel, Education'**

Publication Series of UNU-EHS

No. 6/2007

About the Authors



Dr. Koko Warner is an academic officer at the *United Nations University Institute for Environment and Human Security* (UNU-EHS). Dr. Warner has worked for the past eight years on the economic and societal impacts of natural disasters and climate change in developing countries. Warner coordinates the Munich Re Foundation Chair on Social Vulnerability. At UNU-EHS she is responsible for the area of environmental migration and social vulnerability. Her research encompasses the economic and social science analysis of how groups of people manage shocks and risk, including how they use financial tools including insurance to manage these risks. She currently also serves as an assistant professor at the *University of Richmond's Emergency Service Management* graduate program. She holds a PhD from the University of Vienna Department of Economics.



Christian Kuhlicke is a PhD student at the *Helmholtz Centre for Environmental Research in the Department of Urban and Environmental Sociology*. He studied Geography, Sociology and Geology at the University of Potsdam and spent one year as a Fulbright scholar at the University of Kentucky. His thesis deals with the interrelatedness of knowledge, ignorance and vulnerability both empirically and theoretically.



Danny H. de Vries is a PhD candidate in the Department of Anthropology and Predoctoral Trainee in Demography at the *University of North Carolina at Chapel Hill (UNC-CH), USA*. He has worked as a Research Associate at UNC-CH's Center for Urban and Regional Studies on social vulnerability and hazard mitigation research projects funded by the United States Federal Emergency Management Administration, and is currently a monitoring and evaluation officer at USAID. Vries completed his master thesis in the Department of Psychology at the *University of Groningen, the Netherlands* on images of nature, environmental values, and landscape preferences.



Patrik Sakdapolrak studied Geography with Sociology and Social Anthropology at the *University of Heidelberg/Germany*. For his master dissertation entitled "International Labour Migration as a Livelihood Strategy: A Case Study from Northeast-Thailand" he conducted field research on international labour migration in Thailand, and finished his degree in Geography with distinction. In addition, he studied at the *University of Wollongong/Australia*, where he obtained the master degree with distinction in Social Change and Development. He is currently conducting a PhD research on the topic "Adaptation Behaviour and Negotiation Processes" in the Department of Geography at *Rheinische Friedrich-Wilhelms-University Bonn*.

Dr. Amber Wutich is a Postdoctoral research associate at *Arizona State University's Global Institute of Sustainability*. She is a cultural anthropologist, and has conducted research in Bolivia, Mexico, the United States, and China. Her research focuses on water scarcity among the urban poor. She also studies reciprocity, social networks, science-policy interactions, and research methods.



Byron Real is a PhD candidate at the *University of Florida*, Department of Anthropology. He is also a lawyer from the *Pontificia Universidad Catolica del Ecuador* in Quito and practices human and environmental law.



Fernando Briones Gamboa is a PhD candidate in Anthropology at Social Geography Laboratory, *Ecole des Hautes Etudes en Sciences Sociales*, Paris. He completed his research in the project ENSO Disaster Risk Management in Latin America (LA RED, IAI) at CIESAS (Centro de Investigaciones y Estudios Superiores en Antropologia Social, Mexico City).



Firoz Verjee specializes in the use of geospatial technologies for environmental and humanitarian risk management. Between 1995-2000, Verjee represented the Canadian Space Agency's RADARSAT program in Asia. Since 2001 he is based in Washington DC providing full time humanitarian intelligence services to the US Government, World Bank, United Nations, and several commercial, academic and non-governmental organizations. Currently he is completing a PhD in disaster management at the *George Washington University*.





Fabiola Sagrario Sosa Rodriguez is currently a PhD student in Urban and Environmental Studies at *El Colegio de México*. She obtained a Master's degree in Urban Development Studies and a Major in Economics. She is also working as a researcher of the City Program University Studies supported by the *National University of Mexico* (UNAM). Rodriguez participated at the Mexico City Risk Profile for Earthquakes and Mega-Cities Initiative (EMI), has collaborated with Mexican research institutions in several projects, and worked for Mexico City Government.



Laura Olson is a research scientist at the *George Washington University* Institute for Crisis, Disaster, and Risk Management. She has authored case studies on public safety and worked as a disaster preparedness consultant for federal, state, and local government entities in the Washington D.C. region. Olson is currently a PhD candidate in the field of public administration at the *George Washington University School of Business*. She holds a Master's Degree in Political Science and German Literature from the *Karls-Ruprecht-Universität Heidelberg*, Germany and a Bachelors Degree in Political Philosophy from *Macalester College*.

Perspectives on Social Vulnerability

Edited by Koko Warner

**Selected Papers from the First Summer Academy
on Social Vulnerability
22-28 July 2006, Hohenkammer, Germany**

Acknowledgements

We would like to thank Vilma Liaukonyte, Ilona Roberts, and Francesca Burchi for their assistance with copy editing; Alexander Fekete for feedback about the introductory chapter; and the academic officers of UNU-EHS, Katharina Thywissen, Jörn Birkmann, Torsten Schlurmann, Juan Carlos Villagran de Leon, Dusan Sakulski and Fabrice Renaud for comments on the chapters of this SOURCE. We also would like to thank all peer reviewers for their critiques of individual chapters.

Úrsula Oswald Spring shaped the program for this year's academy, and all the Munich Re Foundation Chairs on Social Vulnerability – Hans Georg Bohle, Anthony Oliver-Smith, and Tom Downing helped participants articulate the main outcomes of the academy – a working definition of social vulnerability and the research and policy agenda. Ben Wisner and Hans Günter Brauch, CASA scientists, played mentoring roles that also facilitated the refinement of papers in this volume.

We appreciate the collaboration of the Munich Re Foundation in preparing and executing the Summer Academy. Angelika Boos strongly supported organizational and logistical arrangements for the academy. Dirk Reinhard ably facilitated some of the key discussions among the academy participants. The partnership with the Munich Re Foundation makes the MRF Chair on Social Vulnerability and the annual Summer Academy possible. The Foundation's generous funding of the Summer Academy created the forum where these and other contributions on social vulnerability were discussed and debated.

Finally, we are deeply grateful to Janos Bogardi, Director of UNU-EHS, and Thomas Loster, Chairman of the Munich Re Foundation, for their vision and leadership in bringing together three "generations" of scientists to push the frontiers of research and practice. Their personal involvement breathed vigor and momentum into a creative process and represents a lasting contribution to applied science.

Foreword

“Perspectives on Social Vulnerability” is a title that suggests some of the fundamental aspects of the multidisciplinary, debate-filled, and policy relevant research surrounding the impact of shocks groups at risk from multiple stressors. This publication is the first SOURCE dedicated to examining the state of research and emerging perspectives on social vulnerability. The volume is part of a larger effort by the *United Nations University Institute for Environment and Human Security* (UNU-EHS) to consolidate research on social vulnerability and facilitate science that increases the understanding, and proposes possible solutions to manifestations, of social vulnerability to environmental and social stressors. In response to a growing need for knowledge about social vulnerability UNU-EHS began forging new partnerships to fill knowledge gaps and foster a corps of scientists to address complex questions surrounding the multiple aspects of vulnerability, including social vulnerability.

UNU-EHS and Social Vulnerability Research

Three complementary components make up our approach to addressing social vulnerability. First, UNU-EHS provides, in partnership with the Munich Re Foundation, leading academics a platform for expanded research on social vulnerability. In 2005 we set up the Munich Re Foundation Chair on Social Vulnerability. The partnership complements other research on vulnerability at UNU-EHS, such as linkages between human and environmental systems. Second, we link the research of young and established researchers at the annual Summer Academy. The 2006 Summer Academy presented a unique platform to exchange experiences and fortify research networks outside of traditional academic fora. Academy participants debated the state-of-the art in social vulnerability science, including aspects such as water availability and sanitation, flood and drought, poverty and the lack of risk awareness. Of particular importance were interdisciplinary analysis and the search for sustainable policy recommendations. And finally, UNU-EHS explores ways to mainstream social vulnerability into vulnerability assessment. The *Expert Working Group on Vulnerability* (EWG) is a forum for discussion and documentation of the challenges and progress in conceptualizing and reducing vulnerability to shocks and disasters.

The Current Volume

Following the introductory chapter by the editor, this volume has three sections. Chapters in the first section address general frameworks for thinking about social vulnerability to multiple stressors. The second section includes chapters that examine some of the factors that contribute to social vulnerability. This section features case studies of water scarcity in Cochabamba Bolivia, migration following Hurricane Katrina, and flood risk management in Mexico. Each of these case studies examines key factors that contribute to or alleviate social vulnerability. The third section of the volume looks at practical applications of research in social vulnerability. This section highlights applied research in GIS technologies used to locate refugee camps, water management in megacities, and types of interventions that build institutional resilience to stressors like natural disasters. These chapters underscore the importance of examining social vulnerability when designing and implementing policy.

Outlook: Network of Research on Social Vulnerability

By creating bridges between young and established researchers, and bringing together experts from academia and policy, UNU-EHS facilitates networks in social vulnerability research. Each of the components described above involves collaboration with key scientists, policy makers and other stakeholders. This approach allows us to play a catalyst role in expanding knowledge about social vulnerability. We hope in coming years that this nexus for social vulnerability research will amplify the message that social vulnerability must be addressed in order to lower the risk among the world’s most vulnerable people.



Janos J. Bogardi
Director UNU-EHS

Foreword

Under the motto “From Knowledge To Action,” the *Munich Re Foundation* acts as a catalyst for knowledge accumulation and implementation and strives to serve people at risk.

In 2005, the Foundation entered into a partnership with the *United Nations University Institute for Environment and Human Security* (UNU-EHS) to support and initiate policy-relevant research on social vulnerability. Together we have established a Chair on Social Vulnerability at UNU-EHS.

The Chair, consisting of four designated chairholders acting on a rotating basis and assisted by an Academic Officer, Dr. Koko Warner, explores the cultural and economic dimensions of social vulnerability including institutional and governance factors. Four internationally renowned professors hold the Chair:

- Prof. Dr. Úrsula Oswald-Spring, *Universidad Nacional Autónoma de México* (UNAM) – Psychologist and politician, environmental and gender specialist – 2005/2006;
- Prof. Dr. Hans-Georg Bohle, *University of Bonn*, Germany – Geographer and expert on poverty and resilience, focus India – 2006/2007;
- Prof. Dr. Anthony Oliver-Smith, *University of Florida*, USA – Anthropologist on Central America specialising in migration and displaced persons – 2007/2008; and
- Prof. Dr. Thomas E. Downing, *Stockholm Environment Institute*, United Kingdom – Climate and environmental scientist – 2008/2009.

Special attention is given to indigenous perceptions, participatory approaches, and community-based coping practices to detect and reduce vulnerability. Working with UNU-EHS on social vulnerability capitalizes on each organisation’s focus on human well-being amidst changing global conditions. The goal is to develop a cutting-edge research and policy implementation agenda on social vulnerability, and to provide a platform for dialogue between young scientists, established experts and UN representatives working at the intersection of development, sustainability and social vulnerability.

The annual Summer Academy linking up young researchers, senior scholars, and other experts is one of our major activities within the Chair network on social vulnerability. The first academy took place in the summer of 2006 at Schloss Hohenkammer, Germany. UNU-EHS and the *Munich Re Foundation* invited 15 experts and 23 selected PhD candidates from twelve countries in four continents. Nine of the students came from developing countries. The cross-disciplinary character of social vulnerability issues was mirrored by the participants’ backgrounds in fields as broad as anthropology, geography, hydrology, economics, engineering, and sociology . Participants debated the state-of-the-art in social vulnerability science, including aspects such as water availability and sanitation, flood and drought, poverty, and the lack of risk awareness. Of particular importance were interdisciplinary analysis and the search for sustainable policy recommendations (the programme, presentations, and proceedings can be found online at www.ehs.unu.edu and www.munichre-foundation.org).

This volume contains perspectives that bring together some of the recent thinking on the complex factors contributing to social vulnerability with chapters dedicated to individual research contributions as well as to growing research networks.

We hope this volume will help readers reflect on the factors that contribute to social vulnerability, with a view to helping people most at risk when disasters strike.



Thomas Loster
Chairman of the Munich Re Foundation

Executive Summary

Koko Warner

Water-related disasters have in recent years drawn increasing scientific and popular attention to examine not only hazards themselves, but the social conditions that influence how people are affected by such disruptions. Decision makers demand improved understanding of the factors that make certain demographic groups vulnerable to stressors. This understanding shapes policy responses to foster resilience, and methods to move from knowledge to action, to reduce the vulnerability of society to multiple stressors including water-related risks. Experts share a growing consensus that understanding vulnerability is vital to reducing the negative effects of crises, disasters, and other shocks on society.

Social vulnerability is one dimension of vulnerability to multiple stressors and shocks, including natural disasters. Social vulnerability to disasters refers to the inability of people, societies, and organizations to withstand adverse impacts from multiple stressors to which they are exposed. Social vulnerability is due in part to characteristics inherent in social interactions, institutions, and systems of cultural values. The multidisciplinary field of social vulnerability research has emerged to address these complexities. Its goal is to provide the scientific basis upon which to investigate, assess, and recommend actions for the reduction of vulnerability factors. Recognizing the need to fill gaps in knowledge and policy understanding, the *United Nations University Institute for Environment and Human Security* and the *Munich Re Foundation* formed a partnership to contribute to research on social vulnerability and progress from knowledge to action. Under this partnership, the Chair on Social Vulnerability was created with four renowned professors appointed to hold the chair over a four-year period. The project also established an annual Summer Academy. The purpose of the academy is to bridge knowledge between established scientists and doctoral students working on social vulnerability topics.

In the summer of 2006 a group of international experts and PhD candidates participated in the first annual Summer Academy, with a special focus on water-related vulnerabilities. The academy added fresh momentum to research on practical solutions to increasingly complex challenges that contribute to social vulnerability worldwide. These challenges include water risks and resource scarcity, poverty and climate change, and a spectrum of other stressors. The experts prioritized the following issues for action to understand and reduce social vulnerability:

Research

- Create a common understanding of social vulnerability – its definition(s), theories, and measurement approaches;
- Aim for useable science that produces tangible and applied outcomes;
- Advance tools and methodologies to reliably measure social vulnerability.

Public Awareness

- Strive for better understanding of contains nonlinear relationships and interacting systems (environment, social and economic, hazards), and present this understanding coherently to maximize public understanding;
- Disseminate and present results in a coherent manner for the use of lay audiences. Develop straight forward information and practical education tools;
- Recognize the potential of the media as a bridging element between science and society.

Policy

- Involve the local communities and stakeholders that are considered in vulnerability studies;
- Strengthen people's ability to help themselves, including an (audible) voice in resource allocation decisions;

- Create partnerships that allow stakeholders from local, national, and international levels to contribute their knowledge; and
- Generate trust individually and locally. Promote ownership of vulnerability reduction efforts.

Debate and ongoing discussion surround the causes and possible solutions to social vulnerability. In cooperation with scientists and policy experts worldwide, a new force is gathering around practice-oriented research in this area. This volume is dedicated to extending the knowledge and contributing to the reduction of social vulnerability worldwide.

In the first section of this SOURCE, three authors discuss frameworks for relating social vulnerability to multiple stressors. Their chapters discuss how groups of people think about risk, how policies designed to prepare social systems for anticipated shocks can fail if the framework for considering social vulnerability is not considered. Kuhlicke discusses the role of knowledge in reducing risk. He emphasizes that knowledge itself does not mitigate a disaster. Rather, a key question to ask is “which knowledge is applied by which means and to which end?” Kuhlicke explores dimensions of knowledge, learning, ignorance and forgetting, to reach conclusions relevant for how social vulnerability is approached in modern society. The next author, DeVries, addresses a related topic of memory and temporal vulnerability. DeVries explores how social memory and perception affects a group of people’s ability to prepare for and withstand shocks, and why surprises may occur even when preparedness measures have been made to avert the worst consequences of an anticipated shock. Sakdolparak completes the first section with a chapter devoted to outlining an analytical framework of social vulnerability, which also serves to illustrate a specific case study of health and water in Chennai, India. These chapters challenge the reader to conceptualize social vulnerability as an embedded aspect of human systems and not only a factor that is present during and immediately after a disaster.

The second section of the volume turns its attention to some of the factors that contribute to social vulnerability in illustrative case studies. Wutich describes the effects of urban water scarcity on the residents of a squatter settlement in Cochabamba, Bolivia. Her findings indicate patterns of vulnerability among families with fewer assets and less access to market systems – patterns that can be understood more clearly through a lens of social-ecological systems theories. In the next chapter, Lopez describes a case study of the social structure of poor and undocumented informal immigrants in New Orleans during and after Hurricane Katrina. Lopez finds that these groups foster social solidarity by applying traditional elements of social capital. This actually strengthened group identity and cooperation. Such aspects of social capital helped these groups survive in the aftermath of Hurricane Katrina. Lopez’s findings point to the importance of links between cultural factors and social resilience to natural threats. In the last chapter of this section, Briones reports a case study on flood risk in Oaxaca, Mexico. He finds that political considerations contribute to build a context of social vulnerability, and argues that political conflicts can lead to predictable patterns of social vulnerability. Briones shows how disagreements over land and water resources lead to higher flood risk for socially marginal groups. These factors – social ecological, culture, and political considerations – are three of the driving factors behind social vulnerability. Future research will further examine these and other factors.

The third section of the volume looks at practical applications of research in social vulnerability. Verjee describes how the use of GIS technologies have been used to locate refugee camps in better harmony with local water and environmental conditions, leading to better hygiene, water, and health for the inhabitants of the camp. This chapter illustrates how geospatial and other technologies can be used in combination with research in social vulnerability to address practical needs and improve the ability of groups of people to deal with risk. In the next chapter, Sosa looks at water management policy in Mexico City. She analyses the efficiency of the megacity’s water management regime and offers policy recommendations to improve the ability of vulnerable groups to access water and manage social vulnerability due to water problems. Sosa’s chapter highlights how specific policy areas can affect the social vulnerability of marginalized groups, as well as opportunities to reduce that vulnerability through

existing policy channels. Olson examines the types of interventions that build collaboration and resilient civil society social structures following disasters. Her work again underscores the importance of examining social vulnerability when designing and implementing policy.

In the future, links will be strengthened between ongoing expert work and the outcomes of the summer academies to fill knowledge gaps about causes of and solutions for social vulnerability.

TABLE OF CONTENTS

Perspectives on Social Vulnerability: Introduction <i>by Koko Warner</i>	14
SECTION I. THEORETICAL FRAMEWORKS	23
1.1 (Non-)Knowledge in Hazard and Vulnerability Research: A Heuristic Typology for Empirical Case Studies <i>by Christian Kuhlicke</i>	24
1.2 Being Temporal and Vulnerability to Natural Disasters <i>by Danny H. de Vries</i>	36
1.3 Water Related Health Risk, Social Vulnerability and Pierre Bourdieu <i>by Patrick Sakdapolrak</i>	50
SECTION II. CONTRIBUTING FACTORS	61
2.1 Vulnerability, Resilience, and Robustness to Urban Water Scarcity: A Case from Cochabamba, Bolivia <i>by Amber Wutich</i>	62
2.2 Hard Decisions in the Big Easy: Social Capital and Evacuation of the New Orleans Area Hispanic Community During Hurricane Katrina <i>by Byron Real</i>	72
2.3 Social Distribution of Risk: A Case Study in Tehuantepec, Mexico <i>by Fernando Briones Gamboa</i>	84
SECTION III: PRACTICAL APPLICATIONS	93
3.1 Mapping Water Potential: The Use of WATEX to Support UNHCR Refugee Camp Operations in Eastern Chad <i>by Firoz Verjee & Alain Gachet</i>	94
3.2 The Effectiveness of Water Policy on Reducing People’s Risk Exposure to Water Management Inefficiencies in Mexico City <i>by Fabiola Sagrario Sosa Rodríguez</i>	103
3.3 Case Study of a Catastrophic Event -Hurricane Katrina: An Evaluation of Social Vulnerability and Community/Organizational Resilience <i>by Laura Olson</i>	115
Acronyms	125
Index	126

Perspectives on Social Vulnerability: Introduction

Koko Warner

Abstract

This chapter introduces emerging perspectives on social vulnerability. The chapter provides a working definition of the term, and points out the policy relevance of social vulnerability. It discusses the importance of examining social vulnerability as a unique research topic that complements risk reduction studies and practical efforts. The chapter outlines some of the major concerns and debates surrounding the research area, including thematic foci and methodological approaches. The chapter concludes with an overview of ten important action areas for social vulnerability research and policy.

I. Introduction

Social vulnerability has attracted attention from policy makers who demand knowledge about how to manage risk in the face of complex human systems – including challenges of poverty and equity, environmental and social problems, and a variety of other stressors to society. This chapter introduces a selection of current perspectives on social vulnerability. The volume aims to expand knowledge for reducing social vulnerability, and presents research from participants in the 2006 Summer Academy on Social Vulnerability.

II. What Is Social Vulnerability?

Research on social vulnerability to date has stemmed from a variety of fields in the natural and social sciences. Each field has defined the concept differently, manifest in a host of definitions and approaches (Blaikie, Cannon et al. 1994; Henninger 1998; Frankenberger, Drinkwater et al. 2000; Alwang, Siegel et al. 2001; Oliver-Smith 2003; Cannon, Twigg et al. 2005). Yet some common threads run through most of the available work. What follows is an attempt to provide a basis for discussion and further research: the “5 w’s of social vulnerability.”

The 5 W’s of Social Vulnerability: What, Who, Where, When, Why

What is social vulnerability? In its broadest sense, social vulnerability is one dimension of vulnerability to multiple stressors and shocks, including natural disasters. Social vulnerability to disasters refers to the inability of people, organizations, and societies to withstand adverse impacts from multiple stressors to which they are exposed. These impacts are due in part to characteristics inherent in social interactions, institutions, and systems of cultural values. Oliver-Smith states, “the concept of social vulnerability expresses the multidimensionality of disasters by focusing attention on the totality of relationships in a given social situation which constitute a condition that, in combination with environmental forces, produces a disaster” (Oliver-Smith 2003). Examples of social vulnerability could be power relationships that exclude certain groups or individuals from benefiting from disaster risk reduction or post-disaster recovery efforts. Such power relationships manifest themselves between individuals or socio-economic groups, within institutional frameworks, or culturally-determined dialogues about stressors.

Who are those most affected by social vulnerability? Marginalized groups, such as the poor, women, children and elderly, tend to be the most affected by shocks like natural disasters (Blaikie, Cannon et al. 1994; Enarson 1998). Some groups, such as poor women, may also have coping mechanisms such as strong social networks that help them survive the negative effects of disruptive shocks ranging from personal threat to large scale catastrophes (Scott 2000; Olsson, Folke et al. 2004). More needs to be known about the mechanisms of vulnerability and resilience in groups of people most affected by shocks.

Where is social vulnerability the biggest problem? Social vulnerability is found most pervasively and more extremely in developing countries. Ideally, efforts to reduce social vulnerability go hand in hand with sustainable development and improvements in quality of life. Yet in cash-scarce contexts, investing in vulnerability reduction may compete with economic development and contradicts forces of growth. Conditions such as environmental degradation, water-scarcity or civil conflict are also factors that can affect spatial concentration of social vulnerability. This is not only a problem between countries but within countries, i.e. it is laid bare even in developed countries when, for example, large disasters strike (Cutter, Mitchell et al. 2000). The concept of “hotspots” has evolved to identify, rank, and analyze areas where social vulnerability and other components of vulnerability are particularly concentrated (Watts and Bohle 1993; Wu, Yarnal et al. 2002).

When is social vulnerability most apparent? Social vulnerability is most apparent in the immediate wake of disasters and other shocks when unequal patterns of suffering and recovery gain attention. Because it is most apparent when calamity occurs, many studies of social vulnerability are found in risk management literature (Peacock and Ragsdale 1997; Anderson and Woodrow 1998; Alwang, Siegel et al. 2001; Conway and Norton 2002). However, social vulnerability is a pre-existing condition that affects a society’s ability to prepare for and recover from a disruptive event. Shocks introduce new social vulnerabilities as people are exposed to the stresses induced by reconstruction.

Why does social vulnerability persist? Social vulnerability is created through the interaction of social forces and multiple stressors, and resolved through social (as opposed to individual) means. While individuals within a socially vulnerable context may break through the “vicious cycle,” social vulnerability itself can persist because of structural – i.e. social and political – influences that reinforce vulnerability. In a time when policy directives increasingly focus on reducing aspects of vulnerability – such as poverty, hunger, disease, etc. – it is critical to understand these reinforcing factors and to address the systems in which social vulnerability occur. The research strives to identify the key variables, mechanisms, and processes of social vulnerability. It aims to suggest ways to unravel and dispel the central drivers of vulnerability so that sustainable improvements can be achieved in making society resilient to stressors and shocks.

There is a vast literature on how people manage a variety of risks they face in life. One may ask whether it is necessary to focus on social vulnerability, given already extensive discussion on risk and risk reduction. At least three key points underline the necessity of examining social vulnerability as a separate but linked topic to risk reduction and the pursuit of overarching development goals.

III. What Is Unique About Social Vulnerability – Why Not Focus On Risk Reduction?

International attention and effort has been devoted to mainstreaming risk reduction efforts into normal economic and social development activities (Munasinghe and Clarke 1995; UNDP 2004; UNISDR 2005). The question arises whether it is necessary to examine the factors surrounding vulnerability through a new lens; substantial discussions have emerged about the need to rethink the conceptualization of risk and vulnerability from a holistic perspective (Cardona 2003), including better understanding of human factors (IDB and ECLAC 2001). The study of social vulnerability is, however, made unique by at least three characteristics. These enable research on social vulnerability to contribute substantially to understanding how to reduce risk more effectively, and in ways that enhance efforts to reach development targets (IISD, IUCN et al. 2003; UN 2006). These three characteristics are a focus on people, complex social systems, and non-structural solutions.

People: The social vulnerability approach focuses on people who are at greatest risk to be negatively impacted and in greatest need to receive assistance – not only when a disaster or other shock occurs, but on an ongoing basis. The social vulnerability approach goes beyond individual risks that vulnerable people face (Nakagawa and Shaw 2004; Cannon, Twigg et al. 2005). The focus on social vulnerability considers multi-scalar phenomena, examining the overall relationships of and between individuals,

organizations, society, and the environment. The focus is on building profound and systemic resilience to shocks.

Complex social systems: A challenge for research and action is to understand the interaction and relative importance of factors within social systems that contribute to social vulnerability. Already research offers a multitude of discipline-specific definitions and theories on social vulnerability. What is needed now is a multidisciplinary approach to tackle the complexity of social systems, and patterns of vulnerability in those systems. For example, sociologists contribute by advancing knowledge on risk perception and disaster response; geographers develop tools and methods to identify people at risk; anthropologists investigate local risks and coping strategies, and climatologists add the notion of adaptation and long-term risks. A multidisciplinary approach to social vulnerability creates integrative concepts and frameworks so that aspects of complex social systems can be understood in the context of the entire system and not only from a single scientific discipline.

Considering non-structural solutions: In the past, flood and other risks were mitigated through structural measures like dams, flood walls, irrigation systems, and other changes to the built environment. Risk reduction was synonymous with achievements in engineering. However, increasing losses worldwide suggest that structural measures alone cannot fully address vulnerability reduction (Anderson and Woodrow 1998; Frankenberger, Drinkwater et al. 2000; Heijmans and Victoria 2001). For example, a structural failure in the levees in New Orleans triggered massive flooding. In turn, addressing the flooding was complicated by issues of social vulnerability that had been largely ignored in city risk management plans (Cutter, Boruff et al. 2003). In this case, structural protection missed the target of making New Orleans resistant to coastal hazards, and failed to take into account the predisposition of the people and deficiencies in resilience to cope with and recover. Research on social vulnerability recommends moving beyond structural measures of risk reduction. It targets root causes of social inequity and aims to strengthen people's capacity to respond to and recover from shocks.

IV. The Policy Relevance of Social Vulnerability

Social vulnerability has emerged as a policy-relevant research area, due in part to widening economic and social gaps between already-developed and less developed countries. Since the 1970s and 1980s, policy discussions of human welfare have become closely linked to discussions of environmental quality. Nascent within this concept was the idea of vulnerability, reflected in early publications by ecologists and social scientists (Holling 1973; Timmerman 1981). Research on the effects of specific stressors like environmental degradation on society grew during this time period. The Brundtland report (1987) introduced the concept of sustainable development, followed by broad public discussion and a series of United Nations summits on environment and sustainable development (World Conferences in Rio 1992 and Johannesburg 2002). As signals of environmental degradation, natural hazards, migration, and a wide spectrum of other stressors have increased, experts have sought a new concept of human security and development to guide policy. By the beginning of the 21st century, climate change and harrowing effects of natural hazards like extended drought or extreme hurricanes (Hoeppe and Pielke 2006; IPCC 2007), crushing economic inequality, disease, lack of resources and resulting migration have all shaped a new reality for the human security paradigm (Figure 1).

The new paradigm inseparably links humans, their social systems, and their environments and strives to achieve freedom from fear, freedom from hazard impact, and freedom from want (Holzmann and Jorgenson 2000; UNDP 2004; Annan 2005). The paradigm has been shaped in part by a recognition of the need to achieve greater societal resilience and improved environmental conditions among the world's most vulnerable people (UN 2006). Research addressing people within their social context can contribute to policy design to improve environmental and human security.

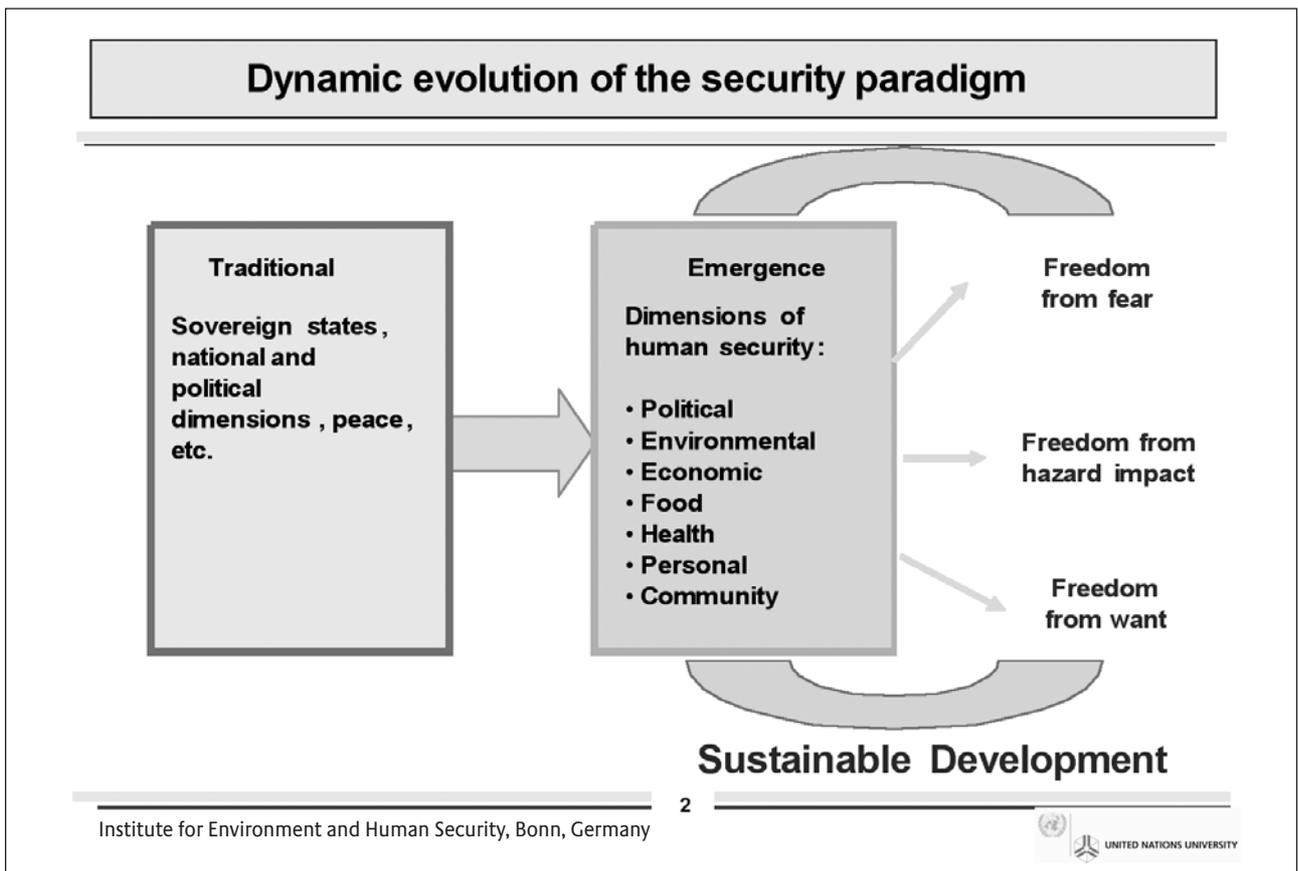


Figure 1: The concept of security and development has shifted from state-centric concepts and the apparatus of macroeconomics and war to a more encompassing concept of human development and security – security from disruptions natural and social

V. What Are Major Concerns and Debate?

The major concerns and debates surrounding social vulnerability highlight areas where new thinking is needed in order to achieve the goals in policy guideposts like the Millennium Development Goals (UN 2006) and Hyogo Framework of Action (UNISDR 2005). Some thematic concerns are highlighted here – including water, policy frameworks, environment, gender, and violence – as well as a key methodological debate.

Thematic Concerns

Water: Scarcity of water and water quality issues are main concerns for the future. The lack of access to improved water sources makes people susceptible to diseases and deterioration in health, and in the case of sustenance farmers, threatens their livelihoods. Ultimately, a threat to people's livelihoods and their physical health is another factor that contributes to social vulnerability (Epstein 1999).

Policy frameworks: Social vulnerability operates at the intersection of sustainability and development. Good governance, environmentally sensible choices as well as just economic and social development reduce social vulnerability to natural hazards. The concept of social vulnerability requires integration into sustainable development to achieve its full potential and reduce the adverse impacts of external shocks.

Environment: Environmental degradation increases people's risk to suffer from natural hazards. It is mostly the poor and marginalized who live in areas of highest risk. Encroaching deserts threaten people's livelihoods and strain their resources to recover. Deforestation makes slopes more susceptible to land-/mudslides and reduces their ability to drain precipitation. Catastrophic landslides that kill

hundreds of people are common in urban slums. Coastal erosion, drainage of wetlands and the destruction of mangroves, elevate physical exposure and make people more susceptible to catastrophic hurricanes (typhoons, cyclones) and storm surges (Dow 1992; Peacock and Ragsdale 1997).

Gender: Factors such as traditional division of labor, limited access to education and health care, lack of empowerment and entitlement, put women at the forefront of socially vulnerable groups (Morrow 1997; Fothergill 1998). They care for children and the elderly. The home-bound status of many women often makes them the first victims of variety of stressors (Sapir 1993). Development programs that target women and girls can directly or indirectly reduce women's social vulnerability.

Violence: Civil strife and war further complicate the landscape of social vulnerability. Just as social vulnerability to natural hazards is revealed by disasters, the same is true for violent conditions. When civil disruptions occur it is expected that socially vulnerable groups will feel the impacts most negatively, and recover the most slowly. The social vulnerability exposed during violent disruption is an indicator for both the underlying resilience of a society, as well as a measure of the overall impact and extent of suffering caused by external shocks. For example, research has found "geographies of violence and vulnerability" which go beyond direct violence, and explore structural forms of violence and the ideologies that mobilize and perpetuate violence (Bohle, Downing et al. 1994). This research identifies, in a systematic manner, the arenas and agendas of violence, the actors involved in violence and the violent acts committed. The struggles of the civilian population to cope with and adjust to everyday forms of violence are part of social relations, especially power relations, where violent struggles and coping behaviour are embedded in specific fields of social power (ibid.).

Methodological Debates: Measuring the "Unmeasurable"

Research on social vulnerability frequently deals with elements that are difficult to measure – either because data is unavailable or because the factor of interest is difficult to quantify. Debates surround the question of how to measure the "unmeasurable" in ways that are meaningful to policy makers and operational institutions in the realm of sustainable development (Bell and Morse 2000).

Policy makers require focused research – an effective mix of rich anecdotal, local information about social vulnerability linked with measurable indicators, numbers, values upon which political decisions can be based. Science must respond to this demand through multidisciplinary research providing this blend of information.

The next step in research is to move beyond description and measurement of social vulnerability to the creation of tools to analyze the underlying causes and possible solutions (Birkmann 2006). Until recently, research in this field has described many case studies and local observations. What is needed now is a set of methodologies that can be used to extrapolate the appropriate findings from the existing body of case studies on social vulnerability to other geographical areas (Bankoff, Frerks et al. 2004).

What actions can be taken?

"First we must pursue a real understanding of root causes of social vulnerability; then, if necessary and possible we can try to measure it" (Hans-Georg Bohle)

The discussion of social vulnerability to multiple stressors requires further development. Existing tools and theories provide the point of departure for building new methods and approaches that will expand understanding and analyzing social vulnerability.

Challenges

Beyond this, some of the challenges that lie ahead for research and action to reduce social vulnerability include:

- Action-oriented science: Involve local scientist and stakeholders: increase the participation of scientists from developing countries. Develop theories and methods into a coherent and recognized body of research literature. Balance qualitative and quantitative methods that lend useful policy insights for the reduction of social vulnerability.
- Systemic approaches: Seek to understand social vulnerability in its local context, while searching for systematic, theoretical approaches that allow lessons learned in one location to be of value for other geographic areas and social contexts. Strive for research that adds to understanding of the roles of culture, environmental, and social contexts to the vulnerability of people to multiple stressors. Distill lessons that can be useful across geographic and cultural contexts.
- Including stakeholders: Involve local stakeholders in research efforts to gain greater clarity and (possibly) new conceptualizations about the structures and mechanisms of social vulnerability. When more refined understanding of the mechanisms of social vulnerability is in place, then involve local stakeholders in decision-making about how to reduce social vulnerability.

Opportunities

Embedded within these and other challenges are also a spectrum of opportunities to address social vulnerability. Just three of the many entry points to further understand and contribute to the reduction of social vulnerability are:

- Water: Team up with development projects to improve water quality and access issues. Focus on equity and conflict reduction around water issues to improve livelihoods and health.
- Women: Recognize the role of gender in shaping vulnerability and focus policies and actions on women, who can in turn reach their partners, children and the elderly.
- Risk management tools: Enhance risk management capabilities of those most affected. Focus on local risk management tools like microfinance and microinsurance that empower vulnerable people and enhance their risk management capabilities.

VI. 10 Important Action Areas for Social Vulnerability

New momentum and consensus has emerged about how to move research and policy related to social vulnerability forward. The focus of the first Summer Academy on Social Vulnerability was on water, yet the discussions there raised as many questions as were answered. The discussion articulated major questions and gaps that future research should address. An agenda of 10 important issues were defined to help shape the future of this research area. These include a research agenda, recommendations for public awareness, and policy considerations for programs that address social vulnerability.

Science

- A common understanding of vulnerability. Research requires clear definitions, a sound theoretical founding, and consideration of the spatial, temporal, and socio-economic context. Significant research gaps exist today.
- Applied science. Conducting social vulnerability research reaches beyond academia and affects how practitioners and policy makers work with vulnerable populations. The research should move beyond description to more powerful analysis with usable, practical, and significant application possibilities.

- Measuring and analyzing vulnerability. The tools for measuring social vulnerability can be further sharpened. Solid qualitative and quantitative methods are needed to facilitate decision making and action related to social vulnerability reduction.

Public Awareness

- *Complexity*: Social vulnerability contains nonlinear relationships and uncertainty about systems that are not yet well-understood. Social vulnerability also represents a mosaic of interacting systems (environment, social, and economic). Yet complex issues must be presented coherently to maximize public understanding.
- *Education*: The public needs straightforward information and opportunities to learn about the roots and possible solutions of social vulnerability. Practical tools, knowledge, and educators can positively shape vulnerability-reducing behaviors and community action.
- *Media*: The media provides a bridge between science and society, and signals to policy makers the significance of social vulnerability. The media can raise awareness about the distribution and causes of social vulnerability by telling the stories of vulnerable people.

Policy Implications

- *Involvement*: Involve the communities considered in vulnerability studies. Participatory research and action methods are critical to sustained vulnerability reduction measures. Involvement of key stakeholders allows for helping science serve local priorities for vulnerability reduction.
- *Empowerment*: Strengthen ability of people to help themselves – increase sustainability by giving affected people tools they need to help themselves and shape their own resiliency-building approaches
- *Partnerships*: Create partnerships that allow stakeholders to contribute to vulnerability reduction: international (capacity, resources, and vision), national (legal frameworks and resource channeling), local (understanding of complex issues and contact with those affected).
- *Ownership*: Finally, research, awareness, and policies about social vulnerability will fail if they do not involve those people who experience social vulnerability. Individual and group “ownership” of vulnerability reduction efforts are the most important components. Living conditions will improve in a sustainable manner only when the most important stakeholders – the vulnerable themselves – embrace the idea of vulnerability reduction and own the tools to contribute to building more resilient communities.

VII. Conclusions

Research on aspects of vulnerability has existed for decades, yet a new stage has begun that locates social vulnerability as a specific, policy-relevant field of investigation. It is important to distinguish social vulnerability for at least three reasons: because it puts people at the center of the debate, because it addresses the vast complexity of risk management within the context of social systems, and because the study of social vulnerability encompasses non-structural solutions for risk reduction.

This volume thus sets out to begin filling some of the knowledge gaps by sharing emerging research on social vulnerability. In the chapters that follow, the reader will gain a sense of the “state-of-the-art” in social vulnerability studies and the debates that define it. In future years this work will continue, linking the summer academies and Munich Re Foundation Chair on Social Vulnerability to other expert work on vulnerability and risk reduction.

References

- Alwang, J.; Siegel, P. B et al. (2001): *Vulnerability: A View from Different Disciplines*. Social Protection Discussion Paper Series No. 0115. Washington, D.C., Social Protection Unit, Human Development Network, The World Bank.
- Anderson, M. B.; Woodrow, P. J. (1998): *Rising from the Ashes: Development Strategies in Times of Disaster*. London, IT Publications.
- Annan, K. A. (2005): *In Larger Freedom: Towards Development, Security, and Human Rights for All*. Report of the Secretary General on the integrated and coordinated follow-up to the outcomes of the major United Nations conferences and summits in the economic, social, and related fields. 05-27078(E). New York, United Nations Press.
- Bankoff, G.; Frerks, G. et al. (2004): *Mapping Vulnerability*. Sterling, Earthscan.
- Bell, S.; Morse, S. (2000): *Sustainability Indicators: Measuring the Immeasurable*. London, Earthscan.
- Birkmann, J., (Ed.) (2006): *Measuring Vulnerability to Natural Hazards: Towards Disaster Resilient Societies*. New York, UNU Press.
- Blaikie, P.; Cannon, T. et al. (1994): *At Risk: Natural Hazards, People's Vulnerability, and Disasters*. London, Routledge.
- Bohle, H.-G.; Downing, T. E. et al. (1994): Climate Change and Social Vulnerability: the Sociology and Geography of Food Insecurity. In: *Global Environmental Change*. No. 4: pp 37-48.
- Cannon, T.; Twigg, J. et al. (2005): *Social Vulnerability, Sustainable Livelihoods and Disasters*. Report to DFID Conflict and Humanitarian Assistance Department (CHAD) and Sustainable Livelihoods Support Office. London, DFID. pp. 63.
- Cardona, O. D. (2003): The need for rethinking the concepts of vulnerability and risk from a Holistic Perspective: A necessary review and criticism for effective risk management. In: Bankoff, G. F. G.; Hillhorst D. (Eds.): *Mapping Vulnerability: Disasters, Development and People*. pp.17.
- Conway, T.; Norton, A (2002): Poverty, Risk and Rights: New Directions in Social Protection. In: *Development Policy Review*. Vol. 20(5).
- Cutter, S. L.; Boruff, B. J. et al. (2003): Social Vulnerability to Environmental Hazards. In: *Social Sciences Quarterly*. Vol. 84(2). pp. 242-261.
- Cutter, S. L.; J. T. Mitchell, et al. (2000): Revealing the Vulnerability of People and Places: A Case Study of Georgetown County, South Carolina.. In: *Annals of American Geographers*. No. 90(4). pp 713-737.
- Dow, K. (1992): Exploring differences in our common future(s): the meaning of vulnerability to global environmental change. In: *Geoforum*. Vol. 23. pp. 417-436.
- Epstein, P. (1999): Climate and Health. In: *Science*. Vol. 285(5426). pp. 347-348.
- Fothergill, A. (1998): The neglect of gender in disaster work: an overview of the literature. In: Enarson, E.; Morrow, B. H. (Eds): *The Gendered Terrain of Disaster: Through Women's Eyes*. Westport, CT, Praeger Publishers. pp11-25.
- Frankenberger, T. R.; Drinkwater, M. et al. (2000): *Operationalizing household livelihood security: a holistic approach for addressing poverty and vulnerability*. Forum on Operationalising Sustainable Livelihoods Approaches. Pontignano (Siena), FAO.
- Heijmans, A.; Victoria, L. P. (2001): *Citizenry-Based & Development-Oriented Disaster Response: Experiences and Practices in Disaster Management of the Citizens' Disaster Response Network in the Philippines*. Quezon City, Center for Disaster Preparedness.
- Henninger, N. (1998): *Mapping and Geographic Analysis of Human Welfare and Poverty: Review and Assessment*. Washington DC, World Resources Institute.

- Hoeppe, P.; Pielke, R. J. (2006): *Workshop Report. Workshop on Climate Change and Disaster Losses: Understanding and Attributing Trends and Projections*. Hohenkammer, Germany, MunichRe.
- Holling, C. S. (1973): Resilience and stability of ecological systems. In: *Annual Review of Ecology and Systematics*. Vol. 4. pp. 1-23.
- Holzmann, R.; Jorgenson, S. (2000): *Social Risk Management: A New Conceptual Framework for Social Protection, and Beyond*. Washington DC. The World Bank. pp 30.
- IDB; ECLAC (2001): *A Matter of Development: How to Reduce Vulnerability in the Face of Natural Disasters*. Mexico City. IDB and the Economic Commission for Latin American and the Caribbean (UN). pp.45.
- IISD; IUCN, et al. (2003): *Livelihoods and Climate Change: Combining disaster risk reduction, natural resource management and climate change adaptation in a new approach to the reduction of vulnerability and poverty*. Manitoba, IISD, IUCN, SEI.
- IPCC (2007): *Climate Change 2007: The Physical Science Basis*. IPCC Working Group 1 Contribution to the Fourth Assessment Report. Geneva, IPCC Working Group 1.
- Morrow, B. H. (1997): Stretching the Bonds: The Families of Andrew. In: Peacock, W. G.; Morrow, B. H.; Gladwin, J. (Eds.): *Hurricane Andrew: Ethnicity, Gender and the Sociology of Disasters*. New York, NY, Routledge. pp.14-170.
- Munasinghe, M.; Clarke, C. (Eds.) (1995): *Disaster Prevention for Sustainable Development*. Economic and Policy Issues. Yokohama, The International Bank for Reconstruction and Development/The World Bank.
- Nakagawa, Y.; Shaw, R. (2004): Social Capital: A Missing Link to Disaster Recovery. In: *Journal of Mass Emergencies and Disasters*. Vol. 22(1). pp. 5-34.
- Oliver-Smith, A. (2003): Theorizing Vulnerability in a Globalized World: A Political Ecological Perspective. In: Bankoff; Frerk; Hillhorst (Eds.): *Mapping Vulnerability: Disasters, Development and People*. London, Earthscan. pp. 10-24.
- Peacock, W. G.; Ragsdale, A. K. (1997): Social Systems, Ecological Networks and Disasters. In: Peacock, W. G.; Morrow, B. H.; Gladwin, J. (Eds.): *Hurricane Andrew: Ethnicity, Gender and the Sociology of Disasters* NY. New York, Routledge.
- Timmerman, P. (1981): *Vulnerability, Resilience, and the Collapse of Society*. Toronto. Institute for Environmental Studies.
- UN (2006): *The Millennium Development Goals Report 2006* (UNDPI). New York, United Nations: 48.
- UN (2006a): *Review of the First United Nations Decade for the Eradication of Poverty*. E/CN.5/2006/3.
- UNDP (2004): *Reducing Disaster Risk: A Challenge for Development*. Geneva, United Nations Development Programme Bureau for Crisis Prevention and Recovery.
- UNFCCC (2004): *Compendium on Methods and Tools to Evaluate Impacts of, Vulnerability and Adaptation to Climate Change*. UNFCCC: 145.
- UNGA (1987): *Brundtland Report: Our Common Future*. Report of the World Commission on Environment and Development. World Commission on Environment and Development. U. N. G. Assembly. New York City, United Nations. a/43/27: 318.
- UNISDR (2005): *Hyogo Framework for Action 2005-2015: Building the resilience of nations and communities to disasters*. World Conference for Disaster Risk Reduction. Kobe, Japan, UN. International Strategy for Disaster Reduction (ISDR).
- Watts, M. J.; Bohle, H.-G. (1993): The space of vulnerability: the causal structure of hunger and famine. In: *Progress in Human Geography*. Vol. 17. pp. 43-67.
- Wu, S. Y.; Yarnal, B. et al. (2002): Vulnerability of coastal communities to sealevel rise: a case study of Cape May county, New Jersey, USA. In: *Climate Research*. Vol. 22. pp. 255-270.

SECTION I

THEORETICAL FRAMEWORKS

1.1 (Non-)Knowledge in Hazard and Vulnerability Research: A Heuristic Typology for Empirical Case Studies

Christian Kuhlicke

Introduction

Knowledge is regarded as an increasingly important resource in our societies. Phrases like “knowledge society” or “life-long learning” describe this development pointedly. Also, in hazard and vulnerability research knowledge plays a vital role. Gilbert F. White wrote in the introduction to “Natural Hazards: Local, National, Global” a sentence that still paraphrases, quite succinctly, the driving force behind hazard and vulnerability research: “Were there perfectly accurate predictions of what would occur [...] there would be no hazard” (White, 1974: 3). If scientists are able to calculate place, time and magnitude of a next earthquake convulsing a city like Istanbul and if they are also able to predict how people would behave, it would be possible for decision-makers to influence their actions in an adaptive manner – at least this is the ratio of such an understanding of knowledge. It is surely no exaggeration to state that the accumulation and dissemination of knowledge is one of the core issues in risk and disaster management as well as in hazard and vulnerability research.

However, this paper argues that most understandings of knowledge are based on common sense definitions of knowledge and are therefore too simplistic to grasp the manifold and complex interactions between various forms of knowledge. They appear not to be useful for an exact empirical analysis of how people’s knowledge may relate to their vulnerability. Additionally, the dimension of ignorance is excluded from most studies. What Michael Smithson wrote at the beginning of the 1990’s still describes a considerable deficit: there is relatively few work done on the specific role ignorance may play before, during and after disasters (Smithson, 1990). This seems surprising, since disasters are often defined as unexpected events, which means they were not anticipated, foreseen, properly predicted and so on. Disasters point towards forgotten and in a more fundamental manner, to unknown facets of societies social and material environment.

Against this background, the following argument wants to accomplish two things: Firstly, it reconstructs how different perspectives on natural hazards and disasters as well as on risks conceptualize knowledge and ignorance. In this respect the overview does not aim at a comprehensive and detailed reconstruction of the historical development of the discourses; it rather focuses on central assumptions and arguments. Secondly, a heuristic typology of how to empirically analyse the various forms of knowledge and how they relate to ignorance is outlined. The argument ends with promising future direction for both empirical research as well as more theory driven considerations of the issue of natural hazards and disasters.

This paper derives from research for my PhD-thesis, which is currently written within the interdisciplinary research project FLOODsite (funded by the European Commission; GOCE-CT-2004-505420). The thesis deals with the relation of knowledge, ignorance and vulnerability both empirically and theoretically.

Knowledge and Natural Hazard Research

From the very beginning of natural hazard research in the 1940’s knowledge has played a prominent role. It is particularly Gilbert F. White, who was influenced by Harlan Barrow’s human ecology (Barrows, 1923) and John Dewey’s pragmatism (Westcoat, 1992), who positions knowledge prominently in his work. However, he does not investigate knowledge empirically; he rather conducted empirical studies to generate new scientific knowledge, which, of course, is what scientists are supposed to do. At this point it seems important to point out that White’s understanding of science goes beyond a pure self referential perceptive on scientific work. For him science is not an endeavour taking place in a somewhat distanced ivory tower where contemplation takes place for its own sake, on the contrary, science is a

means to an end – changing the world. Therefore his view on science is not so much inspired by theoretical questions; it is rather driven by the question of relevance for the wider society (White, 1972; White, 1994). Westcoat writes about White: “the test is always pragmatic: what differences do our studies make for people and environments” (Westcoat, 1992: 588). Therefore natural hazard research is supposed to answer two questions: “How does man adjust to risk and uncertainty in natural systems, and what does understanding of that process imply for public policy” (White, 1994: 5). White’s pragmatic understanding of science was directed towards public policy making and thus to the translation of scientific knowledge, generated by numerous empirical studies, to public authorities. Today White’s personal commitment is seen as a significant contribution to the reshaping of American flood management policies (Cutter, et al., 2000).

Surely one of the central empirical findings of this research tradition is the paradox of technical flood protection measures: While in the US the fiscal expenditure on flood control was rapidly increasing after the devastating 1927 Mississippi flood (Delano, 1928; Haas, 1929; Hoover, 1928; Morgan 1928), the monetary flood damages were not – as intended – decreasing, on the contrary they were constantly rising. Although this result surprised both decision-makers and the scientist themselves and was generally contrary to “public expectations” (White, 1994: 7), it did not lead to any intellectual irritation. White confines his scientific duty to point out the findings to the federal agencies and to further scrutinize human adjustments to floods, the range of choices and people’s perceptions of hazards (Kates and Burton, 1986).

Only recently have White and his colleagues started reflecting upon the deeper implications of their findings and uttered their deep puzzlement about a – still – unexpected development. In an article entitled “Knowing better and losing even more: The use of knowledge in hazards management” (White, et al., 2001) they reflect upon the relationship between losses and knowledge. In this article it is no longer the increasing amount of money spent on flood protection measures that irritate them, but rather the constant accumulation of knowledge. Despite the increase in studies that have been conducted on natural hazards and disaster, and despite an increasing volume of publication regarding this matter, the losses caused by natural disasters are not decreasing; they are still increasing.

The authors offer five different explanations for this trend. Firstly, there is still a considerable lack of knowledge; Secondly, there is enough knowledge but it is not used; Thirdly, knowledge is ineffective; Fourthly, there is a time-gap between the application of knowledge and its effects; Fifthly, knowledge is used effectively; however, there is an increase in vulnerability triggered by scale and speed of modernization and developmental processes. Nevertheless, the authors maintain their unflinching belief in the authority and superiority of science and therefore plea for a better and more efficient application of the “best available knowledge in the best possible way” (White et al., 2001: 90). In conclusion, the paradox is not primarily explainable as a matter of knowing but rather as a matter of applying: We know enough, but we do not apply our knowledge efficiently enough - this is the tenor.

In their reply entitled “Knowing Sufficient and Applying More: Challenges in Hazards Management” Weichselgartner and Obersteiner (Weichselgartner and Obersteiner, 2002) follow a similar line of argumentation, although there is one major difference with the argument of White and his colleagues. According to Weichselgartner and Obersteiner, hazard management, and more generally, natural hazards research, is mostly defined by the dominance of “technical fix” and “hard science” approaches. Representatives of this perspective restrict their notion of knowledge simply to the level of scientific expertise, other forms of knowledge are excluded. Weichselgartner and Obersteiner argue that lay people’s knowledge and experiences also offer a viable resource for reducing the damage caused by natural hazards.

This line of argumentation is offers a different perspective and follows Kenneth Hewitt critique on the “traditional paradigm” that “the prevailing scientific view of these problems is quite a recent invention” (Hewitt, 1983b: 3), which permits hazards to be treated as a problem for the advanced research of

scientists, engineers and bureaucrats. The representatives of the traditional paradigm were criticised for not taking the life-world of people and their knowledge into account.

Knowledge and Vulnerability Research

The concept of vulnerability signifies an end to the one-dimensional practice of simply focusing on the natural hazard; it emphasises, in a very general sense, that the people at risk are both of analytical and political interest. Natural disasters are not natural per se and they are by no means accidental, they are rather characteristic for the place and/or society in which they occur (Hewitt, 1983a; Hewitt, 1997; O'Keefe, et al., 1976; Bohle et al., 1994; Cannon, 2000; Mustafa, 1998). This concept attempts to acknowledge the "conditions that reduce the ability of people and places to respond to environmental threats" (Cutter, 2003: 6). It highlights the historical, cultural, social, and political processes and structures – the "root causes" - that lead to "unsafe conditions" (Blaikie et al., 1994).

However, in this analytical perspective there is the tendency to conceptualize people as weak, passive and deviant in the sense that they share similar "pathologies like or derived from, poverty, underdevelopment and overpopulation" (Hewitt, 1997: 167). Therefore approaches have been developed recently that no longer try to simply declare specific persons, groups or entire regions as vulnerable (Bankoff, 2004), but rather try to uncover how vulnerable people view their own vulnerability (Delica-Willison and Willison 2004).

Central is the notion of local knowledge - that is, stocks of knowledge which a group of people have developed in a specific environment and which has ensured its survival (Schmuck-Widmann, 2001: 36). By placing these stocks of knowledge at the forefront of the analysis, expert's knowledge is no longer judged as being the single and most important resource for reducing people's vulnerability, rather people's own knowledge and capacities that have developed through the centuries are seen as essential for reducing the impact of natural hazards on societies. It is a perspective that recognizes and appreciates that "non-Western peoples have historically developed sophisticated strategies and complex institutions to reduce the constant insecurity of their lives" (Bankoff, 2004: 32). However, with this analytical step a dichotomy opens up between place-specific local stocks of knowledge on the one hand and globally valid and universally applicable scientific knowledge on the other hand. While knowledge developed in western social sciences is often seen to be too simplistic and rather monolithic, local knowledge and capacities are seen as more adaptive and in balance with their environment and therefore as a more appropriate way of dealing with environmental threads and instabilities (cf. also Agrawal 1995).

However, there are some objections to an uncontested incantation of the central position of local knowledge. Firstly, there is a tendency to regard local knowledge as a "deus ex machina" (Antweiler, 1995: 30; cited in Schmuck-Widmann, 2001: 39). Ben Wisner, for example, directly links local knowledge to vulnerability: "I view vulnerability, to some extent, as the blockage, erosion or devaluation of local knowledge and coping capacities, or – taken together – as local capacity" (Wisner, 2004: 189). Therefore, he concludes, it is the central duty of researchers to rediscover these forms of knowledge and to empower people that they are prospectively able to regain their own knowledge.

However, one may criticise Wisner for developing a teleological notion of knowledge, which is quite close to White's conception of hazard research: While White constructs correlations between scientific knowledge and disaster reduction ("If scientists are able to better predict the contingent future, disaster will no longer occur"), Wisner constructs a correlation between the rediscovery of local knowledge and vulnerability ("If people are able to rediscover their local knowledge, disasters will no longer occur"). While the empirical basis of both authors is different (scientific vs. local knowledge), their underlying assumption is similar: "Better" knowledge results in fewer damages, eventually.

Secondly, it is debatable whether it is appropriate to emphasise the importance of local knowledge in an increasingly complex and interwoven world: "Given major rapid changes in environmental

conditions, locale (because of migration), population growth or decline (for example, because of HIV/AIDS), and economic and political change, some conventional local knowledge may no longer be applicable" (Wisner, 2004: 189). Generally, various publications on risk research point towards a fundamental change in modern societies. Particularly, the growth of publications during the 1980's and 1990's which concentrate on the issue of risk, may be read as an indicator that underlying societal structures and processes are changing and are thus increasingly interpreted as risky and uncertain. The literature shows that uncertainty (e.g. Bonß, 1995; Smithson 1989) and non-knowledge (e.g. Böschen and Wehling, 2004) are central characteristics, at least for so called modern societies. In the literature on risk and uncertainty a considerably more complex interrelatedness between various forms of knowledge and ignorance is outlined and analysed.

However, one has to keep in mind that both discourses are developed in different contexts: While on the discourse regarding vulnerability and local knowledge is empirically derived from so called developing countries (cf. also Bankoff, 2004), the discourse on risk, uncertainty and ignorance is advanced in modern societies. Nevertheless, it would be misleading and overly simplistic to assume that both spaces could be treated separately. Some authors that conducted their research in the Western world (Knorr-Cetina, 1999) and in the non-Western worlds (Evers, 1999) observe a worldwide development towards knowledge societies.

Additionally, a locality is not simply a box that invites an "analytical restriction of knowledge as bound to an artificial cut-off place, continuing to construct the 'myth of a village community'" (Albrow, 1998; cited in Müller, 2003: 330). However, to be able to capture and understand current dynamics, regardless of the context (developed vs. developing, global vs. local etc.), it is important to develop an analytical instrument that allows both an explorative investigation of the various forms of knowledge that are developed, tested and validated in a specific locality (local knowledge), on the one hand, and forms of knowledge that claim a more general not to say global validity (e.g. scientific knowledge). Before I try to outline such a heuristic typology, two authors in particular who pay attention to modern societies have to be introduced. They seem important, since they allow a reasoned categorisation of knowledge, which may allow us to better understand the complexity between different forms of knowledge as well as different forms of ignorance.

Knowledge and Ignorance in Reflexive Modernity

Anthony Giddens in his conception of reflexive modernization emphasises the importance of knowledge. In his line of argumentation modernity is defined by a highly nervous, "institutionalized reflexivity and this in a twofold sense: on the one hand, people react reflex-like on systemic processes; on the other hand, they constantly adapt their social practices to changing information and circumstances. Individuals are characterized by a decreasing ability to master reality by recurring to traditions (Giddens, 1996). While in traditional societies the relationship among people as well as between people and their environment is ordered by more or less given and standardized roles, guaranteeing an ontological security; in modern societies people have to trust that modern systems meet their expectations. Security is no longer given but rather has to be actively constructed.

Giddens defines late-modernity as a phase where the future is defined by higher degrees of contingency and this because of, not in spite of, knowledge that society accumulates about its own foundations as well as its material environment (1990; 1996). As a consequence, traditional forms of authority and knowledge are disappearing and individuals start thinking and reflecting for and about themselves. This implies also that knowledge is no longer an undisputed and simply given category. Knowledge itself becomes an object of reflection and critique.

If one relates this argument to the debate about local knowledge, a second dimension opens up: While local knowledge is rather place oriented and context bounded, reflexive knowledge is a form of meta-knowledge that is relatively free of spatial configurations. It carries the possibility of a "critical appraisal

of the world and the self" (Mead, 1934; in Matthiesen, 2005). Secondly, reflexive knowledge may be seen as an important form of knowledge with regard to vulnerability, since it allows the adaptation of people in a changing environment. However, it is a matter of empirical research to find out which groups may be reflexive in the sense of Giddens and which groups are rather excluded from modernization processes that may be described as reflexive in the sense of Giddens.

Another prominent theory to describe modern societies is Ulrich Beck's hypothesis of risk society. The risk society is characterized by the paradox of the proliferation of risk in the face of ever more stringent risk management efforts (Beck, 1992). This inevitably leads to the crisis of legitimacy of modern institutions. For Beck, "first modernity" was defined by industry, national states, classes, roles for men and women, small families, belief in technology and science etc. Although the central contours of a stated "secondary modernization" still have to be adequately thought through and defined, for Beck, internal and unintended side-effects of modernization processes are central for modern societies (1996a). It is no longer an external nature, like for example an uncontrollable river that threatens humanity and it is no longer solely the river or God that is blamed by humans, but rather the internal side-effects of the side-effects ("die internen Nebenfolgen der Nebenfolgen") that have to be taken into account. It is not mad cow disease per se (a direct side-effect of modernization: in this case, of the industrial like animal husbandry) that is of interest for his analysis but rather how certain markets, actors and responsibilities are electrified by mad cow disease (Beck, 1996a).

In contrast to Giddens, in the argumentation of Beck the role of ignorance is central. For him the unintended side-effects of modernization can be read as an observable accumulation of non-knowledge ("Nicht-Wissen") (Beck, 1996b) with the following implications: Firstly, the more societies become modern, the more they generate knowledge with regard to their foundations, dynamics and conflicts. Secondly, the more a society generates knowledge about itself and the more it applies this knowledge, the more insistent traditional constellations of actions within given structures dissolve. Traditional structures are replaced by "knowledge dependent and knowledge mediated" social structures and institutions. Thirdly, knowledge enforces decisions; it opens up situations of action. Individuals are set free of given structures and have thus to define their identities and their spaces of action under conditions of produced insecurity regarding forms and strategies of "reflected" modernization. A consequence of these side-effects of modernization processes is that conflicting systems of knowledge and rationalities emerge and this particularly on the level of expertise (cf. discussion on human-induced climate change): Knowledge about side-effects opens up a "battle field of pluralistic rationality claims" (Beck, 1996b: 299). For Beck, therefore, it is no longer knowledge that is the defining medium of reflexive modernization but rather non-knowledge.

If one relates this argumentation to White and his student's empirical research, one is able to define surprising similarities between both schools of thought. White's empirical findings can be read as an empirical proof for Beck's hypothesis of reflexive modernization processes. Technical flood protection measures are a central characteristic of the modernization process and its unintended and mostly unacknowledged side-effects are a considerable increase in monetary damages. There is, however, one central difference between both arguments: While White ultimately hopes to be able to solve pressing societal problems by applying the "best knowledge available", Beck deconstructs the very basis of such a teleological notion of knowledge. If one reads White's correlation between an accumulation of knowledge and an example of improvement (e.g. less damage) through the eyes of Beck, it turns out that the correlation is based on a wrong assumption, since it does not acknowledge the paradox that new knowledge inevitably is connected to emerging ignorance: "every state of knowledge opens up even more notions of what is not known" (Krohn, 2001: 8141). Additionally, the generation of knowledge about the occurrence of an earthquake in the city of Istanbul enforces decisions like when is the appropriate time to evacuate the city, which persons should be evacuated first, is the scientific information reliable and trustworthy, and so on. Thus White's conclusion to simply apply expert's knowledge in order to solve the

problem misses the point, since it does not theorize its side effects – that is the increase in non-knowledge inevitably interwoven with the production of knowledge.

However, both Giddens and Beck concentrate their thoughts mostly on the level of experts and organizations. The life world (“Lebenswelt”) of people, as both authors are criticized, is seldom taken into account (Wynne, 1996). Additionally, their thoughts are broad in their orientation and general in their claim. It is rather difficult to apply their thoughts to a specific context (cf. also Krücken, 1996: 185). Therefore it is necessary to more precisely define what I understand as the “known” and “unknown”.

Knowledge and Ignorance – a Heuristic Typology for an Empirical Analysis

Before developing a heuristic typology, the paper brings together the different arguments, which have been previously outlined. Generally, in the geographical discourse on hazards and vulnerability a dichotomy is made up between expert and scientific knowledge on the one hand and local and layman’s knowledge on the other hand. However, it is disputable whether this categorisation does justice to the complexity of the issue under investigation:

Firstly, there is no homogenous body of expert knowledge. Empirical work conducted on the possible consequences of a hypothesized alteration of modern societies indicates that the generation of new scientific expertise does not necessarily lead to an increasing clarity; on the contrary, stable and undisputable decision-structure seems to dissolve and to be replaced by increasing contingency and uncertainty (Beck and Lau, 2004; Funtowicz and Ravetz, 1996).

Secondly, the juxtaposition inherent in most work on hazards and vulnerability seems simplistic, since the hypothesis of a rising „knowledge society,, (Stehr, 1994) as well as the work of Giddens indicates, scientific knowledge itself is increasingly pouring into most spaces of daily life. Science and new technology are remaking the very social institutions, for example, in such areas as work, education, physical reproduction, culture, the economy, and the political system (Stehr, 1994). As a consequence scientific knowledge is displacing other forms of knowledge which were established in societal systems such as politics, economy and religion.

Thirdly and closely related to the argument at hand, it seems at least questionable whether it is empirically fruitful to emphasize the importance of local knowledge simply for normative reasons. It might be more promising to take a closer look at how other forms of knowledge (e.g. scientific, technological) penetrate, challenge and possibly replace local forms of knowledge and how hybrid constellations, which might be either productive or counterproductive for reducing vulnerable conditions, are evolving under processes of globalisation (Berking, 2004).

Fifthly, the dimension of the known and unknown should be considered more thoroughly in empirical studies on hazards and vulnerability. Current debates on modern societies and in a more general sense on the crisis of scientific knowledge (cf. also Collins and Evans, 2002) point towards an increasing relevance of the unknown. Although these debates mostly relate to the scientific uncertainties and non-knowledge associated with “new” risk (Böschen and Wehling, 2004 etc.), conceptual reflections as well as empirical studies show that this dimension may also be fruitful for more context-specific “life-world” analyses.

Summarizing some of the debate above, I will outline suggestions for how to understand and define different forms of knowledge and ignorance in a way that allows empirical investigations concerning the various interactions between different forms of knowledge and ignorance. Basis of my understanding is the work of Michael Smithson (Smithson, 1990), Ulf Matthiesen and Jochen Bürkner (Matthiesen, 2005; Matthiesen and Bürkner, 2004) as well as of Matthias Gross (Gross, forthcoming). It seems important to distinguish in a very general sense three different terms:

Information: Information is a difference, which makes a difference (Bateson, 2001). The meaning of the difference is above all dependent on the relevance structure of the respective actor, which means, firstly: without a relevance structure there is no information; secondly, different actors and different groups of actors may deduce different information from the same data (Matthiesen and Bürkner, 2004).

Knowledge: Knowledge describes an ambiguous cognitive operation with a demanding selectivity. Its main function is to categorize and select data and information within specific types of relevance. In this understanding knowledge is closely connected to the process of sense-making. It entails comparison, combination and above all dialogical practices (Matthiesen and Bürkner, 2004).

Ignorance: Ignorance should be used as an umbrella term generally pointing to the border of the limits of knowing. Thus it should be apparent that ignorance is closely related to knowledge and may be understood as knowledge about the limits of an established and existing relevance structure of an actor. It is "a type of knowledge about the limits of knowing" (Gross, forthcoming).

In the following a typology of different forms of knowledge as well as ignorance will be outlined.

A very important form of knowledge that is surprisingly often neglected or underrated within disaster and hazard research is knowledge of everyday-life: "Knowledge of everyday life and common-sense relevance structures enable us to act within life world environments and everyday praxis networks" (Matthiesen, 2005). Particularly with regard to disasters, this form of knowledge becomes virulent. Throughout their lives people gained more or less uncontested and thus stable stocks of knowledge about their natural and social environment. This knowledge is taken for granted "until further notice, that is, until its continuity is interrupted by the appearance of a problem" (Berger and Luckmann, 1967: 24). A disaster surely is an event that by definition exceeds forms of everyday knowledge that are taken for granted and has thus to be carefully examined. Taking this form of knowledge into account allows one to empirically reconstruct how well-established routines and unquestioned institutions, which are the constituting moment of an "objectified reality", define the normality which disasters seem so violently to interrupt. This form of knowledge is the basis of all other forms of knowledge.

Another important form which is usually referred to as "local knowledge" should be included. A differentiation between local knowledge and milieu knowledge seems appropriate. "Local Knowledge consists of knowledge and practical capabilities which have emerged from local conditions and natural and social surroundings, and which have often been tested over a long period of time" (Schröder, 1995: 1; cited in Schmuck-Widmann, 2001: 38). Thus it is knowledge that is bounded to the local context on the one hand and tested and gained within the local context on the other hand. Milieu knowledge is not necessarily bound to a specific spatial context, since it describes knowledge about social processes within specific milieus that may be relatively mobile (e.g. translational milieus) or relatively confined to a certain place: "Milieu knowledge circumscribes the social processes of cognising 'how things normally are going' within different social networks and milieus" (Matthiesen 2005).

Furthermore, and in line with White's concept of knowledge, expert's and professional's knowledge may be of importance with regard to natural hazards. It encompasses scientific and codified knowledge expertise and is particularly important for the analysis of the organisational level of disaster management (fire brigade, disaster protection organisations, weather forecasting etc.) as well as hazard management (spatial planning, environmental organisations etc.). It may be used by experts and decision-makers before, during and after a flood to predict precipitation, the behaviour of the river, design flood protection measures etc. Furthermore, product knowledge will be introduced as a form of technological knowledge that is narrower than expert knowledge. It is directed towards specific products: For example with regard to pumps, telephones, electricity and so on (Matthiesen 2005).

Institutional knowledge describes knowledge about how organisations and institutions are working: It is "knowledge about the systemic and functional as well as formal and informal logics of organisations and institutional arrangements. Institutional knowledge is distributed highly unequally between

different actor networks and societal strata" (Matthiesen 2005). This form of knowledge is particularly important with regard to interaction among various actors among local and regional disaster and hazards related organisations. Steering knowledge includes management and leadership knowledge and "reaches from a) steering competencies in informal (though targeted) cooperation types via b) empowering strategies for governance mode to c) formal-bureaucratic design principles of the top-down control type" (Matthiesen 2005).

The last form of knowledge is described by Giddens and his concept of reflexive modernization. Reflexive knowledge functions as a kind of meta-knowledge that operates from the knowledge of everyday life through all the other forms of knowledge described above. It may create structured interdependencies between the other forms of knowledge that enable active handlings of highly uncertain situations. An actor may be relatively open and alert with regard to unexpected events, since he is aware of the possibility of his ignorance and therefore develops adaptive survival strategies. It possibly enables an adequate translation and coupling between other forms of knowledge and may contribute to an active engagement with ignorance.

This leads directly to ignorance. Ignorance is socially constructed and dependent of the standpoint of the social actor the scientist observes. Thus, ignorance is not understood as some kind of distorted form of true knowledge; there exists no objective form of knowledge and ignorance. Both are understood as a perspective-dependent constellation: One persons' ignorance may be the others person's knowledge. "A is ignorant from B's viewpoint if A fails to agree with or show awareness of ideas which B defines as actually or potentially valid" (Smithson, 1990: 209). However, this argument is rather to be understood as an illustration, since – of course – questions of power and interpretational sovereignty („Deutungshoheit“) become virulent with regard to the validity of knowledge. This has to be kept in mind, when one starts researching questions of ignorance.

Most work on natural hazards, as Watts points out, is based on an "assumption of individual purposeful rationality expressed through a tripartite cybernetic structure: (a) hazard perception, (b) recognition of alternative-adjustments, (c) choice of response" (Watts, 1983: 240). As a result, individuals are understood as rationalistic atoms, defined by imperfect knowledge and acting in a societal space that is without structure and institutions. Watts concludes that maladaptation in this context is simply a function of insufficient knowledge, distorted perception and inflexible decision-making (Watts, 1983: 241).

Therefore, the term "ignorance" does not point towards wrong knowledge or the intentional and conscious disaffirmation of knowledge, it is thus not interested in a specific "state of mind"; it is above all a term pointing to the borders of knowing and thus emphasizes the dynamic interrelatedness of knowing and not knowing (Gross, forthcoming). However, an actor can deal in a very broad sense with these borders of the known. Firstly, he may be aware of them and try to gather more information to become more familiar with a specific topic, which is still "outside" his personal knowledge system, but which he, nevertheless, considers as important to know. According to Schütz a specific topic becomes "thematically relevant" when it exceeds the knowledge of everyday life and when it is considered as important (Schütz 1991). If risky or life-threatening decisions have to be made such a situation may occur. In such a case ignorance is taken into account and further information is gathered. This process may therefore be named non-knowledge.

It should be emphasized that the importance of taking the unknown into account is at the very basis of the concept of resilience as outlined by Holling on his piece on "Myths of Ecological Stability". By translating Häfele's German word "Schlagabsorptionsfähigkeit" (first strike absorption capacity) into the somewhat more convenient word resilience, he added a fourth myth of how scientists conceptualize the stability of eco-systems. While "nature benign" is a myth, which understands nature as friendly and infinitely forgiving, and "nature ephemeral" a myth which can be seen as its counterpart, that is a unstable and fragile nature, "nature tolerant" understands nature as friendly, at least to a certain stage; after a tipper point is passed the entire system is becoming fragile and may collapse eventually.

Somewhat distinct from the previous three myths is the fourth myth: He introduces "nature resilient" pointing towards the absorption capacity of a system by even utilizing or benefiting from change. "Such a myth explicitly recognizes the unknown and the ability to survive and benefit from failures" (Holling, 1978:104).

A second way of dealing with the border of the known is by defining a new topic, which exceeds routines, as unimportant or even as dangerous. This may be labelled negative knowledge (Knorr Cetina, 1999). This dimension is surely a central dimension with regard to disasters. However, which processes lead to more or less consciously negating dangers is one for empirical research.

Conclusions and Outlook

This paper has attempted to reconstruct different perspectives regarding knowledge and ignorance within academic discourses on hazards, risks and disasters and has attempted to develop a heuristic typology allowing empirically driven work on the various interrelations of knowledge and ignorance. The following points seem particularly fruitful to consider in such investigations.

Firstly, to assume that disasters may be hindered and/or mitigated by simply applying "knowledge" seems misleading, since knowledge is always in one way or the other applied; it is more important to ask: "Which knowledge is applied by which means and to which end?" Secondly, it may be more appropriate, considering the current global dynamics, to not simply focus on local knowledge, but to rather take into account the interrelation of rather localized forms of knowledge (e.g. local knowledge and milieu knowledge) with more dis-embedded forms of knowledge. Thirdly, reflexive forms of knowledge seem, at first sight, promising with regard to the vulnerability of people, since this form of knowledge may facilitate a constant adjustment to changing environments, which means – in the end – everything and anything can be expected, and thus disasters are no longer possible. Holling's myth of a "nature resilient" points towards such an understanding of adaptive openness towards radically new and unknown situations. However, this depends upon a degree of reflexivity and flexibility, which may not be thinkable and, more importantly, practical for everyone. Therefore it has to be more critically examined whether Giddens hypothesis is valid for describing, quasi homogeneously, modernity as a reflexive epoch. It seems more promising to develop a more differentiated perspective on modernization processes, which asks which groups may be able to develop a reflexive stand in the sense of Giddens and which groups rather not.

To be sure, this typology offers merely an initial overview regarding possible interrelations and dynamics; nevertheless the topic seems worth pursuing considering current changes both on a global and also on a local level. To understand and grasp these alterations a dynamic understanding is necessary, allowing one to take into account the dimension of forgetting, the dimension of learning, as well as the limits of our understanding of the world, which we are at the same time part of.

References

- Agrawal, A. (1995): Dismantling the Divide between Indigenous and Scientific Knowledge. In: *Development and Change*, vol. 26, no. 3, pp. 413-440.
- Albrow, M. (1998): *Abschied vom Nationalstaat*. Suhrkamp, Frankfurt a.M.
- Antweiler, C. (1995): Lokales Wissen: Grundlagen, Probleme, Bibliographie. In: Honerla, S; Schröder, P. (Eds.), *Lokales Wissen und Entwicklung. Zur Relevanz kulturspezifischen Wissens für Entwicklungsprozesse*, Verlag für Entwicklungspolitik, Saarbrücken, pp. 19-52.
- Bankoff, G. (2004): The Historical Geography of Disaster: „Vulnerability“ and „Local Knowledge“, in Western Discourse. In: Bankoff, G.; Frerks, G.; Hilhorst, D. (Eds.), *Mapping Vulnerability: Disasters, Development and People*. Earthscan, London, pp. 25-37.

- Barrows, H. H. (1923): Geography as Human Ecology. In: *Annals of the Association of American Geographers*. vol. 13, no. 1, pp. 1-14.
- Bateson, G. (2001): *Ökologie des Geistes: Anthropologische, psychologische, biologische und epistemologische Perspektiven*. Suhrkamp Verlag, Frankfurt a.M.
- Beck, U. (1992): *Risk Society*. Sage, London.
- Beck, U. (1996a): Risk Society and the Provident State. In: Lash, S.; Szerszynski, B.; Wynne, B. (Eds.), *Risk, Environment and Modernity: Towards a New Ecology*. Sage Publications, London, pp. 27-43.
- Beck, U. (1996b): 'Wissen oder Nicht-Wissen? Zwei Perspektiven reflexiver Modernisierung', In: Beck, U.; Giddens, A.; Lash, S. (Eds.), *Reflexive Modernisierung: – Eine Kontroverse*. Suhrkamp, Frankfurt a. M., pp. 289-315.
- Beck, U.; Lau, C. (2004): *Entgrenzung und Entscheidung*. Suhrkamp, Frankfurt a.M.
- Berger, P.; Luckmann, T. (1967): *The Social Construction of Reality: A Treatise in the Sociology of Knowledge*. Anchor Books, New York.
- Berking, H. B. (2004): Typen der Globalisierung lokaler Wissensbestände. In: Matthiesen, U.; Bürkner, H.-J. (Eds.), *Stadtregion und Wissen: Analysen und Plädoyers für eine wissensbasierte Stadtpolitik*. VS Verlag für Sozialwissenschaften, Wiesbaden, pp. 43-53.
- Blaikie, P.; Cannon, T.; Davis, I.; Wisner B. (1994): *At Risk: Natural Hazards, People's Vulnerability, and Disaster*. Routledge, London and New York.
- Bohle, H.G.; Downing, T.E.; Watts, M. (1994): Climate Change and Social Vulnerability: The Sociology and Geography of Food Insecurity. In: *Global Environmental Change*, vol. 4, pp. 37-48.
- Bonß, W. (1995): *Vom Risiko: Unsicherheit und Ungewißheit in der Moderne*. Hamburger Edition HIS Verlagsges. mbH., Hamburg.
- Böschen, S.; Wehling, P. (2004): *Wissenschaft zwischen Folgenverantwortung und Nichtwissen*. Verlag für Sozialwissenschaften, Wiesbaden.
- Cannon, T. (2000): Vulnerability Analysis and Disasters. In: Parker D.J. (Ed.): *Floods, Vol. 1*. Routledge, London and New York.
- Collins, H. M.; Evans, R. (2002): The Third Wave of Science Studies: Studies of Expertise and Experience. In: *Social Studies of Science*. vol. 32, no. 2, p. 235-296.
- Cutter, S. L.; Mitchell, J. T.; Scott, M. S. (2000): Revealing the Vulnerability of People and Places: A Case Study of Georgetown County, South Carolina. In: *Annals of the Association of American Geographers*. vol. 90, no. 4, pp. 713-737.
- Cutter, S. L. (2003): Presidential Address: The Vulnerability of Science and the Science of Vulnerability. *Annals of American Geographers*. vol. 93, no. 1, pp. 1-12.
- Cutter, S. L.; Boruff B. J.; Shierly, W.L. (2003): Social Vulnerability to Environmental Hazards. *Social Science Quarterly*. vol. 84, no. 2, pp. 242-261.
- Delano, F. A. (1928): The Report of the Committee on Mississippi Flood Control Appointed by the United States Chamber of Commerce. In: *The Annals of the American Academy*. vol. 135, pp. 25-33.
- Delica-Willison, Z; Willison, R. (2004): Vulnerability Reduction: A Task of the Vulnerable People Themselves. In: Bankoff, G; Frerks, G.; Hiljhorst, D. (Eds.): *Mapping Vulnerability: Disasters, Development and People*. Earthscan, London, pp. 145-158.
- Evers, H.-D. (1999): *Globalisierung der Wissensgesellschaft – Ansätze einer neuen Entwicklungstheorie*, Working Paper No. 310. Sociology of Development Research Centre, University of Bielefeld, Bielefeld.

- Funtowicz, S. O.; Ravetz, J. R. (1996): Risk Management, Post-Normal Science, and Extended Peer Communities. In: Hood, C.; Jones, D. K. C. (Eds.), *Accident and Design – Contemporary Debates in Risk Management*. UCL Press, London, pp. 172-181.
- Giddens, A. (1990): *The Consequences of Modernity*. Stanford University Press, Stanford.
- Giddens, A. (1996): Leben in einer posttraditionalen Gesellschaft. In: Beck, U.; Giddens, A.; Lash, S. (Eds.): *Reflexive Modernisierung: Eine Kontroverse*. Suhrkamp, Frankfurt a.M., pp. 113-194.
- Gross, M. (Forthcoming): The Unknown in Process: Dynamic Connections of Ignorance, Non-Knowledge and Related Concepts. In: *Current Sociology*. vol. 55, no. 5.
- Haas, W.H. (1929): The Mississippi Problem – A Conflict in Economic Emphasis. In: *The Annals of the American Academy*, vol. 19, pp. 1-7.
- Hewitt, K. (Ed.) (1983^a): *Interpretation of Calamity: From the Viewpoint of Human Ecology*. Allen & Unwin, Boston.
- Hewitt, K. (1983^a): The Idea of Calamity in a Technocratic Age. In: Hewitt, K. (Ed.): *Interpretation of Calamity: From the Viewpoint of Human Ecology*. Allen & Unwin, Boston, pp. 3-32.
- Hewitt, K. (1997): *Regions of Risk: A Geographical Introduction to Disasters*. Longman, Essex.
- Holling, C.S. (1978): Myth of Ecological Stability: Resilience and the Problem of Failure. In: Smart, C.F.; Stanbury, W.T. (Eds.): *Studies on Crisis Management*. Butterworth & Co. Ltd., Toronto, pp. 93-106.
- Hoover, H. H. (1928): The Improvement of Our Mid-West Waterways. In: *The Annals of the American Academy*, vol. 135, pp. 15-24.
- Kates, R. W.; Burton, I. (1986): *Geography, Resources and Environment: Vol 1.: Selected Writings of Gilbert F. White*. Chicago University Press, Chicago.
- Knorr Cetina, K. (1999): *Epistemic Cultures: How the Science Makes Knowledge*. Harvard University Press, Cambridge.
- Krohn, W. (2001): Knowledge Societies. In: Smelser, N. J. Baltes, P. B. (Eds.): *International Encyclopaedia of the Social and Behavioral Sciences*. Blackwell, Oxford, pp. 8139-8143.
- Krücken, G. (1996): Der soziologische Ansatz der Risikoforschung. In: Banse, G. (Ed.): *Risikoforschung zwischen Disziplinarität und Interdisziplinarität. Von der Illusion der Sicherheit zum Umgang mit Unsicherheit*. Edition Sigma, Berlin, pp. 185-192.
- Matthiesen, U. (2005): *KnowledgeScapes: Pleading for a Knowledge Turn in Socio-spatial Research*. IRS-Working Paper. <<http://www.irs-net.de/download/KnowledgeScapes.pdf>>, 1 February 2006.
- Matthiesen, U.; Bürkner, H.-J. (2004): Wissensmilieus: Zur sozialen Konstruktion und analytischen Rekonstruktion eines neuen Sozialraum-Typus. In: Matthiesen, U. (Ed.): *Stadtregion und Wissen*. VS Verlag für Sozialwissenschaften, Wiesbaden, pp. 65-89.
- Mead, G.H. (1934): *Mind, Self and Society*. The University of Chicago Press, Chicago.
- Morgan, E. Arthur (1928): A Policy for the Mississippi. In: *The Annals of the American Academy*. Vol. 135, pp. 50-56.
- Müller, C. (2003): Knowledge between Globalization and Localization: The Dynamics of Female Spaces in Ghana. In: *Current Sociology*. Vol. 51, no.3/4, pp. 329-346.
- Mustafa, D. (1998): Structural Causes of Vulnerability to Flood Hazard in Pakistan. In: *Economic Geography*. Vol. 74, no. 3, pp. 289 - 306.
- O'Keefe, P.; Westgate, K.; Wisner B. (1976): Taking the Naturalness out of Natural Disasters. In: *Nature*. Vol. 260, pp. 566-67.

- Schmuck-Widmann, H. (2001): *Facing the Jamuna River: Indigenous and Engineering Knowledge in Bangladesh*. Bangladesh Resource Centre for Indigenous Knowledge (BARCIK), Lalmatia, Dhaka.
- Schröder, P. (1995): Lokales Wissen als konstruktives und kritisches Potential für die Entwicklungszusammenarbeit. In: Honerla, S; Schröder, P. (Eds.): *Lokales Wissen und Entwicklung. Zur Relevanz kulturspezifischen Wissens für Entwicklungsprozesse*. Verlag für Entwicklungspolitik. Saarbrücken, pp. 1-16.
- Schütz, A. (1991): *Der sinnhafte Aufbau der sozialen Welt*. Suhrkamp, Frankfurt a.M.
- Smithson, M. (1989): *Ignorance and Uncertainty: Emerging Paradigms*. Springer, New York.
- Smithson, M. (1990): Ignorance and Disaster. In: *International Journal of Mass Emergencies and Disaster*. Vol. 8, no. 3, pp. 207-235.
- Stehr, N. (1994): *Knowledge Societies: The Transformation of Labour, Property and Knowledge in Contemporary Societies*. Sage, London.
- Watts, M. (1983): On the Poverty of Theory: Natural Hazards Research in Context. In: Hewitt, K. (Ed.): *Interpretation of Calamity: From the Viewpoint of Human Ecology*. Allen & Unwin, Boston, pp. 231-262.
- Weichselgartner, J.; Obersteiner, M. (2002): Knowing Sufficient and Applying More: Challenges in Hazards Management - Short Communication. In: *Environmental Hazards*. Vol. 4, pp. 73-77.
- Westcoat, J. L. J. (1992): Common Themes in the Work of Gilbert White and John Dewey: A Pragmatic Appraisal. In: *Annals of the Association of American Geographers*. Vol. 82, no. 4, pp. 587-607.
- White, G. F. (1972): Geography and Public Policy. In: *The Professional Geographer*. Vol. 24, no. 2, pp. 101-104.
- White, G. F. (1974): Natural Hazards Research: Concepts, Methods, and Policy Implications. In: White, G. F. (Ed.), *Natural Hazards: Local, National, Global*. Oxford University Press, New York, pp. 3-16.
- White, G.F. (1994): Natural Hazard Research. In: Cutter, S. L. (Ed.): *Environmental Risks and Hazards*. Prentice Hall, Upper Saddle River, pp. 4-17. (Reprinted from Chorley, R.J. (Ed.) (1973): *Directions in Geography*. Methuen, London, pp. 193-216.
- White, G. F.; Kates, R.; Burton, I. (2001): Knowing Better and Losing Even More: the Use of Knowledge in Hazards Management. In: *Environmental Hazards*. Vol. 3, pp. 81-92.
- Wisner, B. (2004): Assessment of Capability and Vulnerability. In: Bankoff, G.; Frerks, G.; Hilhorst D. (Eds.): *Mapping Vulnerability: Disasters, Development and People*. Earthscan, London, pp. 183-193.
- Wynne, B. (1996): May the Sheep Safely Grace? A Reflexive View of the Expert-Lay Knowledge Divide. In: Lash, S.; Szerszynski, B.; Wynne, B. (Eds.): *Risk, Environment and Modernity: Towards a New Ecology*. Sage Publications, London, pp. 44-83.

1.2 Being Temporal and Vulnerability to Natural Disasters

Danny H. de Vries

Abstract

The temporal dimensions of social vulnerability to natural or man-made hazards are increasingly recognized. Typically temporality is understood in a historicist manner, wherein the changes in vulnerability are dynamically mapped over a (multiscalar) linear time. This paper investigates how cultural models of historical ecological conditions – grounded in “being in time” or dwelling – might influence vulnerability. Focusing on qualitative and historical research in six U.S. floodplain communities the question is raised how cultural biases in temporal referentiality motivate maladaptive histories to be maintained at the expense of accurate estimations of future conditions. The results identify four dwelling scales of biases, including: disbelief of disaster histories (cognitive level); casual amnesia (social psychological level); erosion of memory networks (cultural level); and historical or scientific uncertainty (epistemological level). A schematic model is presented and recommendations are provided for the active management and maintenance of historical ecological knowledge among at risk populations.

Introduction

Being Temporal

We are suspended in time. We float in successive moments through an abstract current which we call “time”. When we create expectations about the future conditions of this current, we do this by *referencing* what we (or our consultants) have learned from moments in the past. The word “reference” comes from the Latin *referre*, or “to bring back.” And this is what we do: we bring back the past in order to evaluate or anticipate the future. However, as cultural beings this effort is not unproblematic. We do not all chose to bring back the past in the same way. We also do not all have access to consultants and experts providing us information about the past in the same way. In other words, our “temporal referentiality” is prone to bias, even when our notion of what the past was like seems coherent and logical to us. What we have are “cultural models” of the past; explanatory systems which connect parts and emulate relationships among mental constructs. Cultural models which enable prediction and explanation, and are cultural because they are shared and reproduced within a culture (Holland and Quinn 1987). An extreme example of how different such temporal referentiality models can be is illustrated by the case of the Aymera Indians of Peru, who apparently see the future behind them and the past in front (Nunez and Sweetser 2006). This radical reversal of temporal referentiality illustrates that what it means to “be temporal” can dramatically differ across communities. Or, in other words, how “being temporal” is a cultural construction. In this paper I explore how six different floodplain communities in the U.S.A. “brought back” past ecological conditions. How successful were they in reconstructing their historical ecology? Successful enough to be able to be prepared, warned, aware of the potential hazards that might come their way? Misinformed and ignorant? Based on my results, I argue that this latter condition of ignorance is one in which temporality, as a cultural model (not as a process), can affect the vulnerability of a population to hazards. Simply said, this is because ignorance of past conditions brings proneness to surprise. It is in this way that “temporality,” the condition of being temporal or bounded in time, if not adequately cherished and managed, becomes our enemy.

Vulnerability researchers and policy-makers have increasingly shown an interest in the relationship between temporality and vulnerability. Yet, the way in which temporality is conceptualized generally differs from the subjective, culturally situated perspective I have just introduced, instead focusing on temporality as a process. If temporality is mentioned at all, it almost without exception is from the point of view of those studying disasters and explaining vulnerability and embracing the popular notion that temporality refers to a form of “objective” time against which the level of vulnerability can be “mapped”

and understood. Most common in this respect is the suggestion that vulnerability is intrinsically dynamic: "Vulnerability *changes continuously over time* and is driven by physical, social, economic and environmental factors" (Thywissen 2005:34, italics added). More recently, the influence of nonlinear ("new") ecology has suggested that this dynamic temporality actually has multiple scales of analysis, "ranging from a leaf to the biosphere over periods from days to geologic epochs, and from the scales of the family to a socio-political region over periods from years to centuries" (Holling 2001:392). In the cutting edge of vulnerability research, this dynamic and multiscale temporal highway against which changes in the level of population vulnerability to hazards can be measured becomes the condition for rigorous historical analysis aimed at understanding causal or root conditions of vulnerability and to carry out a critique of social reality (Hoffman and Oliver-Smith 2001). What all these different conceptualizations of temporality have in common is a reliance on the notion that time moves at different speeds and that vulnerability changes accordingly, along a multiscale temporal "highway" (sidewalk-bikepath-road) that stretches from the past to the present. Historiographers would call such an understanding of time to be "historicist." It is a conceptualization of temporality where its vulnerability component remains outside of "us".

While the historicist view is without a doubt crucial and significant if any progress is to be made in solving the causal issues leading to social vulnerability, it is not a complete picture of what the study of temporality can bring to vulnerability research. In this paper I will take a fundamentally different perspective on temporality by focusing on cultural models of historical ecological knowledge (or referentiality). Historiographers have described such a view as "presentism": the analysis of the past in which cultural assumptions of the present are taken as starting point (Stocking 1965, Kuhn, 1970, Kragh, 1989). But while the notion of presentism in historiography is routinely attacked for being biased and leading to false histories, it is precisely this cultural bias which is central to the question posed: how does the way in which cultural communities bring back the past to anticipate the future create conditions of vulnerability to natural or man-made hazards? At its core, this question concerns a preoccupation with the boundaries of temporal knowledge that flows from our cultural engagement with the landscape. The anthropologist Tim Ingold suggests that the landscape – as a site of vulnerability to natural disasters – is constituted as an enduring record of, and testimony to, the lives and works of past generations who have dwelt within it, and in so doing have left there something of themselves. From this "dwelling perspective," the presumed continuity between mind and world "privileges the understandings that people derive from their lived, everyday involvement in the world" (Ingold 1993:152).

Taking this dwelling frame of reference, the answer to the question how population vulnerability increases by being in time or bounded by time is not sufficiently answered by noting that it is because vulnerability is "dynamic" or "multiscale". Those are descriptions of our view of what temporality is as seen from the outside, in an objective, historicist view. What it does not do is provide us information about how the condition of "being temporal" *acts* to increase a population's vulnerability to hazards. Turner et al. (2003) in this respect point out that multiscale of the human-environment system can cause an increase in social vulnerability because of a failure on behalf of analysts or decision makers to acknowledge larger temporal scales of operation of the systems they are trying to manage:

Analysts must remain aware that vulnerability rests in a multifaceted coupled system with connections operating at different spatiotemporal scales and commonly involving stochastic and nonlinear processes. Failure to consider this larger context could lead to the identification of "response opportunities," which, if implemented, lead to significant unintended consequences or "surprise" (Turner et al. 2003).

I argue that increased population vulnerability is not so much the result of the multiscale of the coupled system – this is a mere reality we cannot alter and thus has no policy implication by itself – but instead the result of (opportunistic) human failure to *acknowledge* or *remain aware* of the larger

temporal context in policy decisions. In an analogous case, would it be correct to argue that economic vulnerability is caused by “macro-economics” instead of “poverty”? While macro-economics can be used to theorize, describe, and explain poverty, the problem causing population vulnerability to hazards remains poverty, not the existence of macro-economics. At issue is decision making, dwelling, temporal referentiality, and its relationship to historical ecological knowledge, but not objective time itself. In a footnote Turner et al. point out that surprise occurs when the “event, process, or outcome departs from the expectations of the observing community or those affected by the event or process” (ref. 84:172). From this, I believe it is possible to derive a manageable focus for the question of how cultural models and historical ecological knowledge link to population vulnerability: it relates to how human societies socially construct their risk expectations and issues of surprise.

Expectations and Surprise

Social psychologists have traditionally taken an experimental lead in trying to understand how expectations influence decision making, and have identified a number of universal heuristics (underlying principles of belief) concerning the projected likelihood of (hazard) events. The major conclusion from this line of work is that humans can be seen as cognitive cripples and vulnerable to making unwise decisions about the probabilities of events (Tversky and Kahneman 1987). The implied connection to temporality includes, for example, a temporal bias, wherein the human psyche magnifies the importance of events that are close in time (and space), while diminishing the importance of temporally more distant events. Yet, the suggested universality of our cognitive biases only partially explain how surprise might develop from a dwelling perspective. Personal involvement and experience with hazard events is not only influenced by cognition, but also mediated through cultural frames of reference.

Sociologists and anthropologists commonly point at forms of memory as constituting key elements of cultural models. Such shared, cultural memory acts as a valuable way of storing and transmitting knowledge about hazards from one generation to another through practices, images, stories, symbols, beliefs, and landscape design (Gunn 1994, Crumley 1998, McIntosh et al. 2000). Many institutions specialize in the storage of cultural memory, including historical archives, news organizations, and government agencies. All of these combine to provide a complex memory network, a memory bank if you will, which act as an important determinant in the provision of historical ecological knowledge and resulting hazard expectations.

Expectations about future events are also dependent on the capacity of environmental monitoring institutions. Monitoring is generally considered the activity of following the development of parameter(s) of concern in time and (sometimes) space. Environmental monitoring networks or laboratories usually sample cost-effective environmental indicators with the aim of identifying ecosystem trends and vulnerabilities and characterize drivers of change. In comparison to cultural memory, the strength of conventional scientific monitoring is in the collection of synchronic (simultaneously observed) data, in contrast to the depth or length of time-series of local observations held by cultural memory (Berkes and Folke 2002).

Expectations about future hazards then are formed by “cognitive cripples” who rely on complex memory-networks and (if accessible) sophisticated monitoring schemes to refer back to the past events in evaluating likelihood. The extent to which this effort succeeds is not only reliant on the complexity of the temporal environment itself – multiscalar, dynamic – but also the maturity or careful management of cultural memory and environmental monitoring by the communities. When cultural models of past events and conditions accurately portrays objective conditions and provide meaningful significance to stakeholders, future expectations are more realistic. On the other hand, when cultural models of past events are inaccurate relative to objective risks involved, maladaptivity is encouraged, and in this case the likelihood of surprise is increased.

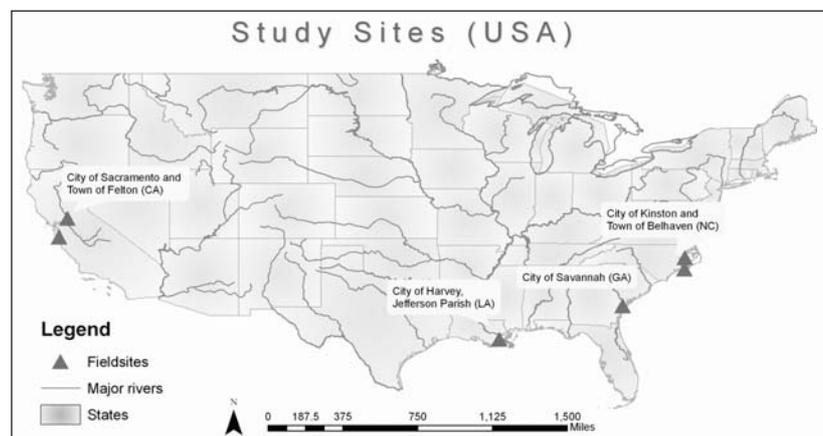
In order to avoid maladaptive situations where perceived historical ecological knowledge systems and objective reality are widely divergent, research is needed on how cultural models of temporal knowledge work, are maintained, or changed to the benefit of the population at risk. How does maladaptivity of the temporal model within an at-risk population develop? What corrupts temporal information? When do we disbelieve historical data? How do cultural models of temporality develop? Is there a specific grammar or narrative which might promote resilience and adaptivity? Guided by such research questions, this paper elaborates on findings which resulted from dissertation research in historical ecology using examples from floodplain histories across the United States.

Method

Historical ecologists study the human-environmental dialectic through regionally documented ethnography, archaeology, natural sciences, and historical evidence. Focusing on systems as totalities with multiple spatial, temporal, and cognitive scales of analysis, the aim of historical ecologists is to connect the human dimensions of culture and experience to the ecological realities of complex, nonlinear systems (Crumley 1994, Marquardt and Crumley 1987). Using this framework, the research methods included qualitative interviews and historical research in order to obtain knowledge on what decision makers, evaluators, residents or other stakeholders actually understand or know about the history of their landscape, how this historical knowledge is constructed by scientists and experts, how this narrative is influenced and translated by media and other communication channels, and how it finally shapes risk expectations among stakeholders.

Borrowed from Actor-Network Theory (Latour 1988, 1999), the methodology includes an emphasis on the concept of referentiality. Derived from linguistics and philosophy, to refer is a term that is used to call attention to something. In our daily use of the word, a reference signifies a course of information or a quoted passage in a text. Applied to documents, Latour suggest that a reference does not designate an external referent that will be meaningless (as in a lifeless object), but instead is our way of keeping something constant through a chain of transformations. Thus, when a piece of Amazonian soil is referenced, it connects the actual material with an academic text referring back to it. Referencing thus designates the quality of this chain in its entirety. Applied to temporality, references generally orient people. In the minds and lives of those who experienced a hazard event, the event becomes a permanent marker, a point of reference with which to position other events in time and with which to measure their significance (Alexander 2000). Focusing on temporal references, the extent and form of historical ecological knowledge can be identified. Temporal references are expressed in the present yet relate to the past and as such bring the past back into the present. They are an important element in how people generally “make sense” of their immediate temporal environment. An analysis of temporal references helps understand how people share a common understanding of the past and where this information comes from. Thus, when aiming to analyze cultural models of the environment, I have particularly focused on how people use temporal references to calibrate (or orient) their risk perception, and in particular how references to surprise and shock are temporally embedded.

Data for this research was gathered during two years of intermittent ethnohistoric fieldwork and documentary research centered upon stakeholders in various floodplain localities across the U.S.A., shown in Map 1.



Map 1

The localities studied included residents and mitigation managers from neighborhoods in the City of Harvey (Jefferson Parish, Louisiana), City of Savannah (Georgia), City of Kinston and Town of Belhaven (North Carolina), the Town of Felton in Santa Cruz County and city of Sacramento (California). The criteria for choosing these sites included the historical depth (both long term and relatively short colonization), biophysical diversity (riverine and coastal), and high number of repetitively flooded households. Documentary research includes archival and newspaper research. In total, twenty-three residents and twelve local or state level officials engaged in floodplain mitigation or management were interviewed, some multiple times. Interviews were transcribed and analyzed using Nvivo qualitative analysis software.

Results

Temporal Dwelling Scales

Generally, the results of the data analysis were classified in four different “dwelling” scales, all dealing with the temporal dimensions of vulnerability seen from the perspective of historically situated populations vulnerable to surprise. The identified temporal dwelling scales include: 1) Disbelief of Disaster Potentiality; 2) Casual Amnesia; 3) Erosion of Memory Networks; and 4) Historical or Scientific Uncertainty. The topics qualitatively highlighted in each of these scales in this paper are listed in Table 1.

Table 1: Identified Temporal Dwelling Scales

Disbelief of Disaster History (cognitive)	Casual Amnesia (social psychological)	Erosion of Memory Networks (cultural)	Historical or Scientific Uncertainty (epistemological)
The rare “fluke” event or lack of sequential flooding	Short-term salience of flood events to daily life	Loss of Intergenerational Memory	Settlement in new landscapes for which no temporal information is known
Public ambiguity of recurrence interval (Gambler’s Fallacy)	“Blackboxing” of event due to trauma	Complacency	Lack of historical archives
Inability to recognize seasonal flood cycles in landscape	Intentional forgetting due lack of alternative settlement options	The influx of outsiders	Lack of monitoring and evaluation of long-term and immediate changes in environmental conditions
Primacy of experience	Flooding as a way of life	High planning and mitigation staff turnover rates	Lack of communication through geographic isolation
Outdated baseline referentiality	False sense of security through technological optimism		Lack of historical accurate floodplain mapping
Normalcy bias	Belief that the government will eventually fix the problem		

Using excerpts from interviews and observations across the field sites, I will briefly describe each of the elements listed in Table 1.

Disbelief of Disaster History

There is a number of temporal factors which motivate the notion that the potential for a hazard is lower than it actually is. Already pointed out in the introduction are the psychological mechanisms underlying our cognitive capacity (Tversky & Kahneman 1978). Here I summarize how the temporality of some hazard events appeared to have influenced a culturally shared disbelief in the potential for future flooding, as such increasing vulnerability.

One such factor is the notion of “the fluke.” An example of this is the occurrence of flooding due to Hurricane Fran in 1996 in eastern North Carolina after the 32-year lull in flooding. While people had presumed that the flood control measures resulting from a new upstream dam had made an impact, the fact that they were flooded at a level higher than ever before appeared so unlikely that it was not taken very seriously. Unfortunately, it was only three years later that the inaccuracy of this notion was shown when Hurricanes Dennis and Floyd caused a disaster which exceeded Fran multiple times. A similar experience comes from the City of Savannah on a smaller temporal scale. While the 1995 flood event was still recent, a brief torrential rain in June of 1999 had a severe and very unexpected impact with no precedent. A local mitigation manager notes: “I think the 1999 event was just so extraordinary and had just not been experienced prior to that, that people were thinking ‘Oh, it is not going to happen again.’” (City of Savannah Official, 2005). The notion of the fluke seems to counter perceived potentiality for surprise because the event is not taken as part of a series of sequential events, but somehow seen as “outside” the normal. As explained by a Savannah city official, sequential events in particular appear to heighten the impact of concern after flooding:

Official: The history is critical. If there is a series that maintains community memory, everybody would probably be a little bit more cautious.

Interviewer: What do you mean by series?

Official: Sequential events that happen and that if those are strung together closely enough then people will go ‘oh.. these things need to be... we need to think about this risk. We should not build in this spot.’
(City of Savannah Official 2005)

While theoretically the likelihood of sequential events is entirely stochastic because the likelihood of any event is the same in each year, communication problems often occur between engineers and managers explaining this phenomenon to the general public. While engineers typically label the statistical calculation that an event has a likelihood of recurring 1% each year as a “100 year event,” the public persistently takes this to mean that if a 100 year event happens, it will be another 100 years before it happens again. This gambler’s fallacy can cause serious issues of mistrust between mitigation managers and the public, as illustrated in the case of the three 100 year flood events occurring in 1995, 1996, and 1999 floods in the City of Savannah: “People think it won’t happen again for 10 years or for 100 years. And so, when we had these events occurring in a close period of time, the public begins to mistrust us” (City of Savannah Planning Officials 2005).

Disbelief of the potential of flooding is also caused by a lack of experience among those seeking to purchase properties to recognize (seasonal) flood features in the landscape. This is particularly so in flash flood environments such as Felton Grove in Santa Cruz County, where the speed of transition from a small creek to a raging river can be overwhelming. A local mitigation official notes:

People build and buy in places where they don’t notice the little creek and the 12 foot beam across the little creek, and the four feet diameter redwood log that floated up on top of it. They just don’t have any situational awareness of what the winter storms in particular can do here. And the next winter they come in and say ‘nobody told me’ (Santa Cruz County Mitigation Official 2004).

As one resident remarked, the discrepancy between these landscape features and the told reality simply does not sink in until people experience it themselves. When it concerns an unimaginable event such as flooding that turns normality upside down, experience has primacy:

There is a difference between “man, it really floods here and that is not a good thing” and actually seeing it and being there. Because it is an experience you won’t, you cannot fathom what it is like and how fast it happens (Felton Grove Resident 2005).

The results further suggest that people tend to adhere to certain historical analogs as temporal reference points used to evaluate future risk. When this baseline referentiality is outdated or not indicative of the potential magnitude of events, temporal vulnerability is enhanced, because expectations are undermined by unknown or not experienced potentialities hidden in the human-environmental dynamic. An example comes from the situation in Jefferson Parish. When speaking with the Parish mitigation official, it appeared that the baseline reference for a hurricane type event impacting the City of New Orleans used by him and his colleague was Hurricane Betsy in 1964. This historical analog provided the experiential knowledge that provided a model of what to expect; the impacts of this event seemed to set the boundaries for the height of concern. Amongst all the floods, Betsy stood out as rare and significant:

That was a unique situation, grade three or four hurricane that came into the Gulf at the worst possible time. And it put water over our levees outward from the canals, just went over the levels, hours of storm surge, with nowhere to go (Jefferson Parish Mitigation Official 2004).

However, while Hurricane Betsy created severe damage in 1964, its impact was incomparable to the devastation which Hurricane Katrina left behind in August, 2005. Although scenarios of Katrina had been provided, the adherence to Betsy as the baseline temporal flood reference set the stage for a disbelief in the potentiality of Katrina-style flooding in the area. Several near-misses in the period after Betsy did not alter this perception and instead supported this notion of the temporal uniqueness of Betsy. To some, adherence to such outdated notions of what is possible in fact is a way of survival. Particularly elderly people are prone to support a normalcy bias in which the increasing speed with which landscape changes have occurred in the past decades since old age set in are often ignored to the benefit of cognitive stability. A Jefferson Parish resident active in levee monitoring, himself a senior citizen, explained this perception: “A lot of people... old-time people, who have been here all their lives, they seem to think they are far away from the Gulf of Mexico, and you really aren’t going to have a problem. They don’t understand that the tidal surge will just go right across here” (Jefferson Parish Resident 2005).

Casual Amnesia

Flood memory seems to be a fickle beast with a short-term nature. While flood concerns are high in the immediate aftermath of any flood event, this concern quickly dissipates. This issue appears related to the differential emphasis given on the temporal scale of human consciousness and the longer temporality of flood events. For example, in interviews with some Louisiana residents it was stated: “We figured ten years, no flood means no problem. We had water in the streets occasionally, but it always went down.” Two Californian mitigation managers complained about a similar situation they faced after a flood in the City of Sacramento in 1995. While immediately after the 1995 flood any public hearing included a flood argument, only seven years later hardly anyone showed up: “And the ones that do show up are not interested in talking about flooding, but other sexy topics like West Nile.” To remedy this problem, the mitigation official ironically noted “we just need to get flooded...”

As it seems, many flood victims actually want to forget about a flood in order to move on with their normal lives. I have labeled this tendency *casual amnesia*, after a use of this term by the critic Naomi Klein concerning the U.S. debate on torture (Klein 2005), to suggest that this type of intentional forgetting has a casual or indifferent attitude associated with it. When I asked a City of Savannah planning official who

directly worked with residents on mitigation issues how long it takes for people to lose their memory about a storm, her response suggested a transition where the trauma of the event turned into something more anecdotal within years:

I can tell you about 1999, and we are six years away and people laugh about it now. People go like 'oh remember, we had to take the piano up the stairs!' I mean, it is very anecdotal. Not... there are some people who are a bit dramatic, and every time it rains they are hyperventilating. So those are fresh. But the majority of the people who flooded in 1999, it is not fresh on their mind anymore (City of Savannah Planning Official 2005)

While this apparent need to forget about flooding seems maladaptive, there are a number of reasons why residents appear to engage in this practice. For some the trauma of the flood itself motivates a "black boxing" of the event in the corner of consciousness. A Sacramento mitigation official expressed how attribution of the lack of flooding to random technological innovation – real or not – helped residents in such situations to square away their worries:

They point to a drain inlet that is new in their street, or an article in the newspaper about a pump plant that was constructed in some entirely different location, or some blackberry bushes were cleared away, so they don't feel they will flood again. We know for sure those changes are not going to mitigate their problem, but they just... it is too... I think part of it is that it is just too traumatic for them to think about it again (Sacramento County Mitigation Official 2004).

Casual amnesia about the potential of flooding is also associated with a strong belief in technological improvement and a belief in governmental willingness to fix the problem. For example, residents from Jefferson Parish who had flooded a total of eight times mentioned that even though they had experienced many floods, each time it was still a surprise:

We know this is the last. You know. Each time. Especially if you get that many. It can't go on. We know they are doing things. They are building pumping stations. The leaders saying we got so much money appropriated. We are going to do something about it. But a lot of times it does not work that way. They took the money for something else, you see (City of Harvey Resident 2005).

Another reason for casual amnesia is that there might be few suitable alternative places for relocation to. This could be for either economical or political reasons. For example, in the tight real estate market of Santa Cruz, economic priorities induce a willingness to forget. A local floodplain planner explains how a mindset of "we are going to get over this" kicks in before a flood is even finished, and indicates the main reason for this lies in the extreme financial dependence of residents on the value of their high-priced California property:

People perceive these natural events as damaging to their property value. And they just want to forget about it, and don't want anybody else to remember it. I think there are several really strong factors pushing people to just move on and not really absorb any lesson from what happened (Santa Cruz County Planning Official 2005).

More politically, residents in the neighborhood of Lincoln City in the City of Kinston explain how a history of racial segregation can have a lot to do with a prevailing attitude of indifference to flooding:

After they experienced one or two floods, yeah that is how they learned. But nobody ever told them... You have to remember you are living in a segregated society. And you are limited where you can live anyway. And this was the only place that, you know, they were able to live (City of Kinston Resident 2005).

Generally, this apparent reduction of cognitive dissonance could be reframed as being a way of accepting that flooding is part of normal life. When I ask residents of the floodprone neighborhood of Maplewood in Jefferson Parish why they still live in their home after being flooded six to eight times while having to constantly deal with the ongoing threat of a twenty feet storm surge due to a major hurricane, they answer: "It is hard to understand. It is a way of life. I should have moved away. I don't

know why I did not. It is not a top priority," and "I guess you could say convenience" (pre-Katrina response, City of Harvey resident 2005).

Erosion of Memory Networks

Intergenerational or cultural memory plays an important role in preserving histories of past events. Among the field sites, generational memory appeared to be most challenging for stakeholders in the City of Savannah. Located directly on the east coast in swamplands vulnerable to serious storm surge and Atlantic hurricanes, the City nevertheless only experienced a few weak direct hurricane hits in the twentieth century (1979, 1964, 1959, 1947, 1940), while in the nineteenth century thirteen fierce storms produced havoc for the developing coast. Yet, when speaking to Savannah locals, the temporal flood references used mostly relate to a flood event in 1982 and a flood in 1994. While some elderly speak of events in the 1950s, little emphasis is given to the disastrous hurricanes events around or before the turn of the century (such as 1893 and 1896). According to one City official who came from the north to work in the City, this lack of intergenerational memory has had major impact on mitigation planning:

People's memories and their knowledge was completely out of synch with some of the realities of the problem. Some people did know. Old timers knew this neighborhood flooded since the 1920s. New people would come to meetings and act like.....?! In fact, not until we dug into the records did we know either. So, I guess what is most surprising is this lack of knowledge of the history and topography and where we are actually living (City of Savannah Official 2005).

According to a State level emergency management official involved with the City for over twenty years, this coincidental lack of major impacts for more than 100 years will eventually cause a serious issue of surprise for many residents when a major event does hit:

If you look at the hurricane history between 1800 and 1900, you will find that Georgia had more than its fair share of major hurricanes, but nothing since. Obviously that makes it a challenge locally for emergency management offices throughout that area to keep on preaching we have a hurricane threat. And, they can see the news and see this is what one of these things can do. All we can do is just be thankful. Most people think it is going to go some place else (Georgia State Hazard Mitigation Office 2004).

While intergenerational memory about past events might be present among elderly, a lack of major flood events reminding them through time jeopardizes the strength of this referentiality. It appears that a sense of complacency – a feeling of contentment or self-satisfaction coupled with an unawareness of danger, trouble, or controversy – takes over when nothing happens for a substantial period of time. A town official in the eastern North Carolina town of Belhaven characterizes his town's attitude towards flooding after a 32-year lull of major events in precisely this way: "Everybody had grown very complacent with it, then all of a sudden it was 'my gosh here it comes!'" (2005).

Describing the impact of these storms, the town official also stated that the impact of these surprising events was highest among outsiders. While none of the southern locals put out "For Sale" signs, many of the northern newcomers who had bought retirement property on the waterline did. Generally, several interviews showed how outsiders have a strong deteriorating influence on flood memory because their unawareness of geographical particularities and hazard history combined with a lack of understanding of local culture and customs. One Savannah City official suggested that this erosion of memory due to outsiders is particularly prone to happen in areas where disasters strike, because of extreme economic shifts in the housing markets. Perhaps most telling in this respect is the situation in the flash flood environment of the Californian neighborhood called Felton Grove, located in the town of Felton in the mountains of Santa Cruz County. Established initially as a set of cabins in the mid-twentieth century in a flash flood riverine environment, the importance of local cultural memory about the seasonality and speed with which the river changes was emphasized to be severely undermined by outsiders:

You have 30% of the residents there now who have no idea what is possible in the winter, and how fast that river can come up. The fact that it is raining cats and dogs, the soil is saturated and there is a big storm coming. Do they get ready? No... they are waiting for the fire department to come over and tell them (Santa Cruz County Mitigation Official 2004).

Yet, even when those who carry memory of past events express the danger inherent in the residential landscape, outsiders appear to be skeptical about their expressed concern. One flood-experienced resident engaged in a real estate business in Felton Grove explained why her clients would still buy despite being warned:

Sometimes people would talk with some of the old timers, back before elevations. They tell stories, but they are still here, so it can't be that bad! That is what people think (Felton Grove Resident 2005).

The erosion of historical memory at the neighborhood level which results from such neighborhood transitions has its equal in institutional memory when important historical knowledge is lost due to a high turnover of mitigation or planning staff. Staff turnover in fact appears to be a major issue hindering the layers of bureaucracy managed by the *U.S. Federal Emergency Management Agency (FEMA)* from effectively responding and mitigating disasters. Speaking about their dealings with FEMA, Santa Cruz County mitigation officials mentioned frustration: "You deal with one guy one year, the next one next year." At the state level the same problem is well illustrated by the situation of a former Louisiana state hazard mitigation officer. In charge of all state-wide mitigation, staff transition and the resulting lack of institutional memory appeared to be a major hurdle:

When I first got here I was by myself. There was a temporary worker here, but she was not full time, she was here maybe three months then she left. The hardest thing for me was to get a complete and total understanding of all the ongoing projects in the State of Louisiana, because my predecessor went to work for a company and transitioned exactly two days with me (Louisiana State Hazard Mitigation Officer 2004).

The officer remarked that fortunately there had not been any major disasters during his initial period of training, but even when he had things more under control, the rapid transition of staff within the military-style emergency management culture continued to be an issue. Plagued by field deployments, low pay, and high stress, the officer remarked in frustration: "I was still maintaining a staff, but every time I turned around I lost somebody." At a more local level, in Jefferson Parish, Louisiana, the loss of knowledgeable staff in the drainage department was emphasized by one of the citizens I interviewed. He had chaired a public committee monitoring the Jefferson Parish levee system and emphasized how the very complex situation of pumps and dikes was met with very capable and experienced people who suddenly all retired. The loss of historical knowledge concerning how the system had behaved in the past and how historical crisis situations had been solved was particularly severe due to a simultaneous overhaul of the Parish management: "And I say that because the new councilmen, a lot of them are young. The older ones were people who lived through this thing" (City of Harvey Resident 2005).

Historical or Scientific Uncertainty

There are situations in which knowledge about past environmental conditions are simply unknown. The most obvious situation is when migration causes settlement in new landscapes about which no temporal information is previously stored. Although such frontier settlements are relatively rare in today's world, for many U.S. locations initial colonization is relatively recent considering the depth of memory in older civilizations. For many of the early dwellers in floodplain environments, it meant that taking risks was part of daily reality, and this lack of knowledge could be translated in environmental management, which in hindsight might have been counterproductive (leading to issues such as subsidence, in turn increasing flood potentiality). But even in more recently developed neighborhoods such as Maplewood and Felton Grove, the historical knowledge is relatively shallow since it was only in the second half of the 20th century that swamplands and riverine floodways were converted into

permanent residencies. Imposing flood control in such conditions was less of a gamble because of previous exposure to nearby conditions, yet even with pumps and levees the long-term properties of the landscapes were relatively unknown.

Beyond the novelty of an environment, it can also happen that archiving and monitoring of changes in environmental conditions is lacking. The City of Savannah, despite its relatively historical image, actually appears to have suffered from a long period of relatively inadequate city management. During this period, which lasted from 1910 until 1954, corruption ruled and little attention was given to the archiving and maintenance of public accountability. After this period, the major deficit with which the City struggled left little room for improvement on this front. In addition to this, officials explained to me that it was only since 1994 that historical events had been reconstructed and entered in a “structural flooding database,” which now goes back to about 1982. One major hurdle the City faced was the influence of coastal microclimatology on record keeping. Dependent on only one rainfall gauge located at the airport, floodplain management officials were dissatisfied with their ability to monitor the environment in downtown Savannah located in a different microclimate.

In flash flood environments where events have a quick turnaround time, the importance of an accurate monitoring system also relates to immediate prediction of flood crests. Sometimes, this goes wrong, as an example from Felton Grove’s ALERT early warning system illustrates:

In 1998 we had three feet of freeboard, and we had a storm come [sic] in at mid level at the mountains, and it was raining about 1.5 inch per hour. At 1.5 inch per hour, you have trouble seeing through it. It came in below the rain gauges in our ALERT system, so we did not see it. In fact, it was raining buckets for two hours and it came in right above Felton Grove, so it came on in the San Lorenzo as a big surprise (Santa Cruz County Planning Official 2004)

A shortage of historical information about hazards in a flood environment also means a decreased certainty of knowing where floodplain boundaries are located. Taking again the example of the City of Savannah, it is no surprise to learn that the City has not determined the location of the actual 10, 100, and 500 year flood inundation areas and the associated flow rates that go with them. The impact of this situation is a lack of explicit guidance to developers using *Floodplain Insurance Rate Maps* (FIRM) where additional drainage is necessary, and an increased likelihood of ecological surprises. A Savannah city official notes:

So, it just happens that Savannah has a lot of canals, low areas, and they have allowed development to occur [there]. Although most of that is pre-FIRM, 1950s, and 60s, some 70s but not much. It is all built before floodplains were mapped. But even now the City needs an updated map (City of Savannah Official 2005).

Because FEMA only updates floodplain maps once every 15 to 18 years, many residents and officials noted that floodplain guidelines were outdated due to environmental changes or just bad mapping. For example, one homeowner who had been flooded six times explained to me that his house is officially not in a floodplain, while others who were never flooded are located inside the boundaries.

Conclusion

A Temporal Dwelling Model of Vulnerability

I have argued that a presentist, dwelling perspective looking at temporality as a cultural model provides a conceptualization of the temporal dimension in vulnerability research which complements the generally accepted historicist notion that vulnerability is dynamic, multiscale, and has historical roots. Focusing on the issues of expectations and surprise, I believe that a referential perspective provides a powerful way of looking at the relationship between temporality and vulnerability. To support this notion I have provided four different “dwelling” scales, all dealing with the temporal dimensions of vulnerability yet analyzed and seen from the culturally biased perspective of historically situated

populations vulnerable to surprise. The identified scales include the cognitive, social psychological, cultural, and epistemological levels of human perception and understanding. They respectively include: the complex of causes which induce disbelief of disaster (or exposure) histories; casual amnesia (note: not “causal”); erosion of memory networks; and historical or scientific uncertainty. These findings are depicted in a schematic model of concentric rings each representing a scale of dwelling (Figure 1). As

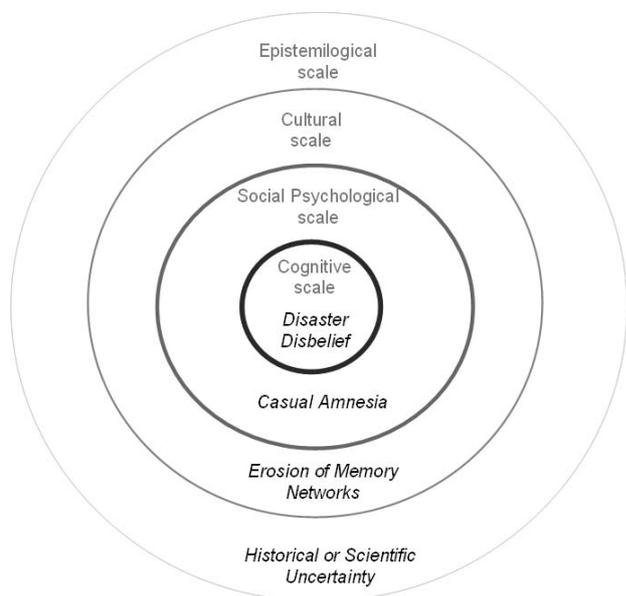


Figure 1: A Temporal Dwelling Model of Vulnerability

is typically presumed in complex systems, these scales are layered, nested, and not necessarily hierarchical (top-down), but interactive, influencing each other (heterarchically organized). I argue that these different dwelling scales and their examples in fact represent human biases or ontological boundaries which restrict our awareness and knowledge about historical conditions. Because of this characteristic, the scales and the given examples can directly lead to maladaptive expectations which increase the likelihood of surprise. In other words, the examples provided are examples of vulnerabilities within the system of human organization *vis-à-vis the temporal environment*. Perhaps one could suggest such vulnerabilities to be specific “temporal vulnerabilities,” to distinguish them from “economic” or “physical” vulnerabilities, or even more importantly, “historical vulnerabilities,” the latter representing an objective history of vulnerability, but not the condition of “being temporal” (temporality) itself. On the other hand, when actively managed, they can be seen as tools available for the strengthening of resilience and coping within cultural systems. The strengthening specifically deals with the ability of populations to adapt and respond to the dynamic, multiscale environment that exposes them to potentially disastrous hazards.

This environment itself, the context in which this model operates (effectively or not), is itself composed of complex temporal properties. Less stable environments, where disasters typically occur on smaller temporal scales, include non-linear features such as sudden systemic changes, temporal (and spatial) multiscale, and are guided by self-organization. But even in more stable systems temporality exists in the form of cyclical features such as the natural seasons themselves, the timing of the events relative to these cycles, the frequency of hazard events, and of course changes in the intensity of the events, including the speed with which hazards occur. Altogether, the overlap of temporally complex environments and the boundaries and weaknesses of human understandings of it make it even more urgent that attention is paid to how our own temporal tools and capacity influence our expectations.

To general policy recommendations as a result of this research includes a call for a careful evaluation of the extent to which memory networks and monitoring institutions are locally and scientifically accurate and accessible. Further, an active management of this aspect of vulnerability can be done by providing general educational strategies which aim at the explicit preservation, archiving, and dissemination of hazard memory. It does not take a lot of public funds to actually secure high water marks in the cultural landscape or provide other visual clues (photographs, descriptions) of past events. Further, a more elaborate strategy would focus on museums, archival institutions, and other publically accessible places to evaluate use of materials that memorialize past hazards. It is even possible to measure and monitor how cultural models of vulnerability might be stretched, for example by simply plotting the temporal distance to the last series of flood events. Further, serious capacity building should be a common strategy to build hazard memory in institutional settings. This should also be extended into neighborhood organizations, where long-time residents function as important anchors of past

knowledge of events. Finally, any governing institution would do well in checking how accurate floodplain maps actually are, and how well the local public understands the meaning of the terminology used. Altogether, these strategies might help to prevent cultural models of historical ecological conditions from becoming enemies, rather than friends, when dealing with hazard preparedness, mitigation, and early warning.

References

- Alexander, David (2000): *Confronting Catastrophe: New Perspectives on Natural Disasters*. New York, NY: Oxford University Press.
- Berkes, F. and Folke, C. (2002) Back to the future: ecosystem dynamics and local knowledge. In: Gunderson Lance H. and Holling, C.S. (Eds.): *Panarchy: Understanding Transformation in Human and Natural Systems*. Island Press, Washington.
- Crumley, C.L. (1994): *Historical Ecology: Cultural Knowledge and Changing Landscapes*, In: Crumley, Carole L. (Ed.) pp. 183-201. Santa Fe, NM: School of American Research.
- Crumley, C.L. (1998): From Garden to Globe: Linking Time and Space with Meaning and Memory. In: Balee, William L.; Crumley, Carole L. (Eds.): *The Way the Wind Blows: Climate, History, and Human Action*. The Historical Ecology Series. New York, NY: Columbia University Press. pp. 193-208.
- Gunn, Joel D. (1994): Global Climate and Regional Biocultural Diversity. In: Crumley, Carole L. (Ed.): *Historical Ecology*. Santa Fe, NM: School of American Research. pp. 67-97.
- Holland, D.C.; Quinn, N. (1987): *Cultural Models in Language and Thought*. London: Cambridge University Press.
- Holling, C. S. (2001): Understanding the complexity of economic, ecological and social systems. In: *Ecosystems*. Vol. 4. pp. 390-405.
- Hoffman, S.M.; Oliver-Smith, A.O. (2002) *Culture and Catastrophe: The Anthropology of Disaster*. Santa Fe, New Mexico: The School of American Research Press.
- Ingold, T. (1993): *The Temporality of Landscape*. World Archaeology. Volume 25.
- Irons, Larry (2005): Hurricane Katrina as a Predictable Surprise. In: *Homeland Security Affairs* I. No. 2.
- Klein, Naomi (2005): 'Never Before!' Our Amnesiac Torture Debate. In: *The Nation*. December 26.
- Kragh, H. (1989): *An Introduction to the Historiography of Science*. Cambridge: Cambridge University Press.
- Kuhn, T.S. (1970): *The Structure of Scientific Revolutions*. Chicago; London: University of Chicago Press.
- Latour, B. (1988): *Science in Action: How to Follow Scientists and Engineers Through Society*. Cambridge, MA: Harvard University Press.
- Latour, B. (1999): Circulating Reference: Sampling the Soil in the Amazon Forest. In: *Pandora's Hope*. Cambridge, MA: Harvard University Press.
- Marquardt, William H.; Crumley, Carole L. (Eds) (1987): *Regional Dynamics, Burgundian Landscapes in Historical Perspective*. San Diego, CA: Academic Press.
- McIntosh, Roderick J.; Tainter, Joseph A.; Keech McIntosh, Susan (Eds.) (2000): *The Way the Wind Blows: Climate, History, and Human Action*. The Historical Ecology Series edited by William L. Balee and Carole L. Crumley. New York: Columbia University Press
- Núñez, R.; Sweetser, E. (2006): With the Future Behind Them: Convergent Evidence From Aymara Language and Gesture in the Crosslinguistic Comparison of Spatial Construals of Time. In: *Cognitive Science*. Vol. 30(3). pp. 401-450.

- Stocking, G.W. (1965): On the limits of presentism and historicism in the historiography of the behavioral sciences. In: *Journal of the History of the Behavioral Sciences*, Vol. 1, 3, pp. 212-218.
- Thywissen, Katharina (2005): *Components of Risk. A Comparative Glossary*. SOURCE No. 2, United Nations University Institute for Environment and Human Security. Bonn.
- Turner, B. L.; Kasperson, R. E.; Matson, P. A.; McCarthy, J. J.; Corell, R. W.; Christensen, L.; Eckley, N.; Kasperson, J. X.; Luers, Am; Martello, M. L.; Polsky, Colin; Pulsipher, A.; Schiller, A. (2003): *A Framework for Vulnerability Analysis in Sustainability Science*. Proceedings of the National Academy of Sciences. June 5, 2003, 10.1073.
- Tversky A.; Kahneman. D. (1987): *Judgment Under Uncertainty: Heuristics and Biases*,. Cambridge: Cambridge University Press. pp. 3-22.

1.3 Water Related Health Risk, Social Vulnerability and Pierre Bourdieu

Patrick Sakdapolrak

Floods during the monsoon season, water scarcity during the dry months, contaminated drinking water, and lack of waste water facilities – embedded in this multifaceted water crisis the population of the South Indian megacity of Chennai is facing constant health threats. Within this setting the paper will introduce thematically and conceptually the ongoing research project “Adaptation behaviour and negotiation processes: how the vulnerable cope with water related health risk in Chennai, India” financed by the *German Research Foundation* (DFG) and the *Federal Ministry for Economic Cooperation and Development* (BMZ). Thematically the paper will point out the importance of the health and water complex in vulnerability sciences in general and address the specific features of the complex within metropolitan Chennai. Conceptually the paper will represent a brief outline of the analytical framework of social vulnerability. Therefore, it will address its roots, summarize its features and introduce Pierre Bourdieu’s social theory as a possible way to embed social vulnerability theoretically.

Why Focus Social Vulnerability Research on Health and Water Issues in Megacities?

By positioning the research thematically at the nexus of three interweaved topics – namely human health, water stress and urbanisation – the paper addresses subject areas which are of high relevance for development policy aiming at the reduction of social vulnerability.

There is broad consensus in the global political agenda that human health is central for human security and human development. This is demonstrated e.g. by the Report “Human Security Now” of the Commission on Human Security (2003). In this report a complete chapter is dedicated to health issues. Another example is the *Millennium Development Goals* (MDG) of the United Nations, with four out of eight MDGs focused directly on human health.

A recent report of the WHO (Prüss-Üstün et al., 2006: 9) reveals that 24 % of global diseases are caused by environmental exposures which can be averted. Furthermore, it is estimated that 23% of all deaths (premature mortality) can be attributed to environmental factors (ibid.). These statements highlight the importance of environmental health. Among the environmental risk factors, water-related risk factors are particularly critical, as approximately one quarter of global environmental disease burden (WHO 2006) can be traced back to them.

Moreover it can be expected that the significance of urban areas and urbanisation processes for development policy in general and environmental health in particular will rise in the near future. This is not only because more than half of the world’s population is estimated to live in urban areas – among them even one-quarter to one-third in absolute poverty (Sánchez-Redriguez and al. 2005) – but also because the rapid urbanisation process especially in developing countries poses multiple and complex threats to the urban population (Krafft et al., 2002: 17-21; Coy et al., 2003; Kraas, 2003; Krafft et al., 2003).

Thus, while addressing the interface between human health and water related risk factors in the Indian megacity Chennai, the research project places a special focus on problem areas of considerable relevance for development policies that aim at the reduction of social vulnerability. Basic research on this topic has to be regarded as a contribution to reduce social vulnerability and enhance the quality of life of the vulnerable people.

The following section of the paper will outline the specific features of the health and water complex in Chennai. The socio-economic setting of Chennai will be briefly introduced and followed by a description of the water stress and water related health risk in Chennai.

The Megacity Chennai

Since its foundation by the East-India Company in 1640, Chennai, formerly Madras, has evolved into the fourth largest Indian agglomeration with a population of 4.2 million (city) and 7.5 million (metropolitan

area) respectively. That way, Chennai represents one out of six Indian and worldwide 39 megacities. It is located in the south of India at the Bay of Bengal, is the capital of the state Tamil Nadu and has the third largest port of India, where about a fifth of the Indian exports are handled (Nestle et al., 2005). Since the liberalisation of the Indian economy in the early nineties the city has experienced a dynamic economic development, which is prominently expressed by the fast growing information technology (IT) sector. According to the former head of the Chennai Metropolitan Development Authority (CMDA) it is expected that as many as 500,000 jobs will be created in the IT sector in the coming year. This development is also manifested in the cityscape: Huge investments flow into infrastructure developments and modern high rise office complexes dominate the so-called IT-Corridor in the south of the city.

As a fast growing megacity Chennai is also prime destination for labour migrants from rural areas. There are two major push and pull factors for the movement of people towards Chennai: Firstly, unequal intra-state development and growing income disparities (TNHDR, 2003) as well as the socio-environmental crisis in parts of Tamil Nadu, e.g. the Cauvery-Delta (Bohle, 2004). Secondly, the rapid economic growth of the metropolitan area. Arriving in Chennai the landless labourers, tenant farmers and small scale peasants are faced with insecure income generating opportunities and an overloaded urban infrastructure (Coy et al., 2003). Both of these factors are pushing them into social and spatial marginality. This development becomes obvious as around a quarter of the city's population are living in the over 1500 slum communities, which are spread all around Chennai (Bohle, 1984; Bunch, 1996; TNSCB, 2005: 38). Based on a survey on slums carried out by the Corporation of Chennai (CoC), Chandramouli (2003) states that 35.5% of dwellings are of semi-permanent or temporary type with 67% consisting merely of one single room. Direct access to drinking water is limited to 26% of the slum dwellings, while 54.8% are located within 500 meters of a water source. 56% of households have closed drainage, 13.9% have open drainage, and 30.1% have no drainage at all. 79.4% of dwellings have access to electricity.



Figure 1. Chennai, India – a dynamically developing mega-city (Source: P. Sakdapolrak)

Summarizing, it can be said that the economic development of Chennai is coupled with an increasing polarisation and fragmentation process (Scholz, 2002). This results in an increasing number of vulnerable people who are more and more at risk of exposure to ill-health due to the overall living conditions.

Water Stress and Health in Chennai

Water stress can be defined as water related conditions that negatively affects the human population and causes problems. Human health is linked to water stress in terms of quantity (conditions of scarcity and surplus) and quality (poor water quality) of available water.

Chennai is particularly suitable as a study area of the water-health complex, because the region is characterized by a monsoonal climate with pronounced seasonality – intensive dry periods alternate with periods of excessive rainfall and occurrence of tropical cyclones. The most severe water related problem of Chennai is water scarcity. Chennai is constantly struggling with a structural shortage of water (Ruet et al., 2002). With 78 liter per capita per day (lpcd) Chennai has the lowest per capita water availability among Indian metropolitan cities (WBGU, 1997: 199). The public water supplier, Chennai

Metropolitan Water Supply and Sewerage Board (Metro Water), accounts for only 64 % (other estimates put the figure as low as 44 %) of the resource in a normal month (Ruet et al., 2002). Another 4 % comes from private tankers, 10 % from community tanks and wells and 21 % from in-house wells. It is estimated that 80 % of the fresh water of Chennai is from ground origin (Navdanya, 2005: 105). This is the particularity Chennai faces due to the scarcity of local surface water sources. The reason for the structural water shortage is caused by the dependency of the city's water supply on a number of very unreliable sources: the North-East monsoon, which is of short duration and highly variable; only few perennial rivers with a limited storage capacity; ground water resources, which have been indiscriminately exploited without much recharge. In addition, this unfavorable circumstances are coupled with the growing demand of a rapid urbanizing city. This results in a drop of water availability per capita during scarcity periods to a level which is insufficient to cover basic water needs. This happened for example during drought periods in 2001 and 2004, where the level dipped down to 35 lpcd and 25 lpcd respectively (Ruet et al., 2002: 67; Nestle, 2004).

Next to water scarcity, water quality represents the second main problem in Chennai. A major share of the ground water resource of the city is of poor quality and not suitable for drinking (Nestle, 2004: 71). Appasamy (1996) states that poor waste management (especially industrial waste), salt water intrusions and the pollution of the surface water are the main factors which affect the quality of ground water resources. Fresh water and tap water contamination is also a problem due to insufficient sewage treatment, cow dung, industrial pollutants and the infiltration of the polluted surface water into the old and leaking pipeline system (Appasamy, 1996: 17) which doesn't have a continuous water flow. The outbreak of cholera in May 2004 which was caused by contaminated tap water makes the problem exemplary (Subramanian, 2004). Last but not least, water excess is another water related stress the inhabitants of Chennai are facing. Devastating tropical cyclones and excessive rainfall led time and again to widespread flooding in Chennai (Nayantara, 1996: 95-118). In particular low-lying areas, where the urban poor are forced to live (Nestle et al., 2006), were affected.



Figure 2: Health risks through stagnating water during the monsoon in Chennai, India (Source: P. Sakdapolrak)

The described water stress scenario of Chennai constitutes multiple health risk factors for the population of the city. The disease outcome resulting from the exposure to these stressors are passed on mainly through four transmission routes, as Eyles and Sharma (2001) specify:

- water-borne diseases: a disease that spreads through water supplies, which are contaminated with pathogenic micro-organisms (e.g. cholera, typhoid);
- water-based diseases: a disease that spreads through parasites found in intermediate organisms living in contaminated water (e.g. shistosomiasis, dracunculiasis);
- water-vectored diseases: a disease that spreads by insects (e.g. mosquitoes) that depend on water (e.g. malaria, dengue);
- water-washed diseases: a disease that spreads as a result of poor personal hygiene and skin or eye contact with dirty water (e.g. trachoma).

The Health and Family Welfare Department (HFWD) (2004) of the Government of Tamil Nadu, the Tamil Nadu Human Development Report (TNHDR 2003) and the National Family Health Survey (NFHS-2, 2000)

identified some main health concerns in Chennai which are associated with water stress. These concerns will be described below:

Diarrhoeal diseases. Diarrhoeal diseases represent a high disease burden in the state of Tamil Nadu. According to the Health Department (HFWD, 2004) "Tamil Nadu is endemic for Acute Diarrhoeal Diseases (ADD) with sporadic outbreak of cholera in most of the districts throughout the year and in epidemic proportions during the rainy seasons and peak summer periods". In 2004, 77333 cases of ADD and 1500 cases of cholera were reported, showing no sign of improvement over the previous years. The extreme flood events that hit Chennai in November and December 2005 again demonstrated how vulnerable the population is towards flood-related health risks. Within a few days, cholera cases have been reported in the city.

Malaria and Dengue. Chennai, accounting for 6.8% of the population in Tamil Nadu, experiences approximately 70% of the malaria cases reported in the state of Tamil Nadu. In 2003, 29058 cases occurred in Chennai, which signifies a 6.8% increase within the previous year (CoC, 2005). *Anopheles stephensi* and *Anopheles culicifacies* are the two main malaria vectors in the area (Balakrishnan, 2003; CoC, 2005). Dengue represents the other predominant vector-borne disease in Chennai, showing an outbreak of nearly 800 cases in 2001 and several hundreds of cases reported each year from that time onwards (Kabilan et al., 2004; CoC, 2005). Population migration and rapid urbanization with poor management of water resources represent risk factors for these vector-borne diseases.

Theorising Social Vulnerability: Can Bourdieu Help Us?

In the following section the social vulnerability framework will be introduced as a guiding analytical tool for the study. After a brief discussion about the roots of the vulnerability concept, the common features of the understanding of vulnerability will be outlined, followed by the social theory of Pierre Bourdieu as a possible way to embed the framework theoretically.

The concept of vulnerability has become a central analytical category in the academic and practitioner's discourse on environment and health (Bohle, 2005). So, e.g. the Intergovernmental *Panel on Climate Change* (IPCC) (2001) uses the concept of vulnerability as a framework and dedicates a whole chapter on vulnerability towards environmental health risks in the context of climate change. The WHO (2003) as well recently adopted the term human health vulnerability.

The concept has its roots in and was based on two broad areas of research: hazard research on the one hand and poverty research on the other hand. Since the late 1980s vulnerability has featured most prominently in hazard research. The basic underlying model of vulnerability as used by early approaches in the field of hazard research was founded on the risk-hazard-model, where specific environmental risks result in hazards for individuals, social groups or a whole system. The vulnerability concept represents the result of critiques which arose towards the risk-hazard model. Firstly, it was criticised that the basic of the concept does not treat the ways in which the impact of hazards are amplified or attenuated. Secondly, distinct exposed subsystems that lead to significant differences in the consequences of hazard exposure were neglected. Lastly, the model does not treat the underlying social, economic and political structures that underlie the differential exposure and consequences, as it was pointed out by Turner et al. (2003: 8074). Outside the field of hazard research vulnerability received broad recognition during the 1980s in poverty and development research (e.g. Chambers, 1989). In particular Sen's (1982) work on entitlement was of vital importance for the vulnerability concept. Vulnerability was carved out as an implicit concept in Sen's entitlement approach (Fünfgeld, 2006: 26). As Bohle (2006) points out, in the social science poverty research the concept of vulnerability was used to broaden and disaggregate the concept of poverty. The relationship between poverty and vulnerability is not clearly determined. Chambers (1989: 1) emphasises that vulnerability is not poverty. Prowse (2003: 7-9) shows that vulnerability can result in poverty (vulnerability to poverty), can be seen as a cause and symptom of poverty and as a dimension of poverty.

Since its emergence in the 1980s vulnerability has become widespread in a diverse and multi-disciplinary field of social and environmental research and provoked a large body of academic literature and has been adopted by large multi-lateral organisations (e.g. WHO).

Cutter (1996: 529-31) notices that despite considerable efforts a common conceptualisation of vulnerability is still lacking. The reason for this lack, as Cutter (ib.) explains, arises from different epistemological orientations (political ecology, human ecology, physical science, spatial analysis) and subsequent methodological practices. The concept remains “somewhat fuzzy”, as Vogel et al. (2004) observe.

Nevertheless some common features of almost all conceptualisation of vulnerability can be discerned. Most approaches analyse particular risks (mostly external stresses, processes or events), the mechanism by which systems, social units or individuals deal with them and the potential adverse outcomes in relation to that risk (ib.). Vulnerability is considered as a multidimensional phenomenon that is socially and spatially distinguishable (Bohle, 2005). Exposure, sensitivity and adaptive capacity are three components of vulnerability that can be widely found, although they may use inconsistent terminology and assign different relative weights to each component (Prowse, 2003). Exposure can be defined as the risk of being exposed to environmental and social stressors; sensitivity can be seen as the risk of being susceptible to stressors; adaptive capacity can be defined as the ability to cope with and adapt to stressors and recover from the adverse consequences. All these elements of vulnerability are functionally and dynamically connected and interlinked through feed-back processes that are changing over time (Turner et al., 2003; Vogel et al., 2004).

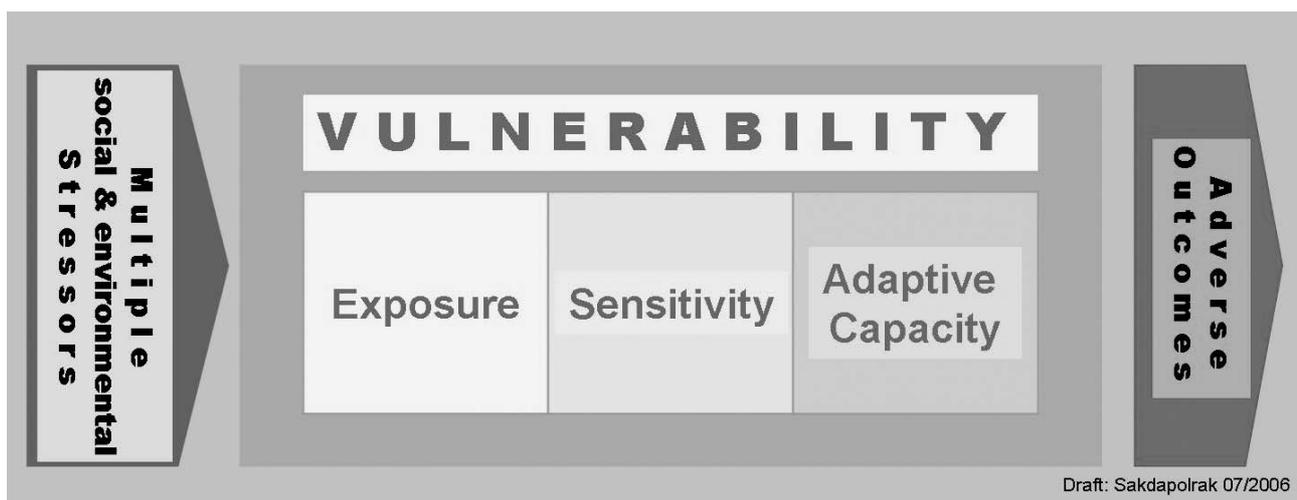


Figure 3: Vulnerability framework – Basic dimensions

Social vulnerability is a characteristic of people. It is, as Downing (2002: 375) remarks, a social phenomenon relevant to particular social groupings. Thus, social vulnerability can be conceptualized as a function of exposure, sensitivity and adaptive capacity of groups of people, households and individuals in the context of environmental and social stressors. At this level an understanding of vulnerability needs to be reached (Prowse, 2003: 6) and it is a particular challenge, as Wisner (1993: 16) emphasizes, “to create ways of analyzing vulnerability implicit in daily life”.

In order to realize this aim, vulnerability analysis, as Wisner (1993: 130) demands, needs to be grounded in a social theory that balances structure and agency, determination and freedom. Bohle et al. (1994) say that a theory of social vulnerability should be able to map the space of social vulnerability. This map is defined by determinate political, economic, and institutional capabilities of people in specific places and in specific times. Moreover, it should be able to identify “the historically and socially specific realms of choice and constraint [...] which determine risk exposure, coping capacity and recovery potential.” (ib.). Since the statement of Chambers, that vulnerability lacks a theory, there have been several models

proposed for theorising social vulnerability in the way described above (Watts et al., 1993; Wisner, 1993; Tröger, 2004). Within the scope of the study of social vulnerability towards water related health risk in Chennai, the concepts of Pierre Bourdieu are proposed as a basis for the analysis of social vulnerability.

Bourdieu's Social Theory – An Outline

Bourdieu understands the society as a network of semi-autonomous fields (Curtis et al., 1998: 652). Fields are systems of objective relations between positions that are constituted by various species of capital or power (see below). Positions in a field are occupied by actors and interrelated. Fields are characterised by asymmetric power relations – dominations and subordinations (Dörfler et al., 2003). Therefore, fields can be seen as structured systems of people occupying positions of social relations (Curtis et al., 1998: 652). However, the relations are not to be understood as direct interactions or connections, but in terms of exterior relations of difference, especially with regard to efficient species of capital or power (Bourdieu et al., 1996: 127). The difference between the concept of network and the concept of field is important to keep in mind. Fields are defined by differential relations between properties while networks are defined by actual connections. In a field, unlike in a network, people with little interaction with one another can be grouped together very closely. The relations between positions occupied by actors in a field are characterised by struggle and competition over access to goods, resources, positions and power that are at stake.

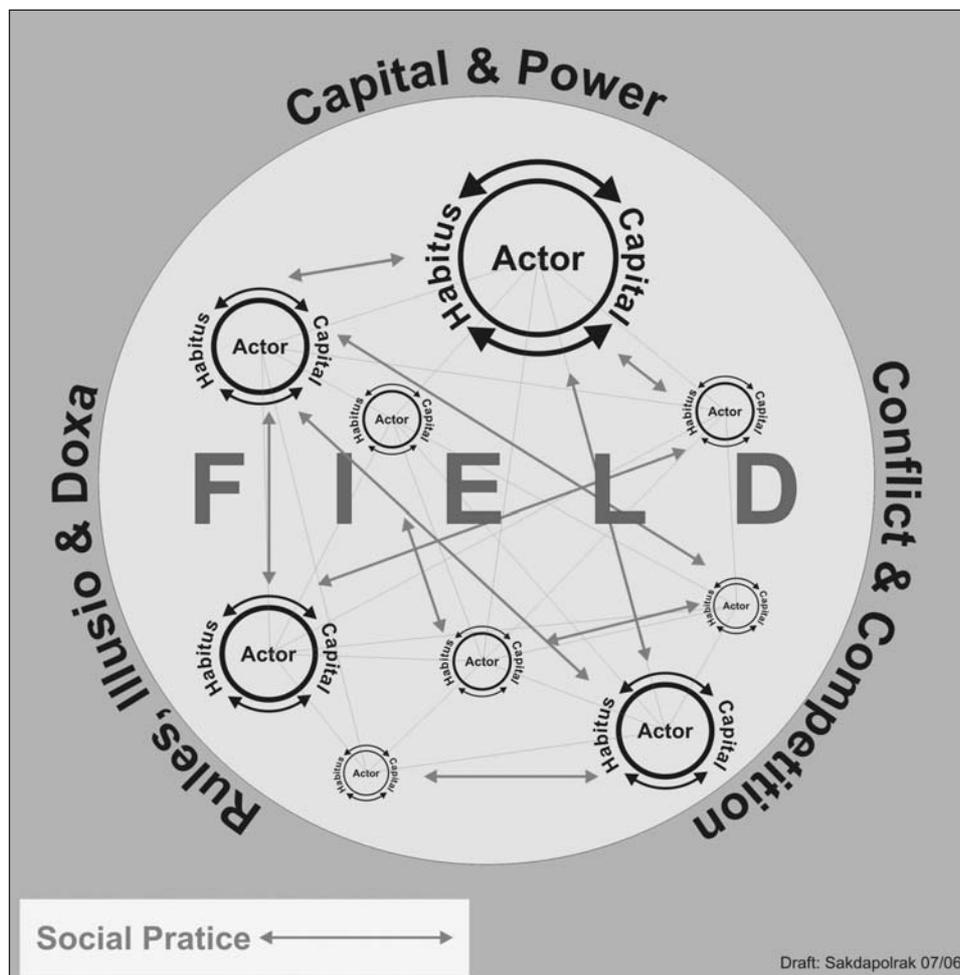


Figure 4: Schematic illustration of Bourdieu's social theory

In his explanation of fields, Bourdieu often uses game as a metaphor. Like in a game, a field is only possible if there are players existing which know how to play and which are inclined to play. Both, field and game, are spheres defined by specific rules, which set a certain frame but do not determine the

individual action of the players (Fuchs-Heinritz et al., 2005: 143). The various involved players are endowed with different species of capital effective in the game. The powerful players in the game and dominant actors in a field, i.e. those who are endowed with the largest volume and the best structured species of capital, are in the position to set the rules that determine the normal functioning of the game and consequently define the profits that can be achieved (Bourdieu et al., 1996: 132).

The pre-condition for a game to be played at all is the fundamental belief of the players in the stakes of the game. The term *illusio* in Bourdieu's work refers to the tacit recognition of the value of the stakes and the practical mastery of the rules of the game (Bourdieu, 1998: 128). There is a specific *illusio* for all fields that exist. The rules that determine the game, as Bourdieu observes, are often perceived to have the character of a natural given fact. They are accepted and not scrutinized by the players involved (Bourdieu, 1976). This phenomenon is termed *doxa* by Bourdieu (Bourdieu, 1976).

As mentioned above, the structure of the field is determined by the position of actors in the field, and this is again determined by the overall volume and the kind of species of capital that each actor disposes. Capital is what ever has an effect; it can be conceived as power (Bourdieu, 1983: 184) or as social energy (ib.: 183). It is the medium or resource which enables actors that are endowed with it to act within the field. Capital and field are closely related concepts since capital does not exist and function if not in relation to a field. Bourdieu differentiates between different forms of capital (economic, cultural, social, symbolic etc.) (ib.). Different species of capital are transformable at varying cost and effort (ib.: 195-198).

The concept of *habitus* is the subjective complement of the idea of field. *Habitus* is the expression and the result of a constellation of a group of actors within the space of inequality, i.e. unequal endowment with capital in the field (Bourdieu, 1999: 279). *Habitus* does not only reflect relations of inequality but expresses them and conserves their virtue. *Habitus* is a "structured structuring structure" which results from an "internalisation of the exteriority" and produces an "exteriorisation of the interiority" (Bourdieu, 1984). In a general sense *habitus* can be understood as the mental structure through which people deal with the social world. It can be thought of as a set of deeply internalized schemes through which the world is perceived, understood, appreciated, and evaluated. Through *habitus* actors are able to take part in social practices and to produce social practices. *Habitus* enables actors to move and act in fields adequately. *Habitus* only exists through individual practices and interaction (Curtis et al., 1998: 652).

Social practice – everyday activities – is therefore shaped by both, the *habitus* which disposes people to act in a particular ways and the availability for various species of capital in different fields. Bourdieu put the relation between practice, *habitus* and field in the following formula: Practice = [(*Habitus*) (Capital) + Field]. It is argued that the social theory of Pierre Bourdieu is capable of meeting the demands of a theory of social vulnerability as articulated by Bohle et al. (1994). Their notion of vulnerability as a multilayered and multidimensional social space determined by the political, economic and institutional capabilities of people. This corresponds to the field and *habitus* concept of Bourdieu. It is argued that a field of social vulnerability towards stressors or to adverse outcome can be constituted. This field would be structured by specific forms of capital and power, would be governed by a specific set of rules and characterised by competition and struggle over minimised specific social vulnerability or in positive term increased specific human security. The hypothesis is that the position of an actor in a field gives information if and how he is exposed and sensitive to stressors and how coping and adaptation are shaped by choices and constraints which arise from the position in the field and the endowment with capitals. Thus, it is argued that Pierre Bourdieu provides a possible key to decipher social vulnerability.

Outlook

Embedded in the context of water related health stressors in the megacity of Chennai, as pointed out in the first section of the paper, the research project focuses on health-related adaptation and the coping behaviour of a vulnerable population facing multiple water-related health risks in their day to day life. The guiding principle for the analysis is based on the conceptual framework outlined in the

second part of the paper. The research project seeks to explore the following questions: How do people conceptualise health? What do vulnerable people who are continuously threatened by water-related risks do to maintain and protect their health? What are the constraints and the enabling factors for coping and adaptation among vulnerable people? In what way is this coping behaviour a negotiated process and what is the result of the interplay between the interests of different players? The aim of the project is to understand these health-related issues in the context of the everyday life of the vulnerable population.

References

- Appasamy, P. (1996): *Environmental Profile of Madras*. Madras.
- Balakrishnan, P. (2003): *Use of GIS for Malaria Distribution Mapping in Chennai City, Tamil Nadu, India*. Proceedings from the ISI International conference on environmental statistics and health.
- Billig, P.; Bendahmane, D. et al. (1999): *Water and Sanitation Measurement Guide*. Washington DC, USAID.
- Bohle, H.-G. (1984): Probleme der Verstädterung in Indien: Elendssiedlungen und Sanierungspolitik in der südindischen Metropole Madras. In: *Geographische Rundschau*. Vol. 36. pp. 461-469.
- Bohle, H.-G. (2004): Vom Wasserkonflikt zur Wasserkrise: Der Niedergang eines südindischen Deltas. In: *Geographische Rundschau*. vol. 56, no., pp. 40-45.
- Bohle, H.-G. (2005): *Umwelt und Gesundheit als geographisches Integrationsthema*. Geographische Integrationsforschung. D. Müller-Mahn and U. Wardenga. Leipzig.
- Bohle, H.-G. (2006): Geographische Entwicklungsforschung. In: Gebhardt, H. et al. (Eds.): *Geographie. Physische Geographie und Humangeographie*. Elsevier/Spektrum Akademischer Verlag, Heidelberg, pp. 797-815.
- Bohle, H. G. (2006): *Geographische Entwicklungsforschung*. Lehrbuch der Geographie. H. e. a. Gebhardt. Heidelberg, Springer-Verlag.
- Bohle, H.-G.; Downing, T.E. et al. (1994): Climate Change and Social Vulnerability. Toward a Sociology and Geography of Foodinsecurity. In: *Global Environmental Change*. Vol. 4(1). pp. 37-48.
- Bourdieu, P. (1976): *Entwurf einer Theorie der Praxis auf der ethnologischen Grundlage der kalybischen Gesellschaft*. Frankfurt, Suhrkamp.
- Bourdieu, P. (1983): Ökonomisches Kapital, kulturelles Kapital, soziales Kapital. Soziale Ungleichheiten. In: *Soziale Welt*. Sonderband 2. pp. 183-198. R. Kreckel. Göttingen, Otto Schwartz & Co.
- Bourdieu, P. (1998): *Praktische Vernunft: Zur Theorie des Handelns*. Frankfurt, Suhrkamp.
- Bourdieu, P. (1999): *Die feinen Unterschiede: Kritik der gessellschaftlichen Urteilskraft*. Frankfurt, Suhrkamp.
- Bourdieu, P. L.; J. D. Wacquant (1996): *Die Ziele der reflexive Soziologie. Reflexive Anthropologie*. Frankfurt, Surkamp. pp. 95-249.
- Bunch, M. J. (1996): The physical ecology of slums in Madras: A GIS analysis of the 1986 survey of slums. In: *The Indian Geographical Journal*. Vol. 71(1). pp. 32.
- Chambers, R. (1989): Editorial Introduction: Vulnerability, Coping and Policy. Institute for Development Studies (IDS). In: *Bulletin*. No. 20(2). pp. 1-7.
- Chandramouli, I. A. S. (2003): *Slums In Chennai: A Profile*. Third International Conference on Environment and Health. 15-17 December, 2003, Chennai, India.
- CHS (2003): *Human Security Now*. New York, Commission on Human Security.
- CoC (2005): *Health Department*. <<http://www.chennaicorporation.com/dept/health/>>, 15 May 2006.

- Coy, M.; F. Kraas (2003): Probleme der Urbanisierung in den Entwicklungsländern. In: *Petermanns Geographische Mitteilungen*. Vol. 147(1): pp.32-41.
- Curtis, S.; Jones; I. R. (1998): Is there a place for geography in the analysis of health inequality? In: *Social Science & Medicine*. Vol. 20(5). pp. 645-672.
- Cutter, S. L. (1996): Vulnerability to environmental change. In: *Progress in Human Geography*. Vol. 20(4). pp. 529-539.
- Dörfler, T.; Graefe, O. et al. (2003): Habitus und Feld: Anregungen für eine Neuorientierung der geographischen Entwicklungsforschung auf der Grundlage von Bourdieus „Theorie der Praxis“. In: *Geographica Helvetica*. No.58(1). pp. 11-23.
- Downing, T. E. (2002): Linking sustainable livelihoods and global environmental change in vulnerable food systems. In: *Die Erde*. No. 133(4). pp. 363-378.
- Eyles, J. and R. Sharma (2001): Infectious diseases and global change: Threats to human health and security. In: *AVISO*. No. 8.
- Fuchs-Heinritz, W.; König, A. (2005): *Pierre Bourdieu*. Konstanz, UTB.
- Fünfgeld, H. (2006): *Fishing in Muddy Waters*. Socio-environment relations under the impact of violence in eastern Sri Lanka. PhD Dissertation. University of Heidelberg, South Asia Institute.
- GoTN (2003): *Tamil Nadu*: Human development report. Delhi.
- HDRC (2003): *Tamil Nadu*. Human development report.
- HFWD (2004): *Health and Family Welfare Department*.
- IPCC (2001): *Climate Change 2001: Impacts, Adaptation and Vulnerability*. Cambridge, Cambridge University Press.
- Kabilan, L.; T. Velayutham et al. (2004): Field- and laboratory-based active dengue surveillance in Chennai, Tamil Nadu, India: observations before and during the 2001 dengue epidemic. In: *Am J Infect Control*. No. 32(7). pp. 391-6.
- Kraas, F. (2003): Megacities as global risk areas. In: *Petermanns Geographische Mitteilungen*. No. 147(4). pp. 6-15.
- Krafft, T., R.; Bissel et al. (2002): *Health and the Environment: A Crosscutting Issue for Global Change Research*. Munich, German National Committee on Global Change Research.
- Krafft, T., T.; Worf et al. (2003): A New Urban Penalty? Environmental and Health Risks in Dehli. In: *Petermanns Geographische Mitteilungen*. No. 147(4) pp 6-20.
- Navdanya (2005): *Financing the Water Crisis: World Bank, International Aid Agencies and Water Privatisation*. New Dehli, Research Foundation for Science, Technology & Ecology.
- Nayantara, B. (1996): *Climate and Urban Environmental Management: A Case Study of Madras City*. Department of Geography, University of Madras.
- Nestle, M. (2004): *Möglichkeit und Grenzen des Einsatzes von Indikatoren als Instrumentarium nachhaltiger Stadtentwicklung in Chennai (Madras)*. Indien, Department of Geography, University of Heidelberg.
- Nestle, M.; P. Sakdapolrak, et al. (2005): Chennai: Umweltkrise und Gesundheitsrisiken in einer indischen Megacity. In: Glaser, R.; Darmstadt, K. K.: *Planet Erde*. WBG.
- Nestle, M. et al. (2006): Chennai: Umweltkrise und Gesundheitsrisiken in einer indischen Megacity. In: Glaser, R. et al. (Eds.): *Planet Erde, Band Asien*. WBG, Darmstadt, pp. 209-216.

- NFHS-2 (2000): *National Family Health Survey (NFHS-2)*, India 1998-99, 2000. International Institute for Population Sciences.
- Prowse, M. (2003): Towards a clearer understanding of 'vulnerability' In: *Relation to Chronic Poverty*. Manchester, Chronic Poverty Research Centre.
- Prüss-Üstün, A.; Corbalán, C. (2006): *Preventing Disease Through Healthy Environments: Towards an Estimate of the Environmental Burden of Disease*. Geneva, WHO.
- Ruet, J.; Saravanan, V. S. et al. (2002): *The Water & Sanitation Scenario in Indian Metropolitan Cities: Resources and Management in Dheli, Calcutta, Chennai, Mumbai*. CSH Occasional Paper No. 6. Dehli, French Rereach Institute in India.
- Sánchez-Redriguez, R. et. al. (2005): *Science Plan: Urbanization and Global Environmental Change*. IHDP Report Nr. 15. Bonn.
- Scholz, F. (2002): Die Theorie der „frangmentierenden Entwicklung. In: *Geographische Rundschau*. No. 54(10). pp.6-11.
- Sen, A. (1982): *Poverty and Famines: An Essay on Entitlement and Deprivation*. Oxford, Clarendon Press.
- Subramanian, K. (2004): Cholera in north Chennai turns focus on pipeline water quality. In: *The Hindu*. 19 May 2006.
- TNHDR (2003): *Tamil Nadu*. Human development report.
- TNSCB (2005): *Pre-feasibility Study for Identification of Environmental Infrastructure Requirements in Slums in Chennai Metropolitan Area*. Chennai, Tamil Nadu Slum Clearance Board.
- Tröger, S. (2004): *Handeln zur Ernährungssicherung im Zeichen gesellschaftlichen Umbrauchs: Untersuchungen auf dem Ufipa-Plateau im Südwesten Tansanias*. Saarbrücken, Verlag für Entwicklungspolitik.
- Turner, B. L. et. al. (2003): A framework for vulnerability analysis in sustainability science. In: *PNAS* No. 100(14). pp.8074-8079.
- Vogel, C. and K. O'Brien (2004). Vulnerability and Global Environmental Change: Rhetoric and Reality. In: *AVISO*. No. 13.
- Watts, M. J.; Bohle, H.-G. (1993): The Space of Vulnerability: The Causal Struktüre of Hunger and Famine. In: *Progress in Human Geography*. No. 17(1). pp. 43-67.
- WHO (2003): *Methods of Assessing Human Health Vulnerability and Public Health Adaptation to Climate Change*. WHO, Copenhagen.
- WHO (2006): *Water and Sanitation: Water and Health Issues*. Volume, DOI.
- Wisner, B. (1993): Disaster vulnerability: Geographical scale and existential reality. Worlds of pain and hunger: Geographical perspectives in disaster vulnerability and food security. In: H.-G. Bohle. Saarbrücken, Breitenbach. Freiburg. *Studies in Development Geography* 5. pp 13-55.
- Wisner, B. (1993): Disaster Vulnerability: Scale, Power and Daily Life. In: *GeoJournal*. No. 30(2). pp.127-140.

SECTION II

CONTRIBUTING FACTORS

2.1 Vulnerability, Resilience, and Robustness to Urban Water Scarcity: A Case from Cochabamba, Bolivia

Amber Wutich

Acknowledgements

This material is based upon work supported by the United States National Science Foundation (Award No. BCS-0314395), Fulbright-IIE, the Tinker Foundation, and the University of Florida Center for Latin American Studies, Department of Anthropology, and Bureau of Economic and Business Research.

Abstract

This paper uses theories from social vulnerability and socio-ecological systems to examine the effects of urban water scarcity on the residents of Villa Israel, a squatter settlement in Cochabamba, Bolivia during the 2004 dry season. The paper tests the relationship between households' assets within and access to market and non-market water distribution systems and their vulnerability, resilience, and robustness to urban water scarcity. The data were collected as part of an 18-month anthropological study of Villa Israel. Household heads from 72 randomly-selected residences were interviewed at 2-month intervals about water acquisition and use. The findings indicate that households with fewer assets related to the market system are significantly more vulnerable, more resilient, and less robust than those with more assets. Households with less access to the market system are significantly more vulnerable than those with more access. Assets and access related to two non-market water distribution systems were not significantly associated with vulnerability, resilience, and robustness. The paper argues that these findings can only be understood with reference to the political ecology of urban water distribution in Cochabamba at the time the research was conducted. It concludes with recommendations for conducting future research that integrates social vulnerability and socio-ecological system theories more fully.

The concept of social vulnerability was developed for the investigation of natural hazards and disasters. For twenty-five years, social scientists have examined how social systems overlay ecological ones, and shape social vulnerability to environmental stressors. Recently, studies of human and environmental processes were fused in a new field of inquiry – socio-ecological systems (SES) (Berkes and Folke 1998, Redman 1999). Scholars now propose that research on social and ecological vulnerability be merged within one SES-oriented framework (Turner et al. 2003a, Gallopín 2006).

This paper uses the SES vulnerability framework to test hypotheses derived from social vulnerability theory. The study examines urban water scarcity in Villa Israel, a squatter settlement in Cochabamba, Bolivia. Data from 18 months of fieldwork are used to explore how assets and access to water systems make households more vulnerable, resilient, or robust to seasonal water scarcity.

A Vulnerability Framework for Analyzing Socio-ecological Systems

The SES vulnerability framework is used to examine the extent to which hazards (stressors or perturbations) are likely to harm a system, subsystem, or system subcomponent (Turner et al. 2003a:8074). The framework facilitates systemic research on integrated social and ecological processes, nested spatial and temporal scales, feedback loops, and complex processes. Because the framework is designed for use by social and ecological scientists, it requires that vulnerability and its associated concepts be defined in ways that are applicable across disciplines (Gallopín 2006).

For the purposes of this study, vulnerability is defined as "the state or capacity of a system that is unable to adapt to a stressor". A vulnerable individual, group, or social system can be driven to total structural reorganization, chaos, or extinction by stressors, hazards, or shocks (Young et al. 2006). This approach

focuses on the internal side of vulnerability (Bohle 2001), or the processes within the system under study. The external side of vulnerability, or stressors, hazards, and shocks (and exposure to them), is considered to be outside the system. This definition of vulnerability can best be understood in relation to two concepts: robustness and resilience (van der Leeuw 2001, Young et al. 2006).

Robustness has been described as the opposite of vulnerability (cf. Gallopín 2006). It is defined here as “the state or capacity of a system to absorb a stressor without adapting”. A robust system does not respond at all to a stressor; the system can maintain all its functions in spite of the stressor (Wagner 2005). While the concept is newer than vulnerability or resilience, robustness is particularly useful for the analysis of systems that are intentionally designed to withstand stressors and maintain their structure (Anderies et al. 2004). In the social vulnerability literature, Burton et al and Swift have also labelled this quality “absorptive capacity” (Pelling 2003).

Resilience, too, is sometimes described as the opposite of vulnerability; however, it is not necessarily (Gallopín 2006). Resilience is defined as “the state or capacity of a system that is able to adapt to a stressor without changing fundamentally” although function and dynamics may change temporarily (Holling 1973). Resilience is often described a desirable characteristic of systems, but it is important to note that this may not be the case. In fact, a resilient system is one that can come to rest in multi-stable states, and these states can exist in varying degrees of desirability or undesirability (Gunderson and Holling 2002). For instance, poverty is an example of a resilient and undesirable social state (Redman 2006, personal communication). The anthropological literature on coping and adaptation describes a range of processes that should be considered resilient, but not robust (e.g., Laughlin 1978, Dirks 1980, Turnbull 1972).

Because the SES vulnerability framework is designed to facilitate research on complex processes at multiple scales, the analyses required can be quite complicated. There is still no consensus on how to conduct an integrative analysis (Young et al. 2006), although some scholars have suggested a way forward using qualitative analyses of secondary data (e.g., Turner et al. 2003b). To conduct such an analysis with primary data, however, one must go to the field with specific research objectives in mind. For social scientists working within the SES vulnerability framework, the literature on social vulnerability points to a way forward.

Integrating SES and Social Science Approaches

In 1981, Sen’s groundbreaking work demonstrated the importance of entitlements, or a household’s position in society, personal assets, and access to markets, for understanding its vulnerability to famines. Soon after, Hewitt (1983) showed that all kinds of disasters – not only famines – are shaped by the social structures that mediate environmental hazards. Blaikie et al’s (1994) social vulnerability framework demonstrated the importance of rights, resources, and access in determining vulnerability to disasters. Later theorists showed that both market assets (such as savings and possessions) and non-market assets (such as social power and networks) are major determinants of social vulnerability (Moser 1998, Pelling 2003).

The literature on social vulnerability provides strong evidence that assets and access help determine who will be vulnerable to environmental stressors. To understand how access and assets will shape local vulnerabilities, they must be located within a specific SES. The construction of rights and obligations in that SES will establish what kinds of assets and access will be important for understanding the distribution of vulnerabilities across a population. For instance, in market-driven systems, the distribution of accumulated capital and market access will likely affect which members of society are (and are not) vulnerable to environmental scarcities. In non-market systems, other determinants of power and wealth (such as social status or accumulated reciprocal obligations) should predict the distribution of environmental vulnerabilities. In hybrid systems, in which the articulation of market and non-market systems creates multiple pathways to resource acquisition, the role of assets and access in determining vulnerability may be unclear.

In this paper, I suggest that one important approach to understanding social vulnerability to urban water scarcity is to situate data on key assets and access within an analysis of a larger socio-ecological system. To date, only a few published studies have used quantitative data analysis to examine how access and assets shape social vulnerability to urban water scarcity at the local level. No such study has done so using the SES vulnerability framework.

Hypotheses

Based on the literature on social vulnerability, I predict that access and assets will be significantly associated with vulnerability, resilience, and robustness in water-scarce households. The first set of hypotheses deals with access to water distribution systems. Hypothesis 1 predicts that access to market (H1a) and non-market (H1b) water distribution systems will be significantly associated with household-level vulnerability. Hypothesis 2 predicts that access to market (H2a) and non-market (H2b) water distribution systems will be significantly associated with household-level resilience. Hypothesis 3 predicts that access to market (H3a) and non-market (H3b) water distribution systems will be significantly associated with household-level vulnerability.

The second set of hypotheses deals with assets relevant to water acquisition. Hypothesis 4 predicts that market (H4a) and non-market (H4b) assets will be significantly associated with household-level vulnerability. Hypothesis 5 predicts that market (H5a) and non-market (H5b) assets will be significantly associated with household-level resilience. Hypothesis 6 predicts that market (H6a) and non-market (H6b) assets will be significantly associated with household-level robustness.

All of the hypotheses assume that there is a community in which multiple systems of water distribution exist, and that those systems will include market and non-market elements. The hypotheses also assume that seasonal water scarcity will occur, that it will affect all water distribution systems, and that the effect will be significant.

Urban Water Scarcity

Global social and ecological trends like economic restructuring, urban growth, and desertification are making water increasingly scarce – and water access increasingly inequitable – in cities around the world. At least 157 million urbanites have no access to an improved water source, and hundreds of millions more lack adequate access to safe water. The majority of those without safe water live in Latin American (15 percent), African (25 percent), and Asian (57 percent) cities (UN-Habitat 2003). Although much is being done to extend water provision systems to water-scarce urban areas, the root causes of urban water scarcity are complex and difficult to resolve.

While ecosystems shape the physical availability of water resources for human use, human social systems shape peoples' ability to access water resources (Gleick, Singh, and Shi 2001). In cities that lack comprehensive municipal service, urban water distribution generally takes a centre/periphery form in which well-provisioned downtowns give way to outskirts with progressively fewer services (Gilbert 1998). Without adequate infrastructure, the urban poor suffer from severe water scarcity even in cities that have enough water to meet their residents' needs. Beyond this, human-based processes, such as groundwater depletion, salination, deforestation, and desertification, can have enormous impacts on ecosystems, and ultimately affect the quality and distribution of water resources.

Urban Water Scarcity in Cochabamba, Bolivia

Since 1984, Bolivia has endured a number of poverty-inducing economic upheavals including a devastating cycle of debt and hyperinflation, the collapse of the mining industry, and the eradication of a coca-based cash crop industry (Nash 1992, Painter 2006). As a result, migrants have flooded to economic centres like Cochabamba (McFarren 1992). The city of Cochabamba, perched on the southern edge of a water-rich alluvial fan aquifer system in the Andean valleys, is the home of 1.67 million Bolivians (Instituto Nacional de Estadística de Bolivia 2006).

Human settlement and development patterns in Cochabamba have mapped social inequities onto hydrologic patterns of water distribution. The north side of the city – where the wealthiest residents live – sits atop a spring zone, a major river, and a lake. On the far south side of the city – where new migrants and the urban poor occupy squatter settlements – the water table is deeper and surface water is scarcer. Cochabamba’s municipal water supply infrastructure covers only 62 percent of the urban population, in the north and central regions of the city (Terhorst 2003). South-side residents are outside of the municipality’s water service zone, and must find their own water. Most south-side households use a combination of purchases from water vendors, rainwater collection, community-owned groundwater wells, and surface sources to meet their domestic water needs. Such sources are generally expensive, time-consuming, and unreliable to use. In Villa Israel, a squatter settlement located at the far southern tip of Cochabamba, seasonal water scarcity poses a serious threat to human well-being and quality of life.

Water Provision in Villa Israel, Cochabamba

Villa Israel is a squatter settlement of about 1700 residents, mainly displaced miners, coca growers, and farmers. Many of Villa Israel’s residents work as informal vendors of fruit and vegetables in Cochabamba’s main downtown market. Informal market vendors are among the city’s poorest working residents, and earn as little as 8 Bolivianos (\$1 USD) a day. However, some Villa Israel residents make an ample living from cottage industries, corner stores, taxis, or rental properties. The community itself has a school, 14 churches, a clinic, electric and telephone service, and several sports fields. It lacks urban infrastructure such as a bridge, paved roads, sewage and – most importantly – a comprehensive water distribution system. In this section, I give a brief overview of the water situation in Villa Israel. Since there are no published studies on the topic, I present data from my own fieldwork.

There are three year-round sources of water in Villa Israel: water delivery trucks, a community tapstand system, and a reciprocal water exchange system. The water delivery truck system in Villa Israel operates in a market form called an oligopoly, in which vendors are few, water is scarce, and buyers abound. Water delivery trucks carry large cisterns that hold up to 10,000 litres of water. Each day, between one and four water trucks operate in Villa Israel. People in need of water listen for the beeping horn of a water truck. Upon hearing the horn, they dash out into the street in search of the truck. Once they find the truck, they must convince the driver to come to their homes to sell them water. For those people that cannot catch the truck or entice the driver to make a delivery, it can be very difficult to acquire water. People who cannot buy water are sometimes unable to refill their storage tanks for days at a time.

Even for those who can get access to the truck, the price of the water is high. In 2004, water delivery trucks charged 4 Bolivianos (\$0.50 USD) for 200 litres of water, the minimum daily water requirement for a four-person family (Gleick 1996). This sum represents about 20 percent of the standard daily income for an adult in Villa Israel. While most community members consider purchased water to be very expensive, water delivery trucks are the most common source of water in Villa Israel. From April 2004 to February 2005, for instance, 100 percent of Villa Israel households reported buying water from a water delivery truck at least once.

The community-run tapstand system draws water from two small wells in the foothills above the community. Approximately ten tapstands provide 20 to 40 litres of water a day to eligible households around the community. Together, the tapstands form a non-market water distribution system. Because of the danger of water theft, the tapstands are only unlocked once a day under the supervision of a guard. Water is distributed for 20 minutes at each tapstand, at a randomly-selected time between 4:30 am and 9:00 am from Monday to Saturday. Access to the tapstand is restricted by a number of factors. First, people who are not home to wait for their tapstand to be unlocked cannot get access to the system. Second, only Villa Israel homeowners are officially allowed access to the tapstand system. Renters with strong ties to powerful members of the community’s political and religious institutions can also get informal access to the tapstands. Third, each household must attend the monthly meeting of the community government and pay 10 Bolivianos (\$1.25 USD) to get access to the taps. These access

restrictions make getting water from the community tapstand system difficult, costly, and time consuming for many Villa Israel residents. As a result, the system is not very popular; from April 2004 to February 2005, only 39 percent of households reported using the tapstand system even once.

Villa Israel residents also loan, give, and barter small amounts of water among themselves throughout the year. The water exchanges constitute a non-market water distribution system. While the reciprocal water exchange system offers some insurance against water scarcity, many Villa Israel residents avoid participating. When asked why, they explained that they wanted to avoid conflicts, that neighbours do not return borrowed water, or that community members disparage people who seem needy. Despite this, some households do participate in long-standing reciprocal relationships, exchanging 10 to 20 litres of water with neighbours. From April 2004 to January 2005, 38 percent of household heads reported receiving water from someone else at least once.

Field Methods

The research was conducted over 18 months of fieldwork, between June 2003 and July 2005, in Villa Israel, Cochabamba, Bolivia. The field research was conducted by five team members: an American anthropologist, two Bolivian researchers, and two Bolivian translators for Quechua and Aymara. The first four months of research were dedicated to participant-observation. After two months of protocol development and testing, a random sample was drawn from a map of 415 residential constructions in the community. Of the 96 households that were contacted, 72 households (75 percent) agreed to participate. Interviews were conducted with the person who was most knowledgeable about resource acquisition and distribution in the household. Sixty-nine percent of the respondents were women. From April 2004 to January 2005, we conducted five two-month cycles of interviews and observation. The interview protocol included questions about society, economics, water acquisition, and water use (see Wutich 2006, for complete data collection protocols).

Methods of Analysis

Five variables were operationalized using native concepts identified during the participant-observation phase of the research. The two independent variables are access and assets. Measures of access and assets were means taken from 6 months of data collection, from April to September 2004. Access to water distribution systems was defined as (1) access to water markets and (2) access to the tapstand system. Access to water markets was measured on a four-point scale assessing a residence's distance from the centre of Villa Israel. Access to the tapstand system was measured by tapstand use, or the mean number of times that a household acquired water from tapstands over the 6-month period. Assets were defined as (1) market assets and (2) reciprocal assets. Market assets were measured by household income level, on a four-point scale. Reciprocal assets were measured by participation in the water exchange system, or the mean number of times that a household acquired water via reciprocal exchange over the 6-month period. This measure assumes that reciprocal obligations are stored in long-term relationships, that they represent redeemable assets, and that they are balanced over time.

The three dependent variables are vulnerability, resilience, and robustness. Measures of vulnerability, resilience, and robustness were taken from six weeks of data collection conducted at the height of the dry season and water scarcity stress, in August and September 2004. Vulnerability was defined as the inability to complete essential water use tasks. It was measured using a five-point Guttman scale (1950), which assesses the degree to which household members were unable to cook, bathe, clean, do the dishes, and wash laundry due to water scarcity. The scale has a coefficient of reproducibility of .88 which is above the generally accepted cut-off of .85 (Bernard 2002). A high score indicates more elimination of tasks, and thus more vulnerability to water scarcity. Resilience was defined as the modification of water use tasks for the purpose of conserving water. It was measured using a four-point Guttman scale, which assesses the extent to which household members modified water use tasks to conserve water in cooking, bathing, cleaning the house, and washing laundry. The water conservation scale has a

coefficient of reproducibility of .90. A high score on this scale indicates more water conservation and more resilience to water scarcity. Robustness was defined as the extent to which households had 50 litres of water per person per day, the quantity needed to meet minimal human water requirements for drinking and household use in low-technology situations (Gleick 1996). A high score indicates more robustness to water scarcity.

Multiple regressions were used to determine the size, direction, and significance of the effect of four independent variables (access to water trucks, access to tapstands, market assets, and reciprocal assets) for each of the three dependent variables (water task elimination, water conservation, and sufficient water provision). A term for the interaction between market assets and reciprocal assets was also included in the analysis. After running the regression analysis, I was able to identify general patterns in the quantitative data. I then returned to the original quantitative dataset, and identified individual households that had high and low scores on each of the independent variables. Using that list of households, I went back to the qualitative data for each household. I reread the interview narratives to gain an overall understanding to how access and assets affect vulnerability, robustness, and resilience in specific cases. I present the results in the next two sections.

Outcomes

In 2004, the dry season lasted from March to November. The last heavy rains fell between March 17 and March 20 (SENAMHI 2005). Some households' rainwater stores lasted through April and May. In June, water scarcity began to affect the majority of the households. From July to October, nearly all households experienced water scarcity, allowing for the six hypotheses to be tested.

The multiple regression analyses show that the model is significantly associated with the measures of vulnerability ($r^2 = .36, p = .0001$), resilience ($r^2 = .19, p = .02$), and robustness ($r^2 = .20, p = .02$). Only one variable, market assets, was significantly associated with vulnerability ($B = -.63, p = .006$), resilience ($B = -.58, p = .02$), and robustness ($B = 9.13, p = .01$). Access to water markets was significantly associated with vulnerability ($B = -.40, p = .04$), but not resilience or robustness. The other three independent variables (reciprocal assets, access to tapstands, and the interaction term) were not significantly associated with any of the outcome variables.

Table 1: The relationship between access, assets, and water-related outcomes in Villa Israel

Predictive Variables		Outcome Variables		
		Vulnerability	Resilience	Robustness
Market assets	Beta	-0.63	-0.58	9.13
	P-value	0.01	0.02	0.01
Reciprocal assets	Beta	-0.35	2.06	-2.21
	P-value	0.89	0.43	0.96
Market access	Beta	-0.40	0.03	-0.27
	P-value	0.04	0.89	0.93
Tapstand access	Beta	-0.29	0.43	-10.74
	P-value	0.49	0.33	0.10
Interaction Term	Beta	1.28	-0.96	-2.92
	P-value	0.19	0.35	0.85
Model	r^2	0.36	0.19	0.20
	P-value	0.00	0.02	0.02

These results indicate that four of the twelve hypotheses (H1a, H4a, H5a, and H6a) should be accepted. The remaining eight hypotheses (H4b, H5a, H1b, H2b, H3b, H4b, H5b, and H6b) should be rejected.

Discussion

The findings show that market-related variables, such as income and market access, are the best predictors of vulnerability, resilience, and robustness to water scarcity in Villa Israel. In contrast, the two non-market variables, reciprocal assets and access to tapstands, are not associated with water-related outcomes. This provides strong evidence that the dynamics of the market-based water distribution system – and not the non-market systems – determine who is vulnerable, resilient, and robust to water scarcity in Villa Israel. To understand what this means in the context of the wider SES, each of the findings must be examined in turn.

The strong association between income and water-related outcomes clearly indicates that people who have more money can buy more water. This principle unfolds in a number of ways in Villa Israel. Very few people say that they have enough money to buy all the water they need. But people with more money to spend on water do have more bargaining power on the market. Those who tend to make large water purchases are given the personal cell phone numbers of water truck drivers, so that they can call to place an order when they are ready to refill their tanks. Also, those who have long-standing relationships with water vendors are rewarded with a *llapa*, or water bonus, that lowers the price of each water unit purchased. People who do not have the ability to establish these personal relationships cannot enjoy the benefits of personal delivery service or *llapas*. Beyond that, there are many people who simply do not have the money to buy water when they need it. In interviews, some people explained that they ran out of water because they had spent their income on food, business expenses, or some other urgent need. Others said that they did not have enough money to buy water because a family member was out of work. Still others say that water is simply too expensive to fit into their household budget, and reported using a number of risky strategies – such as relying on dwindling rainwater stores during the dry season or walking hours to obtain free river water – to avoid purchasing water. In Villa Israel, then, the culturally-embedded functions of the market (i.e., the role of personal relationships and *llapas*) help explain why people with more income are less vulnerable to water scarcity. People with less income use resilient behaviours (or coping strategies), such as conserving water and using alternative sources, to offset the high cost of water. When those coping strategies are insufficient to maintain the household, people become vulnerable to water scarcity.

In addition to their income, people's access to water markets also affects their vulnerability to water scarcity. People living in the community's centre have less access to the water truck than people at the edges. This can be explained by the distribution of population density in Villa Israel. In the centre of the community, houses occupy small lots, are packed closely together, and are divided into many rental units. At the edges of the community, houses occupy larger lots, there is more empty land, and there are fewer rental subunits. The results indicate that there is more competition for access to water trucks in Villa Israel's densely-populated centre than at the sparsely-populated edges. As a result, people living in densely-populated central zones are more vulnerable to water scarcity because they are more likely to unexpectedly run out of water when they are planning to refill their tanks. Since being unable to buy water is probably experienced as a perturbation rather than a stressor, it does not affect long-term coping strategies or resilience. Because people budget for and buy a fixed amount of water regardless of when they get access, the access measure does not have a significant effect on robustness.

While the mechanisms that link markets and water-related outcomes are clear, it may be surprising that non-market systems are not significantly associated with vulnerability, resilience, and robustness. This is likely because the tapstand and reciprocal water exchange systems only distribute a small amount of water in comparison to the market system. On a normal day, the market system circulates between 10,000 and 40,000 litres of water in Villa Israel. In comparison, the tapstand system distributes between 3,000 and 6,000 litres a day. Based on participants' reports, the reciprocal exchange system probably distributes no more than 50 litres of water per day throughout the entire community. Since they distribute such a small amount of water, the non-market systems probably cannot significantly impact water-related outcomes at the community level.

The reason that the market system distributes so much more water than the non-market systems is because the market system is tied into a wider socio-ecological system in the Cochabamba Valley, while the non-market systems are not. As a result, the market system has the ability to summon water resources from the city's municipal system, the valley's north-side wells and aquifers, and even water from distant dam projects. In contrast, Villa Israel's non-market water systems draw on local water resources like small-scale community wells and neighbours' storage tanks. The ability of water delivery truck-based markets to reach across geographic, ecological, social, and political scales explains their importance to people in a water-poor south-side Cochabamba community like Villa Israel. Conversely, the inability of the non-market systems to link across scales explains why they command so little water and have so little effect on water-related outcomes.

It is important to note that this finding in no way implies that market systems are the only form of economic organization that can link resources across geographic, ecological, social, and political scales. While only the market economy had the kind of political and economic power needed link to socio-ecological systems at the time the fieldwork was conducted (in 2004), this has not historically been the case in Bolivia. In the pre-Columbian era, ayllu systems were used to link coastal, tropical, and alpine ecologies in the Andean region (Wagner 1991). Ayllu systems, while not egalitarian, were based on reciprocal exchanges called *ayni* and labour rotations called *mit'a* (Moseley 1992). Today, the new government of President Evo Morales is attempting to reconfigure the distribution of power and resources in ways that provide viable alternatives to neoliberal markets. The extent to which those policies will be successfully realized remains to be seen. Unless large-scale economic transformations do overtake Bolivia, small-scale adjustments in the function of existing water markets appear to be the most realistic approach to overcoming household-level vulnerability to urban water scarcity. The findings here have real implications for that effort in Villa Israel and communities like it.

Recommendations to Overcome Household-level Vulnerability

During 2004, most of the efforts to improve water provision in Villa Israel were focused on improving the capacity and reach of the tapstand system. The tapstand system is a politically popular issue in Villa Israel because improvements to it bring investment, jobs, and the promise of sustainability. While sustainability is an important long-term goal for Villa Israel and other water-scarce communities, vulnerabilities caused by acute seasonal water scarcity urgently need more attention.

Efforts to help households overcome seasonal vulnerability to water scarcity should focus on the dynamics of community-level water markets. Income is the best predictor of a household's vulnerability, resilience, and robustness to water scarcity. A targeted effort to relieve household-level water scarcity could provide vouchers, subsidies, or graded pricing to low-income households. In comparison to the cost of maintaining and improving a tapstand system, subsidizing water purchases from the water delivery truck may provide a relatively inexpensive way to provide water to the people who need it most. Subsidies might also give low-income households more purchasing power, and alleviate some of the effects of competition for access to water trucks in densely-populated zones of the community.

Another possible relief effort could involve a community water bank to help vulnerable households acquire water in emergency situations. Such a bank could offer small-scale water loans on the scale of 20-200 litres, and accept deferred cash payments in instalments. Relatively small amounts of water could help offset severe scarcity during the height of the dry season. More study would be needed, however, to determine the feasibility and efficacy of a water bank.

Conclusion

This paper employs an SES vulnerability framework to understand how household experiences of urban water scarcity are shaped by access and assets in market and non-market water distribution systems.

Results from Villa Israel showed that market-based assets and access were associated with vulnerability, resilience, and robustness to water scarcity. Non-market assets and access were not associated with water-related outcomes. An analysis of the political ecology of water distribution indicates that the market-based system affected water-related outcomes because it linked resources across geographic, ecological, social, and political scales. Because the non-market systems distributed only limited local resources, they did not have a significant impact on water-related outcomes.

The Villa Israel findings support a central thesis of social vulnerability theory: that access and assets shape local vulnerabilities. They also demonstrate that studies of social vulnerability, resilience, and robustness are enriched by an analysis of the wider socio-ecological system. Future research could improve on the analysis of urban water scarcity presented here by employing the full capabilities of the SES vulnerability framework. Such an analysis could test the relationships between social and ecological predictors of social vulnerability at multiple time scales, in nested spatial scales, or with inputs from feedback loops. From there, we can begin to look beyond seasonal water scarcity to understand how long-term climate changes affect the sustainability of water resources in socio-ecological systems.

References

- Anderies, J.M.; Janssen, M.A.; Ostrom, E. (2004): A framework to analyze the robustness of social-ecological systems from an institutional perspective. In: *Ecology and Society*. vol. 9, no. 1, pp. 18.
- Bernard, H.R. (2002): *Research Methods in Anthropology: Qualitative and Quantitative Approaches*. Altamira Press, Walnut Creek, CA, USA.
- Blaikie, P.; Cannon, T.; Davis, I.; Wisner B. (1994): *At Risk: Natural Hazards, People's Vulnerability, and Disasters*. Routledge. London, UK.
- Berkes, F.; Folke C. (1998): *Linking Social and Ecological Systems*. Cambridge University Press. London, UK.
- Bohle, H.G. (2001): Vulnerability and Criticality. In: *Newsletter of the International Human Dimensions Programme on Global Environmental Change*. no. 2/2001.
- Dirks, R. (1980): Social Responses During Severe Food Shortages and Famine. In: *Current Anthropology*. vol. 21, no. 1, pp. 21-44.
- Gilbert, A. (1998): *The Latin American City*. The Latin American Bureau. London. UK.
- Gleick, P. (1996): Basic Water Requirements for Human Activities: Meeting Basic Needs. In: *Water International*. vol. 21, pp. 83-92.
- Gleick, P.; Singh; and Shi (2001): *Threats to the World's Freshwater Resources*. Pacific Institute for Studies in Development, Environment, and Security, Oakland, CA, USA.
- Gallopin, G. (2006): Linkages between vulnerability, resilience, and adaptive capacity. In: *Global Environmental Change*. vol. 16, no. 3, pp. 293-303.
- Gunderson, L.H.; Holling, C.S. (Eds.) (2002): *Panarchy*. Island Press, Washington, DC, USA.
- Guttman, L. (1950): The basis for scalogram analysis. In: *Studies in Social Psychology in World War II*. Stouffer, A. (Ed.), Princeton University Press, Princeton, NJ, USA.
- Hewitt, K. (1983): *Interpretations of Calamity: From the Viewpoint of Human Ecology*, Allen and Unwin, Boston, USA.
- Holling, C.S. (1973): Resilience and stability of ecological systems. In: *Annual Review of Ecology and Systematics*. vol. 4, pp. 2-23.
- Instituto Nacional de Estadística de Bolivia (2006): *Resumen de Indicadores Demigráficos* (Proyecciones para Julio 2006). <<http://www.ine.gov.bo>>, 13 July 2006.

- Laughlin, C., Jr. (1978): *Adaptation and Change in the So: A Diachronic Study of Deprivation*. In: C. Laughlin, Jr. and I. Brady, (Eds.): *Extinction and Survival in Human Populations*. Columbia University Press, New York, USA, pp. 76-95.
- McFarren, W. (1992): *The Politics of Bolivia's Economic Crisis: Survival Strategies of Displaced Tin-Mining Households*. In: Feldman, S. (Ed.): *Unequal Burden: Economic Crises, Persistent Poverty, and Women's Work*. Westview Press, Boulder, CO, USA, pp. 131-158.
- Moseley, M.E. (1992): *The Inca and Their Ancestors*. Thames and Hudson Publishing, New York, NY, USA.
- Moser, C. (1998): *The asset vulnerability framework: Reassessing urban poverty reduction strategies*. In: *World Development*. Vol. 26, pp. 1-19.
- Nash, J. (1992): *Interpreting Social Movements: Bolivian Resistance to Economic Conditions Imposed by the International Monetary Fund*. In: *American Ethnologist*. Vol. 19, no. 2, pp. 275-293.
- Painter, J. (1994): *Bolivia and Coca: A Study in Dependency*. L. Reinner Publishers, Boulder, CO, USA.
- Pelling, M. (2003): *The Vulnerability of Cities: Natural Disasters and Social Resilience*. Earthscan Publications Ltd., London, UK.
- Redman, C.L. (1999). *Human dimensions of ecosystem studies*. In: *Ecosystems*. Vol. 2, pp. 296-298.
- Sen, A. (1981): *Famines and Poverty*. Oxford University Press, London, UK.
- Servicio Nacional de Meteorología e Hidrología de Bolivia (SENAMHI)(2006): *Boletines Oficiales Mensuales*. <<http://www.senamhi.gov.bo>>, 6 February 2006.
- Terhorst, P. (2003): *Public-Popular Organizations: The Case of Cochabamba, Bolivia*. M.Sc. Thesis. Loughborough University, Leicestershire, UK.
- Turnbull, C. (1972): *The Mountain People*. Simon & Schuster, Inc., New York, USA.
- Turner II, B.L.; Kasperson, R.E.; Matson, P.A.; McCarthy, J.J.; Corell, R.W.; Christensen, L.; Eckley, N.; Kasperson, J.X.; Luers, A.; Martello, M.L.; Polsky, C.; Pulsipher, A.; Schiller, A. (2003): *A framework for vulnerability analysis in sustainability science*. In: *Proceedings of the National Academy of Sciences of the United States of America*. Vol. 100, no. 14, pp. 8074–8079.
- Turner II, B.L.; Matson, P.A.; McCarthy, J.J.; Corell, R.W.; Christensen, L.; Eckley, N.; Hovelsrud-Broda, G.K.; Kasperson, J.X.; Kasperson, R.E.; Luers, A.; Martello, M.L.; Mathiesen, S.; Naylor, R.; Polsky, C.; Pulsipher, A.; Schiller, A.; Selin, H.; Tyler, N. (2003): *Illustrating the coupled human-environment system for vulnerability analysis: Three case studies*. In: *Proceedings of the National Academy of Sciences of the United States of America*. Vol. 100, no. 14, pp. 8080-8085.
- UN-Habitat (2003): *Report on Water and Sanitation in the World's Cities*, UN-Habitat.
- Van der Leeuw, S.E. (2001): *Vulnerability' and the Integrated Study of Socio-natural Phenomena*. In: *Newsletter of the International Human Dimensions Programme on Global Environmental Change No. 2/2001*.
- Wagner, A. (2005): *Robustness and Evolvability in Living Systems*. Princeton University Press, Princeton, NJ, USA.
- Wagner, M.L. (1991): *Historical Setting*. In: R.A. Hudson and D.M. Hanratty (Eds.): *Bolivia: A Country Study*, Federal Research Division of the Library of Congress, Washington, DC, USA.
- Wutich, A. (2006): *The Effects of Urban Water Scarcity on Sociability and Reciprocity in Cochabamba, Bolivia*. Ph.D. Thesis, University of Florida, Gainesville, FL, USA.
- Young, O.R.; Berkhout, F.; Gallopin, G.C.; Janssen, M.A.; Ostrom, E.; van der Leeuw, S. (2006): *The globalization of socio-ecological systems: An agenda for scientific research*. In: *Global Environmental Change* 16, no. 3, pp. 301-316.

2.2 Hard Decisions in the Big Easy: Social Capital and Evacuation of the New Orleans Area Hispanic Community During Hurricane Katrina

Byron Real

Kathleen Blanco (Governor of Louisiana): *I am very happy to talk about our evacuation process, because it is the one thing that we did masterfully.*

Chairman Davis (Congressional Commission): *This was the most successful evacuation you ever had, right?*

Kathleen Blanco: *Absolutely without a doubt.*

Hearing on Hurricane Katrina Before Select Comm., 109th Cong. (Dec. 14, 2005) at 67 (USHR 2006: 124)

Abstract

A reinforced social structure allowed the Hispanic population of New Orleans, particularly the poor and undocumented informal immigrants, to successfully respond, reorganize and rapidly recover from Hurricane Katrina. Informal Hispanic immigrants are negatively affected by a number of socio-economic conditions and legal factors. To offset the social and institutional marginalization these immigrants face, they developed social solidarity by applying traditional elements of social capital that strengthen group identity and cooperation, providing resilience against a disruptive situation such as Hurricane Katrina. Despite the social vulnerability faced by informal Hispanic immigrants due to lack of financial resources, transportation, information, and language barriers during Hurricane Katrina, this community carried out a successful evacuation process which saved many lives. The social experience of informal Hispanic immigrants described in this article is relevant to the study of human security and social vulnerability because it explains the link between cultural factors and social resilience to natural threats and how these aspects may modify social vulnerability.

Introduction

A hurricane is an indiscriminate natural threat that does not spare any spot in its path. Evacuation is the best, and possibly the only, real protection of human life, when a significant natural threat is eminent. Evacuation is a difficult decision to make, not only by local authorities but also by the residents of a given threatened area. After years of evacuating when a natural hazard threatens and is not realized, residents tend to underestimate the threats and decide not to leave their homes. This phenomenon has been called "hurricane fatigue" or "hurricane roulette." Those who have played the odds of incurring personal tragedy in such situations are generally individuals with some degree of social vulnerability.

Three years before the disaster caused by Hurricane Katrina the Times Picayune, the major New Orleans' newspaper, warned: "once it's certain a major storm is about to hit, evacuation offers the best chance for survival," and pointed out that "hurricane evacuations rarely go as planned. Storm tracks are hard to predict, and roads are not designed to hand the traffic flow, so huge traffic jams are a common result" (McQuaid and Schleifstein 2002).

The residents of the New Orleans area were well aware of the probability that a devastating hurricane would one day hit their city. Nevertheless, when in 2005 the feared "Big One" did, in fact, hit the area, the city had not been evacuated. The evacuation process failed despite repeated, insistent warnings. News coverage by the media indicated that a number of federal, state and local authorities, as well as many respected community leaders, cited a lack of organization at all government levels as the direct cause of the failure of the evacuation. The officials failed to apply an adequate decision-making system. This led to a tardy mandatory order to evacuate. The poor handling of transportation issues during the

evacuation further complicated the situation. A large number of individuals chose not to leave the city, even though in many cases they had the means to do so (USHR 2006).

Instead of a socially organized process, as evacuation planning intends to facilitate, in this particular evacuation endeavor, decision-making rested largely with each individual or family. The lack of adequate public information as to the exact path and potential degree of destruction of the hurricane hindered many from making timely, and in this case correct, decisions as to how to preserve their safety. In particular, the populace was totally unprepared for the unforeseen danger of the levee breaches that caused the city to be inundated.

Those residents most vulnerable were not well-informed of the situation and/or those who lacked the means to leave the city. The Hispanic residents were particularly vulnerable, as much of their population met both categories of vulnerability. Most could not understand or follow the information bulletins and instructions, which were provided almost exclusively in English by the authorities. Not only did many Hispanics lack the means of transportation with which to evacuate, most were not even aware of where they might find a safe haven. However, notwithstanding hindrances, this social group evacuated nearly all of its members in a relatively timely and safe manner. Although the evacuation process followed by the Hispanics was unplanned, it was nevertheless effective. The cohesion of this social group, and their evacuation process, which bore a close resemblance to a community-organized one, resulted in relatively few Hispanic casualties from the devastating impact of the hurricane and flooding that followed in its wake.

In order to determine the effects of social vulnerability in the disaster experience of Hispanics, I posed the following questions to organize this research: How did marginality affect their disaster outcome? What was the role of their culture? How did they manage the pre-disaster process? And, was the Hispanic response to the disaster an indicator of social resilience? The response of the Hispanic community lead to hypothesize here that cultural factors such as social networks, language and ethnicity are likely to modify the social vulnerability of the informal Hispanic immigrants, and promote resilience to deal with socio-economic and institutional constraints in the face of natural threats.

The research described in this article is of relevance for the human security and social vulnerability fields because it provides an explanation of the linkage between cultural factors and social resilience to natural threats and how these aspects may modify social vulnerability. This explanation will be useful for improving the understanding of the behavior of marginalized social groups during disasters, and the weight of material aid and social organization in disaster recovery. In addition, the importance of this article for these fields is due to the fact that it is dealing with an issue that has been deficiently researched, which is the effects of natural threats on an immigrant society, which generally is politically hidden in the receiver society. From that situation emerges several additional effects like the lack of a formal migratory status, work insecurity, institutional marginalization, etc., that make worse the social vulnerability that the immigrant group already had.

The phenomena of international migration and social displacement as effect of climate change and natural disasters are likely to increase in the near future. The process of globalization and the periodic economic crisis in poor countries will reinforce this trend. At the same time, as it has been recognized by the International Federation of Red Cross and Red Crescent Societies (IFRC 2004) there is a lack of clear international rules, principles and standards for the protection and assistance of these people when are affected by disasters.

Methods

This document is part of an exploratory research project to determine the effects of Hurricane Katrina on the Hispanic community, one of the vulnerable social groups in New Orleans, the area most affected by the hurricane.

Fieldwork was carried out in the cities of New Orleans and Baton Rouge between February 16 and March 5, 2006, six months after the disaster. The information was gathered by interviews with 53 randomly selected members of the Hispanic community, who were directly affected by the hurricane. This group was composed of women and men of heterogeneous nationality, socioeconomic and educational levels, immigration status, income earning activity, and length of residence in New Orleans and/or the United States. The numbers of interviewees by nationality are as follows: 27 Hondurans, 11 Nicaraguans, 8 Guatemalans, 3 Cubans, 3 Mexicans, and one Ecuadorian. The length of residency in New Orleans (and/or the U.S.), of the interviewees varied from less than one year to more than 35 years. Questions on immigration status of the Hispanics were beyond the goal of this research. However, based on responses to interview questions, it is possible to infer that 18 interviewees correspond to documented immigrants and 35 to undocumented.

The interviews were semi-structured and based on a questionnaire prepared for this research. In fulfilling research standards of the University of Florida, every interviewed person signed an *Informed Consent* form issued by the *University of Florida Institutional Review Board*. All the interviews were conducted in Spanish except two that were in English, the language in which they were more comfortable. Four interviews were conducted in Baton Rouge, and the rest in the New Orleans Metropolitan Area. Four key informants, one in Baton Rouge and three in New Orleans were also interviewed.

Most of the interviewees are people with several pre-existing factors of vulnerability. Most are in the lower economic strata, are poorly educated, have few work skills, lack English comprehension, and do not have immigration documents, which brands them as illegal aliens in this country. To get to this country, some of them have crossed the Mexico-U.S. border walking several days in the desert to get the nearest railroad, and then jumping on the first high speed train passing by. Failing to grasp the handle of one of the train cars could mean a severe injury to the immigrant's hand. Two women interviewed in Baton Rouge related how they spent three days and three nights walking to reach such a train. I said that it is physically impossible, and they replied, but it is psychologically possible if you need to do that. "The proof is that we did it," they confirmed. There is probably some exaggeration in the affirmation of these women, but it depicts the efforts and dangers these people have to deal with to get to this country.

Hispanics, Social Vulnerability and Risk

Natural events such a hurricane, flood, forest fire, earthquake, and drought have long been equated with disaster, but this one-to-one correspondence has been challenged in the past two decades. It is now widely accepted that these natural events do not necessarily create a "disaster." Disasters occur when there is a coincidence between natural hazards and conditions of vulnerability (Maskrey 1989, Canon 1994). The pattern of vulnerability, which is determined by socioeconomic factors, is an essential element of a disaster:

A disaster is made inevitable by the historically produced pattern of vulnerability, evidenced in the location, infrastructure, sociopolitical structure, production patterns, and ideology, that characterize a society (Oliver-Smith 1998, 187).

While the natural hazard is a physical agent, generally in which there is no human intervention, vulnerability is a socioeconomic condition that defines the differing degrees to which individuals or social groups may be affected. Therefore, social vulnerability determines the potentiality of incurring in disaster if a hazard occurs. The occurrence of a hazard places vulnerable social groups (or individuals) at a higher level of risk than those who are less socioeconomically vulnerable.

Vulnerability and risk are not necessarily correspondent conditions. While some risk factors could affect everyone in a given society, the effects may be different in its different groups or individuals. Economic situation, educational level, cultural trends, age, income earning activity, and other factors could be

definers of susceptibility to affects. The chances of being affected due to these factors are “social vulnerability” of that person, family, or social group.

Vulnerability is generally a systemic condition (illnesses, poverty, age) in abeyance that could determine the failure of individuals and groups during a natural event, and thus, leave them open to disaster. Risk is the actual condition of individuals or groups in relation to any hazard. Risk and social vulnerability are not necessarily coincidental: A vulnerable person is not necessarily at risk, and conversely, people at risk are not necessarily vulnerable. For instance, the neighborhoods at risk during the 1998 forest fires in North-Central Florida were primarily upper middle class. Although they were threatened by fire, they could hardly be considered socially “vulnerable.” At risk are people or societies living in areas in which a hazard is likely to occur. New Orleans was “at risk,” when it was determined that Hurricane Katrina was likely to hit the city. The Hispanic community was at risk as well as other social groups in which poverty and other socio- economic conditions impaired their ability to anticipate, cope, resist, and recover from the affects of the hurricane.

In some cases vulnerability and risk are coterminous. This usually happens in cases in which it is known beforehand that a place has become (or was initially) hazardous, but due to poverty or other socioeconomic considerations, some people persist in dwelling or working there. This is often the case when poor neighborhoods are located near petrochemical compounds; when people should work with or near pesticides in the agribusiness industry; or houses that are built on unstable soils. Since these people do not have better options, these are issues that involve the basic structure of the socioeconomic system. These cases show how

[...] the social system generates unequal exposure to risk by making some groups of people, some individual, and some societies more prone to hazards than others ... [therefore] hazards affect people differently *within* societies, and may have very different impacts on different societies ... Inequalities in risk (and opportunity) are largely a function of the principal systems of power operating in all societies, which are normally analyzed in terms of class, gender and ethnicity (Cannon 1994: 14).

Social vulnerability and risk do not only determine pre-disaster conditions. They are also determiners of post-disaster decisions and conditions. The degree of vulnerability and risk depends upon how adaptable or resilient a person or social group may be to address the hardship. The ability of social groups or individuals to bear or absorb sudden (or slow) changes and variation without collapsing is social resilience (Holling 1996.). With respect to disaster, the qualities of resistance, resilience, and adaptation are basic to the reduction of the impacts of actual or future hazards on society. Three basic aspects are definers of resilience:

(1) the amount of change that a system can undergo while still maintaining the same controls on structure and function; (2) the system’s ability to self-organize; and (3) the degree to which the system is capable of learning and adaptation (Carpenter et al, 2001).

This study is based on the assumption that the poor and undocumented Hispanic population of New Orleans was threatened by hurricane Katrina because they were in the path of a hurricane and living in an area plagued by intrinsic physical risks. In addition, this community was particularly vulnerable due to immigration status, poverty, marginality, language barriers, and numerous other conditions that impaired the group’s ability to get adequate information, to anticipate the effects of the hurricane, to cope with the hardship, or get support for recovery. Bearing in mind these social conditions, it was also assumed that this community was not well suited to adapt and maintain its basic structure under the new circumstances imposed by the disaster.

Hispanics in New Orleans and Hispanic Casualties During Katrina

The U.S. Census Bureau designated all immigrants from South and Central American Spanish- and Portuguese-speaking countries as “Hispanic.” This designation is interchangeable with “Latino,” a commonly used term. The U.S. Census of 2000 enumerates 107,255 Hispanics in Louisiana, 2.4% of the

state's total population of 4,468,976 (US Census Bureau 2000). According to the same source, the population of the New Orleans Metropolitan Area is 1,316,510, with a Hispanic population of 100,976, which is 7.6% of the city's residents (Table 1.), which is well below the U.S. national percentage of 12.5% Hispanic. However, that portion may reflect the legal or documented immigrants only. The actual number of the undocumented Hispanics in the United States is unknown.

According to Ciria-Cruz (2005), about 150,000 Hondurans and more than 100,000 Mexicans, and other Hispanics live in Louisiana. The estimate of the Honduran Consulate is even higher for the Honduran population, which with about 200,000 people in and around New Orleans, is the biggest Honduran population outside Honduras (Truax 2005). Counting all Hispanics, regardless of immigration status, this social group may compose between 14% and 17% of the total population of the New Orleans Metropolitan Area, which is twice the official estimate of this population.

Table 1: Hispanic Population in the New Orleans Metropolitan Area

Parishes	Population	Hispanics	%
Jefferson	455,466	32338	7.1
Orleans	484,674	15024	3.1
Plaquemines	26,757	42811	1.6
St. Bernard	67,229	3428	5.1
St. Charles	48,072	1346	2.8
St. John the Baptist	43,044	1248	2.9
St. Tammany	191,268	4781	2.5
Total (New Orleans)	1,316,510	100976	7.6

SOURCE: US Census Bureau 2000

The Hispanic population was not as heavily impacted as other social groups of comparable vulnerability. Although representing 14-17% of the city's total population, this community suffered only 2% of the total casualties registered for the New Orleans area. As of June 2006 the death toll from Katrina was assessed to be 1855 deaths in four states (Table 2.), and an additional 549 persons were reported missing in two states.

Table 2: Casualties Associated with the Katrina Hurricane

State	Deaths	Missing
Alabama	24 ⁽¹⁾	
Florida	14 ⁽¹⁾	
Georgia	2 ⁽⁴⁾	
Louisiana	1,577 ⁽²⁾	482 ⁽³⁾
Mississippi	238 ⁽⁴⁾	67 ⁽⁴⁾
TOTALS	1855	549

Sources: 1)MMWR 2006;

2) DMORT 2006; 3) LDHH 2006;

4) Wikipedia 2006

Depending on the numbers of "missing" persons subsequently to be located, the total death toll could easily exceed 2000. Only 18 Hispanic Louisianans have been reported deceased and only 10 are still reported as missing (Tables 2 and 3).

Table 3: Katrina's Deaths in Louisiana by Race, Gender, and Age

RACE		GENDER		AGE	
African-American	- 451 (53%)	432 males	(53%)	0 to 5	- 1 41 to 50 - 75
Caucasian	- 334 (39%)	421 females	(47%)	6 to 10	- 1 51 to 60 - 119
Hispanic	- 18 (2%)			11 to 15	- 5 61 to 75 - 196
Asian/Pacific	- 6 (<1%)			16 to 20	- 5 75 + - 388
Native American	- 4 (<1%)			21 to 30	- 13 Unknown - 24
Other - 5 (<1) Unknown	- 35 (5%)			31 to 40	- 26

Source: DMORT 2006

Findings

Balancing the Pros and Cons of an Evacuation Amidst Blurring Messages

As a group, the Hispanic community decided to evacuate New Orleans before the hurricane hit the city. This decision was not entirely based on the evacuation suggestion by New Orleans' Mayor Ray Nagin, nor was the decision based on the conviction that Katrina was a monster hurricane that would destroy everything in its path. Evacuation was a difficult decision to make. Many of this Hispanic community do not speak English and up-to-date hurricane information was only minimally available. There are two Spanish language radio stations in New Orleans: 1040 *Tropical Caliente* (formerly *KGLA Radio Mil*) and 830 *La Fabulosa*. The former transmits only until 6:00 p.m. daily, and while although the other transmits 24 hours per day, after 6:00 p.m. the format is automated music with no live news. In addition, the two main Spanish language television stations do not provide local news. Before the hurricane, these stations provided only very limited information, which was practically useless for the purpose of evacuation decision-making.

In the end, and before the hurricane arrived, Hispanics resolved to flee their homes because they realized that many of their relatives, friends, and neighbors were doing so. They invited members of their social networks to accompany them. Leaving the city for a few days with friends and relatives was an attractive proposition. Those without their own means of transportation rode with others who did. All but three of the interviewees had left the city before the hurricane hit. Most had left hours before the first strong winds of the hurricane could be felt.

According to the opinion of the interviewees, the Hispanic population was poorly furnished with information on the hurricane. For example, in the opinion of a Honduran Tulane University student who is fluent in both Spanish and English, the information offered in Spanish was poor not only because it was scarce, but also because the sources were contradictory. "I do not blame the radio stations – says this student – because they did the best considering that the Mayor and other authorities of New Orleans were confused, therefore, they did not provide good information. These radios broadcasted what the Mayor said ... if he and other authorities were confused ...the people were not receiving the correct information."

Another Honduran who had lived in New Orleans for 36 years and is also fluent in both Spanish and English was also convinced that the information provided in Spanish was insufficient for people to make correct decisions in the matter of their safety. He felt the authorities were not adequately prepared for the magnitude of the hurricane.

By communicating their plans with each other, the Hispanics solved the information gap. Families planned to join relatives or neighbors to stay in groups during the evacuated period. Many enticed others to join them in the evacuation with promises of sausage, beer, music and fun. As not everyone had their own car, each available vehicle squeezed in one or two extra passengers. Some families were split into several vehicles. They traveled in caravan to ensure they all arrived safely at their final destination (since some cars may have had break-downs).

Socio-economic Status and Evacuation Strategies

The Hispanic community is not a unified socioeconomic group. Scholarly achievements, immigration status, length of time living in the United States and type of work are some of the definers of socioeconomic status. Hispanics who have lived more than ten years in the U.S. generally have managed to have obtained legal resident status, and even U.S. citizenship; they usually speak and read English fluently. They usually own a house, have stable jobs, and have a social network that goes beyond their co-national Spanish-only speaking relatives, friends, and neighbors. They tend to have better jobs, greater earnings, and have access to social security benefits, health coverage and public services, that is not usually available to many who have been in the U.S. for a shorter period.

On the other hand, Hispanics who have only recently enter the U.S., that is within the past few years and without proper immigration documents, are urged to work in the first available capacity in order to earn money to send to their families. They are in a very different socioeconomic situation, than those more established. Immigrants carry “baggage” in the form of a bundle of social vulnerabilities when they enter a new country. They then begin to add more vulnerability factors to their situation. They do not speak English well, or at all, their social networks are restricted to native Spanish speakers, co-nationals, and co-workers. The lack of proper documentation as legal immigrants prevents most from having bank accounts and credit cards. They work almost exclusively in temporary and underpaid jobs, and they lack social security and health benefits. The great socioeconomic distance between poor Hispanic immigrants and the local population has created a strong social cluster of Spanish speakers, thus reducing potential discrimination.

Although there are some traits that characterized all New Orleans Hispanics at the time of the disaster, the manner of evacuation of the affluent differed from that of the poor. Since the early decision to evacuate also entailed some unavoidable expenses, not all Hispanics were able to afford to evacuate. However, when the poor finally did make the decision to leave the city, their exodus was made much later.

Affluent Hispanic families left the city as soon as they learned that the approaching hurricane was very strong. They decided for themselves when to evacuate, and planned their departure two to three days prior. Their fluency in English, the availability of significantly more and more detailed information available in English, as well as the high literacy level of these families allowed them to track the path of the hurricane, listen to weather forecasts, read opinions in the newspapers, and have a relatively well informed idea of the risk entailed in remaining in the city. In these affluent families, hurricane evacuation is a routine exodus from the city for a few days every year during hurricane season. Annual hurricane evacuation has made the trip a rather innocuous custom, and perhaps a festive occasion – a short, unexpected visit with friends and relatives. These Hispanic families left the city days before the arrival of the hurricane, and they knew exactly where they were going before they left. They made hotel reservations or made arrangements to stay with friends or relatives in other cities or states. For the undocumented, the story was quite different.

Cultural Behavior and Evacuation Among Poor Hispanics

Poor Hispanics, having lived only a few years in New Orleans, generally had the impression from their experience that evacuation alerts were issued on numerous occasions “by chance.” Some that had previously evacuated have lamented the waste of time and money in an unnecessary evacuation. “So many times the city authorities have told us that the wolf is coming, that everybody was time of this sameness” said one Hispanic trying to explain why many poor residents, especially those of the Afro-American community, chose not to leave the city prior to landfall of the hurricane. This choice proved fatal in many instances.

Poor Hispanics did not decide to evacuate until the last minute. Not all of them were aware of the potential problems that the levees of New Orleans posed. Much of the city is at or below sea-level (and below the level of the river). The lack of hurricane information in their native language prohibited many from understanding the dangers.

Many weighed the pros and cons of leaving the city until after the mandatory evacuation was ordered [Although there were adequate warnings 56 hours before landfall, the Louisiana Governor and the New Orleans Mayor ordered a mandatory evacuation 19 hours only before landfall (USHR 2006: 108)]. The economic consideration was an important factor in any decision to be made. For a poor worker who relies entirely on a scant hourly wage, nothing is more true than “time is money.” Evacuation would first mean to set aside potential earnings, expect additional expenses in food and beverages, gasoline and other necessities. Many poor Hispanics work in building construction – masons, painters, roofers, etc. – who typically make weekly (if not daily) arrangements to work. If they usually work with a particular contractor, they know where to work, what to do and what time to start every morning. The contractor controls clock-in and clock-out times and pays at the end of the week for the hours worked. If they miss one or more days of work, the number of paid hours is greatly reduced. In this vein, and more importantly for someone who intends to get up early Monday morning and find a good contract for the week, a Monday morning evacuation seriously cuts into earnings. The decision to evacuate is a financial decision that is very difficult to make.

One of the interviewees, whose husband was a construction worker, reported that she was “glued” to the radio and TV from Saturday night until 5:00 a.m. Sunday August 28, listening to any information or comments about the hurricane. Her husband had told her that they could not evacuate, “[to evacuate] they must be sure that they can pay a hotel and other expenses.” During all the hours of listening to the radio and television, her anxiety increased. She mentally scored whether “it will happen,” “it will not happen.” Her husband and son were sleeping, but she could not relax enough to go to bed. About 4:00 a.m. of that Sunday morning, she watched as Mayor Nagin appeared on a television broadcast and said that “a monster” was coming. He asked that everyone who could do so leave the city. Then the TV showed how empty the roads were (at that time). The word “monster” had stopped her mental calculations, and she woke her family. She was determined to evacuate, regardless of whether they could afford the expenses. She and her family began packing everything that was deemed useful for a few days outside. She and her husband both made numerous telephone calls to friends, especially their co-national co-workers (other Hondurans). They offered to some a ride in their family van. They headed to the home of a friend in Baton Rouge, believing that they would stay out of their home for two or three days at the most. After the hurricane had passed through the city of New Orleans, she watched the pictures of the city on the television and feared the worst. As she was a social worker who worked with many poor Afro-American families, she worried about them. During the following days of their evacuation, she cried for these Afro-American families because she knows that they did not have money to evacuate. She believed that they would remain in their homes because “the hurricane was on [August] 29th and the [Social Security] check comes between the 1st and 3rd of every month, so they run out all their money at the end of the month.” In her opinion many Afro-Americans who are dependent upon Social Security decided not to evacuate.

The case of that Honduran woman and her family who left New Orleans about 24 hours before the hurricane was not typical of this group. Many poor Hispanic evacuated too late. Several of the interviewees reported that they decided to leave the city after noon on the day prior to the arrival of the hurricane – approximately 15 hours before landfall. Their drive to Baton Rouge was continually buffeted by the strong winds of the approaching hurricane. Like everyone else in this community they were debating whether to evacuate, according to the limited information they could gather from the sporadic weather bulletins on *Univision* and *Telemundo*, the two Spanish language channels available in the area. It is important that during this decision-making period everyone was calling friends and

relatives to provide or ask of any new information. "What are you going to do?" was the typical question during these moments. In the opinion of a Nicaraguan gardener it was useful that "el latino antes de moverse o dar un paso avisa a sus familiares que van a hacer" ("the Hispanic before to take a step let it be known to the family"). This social behavior proved effective in motivating others to evacuate.

In some homes the decision to evacuate was no unanimous. In one Honduran home, the mother and the wife of a worker wished to leave, but he was not sure that the hurricane would be as bad as many said. Moreover, he and his mother had lived through Hurricane Mitch in Honduras, and he was sure nothing could be worse than that experience. He had also convinced himself that houses in the U.S. "are more secure" [than those in Honduras]. At noon on Sunday August 28 this family was still in New Orleans with no plans to leave. As friends (first a co-worker, then a neighbor, etc.) began to call asking what this family was going to do and letting them know that they were evacuating, the family finally asked to join the group of evacuees. All were making plans to have fun during the period of evacuation. "If somebody asks you – said this Honduran – "Oye estamos llevando musica, salchichas y cerveza, quieres venir? ("Hey, we are bringing music, sausage, and beers, do you like to come?"), and you infer that all your fiends are going to have good time, you do not miss this chance." So this worker, who had been living in New Orleans for two years, decided to evacuate. He called a couple of co-national single neighbors who he knew did not have a car and invited them to join his family in their van. He also called others to set the time for the departure of the caravan from New Orleans. They headed toward Baton Rouge, usually a one-hour trip. They spent 10 hours on the road. By the time their caravan had left, 2:00 p.m., the roads were crowded, and the strength of the winds was ever increasing, so that the cars were shuddering.

Only three of the 53 Hispanic that were interviewed chose not to evacuate the city. The first one was a woman who worked in a hotel. The manager asked her to stay at the hotel and gave a room to stay with her family. She considered save enough to be in a hotel several stories high, during the hurricane. So she brought her mother and daughter to such hotel room and stayed there with other staff members during the more than seven hours that Katrina devastated the city. She referred that they were okay after the hurricane hit the city, but when the levees breached and the city was flooded, she said that it was terrible. She said that never would forget what her little daughter told her that saw somebody "swimming" outside in the street. What actually happened was that the "swimmer" was a drown person, who was floating in the flooding waters. The child did not know that such person was dead, but for her mother the only idea of having been close to the death caused by Katrina was a traumatized experience. She told that still at the time of the interview, she cannot reconcile, and has problems to sleep.

The other Hispanic interviewee that did not choose to evacuate was a Guatemalan who was so busy working on sealing windows and doors all the weekend, so he was so exhausted to take the initiative to evacuate. Since he is single, he was confident that he would be able to manage the situation when the hurricane comes. Before the hurricane he was requested by several house owners to work covering windows and doors with plywood boards. "It was something easy and well paid" said this undocumented worker who by the time of Katrina was less than a year in the US. As the hurricane was too strong he later regretted his decision of not evacuating and promised himself never again to miss an evacuation order. The last interviewee Hispanic, who did not evacuate, was a single Nicaraguan worker who consciously liked to stay to see the hurricane. He is in New Orleans for two years and do not regret of not evacuating in a hurricane. He says that next time he would like to see another hurricane. These three cases of people who chose to not evacuate before the hurricane landfall show how personal decisions count for vulnerability.

The most remarkable aspect that characterized Hispanics' evacuation was the high sense of community. Practically all the interviewed gave and received calls telling or asking for evacuate, and they left the city in groups. An average of three families got together to leave the city after evacuation was requested by the New Orleans' major. This behavior was important to encourage people to go somewhere else to

get shelter. Even people that did not think in evacuating did that because relatives and friends were living the city and asking for joining them.

For evacuation, the Hispanics used the same social behavior showed when organizing a camping. Or maybe it was like an augur that something bad could happen. With a "sense of good fellowship" they liked to share with others their decisions and being together. In any case, before the disaster occurred what according to Solnit (2005), happens in a community that has been hit by a tragedy, when "the impact is shared, the solidarity may eclipse the suffering, and thus rather than adding to the isolation of individual misfortune such events may undo the loneliness of everyday life" (Solnit 2005: 32).

This sense of community was important for sharing information about where to evacuate, organizations to ask for relief support, and other practical information that in the confusing moments of the disaster are of high interest. Practically all the Hispanics affluent or poor relied in family, neighboring or language related groups for information and taking decisions.

The low number of casualties in this community could measure the success of the evacuation of the Hispanics. However it did not avoid that they were also heavily affected by this tragedy, that their life experience changes, some of them permanent, which are adding to a chain of social vulnerabilities they have accumulated during their life. But at least the shock of the hurricane itself was kept away.

Conclusions

Evacuation is not an easy decision for both, those in charge to declare it and those who have to perform it. These difficulties were evident in the disaster caused by the Katrina hurricane when local authorities of New Orleans failed in conduct an appropriate evacuation process. The declaration of the Superdome coliseum in New Orleans as a "shelter of last resort" is an evident sign that even the local authorities do not believed that the evacuation order should be really mandatory, or at least were conscious that many people will not evacuate, and opened a chance for remaining in town [Lack of clarity has been reported when announcing the measure of leave the city. According to USHR (2006) the different parishes of the city of New Orleans jumbled several terms to describe the level of evacuation. They used "precautionary" evacuation, a "voluntary" evacuation, a "recommended" evacuation, a "highly recommended" evacuation, and a "highly suggested" evacuation, before declaring a mandatory evacuation. All these terms are subjective. In such constraining moments these terms generate confusion to the population. "It appeared many of these officials were bending over backward to avoid using the term mandatory." (USHR 2006: 108)]. So all the casualties occurred in this bowl shaped under-the sea-level city, were from the group of residents who do not evacuated before the hurricane landfall.

All the reasons why these people do not evacuated are related with social vulnerability. Lack of cash, transportation means, and information, are among the explanatory causes of this failure in which incurred exclusively poor people of the white and Afro-American communities. As Cannon (1994, 14) contends "social systems generate unequal exposure to risk by making some groups of people, some individuals, and some societies more prone to hazards than others". However, evidences are that the undocumented Hispanic community, which is among the poorest social groups in New Orleans and then prone to hazards, carried out a successful evacuation process, which saved many lives that otherwise, should be listed in the coroner's records after the disaster. This evacuation went well even though that it was ordered only 19 insufficient hours before the landfall and that public transportation was not provided.

What were the underlying causes that moved Hispanics to evacuate when as the poor Afro-American or white communities of New Orleans, they were also short of cash, without transportation means, and other disadvantages? How this marginalized group managed to get out of the city in those hard moments? Those questions require detailed studies before any try of answer; however it is reasonable to infer that cultural issues should have played an important role in triggering a particular form of social

behavior at the time of a disaster. Cannon (1994) has already hypothesized that hazards like hurricanes “affect people differently *within* societies, and may have very different impacts on different societies... Inequalities in risk (and opportunity) are largely a function of the principal systems of power operating in all societies, which are normally analyzed in terms of class, gender and ethnicity” (Cannon 1994: 14).

The first question to consider in an effort to explain the agency of the Hispanic immigrants during the evacuation is that this community in the U.S. is conscious of its vulnerability. If vulnerability is a weakness, being aware of that weakness may help to offset it. Consciousness of being marginalized spurs identity and internal solidarity, which does not necessarily reflect altruistic feelings, but could represent an individual investment in social relations in order to obtain some present or future benefits. Bourdieu (1986) and Coleman (1988), refer to this phenomenon as social capital, interpreting this as a collective asset that helps in the solution of overwhelming problems.

Another aspect that could explain the behavior of Hispanics during Katrina is social memory. McIntosh (2000) defines social memory as “the accumulation of experiences concerning management practices and rules-in-use that ensure the capacity of social systems to monitor change and to build institutions (formal and informal norms and rules) that enable appropriate responses to signals from the environment” (McIntosh 2000). Here it is important the decisions taken personally and socially. As Thywissen (2006) points up “risk usually involves a decision by the person at risk (to take a certain risk or not), always presuming the individual knows about the risk”.

Evidence from Latin America indicates that spontaneous local community organizations have frequently managed the effects of disaster sometimes better than governmental measures (Delaney 2004). For example of this occurred in El Salvador during hurricane Mitch, when the waters of the dams of the Lempa area started to flood the communities of Usulután and San Vicente, local people coordinated their resources and built on existing social cohesion for evacuation, shelter, health, and security. According to Delaney (2004), they evacuated the vulnerable to high ground and patrolled the river with their own boats to monitor the safety of those who were remaining in their homes with animals. Not one life was lost in these communities, while many died in other villages (Delaney 2004).

Although it remains unclear how sustainable the recuperation of Hispanics from the Katrina disaster will be, at least the social agency demonstrated during the first months after this tragedy has been positive in terms of the ability of this group in self-organizing and adapting to the new situation.

References

- Carpenter, SR; Walker, B; Anderies, JM; Abel, N. (2001): From metaphor to measurement: Resilience of what to what? In: *Ecosystems* No. 4. pp. 765-781.
- Ciria-Cruz, Rene (2005): Ethnic Media Keep a Worried Eye on Katrina's Wake. In: *Pacific News Service*. <http://www.imdiversity.com/Villages/Hispanic/news/pns_katrina_hondurans_0905.asp>, 8 April 2006.
- Disaster Mortuary Operational Response Team (DMORT) (2006): *Reports of Missing and Deceased*. <<http://www.dhh.louisiana.gov/offices/page.asp?ID=192&Detail=5248>>, 6 June 2006.
- Holling C.S. (1996): Surprise for Science, Resilience for Ecosystems, and Incentives for People. In: *Ecological Applications*. Vol. 6, No. 3 (Aug. 1996).
- International Federation of Red Cross and Red Crescent Societies (IFRC) (2004): *International Disaster Response Law*. Appeal no. 01.100/2004.
- Louisiana Department of Health and Hospitals (LDHH) (2006): *People Still Missing Following Hurricanes Katrina/Rita*. <http://www.dhh.louisiana.gov/offices/miscdocs/docs-192/Still_Missing/StillMissing_05022006.htm>, 2 May 2006.

- Maskrey, A. (1989): *Disaster Mitigation: A Community Based Approach*. Development Guidelines No. 3. Oxfam, Oxford.
- McIntosh RJ, Tainter JA and McIntosh SK. (Eds.) (2000): *The Way the Wind Blows: Climate, History and Human Action*. Columbia University Press, New York.
- McQuaid, J.; Schleifstein, M. (2002): *Washing Away* - Special Report. The Times-Picayune 23-27 June, <<http://www.nola.com/hurricane/?/washingaway/>> 8 July 2006
- Morbidity and Mortality Weekly Report (MMWR) (2006): *Mortality Associated with Hurricane Katrina - Florida and Alabama, August – October 2005*. Center for Disease Control and Prevention, March 10, 2006. <<http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5509a5.htm>>, 2 July 2006.
- Oliver-Smith, A. (1998): Global Changes and the Definition of Disaster. In: Quarantelli, E.L. (Ed.): *What Is A Disaster?* Routledge, London and New York.
- Solnit, R. (2005): The Uses of Disaster. In: *Harper's Magazine* October 2005.
- Truax, E. (2005): Apoyo para hondureños. *Diario La Opinión*. Los Angeles, CA 4 September 2005 <http://laopinion.com/archivo/index.html?START=219&RESULTSTART=217&DISPLAYTYPE=single&REETEXT=new+orleans&FDATED12=last+year&FDATED13=&BOOLp00=&SORT_MODE=dateac>, 5 March 2006.
- Thywissen, K. (2006): *Components of Risk. A Comparative Glossary*. SOURCE No. 2/2006, Studies of the University, Research, Counsel, Education. Publication Series of UNU-EHS.
- US Census Bureau (2000): *Race and Hispanic or Latino. Census 2000, Geographic Area: Louisiana Parishes*. <http://factfinder.census.gov/servlet/GCTTable?_bm=y&-geo_id=04000US22&-_box_head_nbr=GCT-P6&-ds_name=DEC_2000_SF1_U&-redoLog=false&-format=ST-2&-mt_name=DEC_2000_SF1_U_GCTP6_US9> 8 July 2006.
- U.S. House of Representatives (USHR) (2006): *A Failure of Initiative. Final Report of the Select Bipartisan Committee to Investigate the Preparation for and Response to Hurricane Katrina*. U. S. House of Representatives. 109th. Congress 2nd. Sesion, 15 February 2006.
- Wikipedia (2006): *Effect of Hurricane Katrina on Mississippi*. <http://en.wikipedia.org/wiki/Effect_of_Hurricane_Katrina_on_Mississippi>, 15 July 2006.

2.3 Social Distribution of Risk: A Case Study in Tehuantepec, Mexico

Fernando Briones Gamboa

Abstract

In the last few decades the number of reports associated with meteorological disasters has been increasing in many places all over the world. However, in some cases disasters seem to be more in connection with social vulnerability rather than extreme climatic events. We analyse the political matters that build a context of vulnerability. In this case study, political conflicts are linked to historical land problems and development projects that lead to population concentration in urban areas and their reorganization by political militancy in new neighbourhoods. Land repartitions and invasions were strategies from involved political forces. On the other hand, local governments ruled by clientelism excluded the opposite groups from basic urban services, increasing and distributing the risk of floods in specific areas of the studied municipalities in Tehuantepec Isthmus in Mexican State of Oaxaca.

Introduction

Water related disasters are not always the result of extreme events. In many places, small disasters happen regularly, even if they don't make it into the national or international headlines. In this case study of Tehuantepec Isthmus (Oaxaca, Mexico) we show the complexity of political factors that may produce vulnerability. This region has particular climatic characteristics: strong dry winds in winter and rains in summer. It is located in a convergence zone of the El Niño phenomenon (ENSO; El Niño Southern Oscillation), the rains show significant levels of variability and hurricanes affect the region. However, we think that it is not only climate that explains the increase in the number of disasters. Analyzing reports from disaster database DesInventar (LA RED, 2006) and doing fieldwork, we observed that disasters are concentrated in specific areas that have recently been urbanized. We wanted to find patterns which would explain the context in which social groups have become vulnerable and how their territories were developed. We analyzed how the geostrategic position of Tehuantepec Isthmus justifies the construction of industrial projects, modifying the social and urban architecture of the region and producing political conflicts in a particular ethical context. We show how local parties and governments may distribute risk by using power as a mechanism for exclusion.

The Distribution of the Risk as Social Process

It is clear that not all social groups share the same sort and level of vulnerability. However, to be vulnerable only make sense in risk situations. Could it be logical to consider that the chances of potential negative impacts are distributed to specific groups by societal mechanisms? The cause of disasters in Tehuantepec seems to be more linked to the context of social vulnerability than physical factors. What are the processes that produce vulnerability and may bring risk to specific territories?

The risk is the "probability of occurrence of damage from the interactions between physical processes – hazard– and factors of urbanization – vulnerability–" (Pigeon, 2002:460). Risk is a process that shows the increase of conditions of vulnerability that make a society susceptible to suffer damages. Wilches-Chaux (1993: 17) describes vulnerability as the "incapacity of a community to 'absorb', by adjustments, the effects of a particular change in their environment."

In a vulnerable society hazards could increase negative effects, but vulnerability is socially constructed in a particular context; it is a consequence of historical, cultural and political processes (Braudel, 1969, Garcia Acosta, 2005) and distribution of income, investments, power concentration and environmental transformations. The PAR model - pressure and release- of Blaikie, Cannon, Davis and Wisner shows that disaster is the intersection of two opposite forces: those that generate vulnerability on the one hand and the physical exposition on the other." (Blaikie et al., 1995). Since the 1970s, the political ecology approach

(Cuny, 1983; Wijkman and Timberlake, 1984) links vulnerability to inequities of development projects. Cuny (1983:54) writes that “disasters accentuate the social fights in a society and emphasize the inherent injustices within a political system”.

Methodology

The first instrument of analysis was the disaster database DesInventar (LA RED, 2006). It is an open source software that systematizes reports of disasters sourced from national and local press, and geo-references them. DesInventar is a LA RED project (Network of Social Studies on Disaster Prevention in Latin America) started in 1994. UNDP’s report Reducing disaster risk: A challenge for development (2004: 43) describes it as a tool to “record all discrete events that have resulted in adverse effects on life, property and infrastructure triggered by natural and man-made phenomena and geo-referenced to the smallest available political-administrative unit in a given country – usually the District or Municipality. By collecting disaggregated data, DesInventar enables the recording of individual localised small-scale disasters as well as the impacts of large-scale hazard events at the local level”.

We collected reports in Oaxaca state for the DesInventar database in Mexico, (ENSO Project: IAI, LA RED, CIESAS), based on national newspapers (El Universal, Exelsior and La Jornada) from 1970 to 2002 and local newspapers (El Imparcial and Sol del Istmo) from 1980 to 2003. The Mexican database has almost 8,000 reports. Although the press does not necessarily offer objective data, local newspaper reports are frequently the only source of information. DesInventar shows tendencies that we try to verify by doing fieldwork, visiting and interviewing more than 100 inhabitants in Tehuantepec area, in cooperation with local authorities.

Climate and Disasters in the Isthmus of Tehuantepec

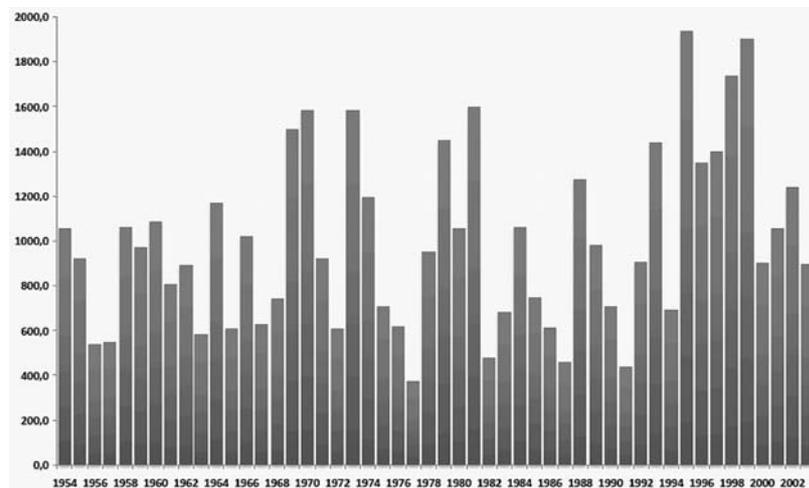
The Tehuantepec Isthmus has 80 municipalities, 39 in the State of Veracruz and 41 in the State of Oaxaca, and it has 2 million inhabitants in 7 cities and more than 200 small towns. The biodiversity is composed by tropical forests in the Chimalapas, Uxpanapa and the Mixe Sierra. There is large petrochemical and agricultural production. 65% of the territory is collective property, called ejidos in Spanish. The Tehuantepec Isthmus is the narrowest part of Mexico, a geostrategic position that historically has provided the argument for the construction of transit merchandize projects between the ports of the northern and southern tips: Coatzacoalcos in the Gulf of Mexico and Salina Cruz at the Pacific Ocean, separated by almost 300 kilometers.



Map 1: México and Tehuantepec Isthmus

This region is exposed to geologic risks such as tremors and tsunamis on the coast of Oaxaca and hydrometeorological phenomena such as tropical hurricanes, storms and floods on both coasts. We will focus on the Pacific Ocean coastline (South of Oaxaca), an economic region (Boudeville, 2001: 147) where even the political and ethnical differences there is “share commercial space”. The districts of Juchitan and Tehuantepec (the first has 22 municipalities and the second 19) are a “metropolitan zone” (Toledo, 1995: 225), in the last few years accentuated by the extension of the highway that links these two points, a result of regional development projects.

The Tehuantepec Isthmus and specially the Oaxaca coast have particular climate characterized by seasonal rains from May to October and hurricanes at the end of the season; the annual precipitation average is 850mm. The rest of the year is dominated by droughts and strong winds (up to 160 m/s) which can create humidity in winter and some rains from December to February. The most remarkable are particularly strong winds called “tehuanos” that in winter produce the phenomenon called Norte. The Norte phenomena are anticyclone winds formed by polar air masses that cross the land from the Gulf of Mexico to the Pacific through a rupture in mountain ranges that separates the Sierra Madre del Sur Range and the Central American Mountain range, in the point called Chivela pass in center of the Isthmus.



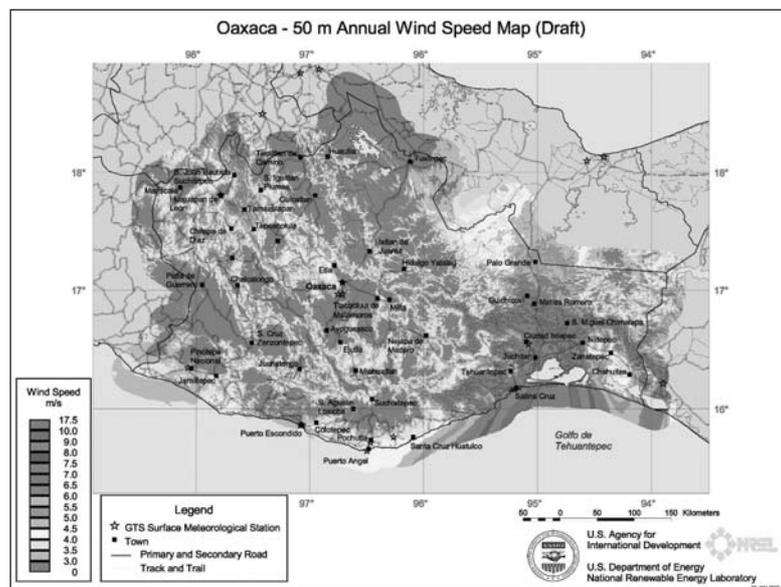
Graphic I: Precipitation in Tehuantepec (Juchitan meteorological station):
Data source: ERIC II. National Water Commission (CNA), Mexico

Although the climate on Oaxaca’s South coast does not seem to be very different from the rest of Mexican Pacific coast (seasonal rains and droughts), the Gulf of Tehuantepec has specific conditions because it is located in the south of the “warm water pool” in the Pacific Ocean. (Magaña, 1999:82) During the El Nino years (ENSO), “changes in the circulation of the ocean near the Equator and the modifications of the atmospheric circulation affect the characteristic averages of the Gulf of Tehuantepec” (Trasviña: 1997, cited by Magaña, 1999:84). This modifies the fishing productivity in the region, since hot water temperature aids thermocline presence. ENSO Phenomenon can explain, “up to 40% of total seasonal variability in the precipitation, particularly in the south of Mexico” Magaña et al. (2003: 323, 325). There is also a relationship between the El Nino phenomenon and the strong winds: “The number of Nortés increases during the El Nino years compared to La Niña years”. Schultz ET to. (1998) discovered that there are more cold fronts crossing the south of Mexico in winter during El Nino” (Romero – Centeno et al. 2003; 2637).

Wind is a very present natural element in the daily life of habitants of Tehuantepec Isthmus. It is not an unusual situation for trailers to pull over because of strong winds on Pan-American highway (winds that cross the country from north to south) in the village called La Ventosa, a toponym that means windy, in district of Juchitan). The most fragile houses get damaged by these winds and the authorities are sometimes forced to close the port Salina Cruz temporarily. However, we know from historical records that these municipalities have had to face floods and winds on regular basis. The name of

Tehuantepec means “hill of the tiger” referring to the sound of the beast: the wind. The cities of Juchitan and Tehuantepec have registered floods since the colonial time; the First report is from 1581 (Garcia Acosta et al, 2003), nevertheless in October and November 1997, hurricanes Rick and Paulina caused the biggest amount of damage. Many communities were flooded; the cities in the region contained a large number of destroyed houses and surrounding villages were cut off for several weeks.

According to the State Atlas of Risk (2003: 103) “Floods caused by overflowing rivers and strong local rains occur in Oaxaca every year. The impact is more and more considerable every year because of modifications of lands use and population located in dangerous zones along rivers that may cause floods.” From this point of view, disasters are not only the result of the intensity and/or frequency of natural phenomena but they are also triggers that show social and territorial dynamics.



Map II: Annual Wind Speed in Oaxaca.

Source: U.S. Agency for International Development, U.S. Department of Energy, National Renewable Energy Laboratory

Policy and Fragmentation

The disaster reports (Desinventar) in the Tehuantepec Isthmus in the last 3 decades show a following tendency: the cities of Juchitan, Santo Domingo Tehuantepec and Salina Cruz are more susceptible to floods. If we study the wind results more closely?, disasters do not affect the whole population equally. The most vulnerable social groups to floods are located in neighborhoods founded in river basins over the last 30 years. Which are the social aspects that rule the urbanization dynamics in these cities?

In order to respond the previous question it is necessary to make a brief historical review. The Tehuantepec Isthmus is a region proud of their ethnical identity. The history and regional culture is based on resistance to centralism and foreign ideas. Before the colonial time (XVI-XVIII century), the zapotecas were a dominant ethnic group in the region who had ambitions to formed a separate state independent from the rest of the national territory and Oaxaca State: Is not stranger that inhabitants of Juchitan or Tehuantepec perceived the isthmus as a country; “First, Juchitan country, then all the others”. In regional history the idea an State of Tehuantepec was considered, separated to Oaxaca. They are not only well known for their resistance to the Aztecs and the Spanish conquerors (who never occupied their territory by force), but also for their contemporary social organization where women have an important role in commerce. They are also tolerant to homosexuality and travesties, the Muxes, men that play women’s role. They are also pioneers of political movements at the municipal level. Actually, the istmenos are a society with a strong regional identity, marked by the chauvinism of their exceptional nature and culture.

In the context of the anti-centralist culture, the nature of the projects that federal governments (the central power) have been developing since 19th century was to take advantage of the strategic importance of Tehuantepec, especially the narrowness between both coastlines convenient for building a fast transit road for merchandize. Actually, since 19th century, United States and Great Britain have been showing interest in obtaining concessions to construct and manage an inter-oceanic channel, an alternative to the Panama Canal (Alvarez, 2003). The railway that links the ports of Salina Cruz and Coatzacoalcos built between 1894 and 1899 is considered "a massive loss" (Ortiz, 1971; 12) but it symbolized the geopolitical interest in the region".

In the last 50 years, many projects have been accomplished despite of the reluctance of istmeños; Benito Juárez Reservoir in Jalapa of the Marques in 1957, a large Irrigation System Called Distrito de Riego 19 in Tehuantepec in the sixties, and a Mexican Oil Company refinery, PEMEX, in Salina Cruz in 1974. These projects are perceived as ambiguous for the inhabitants: there is an image of progress on one hand and of pollution and poverty on the other. For example, the Benito Juárez Reservoir holds 900 million cubic meters of water and occupies 970 thousand hectares and it was built, according to the local authorities, as an alternative to seasonal droughts, to store and distribute water from the Tehuantepec River. Nigh and Rodriguez, (1995; 129) affirm that from each liter, "50% has as final destination the Salina Cruz refinery, another 25 % evaporates and only the 25% remains useful to irrigate lands." The expropriated lands of the Irrigation System (DR-90) left up to "2500 zapotecos without land, they lost 25.175 hectares of the municipality of Juchitan" (1995; 130) and in order to build Salina Cruz refinery the government expropriated 729,6 hectares (1995; 125). These projects follow the oil boom in the seventies; they were formulated as alternative to regional "development". If these big projects mean "progress" for the federal government, for the istmenos they have been part of the reasons for the formation of political forces of resistance. There is not a single development project without a resistance movement.

The regional political movements had their consolidation phase in the sixties. After the murder of several local leaders and the student movement in 1968, coalitions were formed among "Federación Estudiantil Oaxaqueña" that occupied the Oaxaca's State University, (Universidad Autónoma del Estado). The movement ended with a repressive answer from the government and caused the formation of new protest groups with a high level of cohesion in the Tehuantepec Isthmus, consequence of the zapotecas organizational capacity. Examples of these formations are the Coordination of Workers, Farmers and Students of Oaxaca (Coordinadora de Obreros, Campesinos y Estudiantes de Oaxaca, COCEO) in 1972 and the Coordination of Workers, Farmers and Students of Isthmus (Coordinadora Obrero Campesina Estudiantil del Istmo COCEI) in 1974. They linked their movement with the historical fight against landowners, to those expropriations done by the government for region development (Campbell, 1994).

Later, COCEI was transformed into a political party in partnership with the PSUM (Partido Socialista Unido de México, United Socialist Party of Mexico). They won the municipal elections in Juchitan in 1981, becoming the first municipality in the country where other political party than the hegemonic party PRI (Partido Revolucionario Institucional, Revolutionary Institutional Party) won. However, they were overthrown and replaced by employees of the PRI and federal forces occupied the municipality for several weeks. This fact creates a significant friction between the population and the parties that founded their electoral strategies in paternalism, and directly contributes to the configuration of the contemporary social architecture.

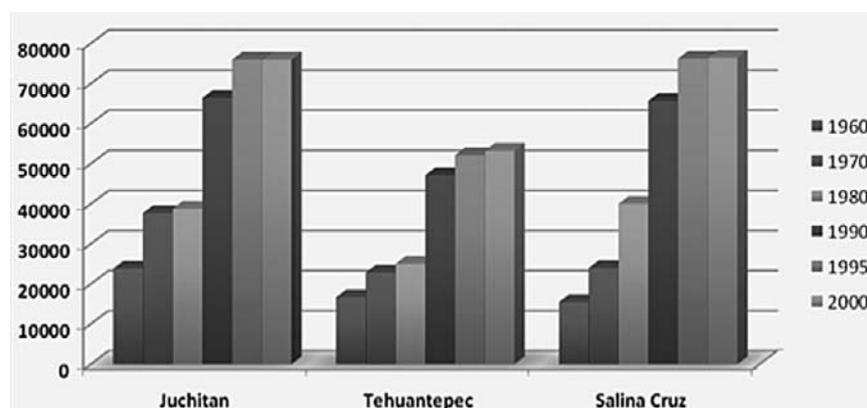
The early eighties were probably the most difficult political times, from demonstrations to repression; the lands were taken over mostly by the COCEI, and distributed among militants by PRI. Both political forces composed their bases of vulnerable groups that had been expelled from communal lands in order to free them for development projects. Both parties looked for power through movements based on the lands issues and clientelism. In the interviews, during the field work, we noticed that the urban space is clearly fragmented by political militancy. Generally, there are four categories of inhabitants in the new districts:

1. Those who arrived in the eighties and benefited from the land distribution;
2. Those who were organized by a political force and invaded private or communal lands;
3. Those who came looking for jobs in new industrial poles of the region;
4. Those moved in the region due to family relationships.

Most of the interviewed people got their lands paying a reasonable price or as a gift from their political faction and built their houses little by little. In many cases they settled down illegally in irregular establishments. These districts, independently of the party, in the beginning of conflicts were temporary occupations but that came to be integrating parts of the urban landscape in the way that their inhabitants began to work. Lands on the river banks are susceptible to suffer small but recurrent floods which limit their inhabitants' capacity of development and keep them in a permanent state of vulnerability.

One thing that the new colonies of the three municipalities have in common is the lack basic urban services. The inhabitants of these districts affirm that the access to basic services (drainage, potable water, electricity, garbage collection) depends on its political militancy. It means that a political party does not offer public services to the citizens in opposition, in fact local government distributing conditions of vulnerability which can under certain climatic conditions generate a disaster, as the 1997 floods during Paulina hurricane.

A representative example of the region is the case of Juchitan's Cheguigo district. This COCEI neighborhood, is established in the basin of "Los Perros" river; floods occur every year when the volume of the river increases during the rainy season; by the way Cheguigo is a zapotec word that means "across of the river". In fact, it is the excess of accumulated garbage in the river that causes the bridges (badly built) work as "corks" that stop water from running. The population has asked the intervention of the PRI municipality and state government several times but without a positive answer, since these inhabitants come from an opposite political force. This situation generates protests and demonstrations. In 2000, even a religious peregrination was made with the local saint (a religious icon) San Vicente Ferrer, who was used by people to demand to authorities to clean the river off before the rains. The priest declare: "I say to them that God does not punish, because God is love. But when San Vicente Ferrer goes out to stress is because the population needs justice" (Lopez, 2000). The municipal government declared themselves without responsibility to a possible flood, since the cleaning works were "responsibility of the National Water Commission that showed inefficiency in application of the resources" (Lopez, 2000).



Graphic II: Growth population (thousands of inhabitants) in the municipalities of Juchitan, Tehuantepec y Salina Cruz, 1960-2000. (INEGI, Mexico)

In the Tehuantepec Isthmus the political conflicts have made the social capacity of adjustment even more susceptible to natural climate phenomena and configured the urbanization process of the cities: By forcing social groups to invade or distribute lands and to establish new colonies without minimum

services, risks were augmented in the areas inhabited by people with the lowest incomes and thus making them even more vulnerable.

But disasters are also explained by the effects of demographic concentration. For example, Salina Cruz port has had several transformations; the most important was the construction of the PEMEX refinery, which attracts workforce from other states (especially Veracruz) and other towns of the region. The three cities that compose this commercial and industrial axis, the northern and southern tips have quadruplicated their population over the last 40 years. Many of the inhabitants were farmers who immigrated to the city looking for better conditions due to the permanent crises in the province. The demographic tendencies show an increase in size of the cities and its population, and the desertion of the small towns. Even though cities are concentrated spaces of vulnerability, they are synonyms of progress and opportunities on the one hand, but in the other they are synonyms of risk.

Conclusions

The geostrategic importance of Tehuantepec Isthmus has been justified, especially in the last 50 years, by development projects that have generated the demographic concentration in the three biggest cities of Oaxaca's southern coast: Juchitan de Zaragoza, Santo Domingo Tehuantepec and the port of Salina Cruz. The development projects also caused the emergence of opposition groups to these projects. This fed an electoral war between the main political forces in the region during the seventies and eighties: The hegemonic party PRI, and radical socialist COCEI party. Both factions used land distribution and invasion as a technique of political seduction and/or forms of protest. The political conflicts configured the social and urban structure of the region. Social groups were forced to live in susceptible zones to floods by the political situation, building new potential risks that may one day become a disaster. The lack of basic public services also works as mechanism of pressure and exclusion of the opposite groups to the municipal government, keeping them in a permanent situation of vulnerability.

References

- Alvarez Macotela, S. (2003): *El Peso de nuestro descontento. La diplomacia británica en torno al paso interoceánico por el Istmo de Tehuantepec 1847-1858*. Instituto Mora, México.
- Braudel, F. (1969): *Histoire et sciences sociales. La longue durée*. In: *Écrits sur l'histoire*. Flammarion, Paris.
- Burgoa, F. (1934): *Geografica descripcion*. Vol. III. Secretaría de Gobernación. México.
- Blaikie, P.; Cannon, T.; Davis, I.; Wisner, B. (1995): *Vulnerabilidad: El Entorno Social, Político y Económico de los Desastres*. LA RED; ITDG, Tercer Mundo Editores. Colombia.
- Boudevill, J.R. (2001): *La región económica*. In: Viqueira, C.: *El enfoque regional en antropología*. Universidad Iberoamericana, México.
- Campbell, H. (1994): *Zapotec Renaissance*, University of New Mexico Press, Albuquerque.
- Cuny, F.C. 1983: *Disasters and Development*. Oxford University Press.
- La Red de Estudios Sociales en Prevención de Desastres en América Latina (2006): In: *Desinventar*. <www.desinventar.org>, July 2006.
- Garcia Acosta, V. (coord.) (2005): *La construcción social de riesgos y el huracán Paulina*. Ediciones de la Casa Chata, CIESAS, México.
- Garcia Acosta, V.; Perez Zevallos, J.M.; Molina Del Villar, A. (2003): *Desastres Agrícolas en México*. FCE, CIESAS. México.
- Gobierno del Estado de Oaxaca (2003): *Atlas Estatal de Riesgos*, Tomo I. Gobierno del Estado de Oaxaca, Oaxaca.

- Lopez, A. (2000): Procesión de católicos juchitecos para pedir desasolve de su rio. In: *Periodico Noticias*. Oaxaca, 13 Apr.
- Lopez, A. (2000) Culpan a la CNA del retraso en obras del rio Los perros. In: *Periodico Noticias*. Oaxaca, 27 Apr.
- Magaña, V.O. (Ed.) (1999): *Los Impactos de El Nino en México*. SEP, CONACYT.
- Magaña, V.O.; Vazquez J.L.; Perez, J.L.; Perez, J.B. (2003): Impact of El Nino on precipitation in Mexico: *Geofísica Internacional* (2003), Vol. 42, Num. 3, pp. 313-330; UNAM, Mexico.
- Nigh, R.; Rodriguez, J.N. (1995): *Territorios Violados*. Presencias/INI. México.
- Ortiz Wadgyrmar, A. (1971): *Aspectos de la económica del Istmo de Tehuantepec*. UNAM, México.
- PNUD (2004): *Reducing Disaster Risk. A Challenge for Development, A Global Report*. New York.
- Pigeon, P. (2002): Réflexions sur les notions et les méthodes en géographie des risques dits naturels. In: *Annales de Géographie*. 627-628; sept-déc. Armand Colin, Paris.
- Romero-Centeno R.; Zavala-Hidalgo J.; Gallegos A., O'Brien, J.J. (2003): Notes and Correspondence Isthmus of Tehuantepec Wind Climatology and ENSO Signal. In: *American Meteorological Society Journal of Climate*: Vol. 16, No. 15, pp. 2628–2639.
- Toledo, A. (1995): *Geopolítica y desarrollo en el Istmo de Tehuantepec*. Centro de Ecología y Desarrollo, México.
- Wilches-Chaux, G. (1993): La Vulnerabilidad Global. In: *Los Desastres No son Naturales*. Maskrey A. (compilador) LA RED; ITDG; Tercer Mundo Editores. Colombia.
- Wijkman, A.; Timberlake, L. (1984): *Natural Disasters; Acts of God or Acts of Man?* Earthscan.

SECTION III

PRACTICAL APPLICATIONS

3.1 Mapping Water Potential: The Use of WATEX to Support UNHCR Refugee Camp Operations in Eastern Chad

Firoz Verjee & Alain Gachet

Abstract

In 2004 the UNHCR commissioned the use of remote sensing to map the potential of buried water reservoirs in the massive Ouaddaï region in eastern Chad. The UN needed to discover renewable water sources urgently and efficiently, as the challenge of providing water to Sudanese refugees and their local host communities was overwhelming. Using a proprietary process called WATEX, French exploration firm RTF analyzed a variety of remotely sensed data to identify areas suitable for refugee camps along the Chadian border near Darfur. Early results are impressive – after drilling test wells at Wadi Dalal, one of RTF's recommended sites, the UNHCR established a major camp in early 2005, announcing that the camp has enough water to support up to 30,000 refugees. This paper provides an overview of the data and methods employed in eastern Chad. It also provides a promising example of how geospatial technologies can support humanitarian operations in arid and semi-arid regions.

Introduction

In its March 2004 appeal to the General Assembly of the United Nations, the *UN Office for the Coordination of Humanitarian Affairs* (UNOCHA) noted the severe challenge of providing assistance to host communities and refugees from Darfur due to water scarcity in eastern Chad (United Nations 2004). Facing an estimated 110,000 refugees at the time, the UNHCR and UNICEF began costly water trucking operations while simultaneously rehabilitating existing water points and undertaking extensive water sanitation training programs. Through its affiliates UNOPS and UNOSAT, the UNHCR also retained the services of Radar Technologies France (RTF) to develop water potential maps to support existing and future refugee camps throughout the region.

After a rapid assessment of available geological, hydrological, topographical, and geospatial data, RTF employed state-of-the-art remote sensing to map the water potential of a region nearly 100,000 square kilometers in size. The humanitarian dimension of the project demanded timely and efficient identification of belowground reservoirs capable of producing sufficient volumes of clean water to support existing and future refugee operations. According to the Sphere Humanitarian Charter minimum standards, this entailed finding reserves capable of providing 15 liters per person per day, without burdensome walking distances or container refilling times (The Sphere Project 2004). For a typical camp population of 20,000 refugees, this meant finding reservoirs of at least 90,000 annual cubic meters of water in volume.¹

This paper describes how geospatial analysis was utilized to remotely assess the water potential of the Ouaddaï region in eastern Chad, rapidly and without extensive field survey. Trial and operational phases of the project were completed over a total of four months between March 2004 and February 2005; as demonstrated in the case study of Wadi Dalal, the project enabled the UNHCR to identify new campsites capable of supporting tens of thousands of Sudanese refugees.

Challenge & Opportunity

The reader is no doubt aware that there were a number of significant challenges presented by the Darfur humanitarian crisis as it began to unfold in 2003 (Bouchardy 2005). Response agencies needed to maintain operations over a border region approximately 650 km long and 84,000 square kilometers

¹ 20,000 people x 15 liters per person per day x 300 no-precipitation days per year x 1000 liters per cubic meter. In order to be suitable for the long-term, reservoirs need to be completely recharged during the annual rainy season.

in size – a region the size of Portugal. Not only was this region undeveloped and largely inaccessible, it was within a zone of conflict that affected the security of both refugees and humanitarian relief workers. Facing a refugee population that quickly approached 200,000, authorities needed to discover massive water reserves able to sustain refugee camps for several years, without compromising the interests of local host communities in Chad (Bouchardy 2005).

This challenge was made even more complicated by the extreme urgency imposed by the escalation of the refugee crisis, the limited resources with which to assess hydrological potential of eastern Chad, and a poor understanding of regional geological phenomena. Basic analysis confirmed that the region's Proterozoic granite basement renders land surfaces generally impermeable, reducing groundwater collection except in alluvial sediments, which are prone to rapid evapotranspiration. Long-term programs to deliver water by tankers to the refugee camps were not sustainable because of long distances and unreliable tracks and deficient bridge infrastructure. An alternative solution was needed to prevent dehydration, water-washed and waterborne disease amongst vulnerable populations.

Recognizing the severity of these challenges, and the inadequacy of traditional water exploration methods, the UNHCR decided to employ a remote sensing process, WATEX, in order to guide water-drilling operations and optimize the location of refugee camps. Developed to support water exploration in arid and semi-arid areas, WATEX exploits the evolution of civilian geospatial technology to analyze large, heterogeneous climatic and geologic regions for groundwater potential. Several recent trends have made the use of such technology possible:

- The availability of *Synthetic Aperture Radar* (SAR) earth observation satellite imagery, which provides highly-sensitive geological and hydrological intelligence not discernable through optical imagery;
- The 2003 release of the *Shuttle Radar Topographic Mission* (SRTM) global terrain model, which provides slope and elevation data of unprecedented quality compared to other topographic information of the region;
- The removal of “selective availability” from *Global Positioning System* (GPS) signals, enabling civilian access to precise location information almost anywhere on the surface of the Earth;
- The widely appreciated “digital revolution”, which now gives even small firms access to high-power computing, user-friendly analysis software, and rich data archives accessible via the Internet (Verjee 2005).

Many firms, including RTF, are exploiting these recent trends to offer new solutions to traditional problems such as groundwater exploration. The UNHCR, together with UNOPS and UNOSAT, recognized that commercial geospatial technologies could be used to respond to the Darfur refugee crisis, creating an excellent example of the positive role the private sector expertise can play in humanitarian assistance and sustainable development. Although such cooperation is not without controversy, the need to encourage public-private partnerships is now firmly established (see “Ethics” box).

Data & Methods

WATEX is a proprietary groundwater exploration process used to locate renewable groundwater reserves in arid and semi-arid environments. Developed over a period of several years, the process dramatically improves the ability of humanitarian and development organizations to identify areas suitable for (temporary and permanent) settlement, cultivation, and development. The process is economical, rapid, and highly effective for water potential mapping even over heterogeneous areas several hundred thousand square kilometers in size.

This section details the types of data and the general methodology used to assess the water potential of the eastern Chadian region of Ouaddaï, along the border of Darfur, Sudan.

The Ethics of Business – Humanitarian Partnerships

As the former UN High Commissioner of Refugees Sadako Ogata pointed out in his landmark article “An Agenda for Business-Humanitarian Partnerships”; there is a widely-held belief that private enterprise and humanitarian assistance do not always share a common social interest (Ogata 2000). This, despite the numerous examples of where private enterprise has successfully worked in union with humanitarian assistance.

Ethical safeguards would, however, be helpful for exploration firms like RTF, which apply many of the same techniques used to discover oil, diamonds, and other precious minerals in order to find water. Should they be able to commercially exploit any incidental hydrocarbon or mineral discoveries made while mapping hydrological potential? Are they obliged to immediately forfeit any commercially valuable intelligence to the host government? How can their humanitarian mapping be extended to include an opportunity for economic development in frontier regions, without creating a conflict of interest, or worse, an actual dispute over refugee settlement and land use? These and other issues need to be considered in order to clarify the “rules of engagement” of successful business-humanitarian partnerships.

Data

The following raw data inputs were used to facilitate the assessment of water potential of the project area:

- Geological formation dates and chronology of the structural evolution of eastern Chad (Kusnir, Brunet et al. 1995);
- Basic rainfall estimates, long-term climate change indicators and water source locations (Schneider 2001);
- 1:500,000 BRGM Geological Map to delineate geological boundaries (Bureau de Recherche Geologique et Miniere 1959);
- Known well locations and associated hydrological information for Ouaddaï (Ragot 2004);
- 1:250,000 topographic maps indicating village names, roads, rivers (Centre for Development and Environment (CDE) 2004);
- Names and locations of existing refugee camps (Bunzli 2004);
- Landsat 7 ETM 15m Panchromatic & 30 m Multispectral satellite imagery, acquired in December 1999, October 2000, June and October 2001;
- ERS- 1 30m C-Band Synthetic Aperture Radar (SAR) imagery, acquired in November 1998;
- JERS-1 18m L-Band SAR imagery, acquired in August and November 1996;
- SRTM Level 1 (3 arc second, 90 m posting) digital topographic maps, complimented by GTOPO30 (1:1,000,000) topographic maps to cover no-data voids.

It should be noted that Ground Control Points (GCP) established the Landsat 7 positional accuracy in the investigation area to within one pixel of actual GCP locations, enabling all other datasets to be georeferenced to the Landsat 7 baseline.

Method

As suggested in the Introduction, the goal of this project was to detect large renewable water reserves capable of supporting refugee settlements of 20,000 per camp, for up to 200,000 Sudanese refugees, in accordance with the UNHCR’s target provision rate of 15 liters/day/person. This automatically precluded water exploration of small or non-renewable reserves, and limited analysis to areas of sizeable, renewable water potential.

This section describes the methodology employed during the project, using a case study of one of the areas identified as being capable of meeting this goal. This area, called Wadi Dalal, was one of several sites identified as having the potential to support at least 20,000 people (Gachet 2005). In February 2005 the UNHCR announced the establishment of the Gaga refugee camp along Wadi Dalal and began resettlement of thousands of refugees soon thereafter (Chamberlain 2005). Proven water reserves at the site are capable of supporting up to 30,000 refugees, making the case study of Wadi Dalal a dramatic example of the impact geospatial technologies can have on humanitarian relief operations (IRIN 2005).

The first phase of analysis involved mapping features which directly (or indirectly) affect the likelihood of finding large, renewable reservoirs. A variety of data sources and imagery were used to determine lithology, weathering processes, vegetation cover, and land use. The SRTM terrain model was used to delineate watersheds, slopes and river profiles, and to estimate energy level of transportation along wadi (i.e. riverbed) courses. The SAR images were processed to map fractures, uplifts and subsidence; these features can determine river direction as well as accretionary or erosional impacts upon reservoir thickness.

WATEX was then employed to map the relative moisture of surface and underlying strata. The penetration and soil moisture sensitivity of SAR imagery has been well established, and known to be optimal in fine, dry sand with minimum volumetric water content (Ulaby, Moore et al. 1986; Williams and Greeley 2000). However, even under ideal conditions, the penetration of microwave signals is restricted to near-surface moisture detection. RTF focused upon the assessment of alluvial water potential along existing wadis and nearby fractures and faults, since deeper reservoirs can still be detectable if capillary moisture flow reaches near-surface strata.

After each region of interest had been sufficiently mapped, an assessment of the following key parameters was undertaken in order to establish an overall rank of each “radar anomaly” with water potential:

1. Size of the radar anomaly, which is an indicator of the water storage volume of a buried reservoir within a wadi. As previously indicated, a reservoir with a sustainable production of 90,000 m³/year is able to support a camp of 20,000 refugees. Assuming an average rock porosity of 10%, this implies the need to find a buried reservoir with an overall productivity of nearly 1 million m³/year. This is equivalent to a wadi reservoir of about 2 km long and 60 m wide, assuming a reservoir thickness of 7.5 m at an average depth of 10 to 15 m). Accordingly, only radar anomalies covering a minimum surface of 12 hectares (2 km x 60 m) were considered in order to meet the above project goal. At this stage of the WATEX process, it is impossible to know if anomalies are associated with buried reservoirs (versus surface moisture linked to clay or silts deposits), and more analysis is required. Figure 1 illustrates an image showing the radar anomaly along the Wadi Dalal.

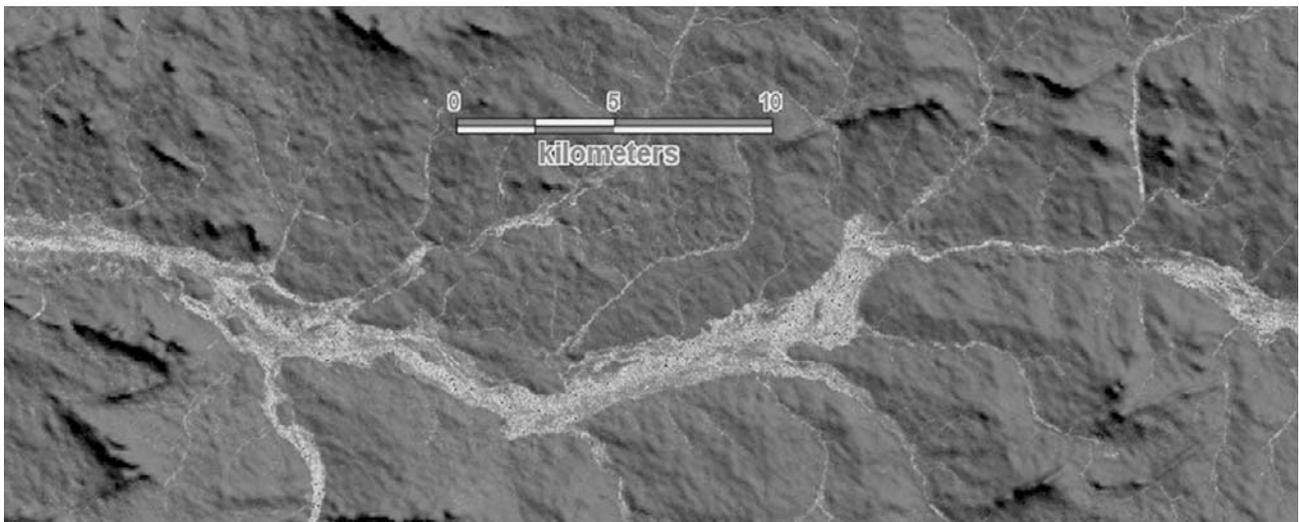


Figure 1: Radar along the Wadi Dalal

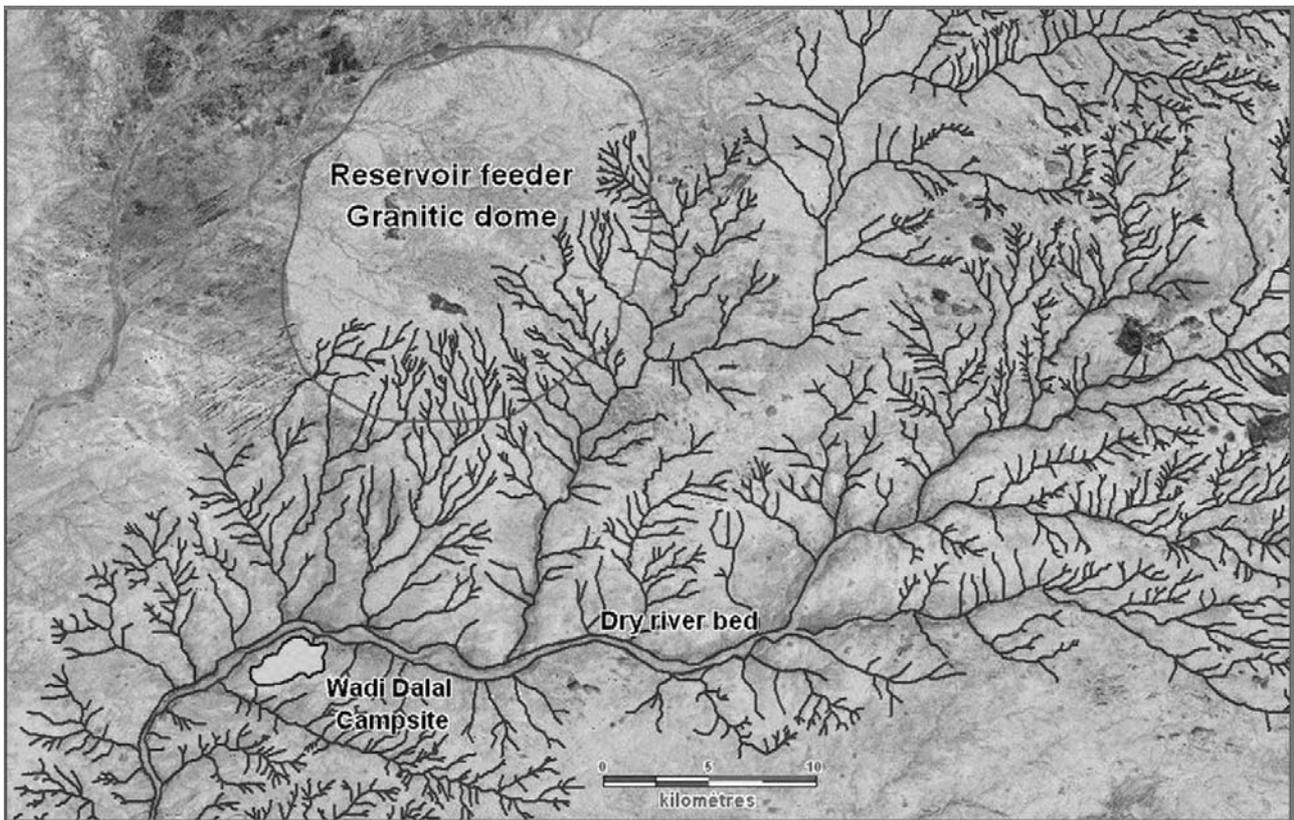


Figure 2: Radar backscattering anomaly revealed by WATEX processing, indicating the potential existence of buried aquifer within the wadi course (All images © RTF 2004).

2. Amount of upstream watershed drainage, since each potentially suitable target must also be fed by an upstream watershed capable of supplying at least 1 million m³/year of water to the reservoir. (The watershed surface area and average annual rainfall were used to estimate total yearly catchment, which was then corrected for evaporation, erratic runoff, and other water losses.)
3. Quality of reservoir gravels, since the origin and nature of the gravels which supply the reservoir determine its ability to reliably absorb and store sufficient water volumes. It is necessary to discriminate between "reservoir feeders" and "reservoir poisoners". For example, basaltic rock types can create excessive silt and reduce reservoir porosity and permeability, and are called "reservoir poisoners". Alternatively, "reservoir feeders" such as quartzite and sandstone can produce gravels that are ideal for sustaining large volumes of water storage. Figure 2 illustrates the large granitic feeder directly above the Wadi Dalal campsite.

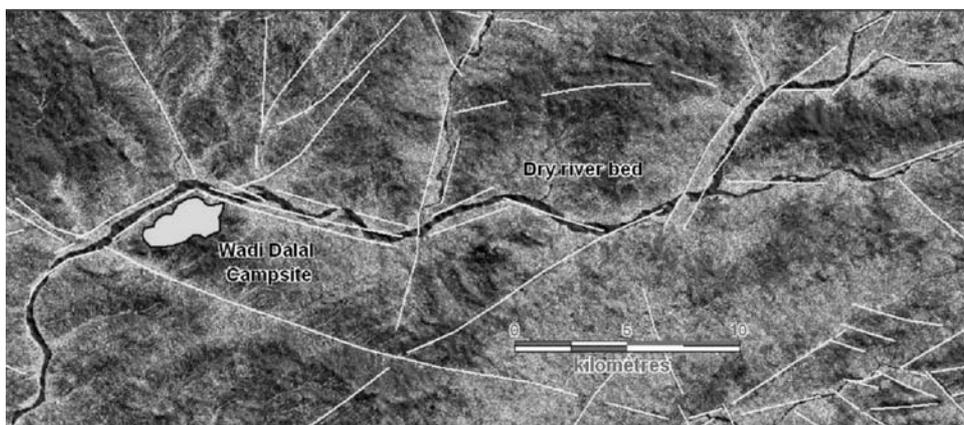


Figure 3: Landsat 7 ETM image in Sultan Combination showing the watershed upstream of Wadi Dalal campsite, and reservoir feeder that provides high-quality gravels to the downstream water reservoir within the wadi.

4. *Major fault structures*, since a linear river system controlled by graben-like structures is more likely to contain thick, multi-layered reservoirs, particularly if it sits downstream from a source of gravel or water-storing material. The ideal scenario is an old, well-framed riverbed with reliable and unchanging watercourse, downstream from a high-quality reservoir feeder. Figure 3 shows the distinct fault structure that frames the Wadi Dalal.

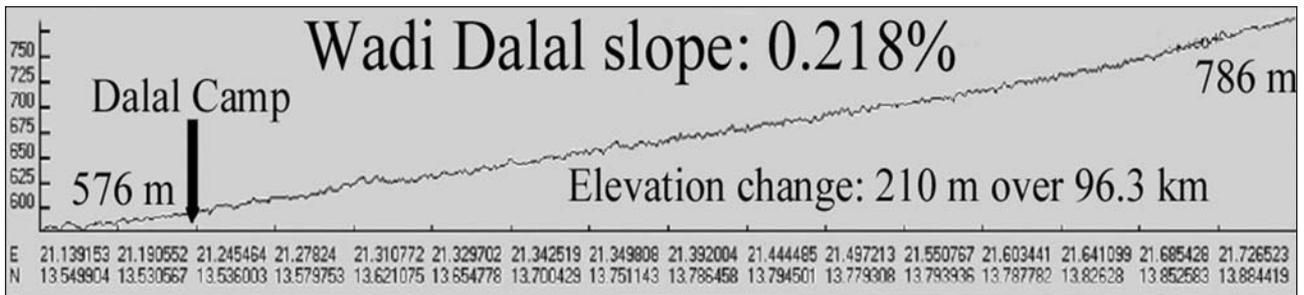


Figure 4: Processed image showing the course of the Wadi Dalal framed by a distinct fault structure, several kilometers long. The campsite is now located on a platform capable of hosting 30,000 refugees safely above the seasonal flood plain. SRTM-derived slope profile of the Wadi Dalal.

5. *Slope of upstream wadi course*, since the optimum riverbed slope needs to be between 0.1% to 0.4%, in order to ensure sufficient vertical recharge of reservoirs within wadi courses (Ragot 2004). (Too shallow a slope, and the reservoir can be prone to excessive silt accumulation, compromising its ability to store sufficient water reserves. Too steep a slope, and the reservoir can be prone to the erosion of the gravel bed that must recharge during the rainy season.) As illustrated in Figure 4, the Wadi Dalal has an average slope of 0.218% over its course upstream of the reservoir.

Once the five parameters listed above were understood, it was then possible to make an overall assessment of the most promising sites. In order for these areas to be suitable for UNHCR camps, RTF considered the implications of refugee resettlement near areas of existing cattle ranching, crop farming, and indigenous settlement. UNHCR-mandated restrictions on resettlement (within 50 km of the Sudan border) were buffered, and sites that were close to roads and wood fuel sources were prioritized. Reservoirs with high suitability were then examined to ensure close proximity to a suitable camp platform, since the Sphere Humanitarian Charter recommends that refugees be within 500 meters of at least one water point (The Sphere Project 2004).



Figure 5: Total collapse of well infrastructure due to seasonal flood erosion, near the village of Abdi in eastern Chad. This can be prevented by locating production wells outside of a wadi, along fractures fed by the wadi's deep reservoir.

The final step of the analysis was to identify drilling locations around high quality sites that were away from the central aquifer and towards the edge of the containment fracture. As illustrated in the above photography, the construction of well platforms directly in the path of wadi flow can be disastrous. Well damage due to flood erosion can be avoided by mapping the fault structure immediately adjacent to an aquifer but away from the wadi channel, and locating well platforms away from actual river flow.

Results

This project demonstrates that geospatial analysis, when merged with geological and hydrological exploration methods, enables the water potential in arid and semi-arid regions to be accurately estimated. It also minimizes the need for costly, time-consuming, and often hazardous ground surveying. Based upon approximately 540 drilling sites throughout Ouaddaï, RTF's WATEX process could have theoretically improved drilling success rates from 42% to 89% if it was available during earlier water exploration programs in the region. (Calculated by comparing WATEX-derived "high potential areas" with the water drilling results of the Chad Hydrological Survey and various NGOs in the past (Ragot 2004).)

Key evidence of the efficacy of the process is the UNHCR's selection of a new location to construct a major refugee camp along the Wadi Dalal, based upon the analysis provided (Chamberlain 2005). The Wadi Dalal settlement of Gaga is about 60 km east of Abéché, and was recommended because of its exceptional combination of characteristics.

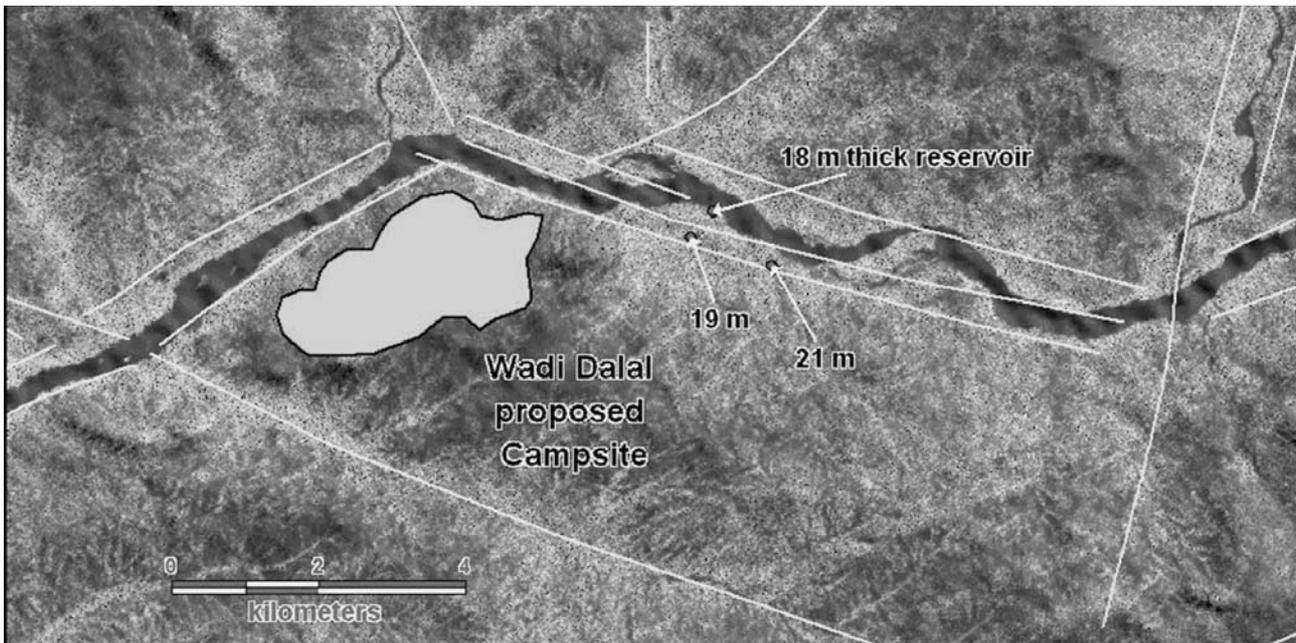


Figure 6: Location of the three exploration wells drilled in March 2005. Based upon the actual well productivity, the UNHCR decided to resettle up to 30,000 refugees to the area.

As predicted, drilling confirmed that it contained a thick, high-quality gravel reservoir fed by a large volume of water. In February 2005, prior to the UNHCR's decision to begin construction of the new refugee camp, RTF estimated that at least 20,000 people could be situated on a platform adjacent to the potential reservoir, based upon estimated water reserves (Gachet 2005). OXFAM, who carried out the drilling, confirmed RTF's prediction with three successful exploration wells drilled in March 2005, and in May 2005 the UNHCR resettled 200 refugees to the newly-established camp, announcing that the site had the capacity to shelter up to 30,000 refugees to the area (IRIN 2005).

Although the above results are impressive, a comprehensive empirical study of the efficacy of WATEX has not yet been undertaken, primarily due to the practical limitations in carrying out such an assessment in an area as remote and insecure as eastern Chad. It is also important to remember that

WATEX dramatically reduces but does not eliminate the need for *in situ* geological survey. Ground penetrating radar, test drilling and field survey are still important elements in the groundwater exploration process.

Conclusions

WATEX is an innovative, holistic approach to groundwater exploration, involving a fusion of humanitarian intelligence, hydrology, geology, and geospatial analysis. This interdisciplinary approach significantly reduces the risk and cost of water exploration, and limits ground survey to only areas with high water potential. There is always, of course, some level of risk in water exploration even with extensive geophysical investigation; but in conditions of humanitarian urgency, scarce resources, and inaccessible and massive areas of interest, WATEX has a demonstrated ability to enable humanitarian agencies to identify suitable areas for resettlement and meet international standards for water access.

The overarching goal of this project was to discover major water reserves on potential campsites capable of hosting up to 200,000 refugees. And while it is too early to know if that goal will be fully achieved, the experience to date with Wadi Dalal is extremely encouraging. Future applications could include irrigation planning and micro dam construction, which are symbiotic with the methodology employed by the process described in this article and in support of longer-term resettlement initiatives.

The authors dedicate this article to the late William B. Wood, Deputy Assistant Secretary of the US Department of State and The Geographer of the United States. Dr. Wood was a major source of inspiration and motivation during the earliest stages of this project, and it was with his encouragement in May 2005 that this article has been produced. The authors join many others in expressing deep gratitude to NASA and the USGS for facilitating collection, processing, and distribution of the SRTM mission data, which provided topographic intelligence that was crucial to this project. Similar appreciation is extended to the governments of Chad, Europe, France, Japan and the United States for providing the aforementioned data used in the project. Finally, RTF wishes to recognize the vision and courageous support of Craig Sanders & Marc Andre Bunzli of the UNHCR, Alain Retiere of UNOPS, and Olivier Senegas of UNOSAT.

References

- Bouchardy, J.-Y. (2005): *Radar Images and Geographic Information Helping Identify Water Resources During Humanitarian Crisis: The Case of Chad/Sudan (Darfur) Emergency*. 31st International Symposium of Remote Sensing & the Environment, St. Petersburg, Russian Federation.
- Bunzli, M. A. (2004): *UNHCR Operations Summary*. A. Gachet. N'Djamena, Chad, UNHCR GIS Unit.
- Bureau de Recherche Geologique et Miniere (1959): *Geological Map*. Paris, BRGM – Republic of France.
- Centre for Development and Environment (CDE) (2004): *1:250,000 Topographic Map of Eastern Chad*. Berne, Switzerland, University of Berne.
- Chamberlain, W. (2005): *Opening Remarks by the UNHCR Acting High Commissioner*. World Water Day, Geneva.
- Gachet, A. (2005): *Tchad-Phase II - Synthèse des études hydro géologiques par télédétection radar du Ouaddaï Oriental*. Tarascon: Geneva, Radar Technologies France:UNHCR: 52-54, 83.
- IRIN (2005): *Chad-Sudan: Twelfth Camp Opened for Darfur refugees*. Geneva, United Nations: IRIN News.
- Kusnir, I., M. Brunet, et al. (1995): *Geologie, Ressources Minérales et Ressources en Eau du Tchad*. 2nd Edition. A. Beauvilain, Centre National d'Appui a la Recherche: 23-27, 77.
- Ogata, S. (2000): *An Agenda for Business-Humanitarian Partnerships*. The Washington Quarterly. No. 23: pp. 167-170.

- Ragot, J.-M. (2004): *Hydrological Information for Ouaddai*. A. Gachet. Valence, France.
- Schneider, J.-L. (2001): *Carte de Valorisation des Eaux Souterraines de la Republique du Tchad*. Geology-Archeology-Hydrology of Chad, Funded by European Development Fund: 1:500,000.
- The Sphere Project (2004): *Humanitarian Charter & Minimum Standards in Disaster Response Handbook*. Chapter 2. Geneva. 2005.
- Ulaby, F. T., R. K. Moore, et al. (1986): *Microwave Remote Sensing Active and Passive From Theory to Applications*. Dedham, Massachusetts, Artech House.
- United Nations (2004): *Chad: Consolidated Inter-Agency Appeal for Darfur Refugees and Host Communities*. New York / Geneva, United Nations Office for the Coordination of Humanitarian Affairs.
- Verjee, F. (2005): The Application of Geomatics in Complex Humanitarian Emergencies. In: *Journal of Humanitarian Assistance*. No. 28 (September).
- Williams, K. K.; R. Greeley (2000): *Radar Imaging of Subsurface Geology Through Sand: Analysis of Penetration Depth Variables with Implications for Mars Exploration*. Proceedings from Lunar & Planetary Science XXXI, Houston, Texas.

3.2 The Effectiveness of Water Policy on Reducing People's Risk Exposure to Water Management Inefficiencies in Mexico City

Fabiola Sagrario Sosa Rodríguez

Abstract

In Mexico City there are discrepancies between inhabitants' risk exposure produced by water management inefficiencies, their recognition by authorities and their perception by people. This fact evidences that water policy in this city has not been effective for reducing people's risk exposure because risks produced by water management inefficiencies are not recognized nor perceived by authorities and people. Also, this policy has not solved the most urgent inefficiencies that affect the city's inhabitants. Finally, water policy has not attended those neighborhoods whose residents are more exposed to these kinds of risks. As a result, the hypothesis that Mexico City water policy has not been effective for reducing people's risks exposure to water management inefficiencies is not rejected.

One of the objectives of water management is to reduce social vulnerability. Therefore, an inefficient water management opposes this objective since it endangers people's lives and it also increases their social vulnerability, which is positively related to these inefficiencies. In this context, the results of this investigation improve the knowledge of risks produced by water management inefficiencies and their impacts on social vulnerability, helping decision makers implement and adjust water policy in order to mitigate people's risk exposure by attending those water management inefficiencies, which in turn affect more inhabitants and/or reduce people's vulnerability.

Introduction

As water is a vital resource for all humanity which is both scarce and unequal distributed among people, water related problems –especially in cities– have become a world concern that require the development of new ideas for improving its management. Although 70% of the planet's surface is composed of water, 97.5% is saltwater and just 2.5% fresh water. However, not all fresh water is available for human consumption and is relatively scarce; of all fresh water resources, 30.8% is underground, less than 0.3% constitutes superficial water, and the rest is frozen in glaciers (WWAP, 2003: 68). Moreover, its natural distribution in all the geographical scales is unequal. Only in the American continent is concentrated 47% of the water in the world; while in Asia 32%, in Europe 7%, in Africa 9%, and in Australia and Oceania 6% (Carabias, 2005: 16).

Additionally, more than 1.1 billion persons in the world do not have secure drinking water, more than 500 thousand million do not have access to fresh water, nearly 2.4 billion do not have sanitary services and 2.2 millions die every year due to water pollution. Finally, nearly 90% of sewage in developing countries does not receive any kind of treatment before it is emptied back into bodies of water. In this context, the Water World Commission considers that the global hydrological system, on which humanity's survival depends, is at risk because it will not be able to fulfill future water demands (WHO-UNICEF, 2000: 12-14). Thus, improving hydraulic resource management has become a world goal, settling as Millennium Goals by United Nations "to reduce in a half the proportion of population that does not have access to secure drinking water and to sanitation services" and "to carry out an Integrated Water Resources Management in all countries for the year 2015" (Yong, 2006: 1).

Evidently, not just natural water disasters provoke human and economic losses. In the long term, water management inefficiencies¹ like aquifer overexploitation, hydrological dependence to farther water

1 The concept of "efficiency" was developed by the Economic Theory, and it is defined as the earnings maximization or costs minimization. Therefore, "inefficiencies" can be understood as deviations from ideal or expected results.

sources, low water quality, floods, insufficient hydraulic infrastructure, and unequal distribution of drinking water, sewage and low prices, will cause more losses than natural water disasters because they are permanently affecting people all around the world. Nevertheless, risks caused by water management inefficiencies have been practically absent in the government agendas of many countries.

As of this moment, the dominant focus in risk study has been technical. According to this perspective, risk is measured as "the product of hazard occurrence probability by the magnitude of damage" (Luján and López, 2000: 66). However, the understanding of risk in all its complexity cannot be reduced to a mathematical model since it fails to consider people risk perception, governmental risk recognition and risk acceptability. On one hand, risk perception and its acceptability are ideologically and politically constructed; as a consequence, people's risk representations or images depend on social values and political discourses (Bechmann, 1995: 77). Risk acceptance depends on: whom is exposed to the risk, if there exists a possibility to repair and control damages, their magnitude, people's familiarity with the risk, and people's proximity to their negative effects. Some perceived risks also have been acknowledged by governmental authorities as part of the government agenda (Beck, 1995: 19-25, 41-42), but there are other risks that are unknown by authorities, the scientific community and people since they do not know or even suspect their existence. Evidently, not only risk's acceptance, but also its negation, is not only a scientific matter but also political (Jasanoff, 1995: 279-293). These considerations also apply to risks produced by water management inefficiencies, whose impacts on Mexico City's inhabitants and their characteristics are not so different from ones faced by other cities.

According to the 2nd article of the Federal District Government Statute, "Mexico City is constituted by sixteen delegations of the Federal District (FD), and it is the headquarters of federal and local powers of Mexico". In an extension of approximately 0.76% of the national territory, Mexico City generates one-fourth of the gross national product, and concentrates approximately half of the direct foreign investment and banking activities, and almost 9% of the national population. It also has one of the biggest urban infrastructure in the country.

In spite of its administrative definition, the city is contained in a natural environment that does not correspond with its political delimitations. Therefore, for studying water-related problems in Mexico City, the Mexico Valley Basin is the most appropriate spatial unit to investigate. This Basin is integrated by 85 municipalities of several states, and it was a naturally closed hydrological unit. However, it has been deeply modified since most of the rivers have been funneled into pipelines, and aquifers are being overexploited in order to satisfy the city's growing water demand (CNA, 2004: 1-27). Because of the complexity of studying the inefficiencies in water management in Mexico Valley Basin, this investigation will be based on the political delimitation of the city due to the fact that the decisions taken and implemented by water policy are according to this delimitation.

The concentration of its people and economic activities in Mexico City are not a recent phenomenon. Since the middle of the 20th century, the city has experienced a growth without precedent that has provoked a quick, dispersed and disordered occupation of its territory, along with considerable social and environmental costs. Because of this, the solution of water management inefficiencies represents a great challenge. Many of these inefficiencies are yet to be studied; nevertheless, because of its capacity to increase inhabitants' risks exposure, the most important inefficiencies include: aquifer overexploitation and hydrological dependence on external sources, unequal distribution of drinkable water and sewage, low water quality, insufficient hydraulic infrastructure, investment and insufficient sewage treatment and treated water reuse. All these inefficiencies have particular magnitudes and characteristics that determine the recognition by both authorities and population.

In this context, it is necessary to wonder if Mexico City water policy has been effective² for reducing people's risk exposure produced by water management inefficiencies. In order to answer this question,

2 "Effectiveness" is the accomplishment of established objectives and goals.

it is necessary to know to what extent Mexico City water policy has been focused on solving those water management inefficiencies that affect most of its inhabitants. If so, it will be pertinent to know if this policy has been implemented in neighborhoods most exposed to risks produced by water management inefficiencies. Lastly, it would be necessary to know if water policy has been able to construct the recognition of these risks in authorities and population.

The hypothesis of this investigation proposed is the following: Mexico City water policy has not been effective for reducing people's risk exposure to water management inefficiencies. First, water policy has not incorporated explicitly and clearly the concept of risks due to a naturalistic vision by authorities about water-related risks; in other words, they only consider those risks caused by hydrometeorological events. Second, this policy has not been focused on solving those water management inefficiencies that affect most of Mexico City's inhabitants because its actions implemented are focused in those inefficiencies whose resolution is more beneficial politically. Third, water policy has not been implemented in the neighborhoods more exposed to risks produced by water management inefficiencies; instead, it has attended those neighborhoods with higher economic resources.

Understanding as social vulnerability people's capacity to anticipate, cope with, resist and recover from the impacts caused by natural and anthropogenic hazards according to people's social, economic, political and physical conditions; water and sanitary service distribution, water quality, water treatment and hydraulic infrastructure for providing these services, and general water management, has a deep impact on people's quality of life and security. Therefore, one of the objectives of water management is to reduce social vulnerability because an inefficient water management endangers people's lives and also increases people's social vulnerability, which is positively related to these inefficiencies. In this sense, it is truly important to modify the paradigm that water-related risks and disasters are not just produced by natural events, because they are also produced by humans and the actions and decisions made by societal institutions.

Methods

Several methods exist for measuring hazards, vulnerability and risks. The method used in this research represents an alternative to these measurements, considered as the most accurate and feasible for testing the proposed hypothesis. Although hazards, vulnerability and risks are complex and dynamic phenomena, measured most appropriately by the use of dynamic models, the availability of information on Mexico City did not allow to the implementation of a dynamic model in the present research. However, this research will use a quantitative and a qualitative methodology. Through quantitative methodology, people's risks exposure to water management inefficiencies in Mexico City and their spatial distribution will be estimated by using principal component models and Geographical Systems of Information. On the other hand, with qualitative methodology authorities, scientists and people's "risk-ideas" of water management inefficiencies will be known by using discussion groups and discourse analysis techniques.

The spatial analysis unit chosen is the "neighborhood" since it constitutes an entity whose residents share ideas, values and a risk culture. It will be possible to identify those neighborhoods more and less exposed to risks produced by water management inefficiencies, and also, to compare the risk-ideas of authorities and people with neighborhoods' exposure levels. Consequently, this research contributes to risk and social vulnerability studies in several ways. First, it complements a quantitative approach with a qualitative one. Secondly, it considers not only people's perception, but also that of authorities. Finally, it proposes an interesting approach to the study of water management inefficiencies and social vulnerability, improving the knowledge of the risks produced by water management inefficiencies and the importance of governmental actions for reducing people's risk exposure produced by the same.

Measuring Risks Produced by Water Management Inefficiencies

a. Water Management Inefficiency Hazard Index

The main water management inefficiencies in Mexico City were estimated by a principal component model.³ With this kind of model, all variables that define each one of the water management inefficiencies will be synthesized in an index, and each index will represent a hazard that inhabitants face. This principal component model has several advantages: it allows the calculating of a value that represents the intensity of water management inefficiencies although its defining variables are measured with different units; with the estimated indexes it is possible to know how these inefficiencies are distributed in the city; finally, multicollinearity does not exist in this kind of model. Nevertheless, it is impossible to know a specific magnitude of water management inefficiencies.

The indexes calculated for each water management inefficiencies will be synthesized in the *Water Management Inefficiency Hazard Index* (WMIHI):

$$WMIHI = \varphi_1 \overline{SI} + \varphi_2 \overline{UDI} + \varphi_3 \overline{LQI} + \varphi_4 \overline{SeDTI} + \varphi_5 \overline{INIVI} + \varphi_6 \overline{TREREUI} \quad (2)$$

where, $SI = f(SFi, SFe, CS, DRAC, \dots)$

$UDI = f(DAv, DAs, NDA, Cah, \dots)$

$LQI = f(CI, BacColf, POrg, DBO5, \dots)$

$SeDTI = f(Ddren, NDdren, CXARes, \dots)$

$INIVI = f(DefINF, PINF, ReqINF, EF, \dots)$

$TREREUI = f(Atrat, AReu, ActReA, \dots)$

$\varphi_i = \text{factor coefficients}$

The indexes and the variables that constitute them are listed in Table 1.

This index will be normalized and transformed to the decimal scale, so its values will fluctuate between zero and ten. On one hand, when WMIHI = 10, the analyzed neighborhood will not face any hazard related to water management inefficiencies. On the other hand, when WMIHI = 0, the analyzed neighborhood will face all water management inefficiencies in the greatest intensity. These rankings were defined using the Mexican scholar system evaluation in order to make easier its understanding for the readers and the decision makers, who can identify without any doubt which neighborhood requires urgent attention for solving water management inefficiencies.

b. Vulnerability to Water Management Inefficiencies

VWMI (Vulnerability to Water Management Inefficiencies) will also be estimated using a principal component model; therefore, it will be possible to know its intensity, to build a hierarchy, and to analyze its spatial distribution in the city. Because VWMI is the fragility of people's physical, social and economic conditions, which limit their ability to confront water management inefficiencies. The following model will be used to calculate this index:

$$V_H = \gamma_1 \overline{IAF} + \gamma_2 \overline{IBS} + \gamma_3 \overline{ICE} \quad (3)$$

where, $PI = f(AI, AES, ADes, Fhidro, \dots)$

$SI = f(DensP, Acabas, Edu, CondViv, \dots)$

$EI = f(Ypcap, DistrY, Empl, PovAI, \dots)$

The factors and the variables that constitute them are listed in Table 2.

3 The principal component model used is: $IPA = M + P.F + E$

(1) where, M_i = average of variable i ; P_{ij} = weight of variable i in the j factor; F_{ij} = ij factor; p = polytomic variables

Table 1: Water Management Inefficiency Indexes

Inefficiencies	Characteristics	Variables*	Index
Aquifer Overexploitation and Hydrological Dependence	Related to high hydrological dependence on external sources and aquifer overexploitation.	a. Internal sources water supply (<i>SFi</i>) b. External sources water supply (<i>SFe</i>) c. Water supply costs (<i>CS</i>) d. Aquifer recharge deficit (<i>DRAc</i>)	Supply Index (SI)
Unequal Water Distribution	Associated with unequal water distribution among inhabitants.	a. Population and households that: a.1 Have running water (<i>DAv</i>) a.2 Do not have water coming into the house (<i>DAa</i>) a.3 Do not have water (<i>NDA</i>) b. Liters/habitant/day consumed (<i>CAh</i>)	Unequal Distribution Index (UDI)
Low Water Quality	Related to pathogen organisms and existence of toxic metals in drinking water.	a. Chlorine (<i>Cl</i>) b. Fecal Bacteria (<i>BacColf</i>) c. Pathogen Organism (<i>POrg</i>) d. Biochemistry Oxygen Demand (<i>DBO5</i>) e. Dissolved solids (<i>Sdis</i>), f. Heavy metals (<i>MetP</i>) g. Ammonia Nitrogen (<i>NAmoN</i>) h. Nitrates and Phosphates (<i>NyP</i>)	Low Quality Index (LQI)
Problems in Sewage Disposition and Treatment	Associated with sewage disposition and treatment, and the lack of drainage.	a. Population and houses that: a.1 Have drainage (<i>Ddren</i>) a.2 Do not have drainage (<i>NDdren</i>) b. Sewage costs (<i>CXAres</i>)	Sewage Disposition and Treatment Index (SeDTI)
Lack of Water Infrastructure and Investment	Related to the gap between required investment versus realized investment, and deficiencies in hydraulic infrastructure.	a. Deficiencies in drinking water, drainage and sewage treatment infrastructure (<i>DefINF</i>) b. Infrastructure problems (<i>PINF</i>) c. Investment required versus realized (<i>ReqINF</i>) d. Physical Efficiency (<i>EF</i>)	Infrastructure and Investment Index (INIVI)
Low Sewage Treatment and Water Reuse	Related to low sewage treatment and water reuse.	a. Water treated in each entity (<i>ATrat</i>) b. Water reuse in each entity (<i>AREu</i>) c. Activities in which treated water is used	Treatment and Water Reuse Index (TREREUI)

* The variables listed are not disaggregated

Table 2: Vulnerability to Water Management Inefficiencies

Factor	Characteristics	Variables	Index
Physical	Related to people's location in dangerous areas, since they are exposed to floods, sinks and/or lack of services.	a. Areas exposed to floods (<i>AI</i>) b. Areas exposed to the lack of services (<i>AES</i>) c. Areas exposed to land collapses (<i>ADes</i>) d. Areas exposed to hydrometeorological events (<i>FHidro</i>)	Physical Hazards Index (PI)
Social	Linked to people's access to education, information, health services, employment, and other public services that determine the way they face water management inefficiencies.	a. Population Density (<i>DensP</i>) b. Access to basic public services (<i>Acabas</i>) c. Education (<i>Edu</i>) d. Housing conditions (<i>CondViv</i>) e. Health (<i>Health</i>) f. Security (<i>Sec</i>)	Social Index (SI)
Economic	Related to the lack of revenues, labor stability and public service access, which limit people's capacity to face water management inefficiencies.	a. Per capita income (<i>Ypcap</i>) b. Income distribution (<i>DistrY</i>) c. Employment (<i>Empl</i>) d. Poverty	Economic Index (EI)

* The variables listed are not disaggregated

Similar to WMIHI, this index will be normalized and transformed to the decimal scale, so its values will fluctuate between zero and ten. When VWMI = 0, the people who live in the analyzed neighborhood have the maximum vulnerability to face water management inefficiencies. On the other hand, when VWMI = 10, the people who live in the analyzed neighborhood are not vulnerable to any water management inefficiency. These ranks were also defined using the Mexican scholar system evaluation for making easier its understanding to readers and decision makers.

c. Risk Produced by Water Management Inefficiencies

The convergence of water management inefficiencies, which constitutes hazards and people's capacity to confront them, or vulnerability, increases or generates greater risks. The "Risk produced by Water Management Inefficiencies," (RWMI_n) per neighborhood will be calculated as a probability; therefore, its value fluctuates between zero and the unit {0 ≤ RWMI_n ≤ 1}. When RWMI_n = 1, the people who live in the analyzed neighborhood face the maximum risk produced by water management inefficiencies; while when RWMI_n = 0, people will not be exposed to this risk. The RWMI_n will be calculated with the following equation:

$$RWMI_n = 1 - \left[\frac{WMIHI * V_H}{600} \right] \quad \forall RWMI_n \in [0,1]$$

And the RWMI_c for the city will be calculated using the next equation:

$$RWMI_c = \frac{\sum_{i=1}^n RWMI_i}{n}$$

where, i defines a particular neighborhood.

Risk Perception

This research will use discussion groups and discourse analysis in order to uncover authorities' and people's risk-ideas. Through discussion groups, participants will evidence their risk-representations, which are social and politically determined. Then, with discourse analysis these risk-representations will be identified. The participants of the discussion groups were selected carefully in order to create homogenous groups and to avoid members' exclusion. The groups will be conformed by four to ten persons, in order not to saturate the communication channels, and will not last more than an hour and a half in order not to exhaust the participants. The discussion groups will be integrated by authorities and Mexico City's inhabitants (See table 3).

Table 3: Discussion Groups

Group	Participants
Authorities	Governmental officials who belong to institutions in charge of water management in Mexico City such as: the National Water Commission (CNA), the Mexico City Water System (SACM), the Ministry of Social Development (SEDESOL), the Ministry of Environment and Natural Resources (SEMARNAT), and the National Ecology Institute (INE).
People	Persons who live in the neighborhoods most exposed and least exposed to risks produced by water management inefficiencies in Mexico City. These neighborhoods will be identified in accordance with the results of the indexes proposed: WMIHI, VWMI and RWMI.

Outcomes

Since this research has not been completed, the results that will be mentioned can only be considered as preliminary and not final. However, they clearly evidence the gap which exists between people's exposure to risk produced by water management inefficiencies and their perception. This gap has increased inhabitants vulnerability since they do not know to what and in which intensity they are exposed. Several water management inefficiencies can be identified in Mexico City, but the ones that

directly affect its population and increase its risk-exposure are: aquifer overexploitation and hydrological dependence on external sources, unequal distribution of drinkable water and sewage, low water quality, insufficient hydraulic infrastructure and investment, and insufficient sewage treatment and treated water reuse. All these inefficiencies have particular magnitudes and characteristics that determine authorities' and inhabitants' perceptions.

Water Management Inefficiencies in Mexico City

a. Aquifer Overexploitation and Hydrological Dependence to External Sources

Of the 34.8 m³/sec water supply that Mexico City receives, 57.47% comes from internal sources of Mexico Valley Basin like wells, springs and the aquifer of Mexico Valley. Almost half of the water of the internal sources comes from the Mexico Valley aquifer, but water extracted from this source doubles the quantity that is being infiltrated, producing a deficit in the aquifer recharge of 17 m³/sec. This deficit has caused sinks in different areas of the city which average reach from 10 to 48 cm/yr, deteriorating the structures of hundreds of buildings and increasing the fractures in drinking and drainage pipes. Also, the aquifer overexploitation has mobilized fossil waters concentrated at its bottom, which contain salts and minerals toxic for human ingestion. Reversely, 42.53% of water supply comes from external sources (Cutzamala and Lerma-Chapala Basins). In order to import the water from external basins, authorities have spent enormous amounts of money on energy consumption, since water is driven along 127 km and is elevated 1,100 m of height; requiring 3.4 millions petroleum barrels, which represents an average cost of 3.66 pesos/m³ of water.

b. Unequal Distribution of the Drinking Water

Mexico City has one of the biggest hydraulic infrastructures in the country. This infrastructure covers 97% of its urbanized surface and it provides drinking water to 94.72% of its inhabitants (8.6 million persons). In spite of its high concentration of hydraulic infrastructure, the effective consumption carried out by its inhabitants is very unequal, and some of its neighborhoods do not have this service at all. Each inhabitant receives a water supply average of 361 liters/day, which is one of the highest water supplies in the world. However, only residents in four of the sixteen delegations have a measured water consumption superior to the minimum quantity required by each individual to satisfy his or her basic needs. The deficit in drinking water supply ascends to 3 m³/sec and affects 1.2 million persons, distributed unequally among the delegations. The entities most affected by the absence of water supply are located at the east of the city such as Tlalpan, Iztapalapa, Xochimilco, Gustavo A. Madero and Milpa Alta; in contrast, the less affected are Cuauhtémoc, Miguel Hidalgo, Venustiano Carranza and Iztacalco, situated at the north of the city.

c. Low Water Quality

The supply of drinking water to the population has high quantities of pathogen bacteria and toxic metals, which considerably exceed the maximum limits specified by law. Also, it exceeds the limits allowable of the amount of nitrates, sodium and dissolved solids. Moreover, in accordance with the Biochemical Demand of Oxygen (DBO₅), 75% of water bodies in Mexico Valley Basin, which represent an important water source for human consumption, do not contain drinking water; it must go through treatment before it can be used for human consumption. In the case of the underground water, it has low quality because it is polluted with sewage and lixivates filtration, among other causes pollutants.

d. Sewage Disposition

Comparing 95.96% of the total households in Mexico City that have drinking water, only 89.49% have drainage; therefore, the increases in water demand have not been compensated with increases in drainage and sewage treatment infrastructure. Although drainage is an essential public service to

preserve people's health, it is one of the public services which has received the least attention. Drainage in the city is constituted by one pipeline which gathers sewage and pluvial waters. The lack of separated pipelines for drawing out sewage and pluvial waters has increased drainage system cost; not only because the amount of water transported saturates the system, but also because in rainy seasons the quantity of water that needs to be treated increases considerably. The lack of separated pipelines implies that almost 700 liters/sec of water (which could be reused) are wasted. It is estimated that the cost of drawing out sewage is similar to the cost of supplying drinking water for city's inhabitants.

e. Lack of Hydraulic Infrastructure

Mexico City is one of the entities in the country which has made the largest investment in hydraulic infrastructure. In spite of this, not all its inhabitants have access to drinking water and drainage. The main problem with hydraulic infrastructure is its obsolescence; in some delegations water supply pipes are more than 50 years old. First, this problem has caused an uneven distribution of drinking water and drainage services, and secondly, it is related with leakages. Almost 32% of the water supply is lost by leakages, signaling that water loss volume continues to be very high, and with the water lost, it is possible to supply cities like Madrid or Rome (UNEP, 1990: 38-40).

f. Low Sewage Treatment and Water Reuse

Sewage generated in Mexico City is drawn out of the valley without any kind of treatment, and it is used for watering vegetables, which later are commercialized in the city. Their consumption has caused severe gastrointestinal illnesses in the population and an increase in infantile mortality. In Mexico City, sewage treatment has had little importance since of the total sewage generated in the city only 11% of it (almost 3.9 m³/sec) is treated. Moreover, this entity has 79 treatment plants that work at 67% of their installed capacity. Of the treated water, 83% is used for watering urban green areas and for recharging the aquifer, 10% for industrial uses, 5% for agricultural uses and 2% for commercial uses. Evidently, treated water can be complementary for satisfying city inhabitants' water demand that does not require a high quality.

Risk Produced by Water Management Inefficiencies and Its Recognition

In spite of the governmental attention received by some water management inefficiencies in Mexico City, according to the present results it seems that water management has not been effective for reducing people's exposure to risk produced by inefficiencies. It has not attended the neighborhoods more exposed to these risks, it has not solved the most urgent inefficiencies, and it has not constructed a social recognition of risk among authorities and population (See table 4).

Conclusions

In order to solve water management inefficiencies in cities, it is essential to develop new approaches since such inefficiencies affect people's quality of life and security. Unequal distribution of water is not the only inefficiency that increases human exposure to risk; other inefficiencies include sewage disposition, water quality and sewage treatment, among others. In this sense, not just hydrometeorological events can cause human and economic losses. In the long term, water management inefficiencies can produce even higher human and economic losses than these natural events since they affect permanently all countries around the world. However, the study of risks produced by water management inefficiencies have been practically absent in government agendas.

Technical emphasis in risk study has reduced this phenomenon to an average value of damages; nevertheless, risk can not be reduced to a mathematical model since it fails to consider the social elements: people's risk perception, governmental risk recognition and risk acceptability. For this reason, there is a clear gap between the risk people are exposed to and its perception, which makes a population more

Table 4: Risks Produced by Water Management Inefficiencies and Their Recognition

Inefficiencies	Risks Caused	Risk Recognition
Aquifer Over-exploitation and Hydrological Dependence	<p>*The aquifer overexploitation has increased sinks and fractures in drinking water and drainage pipes.</p> <p>*Aquifer water has a high concentration of toxic materials. This endangers Mexico City's inhabitants' health.</p> <p>*The hydrological dependence of the city on external sources is very high and it is not sustainable still in the short term due to ecosystem deterioration, high energy costs and water conflict appearance.</p>	<p>*Inhabitants do not perceive that the provision of drinking water and drainage service are really expensive. Because of this, residents usually waste the water and consume it in an irrational way.</p> <p>*Growing dependence of Mexico City on external sources for satisfying water demand has not been recognized by authorities since they look for distant alternative water sources instead of reducing water consumption and waste.</p>
Unequal Water Distribution	<p>*There is an unequal distribution of drinking water in the entities that constitute Mexico City. This has important impacts in the quality of people's life, and in particular, in their health.</p> <p>*In some neighborhoods of the city, their residents do not have access to drinking water.</p>	<p>*There is no perception about water shortage among inhabitants because their water consumption and waste are growing. *Authorities do not recognize the impacts in the quality of people's life for the lack of drinking water because this problem has just been solved with the use of water pipes.</p>
Low Water Quality	<p>*The biggest risk in health which inhabitants face is from the high quantity of pathogen bacteria which are contained in the drinking water.</p> <p>*Water-borne diseases caused by the low water quality have increased the deaths in infants and people's morbidity. These illnesses come from drinking water with low quality and for consuming food contaminated with untreated water.</p>	<p>*The risk inhabitants face for drinking water with low quality is not perceived since they believe that the water they receive at home is safe for drinking, although it contains pathogen bacteria and toxic substances.</p> <p>*Authorities do not recognize the impacts in people's health for low water quality consumption because water monitoring is not obligatory, nor has it been defined who is responsible for carrying it out, and the process itself does not measure the amount of pathogen organism contained in water.</p>
Problems in Sewage Disposition and Treatment	<p>*Although drainage is essential to preserve a population's health, this is one of the public services that has received little attention in the country, increasing inhabitants' risks-exposure to floods and to low water quality supply.</p> <p>*Inhabitants believe that the service of water supply ends when they receive water at home; therefore, they are not concerned with what happens with the water once it is used.</p> <p>* Almost 90% of sewage is poured into natural ecosystems without any treatment, producing severe environmental damages, health problems and reducing water quality.</p>	<p>*Although authorities recognize the necessity to have a good drainage system, they have not incorporated sewage disposition and treatment costs in water prices. This situation has diminished inhabitants' concern regarding what happens with water once it is used.</p> <p>*Authorities do not recognize the impact of the lack of drainage in people's quality of life because this service has received little attention in comparison with drinking water supply. Nor have they considered the high opportunity costs the city faces for not using pluvial water or treated water, and rain water is hardly used nor is it separated from sewage.</p> <p>*There is not recognition about the risks Mexico City confronts due to floods. For instance, if the drainage system fails, the city's downtown would be flooded by sewage.</p>
Lack of Water Infrastructure and Investment	<p>*The lack of investment and maintenance in hydraulic infrastructure has increased people exposure to floods, sinks, and water source pollution.</p>	<p>*Although authorities recognize the necessity for augmenting and attending to hydraulic infrastructure, these measurements have not been enough to resolve what investments are truly necessary.</p>
Low Sewage Treatment and Water Reuse	<p>*Mexico City faces high opportunity costs for not reusing water and for not using pluvial water. The city's environmental costs are very high because sewage is turned into bodies of water without any treatment, increasing water shortage, water sources pollution, and inhabitants' health deterioration.</p>	<p>*Mexico City inhabitants do not use treated or pluvial water for those activities that do not require the highest quality water supply; in consequence their water consumption and waste have increased.</p> <p>*In spite of the high costs for not reusing treated water and polluting water sources, authorities have not designed economic incentives to promote the use of treated and pluvial water.</p>

vulnerable because they do not realize to what they are exposed, and to what magnitude. For this reason it is important to think about the role that scientists have as intermediaries between scientific discovery and decision making. If scientists share their knowledge in a comprehensible way with decision makers and the average resident, they can save many lives and prevent the occurrence of disasters. Therefore, it is fundamental not only to consider risks' recognition and acceptance, but also their negation, in both scientific and political terms.

Considering these observations, in the case of Mexico City there is a clear gap among inhabitants' exposure to risks produced by water management inefficiencies, authorities recognition and people's perception. The mentioned evidence suggests that water management in the city has not been effective for reducing people's exposure to risks because it has not constructed the recognition of them among authorities and people, it has not solved the most urgent inefficiencies that affect people's lives, and it has not attended the neighborhoods whose residents are more exposed to such risks.

Although the most important inefficiencies that affect Mexico City's inhabitants are aquifer overexploitation and hydrological dependence on external sources, unequal distribution of drinkable water and sewage, low water quality, insufficient hydraulic infrastructure and investment, and insufficient sewage treatment and treated water reuse; the highest risk people face is low quality of water supply, due to its concentration of pathogen bacteria and toxic metals and the lack of authorities and people's recognition. Inhabitants believe the water they receive at home is safe for drinking, although it considerably exceeds the Mexican Officials Norms for considering them drinkable. Additionally, authorities do not recognize the impacts on people's health for low water quality consumption since water monitoring is not obligatory, it has not been defined who is responsible for carrying it out, and they do not measure the amount of pathogen organism contained in the water. The same situation occurs in the other inefficiencies, which when matched with a vulnerable population, expose people to risks.

Finally, it is evident that risks produced by water management inefficiencies are dynamic and constantly changing since they are determined by authorities and people's actions and decisions. They are distributed unequally not just in the territory, but also socially; therefore, different people are exposed in different ways to the risks produced by water management inefficiencies. These risks depend on several social, economic, political and environmental factors, whose interactions make their reduction a real challenge, and whose comprehension urges considerations beyond those strictly related to a mathematical model which does not include social elements.

References

- Bechmann, G. (1995): Riesgo y desarrollo técnico-científico. Sobre la importancia social de la investigación y valoración del riesgo. In: *Cuadernos de Sección Ciencias Sociales y Económicas*. No. 2, pp. 59-98.
- Beck, U. (1995): *Ecological Enlightenment*. Humanity Press, New Jersey.
- Beck, U. (1992): *Risk Society. Towards a New Modernity*. Sage Publications, London.
- Blaikie, P. (1996): *Vulnerabilidad, el Entorno Social, Político y Económico de los Desastres*. La RED, Colombia.
- Blaikie, P.; Brookfield H. (1994): *At Risk. Natural Hazards, People's Vulnerability, and Disasters*. Routledge, London.
- Carabias, J. (2005): *Agua, Medio Ambiente y Sociedad. Hacia la gestión integral de los recursos hídricos en México*. UNAM/COLMEX/Fundación Gonzalo Río Arronte, Mexico.
- Comisión Nacional del Agua (2004): *Estadísticas del Agua en México*. Publisher, Mexico.

- Federal District Government (1997): *Plan Maestro de Agua Potable del Distrito Federal, 1997-2010*. Publisher, Mexico.
- Douglas, M. (1985): *Risk Acceptability According to the Social Science*. Routledge, London.
- Douglas, M.; Wildavsky A. (1982): *Risk and Culture. An Essay on the Selection of Technological and Environmental Dangers*. University of California Press, Berkeley.
- García Segovia, A. (2000): *El Desafío del Agua en la Ciudad de México*. CESPEDES, Mexico.
- Nacional Institute of Statistic, Geography and Information (2000): *XII Censo General de Población y Vivienda 2000*. Mexico.
- Jasanoff, S. (1995): Procedural Choices in Regulatory Science. In: *Technology in Society*. No. 17, pp. 279-293.
- Jiménez, B. (2004): El agua en el Valle de México. In: Morán, D. (Ed.): *El agua en México vista desde la academia*. Science Academy, Mexico.
- Krimsky, S. (1992): The role of theory in risk studies. In: Golding, H.; Krimsky, S. (Ed.): *Social Theories of Risk*. Praeger Publishers, Connecticut.
- Libreros, H.; Quiñones A. (2004): Delegaciones políticas. La participación de las delegaciones políticas en la gestión del agua y drenaje del Distrito Federal. In: Martínez Omaña, M. (Ed.): *Gestión del agua en el Distrito Federal. Retos y propuestas*. UNAM/PUEC, Mexico.
- Luján, J. L.; López, J. (2000): *Ciencia y política del riesgo*. Alianza Editorial, Madrid.
- Maskrey, A. (1993): Vulnerabilidad y mitigación de los desastres. In: Maskrey, A. (Ed.): *Los desastres no son naturales*. LA RED/ITDG, Bogota.
- Merino, H. (2000): El sistema hidráulico de la Ciudad de México. In: Garza, G. (Ed.): *La Ciudad de México en el fin del segundo Milenio*. COLMEX, Mexico.
- OECD (2003): *Improving Water Management. Recent OECD Experience*. Paris.
- United Nations Environment Programme (1990): *Desarrollo y medio ambiente para América Latina y el Caribe*. Publisher, Washington.
- Renn, Ortwin (1992): Concepts of risk: a classification. In: Golding H.; Krimsky, S. (Ed.): *Social Theories of Risk*. Praeger Publishers, Connecticut.
- Tortajada, Cecilia (Ed.) (2004): *Hacia una gestión integral del agua en México. Retos y alternativas*. Third World Center for Water Management, Mexico.
- WHO-UNICEF (2000): *Global Water Supply Sanitation Assessment 2000 Report*. New York.
- Wilson, R. (1984): Risk and Their Acceptability. In: *Science, Technology and Human Values*. Vol. 9, No. 2, Sage, London.
- World Bank (2005): *Hazard Risk Management*. Washington.
- World Meteorological Organization, Co-operative Programme on Water and Climate, Japan Water Forum (2006): *Risk Management*. 4th World Water Forum. Mexico.
- World Water Assessment Program (2003): *Water for People, Water for Life*. The United Nations World Water Development Report. Washington.
- Young, G. (2006): *Establecimiento de Metas, Monitoreo y Evaluación de la Instrumentación*. 2nd Thematic Area. 4th World Water Forum, pp.1-30.

Terms and Definitions

Coping Capacities:	The means and ways in which people or organizations use available resources and capacities to face adverse consequences that could lead to a disaster.
Disaster:	Related to serious disruptions of the functioning of a society which cause human, material, economic or environmental losses that exceed the ability of the society to face or cope with it.
Efficiency:	The earnings maximization and/or minimization of costs.
Effectiveness:	The accomplishment of objectives and goals.
Exposure:	Linked to the probability or possibility of human settlements to be affected by natural or man-made hazards.
Hazard:	It is a perturbation, stress or stressor with a natural or man-made origin, which is considered as a dangerous event.
Perturbations:	Rapid events that evolve in an external area outside the location in question.
Resilience:	The ability to maintain basic infrastructures and to recover from losses.
Resistance:	The ability to withstand impacts, and the capacity to respond emergencies.
Risk:	The probability and magnitude of consequences after a hazard, which is the result of a combination between hazards and vulnerability.
Social Vulnerability:	People's capacity to anticipate, cope with, resist and recover from the impacts caused by natural and anthropogenic hazards.
Stress:	A slowly continuous or increasing pressure.
Stressors:	Sources of stress.
Vulnerability:	The fragility of the physical, social and economic conditions of people, which limit their ability to confront hazards.

3.3 Case Study of a Catastrophic Event -Hurricane Katrina: An Evaluation of Social Vulnerability and Community/Organizational Resilience

Laura Olson

Abstract

As used in connection with natural hazards, vulnerability includes the interrelated notions of exposure, resistance, and resilience. In other words, it indicates the human capacity for responding to loss as well as the potential for experiencing loss. Populations that combine high exposure to risk, low levels of resistance and weak resilience are most vulnerable to hazards (Mitchell, 2003).

In approaching the issue of social vulnerability and community resilience in relation to Hurricane Katrina, this article will examine conditions specific to New Orleans, Louisiana and the impact of this catastrophe at the individual and the organizational level. Throughout the world, the causes of the increased vulnerability of many populations to natural disaster situations are all too often discovered to be part of the structure of societies. In this case, poverty, geography, environmental manipulation, climate change, race, and class combined with a natural disaster and all these together became what we now refer to as Hurricane Katrina.

What began as a case study focused on the most vulnerable victims of this catastrophe and their future capacity for resilience eventually spawned an ancillary research project that is focused on organizational resilience. Thirty-three initial interviews were carried out with members of public and non-profit disaster response and recovery organizations at both national and local levels, as well as their clientele, Katrina survivors. This interview data revealed certain response patterns that became the basis of a hypothesis about the types of interventions that build collaboration and resilient civil society social structures post-disaster. An action research approach to organizational resilience was designed as a result of these preliminary findings and is currently being implemented in a large disaster response and recovery-focused non-profit in New Orleans. The purpose of this project is to create an extendable resilience-building model for Gulf Coast non-profit organizations capable of creating complex, systemic change and innovation, promoting community development, and maximizing the knowledge and skills of organizational members through a participatory process. The project is in its initial stages, but the design of this organizational change intervention, as well as the preliminary findings from qualitative interviews will be discussed in this article.

Anatomy of a Storm

In relation to the immanent landfall of Hurricane Katrina on the U.S. Gulf Coast, the National Weather Service predicted "human suffering incredible by modern standards" and warned that "most of the area will be uninhabitable for weeks... perhaps longer" (Final Report of U.S. House of Representatives, 2006). The portion of the public that was left in New Orleans on August 29, 2005, included the poor, the elderly, the infirm, and the evacuation belligerent, all of whom soon found themselves facing unimaginable conditions.

Hurricane Katrina was a hybrid disaster. The hurricane itself unleashed furious and sustained wind and rains, which stalled over Gulf Coast areas upon landfall and battered the area incessantly as the hours wore on. This tempest blighted the area with a destructive power rivalled by few tropical storms in the last century. The second part of this disaster was seen in New Orleans, Louisiana and encompassed the levee breakage that caused 80% of this city to flood as Lake Pontchartrain and the Industrial Canal emptied into residential areas. This flooding was the result of a multiplicity of human systems that failed catastrophically.

Perhaps most poignant, though, was the failure of the socio-economic system of race, class, and poverty that characterized urban New Orleans. The images of those left in New Orleans, such as the African American residents who climbed to the roofs of the submerged Lower Ninth ward and scribbled their pleas for rescue on the surface of these tiny islands are etched on our collective memory as visual representations of the misery and suffering unleashed by this catastrophe.

The Concepts of Social Vulnerability and Resilience

Social vulnerability – “Vulnerability is a basic attribute of the human contribution to disasters. It can be defined as the degree to which humans, and the things they value, are susceptible to loss when affected by extreme events. It is a joint product of exposure, inadequate protection measures and/or limited capacities to absorb and rebound from loss.” (Mitchell, 2005)

Societal structures (poverty, race and class, geography, environment, governance) can increase the exposure of certain marginalized groups and communities within a society - to the degree that their ability to react to a threat is severely hampered. These societal constraints actually serve to amplify the impact of a disaster on these groups, such that a human-caused dimension of disaster becomes unavoidably clear. As Bankoff has noted in this regard, “social systems generate unequal exposure to risk making some people more prone to disaster than others and these inequalities are largely a function of the power relations (class, age, gender and ethnicity among others) operative in every society” (Bankoff, 2005).

This research contributes to the literature on social vulnerability by examining the context of vulnerability in New Orleans and offering an extension of action research approaches for organizational resilience to catastrophic events. The action research-based resilience design that is part of this research project proposes to enhance organizational capacities for adaptation, creativity, and improvisation in New Orleans as part of a wider recovery strategy. *At Risk*, the seminal book on social vulnerability by Ben Wisner, Piers Blaikie, Terry Cannon and Ian Davis, describes action research-style participatory projects that have been specifically applied to the field of international development, as well as to disaster recovery strategies at the level of individual households and communities. “Water projects, sanitation work, reforestation, housing, grain storage design and many other efforts have benefited from participatory or ‘action research’ methods, in which outsiders and local people are equal learners and teachers.” (Wisner et al., 1994) The action research approach employed for the purposes of this research stems from the field of Organizational Behavior and Development and was developed by Neely Gardner, a Public Administration scholar working out of the University of Southern California (Gardner, 1974). The principles are the same as action research applications described in *At Risk*, in that it “begins with respect for the people concerned, and it requires their trust” (Wisner et al., 1994).

The research projects described in this article have struggled with the term resilience, due to its inherent suggestion of a return to a pre-disaster state of normalcy. The work being undertaken here makes use of this term, while at the same time finding it misleading when applied to catastrophic contexts. “The terminology associated with disaster recovery is biased towards optimism. The key words – ‘recovery’, ‘re-establish’, ‘reconstruction’, ‘restoration’, and ‘rehabilitation’ are prefixed with ‘re’, indicating a return to the pre-existing situation. A more realistic view challenges the assumption that such recovery will actually be achieved. Instead, the more pessimistic argument suggests there will be uncertainty, unforeseen events and even the reproduction of vulnerability” (Wisner et al., 1994). For the purposes of this project, resilience is defined in opposition to a return to a pre-disaster state of normalcy, as the generation of a capacity to adapt to a changed environment by continually creating new ways to cope with loss, access personal or organizational resourcefulness, and invent protections against future vulnerability.

Vulnerability in New Orleans

What were the social conditions for the residents of New Orleans like before the Hurricane Katrina? Census data for Orleans Parish in 2000 and 2004 provides some insights into race, class, educational attainment, and poverty. The city had a population of 454,863 people. Of that number:

- 67.8% were African American;
- 28.6% were Caucasian; and
- 3.2% were Hispanic.

In 2003, the median household income in New Orleans for all groups was \$27,408 and 25.5% of the population lived below the poverty line. In comparison, the official poverty rate for the entire U.S. was 12.7% (U.S. Census Data, 2004).

Amongst New Orleanians, the homeownership rate in 2000 was 46.5%, and 55.3% of all homeowners in the city were African Americans. Additional statistics for the African American population put the attainment of a high school degree at 67.4% of those 25 years of age and older, whereas the percent of whites age 25 years of age and older who were high school graduates was 89%. The median African American household income (three person household) was \$21,461 annually, whereas the median household income for whites (two person household) was \$40,049. Of the overall percentage of families living in poverty in New Orleans, 91.1% of these families were African American (U.S. Census Data, 2000). The Brookings Institution 2005 report on Hurricane Katrina also testifies to the societal conditions affecting African Americans that exacerbated the impact of this hurricane.

Racial segregation and concentrated poverty frequently coincided with each other in pre-Katrina New Orleans. No less than 84 percent of the city's poor population was black. Likewise, almost all of the extreme-poverty neighbourhoods in the city were predominately African American. Forty-three percent of poor blacks in the city of New Orleans live in census tracts with extreme poverty levels (The Brookings Institution Metropolitan Policy Program Report, 2005).

Mobility was another factor that greatly impacted the ability of inner city, elderly, disabled, and poor residents of New Orleans to decide to evacuate. This was paired with a mixed message stating that there was a mandatory evacuation of the city, which at the same time informed residents about the ability to shelter at the Louisiana Superdome, which was designated a 'refuge of last resort'. Retrospective accounts of the decision to authorize a mandatory evacuation in New Orleans make clear this should have happened much earlier.¹ The fact that the evacuation order and the opening of a major shelter took place in tandem made it seem as if riding out the storm, a New Orleans tradition, was a real possibility. Elizabeth Fussell provides insight into the factors that shaped the decisions and ability of city residents to evacuate prior to the storm.

New Orleanians plans for evacuation were strongly shaped by their income-level, age, access to information, access to private transportation, their physical mobility and health, their occupations and their social networks outside of the city. These social characteristics translated into distinct evacuation strategies for different sectors of the population... Low-income residents had fewer choices with respect to how to prepare for the imminent arrival of Katrina. Since the storm was at the end of the month and many low-income residents of New Orleans live from paycheck to paycheck, economic resources for evacuating were particularly scarce. Furthermore, low-income New Orleanians are those who are least likely to own vehicles, making voluntary evacuation more costly and logistically more difficult (Fussell, 2005).

1 The White House Report entitled, "*The Federal Response to Hurricane Katrina: Lessons Learned*", as well as the Davis Report of the U.S. House of Representatives Select Bipartisan Committee to Investigate the Preparation for and Response to Hurricane Katrina entitled "*A Failure of Initiative*" detail this point.

Social Vulnerability and Resilience post-Katrina

The forgoing background information on Hurricane Katrina lays a foundation for investigating social vulnerability and community resilience in regards to this event. With this as a starting point, two research projects are being pursued. The first is focused on social vulnerability among Hurricane Katrina survivors, the second on organizational resilience within the non-profit landscape. The purpose of these research projects is:

1. To investigate what is happening now as attempts to recover from Hurricane Katrina and rebuild Gulf Coast communities and the lives of the individuals that experienced overwhelming losses due to this event commence. This research will include a focus on the capacities needed to recover from a catastrophe of this size and scale. This investigation of resilience will include an awareness of the psycho-social effects of disaster.
2. To understand how catastrophic incidents impact human populations and societies. This research examines the degree of exposure, level of resistance, and resilience capacity of the populations that were exposed to Hurricane Katrina. The research is intended to uncover factors that have an effect on the vulnerability of populations to disaster effects and the long-term ability of communities to recover, rebuild, and reconstitute healthy societies.

Methodology / Logic of Inquiry

This research employs an interpretive methodological strategy, which demands that the researcher listen to and analyze the respective interpretations of different parties to the response and recovery efforts. This methodology allows for the fluidity and flexibility in gathering data that characterizes interpretive research. Interpretivism is reflexive, allowing that the researcher also plays a role in the construction of social reality. The interpretive framework that forms the theoretical underpinning of this study looks for the creation of consensus around an interpretation of the events that unfold. This is achieved through conversation, interaction, verbal analysis and comparison of individual interpretations of social phenomena, or “retrospective sense-making”, as Karl Weick² would refer to the process.

Summary of Preliminary Findings

Social Networks and Community Resilience

A large number of Katrina victims, both those left on the Gulf Coast and those now living far from home, have experienced the loss of kinship, friendship, and community networks. A great deal of the casework help being provided to these people concentrates on material goods and physical assets, such that the spiritual goods that are generated by bringing people together has to large extent been overlooked. For many evacuees and survivors; family, friends, neighbours, work colleagues, and familiar community fixtures have been dispersed across the country. Many Katrina victims have been completely cut off from other individuals who share their story and their cultural traditions. New networks of Katrina evacuees/survivors in strange places are the exception rather than the norm. While caseworkers have made enormous efforts to provide help to the Katrina-affected in the communities they serve, the provision of outlets for social support have suffered due to the necessary focus on the material aspects of recovery.

Hurlbert, Beggs, and Haines, who are associated with the Center for the Study of the Public Health Impacts of Hurricanes, have demonstrated the importance of social networks for the resilience and recovery of disaster victims in previous hurricane-related disasters. Their work suggests that these informal networks are fundamental to rebuilding lives. “Our research on Hurricane Andrew showed that, in the short-term recovery phase of that storm, individuals who received more social support

2 Social psychologist, author of *“The Social Psychology of Organizing”*.

experienced better physical health and lower levels of depression than individuals who received less support.” (Hurlbert, Beggs, and Haines, 2005) This research brings the issue of social networks into focus and forces questions about how the disruption of these networks will impact the resilience of Katrina victims.

Research demonstrates clearly the negative effects of hurricanes on physical and mental health. Because of the magnitude of Katrina’s disruption, both the extent and the duration of these health effects may be far greater than in other natural disasters... The extent to which Katrina’s victims can use network ties that existed before Katrina and build new network ties will both affect the negative health consequences of the storm. Drawing social support from their networks and using network ties to rebuild their lives by locating jobs, housing, and schools may mitigate these health effects. If, as research suggests, urban poor individuals prove to be disadvantaged in doing so, then the health consequences for them may be particularly severe (Hurlbert, Beggs, and Haines, 2005).

Caseworkers interviewed within the scope of this case study reported skyrocketing cases of severe depression amongst their clientele regardless of location and distinctly related to shattered social networks. They explained this upsurge in depression by recounting how initial coping mechanisms forced victims and survivors of this catastrophe to focus on meeting immediate needs. As time has passed now, the scope of the destruction of the event and the upheaval in their lives is becoming apparent, and so many people feel that they are unable to create conditions of security and resilience that will allow them to rebuild their lives successfully.

Who Is the Recovery Target Group Living Outside the Gulf Coast Region?

One of the most pressing questions about those devastated by the impact of this catastrophe is – who are the most disadvantaged in terms of their chance of recovery? The preliminary findings of this case study provide some indicators about the nature of the most vulnerable group facing a difficult recovery process post-Katrina. Due to the size and scale of this catastrophe, survivors were scattered throughout the United States and vulnerability amongst evacuees no longer residing on the Gulf Coast looks different to that of individuals that have either returned to the region or originally found relief services and relocation possibilities closer to home. It is important to note that some of the research questions central to this study have not yet been answered fully, so that upcoming field surveys will need to provide more breadth to this study.

Caseworkers and government officials identified the working poor in the Diaspora as facing the most daunting struggles in terms of recovery. This group was identified as not having been the beneficiary of government welfare assistance prior to Katrina, having managed to live at subsistence levels autonomously. Service providers and caregivers pointed to many interlinked reasons this group is currently flailing. Amongst them is an essential distrust of government, a characteristic that has made this group shy away from official agencies offering disaster assistance. Entrenched discrimination and marginalization have left this group embittered and they do not traditionally look to official sources for relief, but rather rely on themselves and extended social networks when in need. Now these households and individuals are adrift in Katrina diasporas throughout the country and the social nets they relied on have been severed. On top of this, outreach efforts that would have reached this group were too few and information on government assistance has been conflicting, confusing, and inadequate.

3 In the United States, the *Department of Housing and Urban Development* (HUD) is the entity in charge of low-income housing programs. HUD provides Section 8 housing vouchers to low-income families or individuals that amount to government funding for monthly housing fees.

If you were a HUD recipient of Sec. 8 housing assistance³, you were the poorest of the poor. This is **NOT** the target audience. These people actually know the system and their economic needs can be met. The true target group post-Katrina is the **working poor**, who have never received 'casework' help before. These people do not know where to go for help. They live a marginal lifestyle and were making ends meet before Katrina, but just barely. This is a group for whom a car breaking down that represents \$300 in repairs presents a real quandary about where to get this money. This group only had liability insurance. There is a big segment of society that does not stand in line and ask for help and thus are taken for granted. This group does not have savings, and cannot afford a lot of insurance. Caseworkers are not used to service provision for this target group (having to go and find them instead of having them come and ask for help) and are used to their day-to-day service provision routine that normally caters to the poorest of the poor. For this reason, the group that is in the greatest need of assistance has been misidentified by most case workers (*Emergency-Manager, FEMA*).

Caseworkers across the country have been seeing Katrina survivors from all income, job skill, and educational classes. Yet, as time wears on, those who are not getting back on their feet are becoming noticeable. They lack job skills that would secure them a viable standard of living. Housing vouchers have now run out and the cost of living in major urban areas throughout the U.S. is greater than what a great many evacuees were used to raising each month. In addition, current recovery programs remain focused on meeting basic economic needs and are failing to provide much needed skill/job training opportunities to those who do not have marketable skills in their new communities.

Who is the Recovery Target Group in the Greater New Orleans Area?

Disaster research points to the occurrence of differential vulnerability, and the characteristics of vulnerable groups in and around New Orleans have been identified differently by caseworkers in the immediate disaster region. Resource scarcity and the sheer number of survivors makes the situation along the Gulf Coast much different to that encountered outside the region. Whereas evacuees were often helped in their quest to find longer-term housing, low-income housing is simply unavailable in the Greater New Orleans area due to the devastation.

People call, you want to assist them, and you have nothing to offer them but a call back. Usually there isn't anything available if you make inquiry calls to other agencies. There may be some resources today, but because of the magnitude of the problem, they are gone within a week or two and so the people who call later, well sorry, there is nothing you can do to help them. For example, a woman came to me and she had 3 girls and she needed rental assistance and they were all living in a FEMA trailer with a relative of hers and the relative's children (9 people), and she had a Section 8 housing voucher. She didn't have the money for a rental deposit, though, and had found a house and needed those dollars, which is why she came asking for help. I had to tell her that the agency that had been doing rental deposits and down payment assistance had no more funds, their resources had dried up. She had left Houston when FEMA stopped paying the rent and came back home seeking assistance, hoping to find a place to live with her children. She was a single mother (*Casework Supervisor, New Orleans*).

The summary themes from initial interview sessions in New Orleans are best characterized as:

1. Exasperation due to the absence of access to vital resources;
2. Perceived inertia in the face of urgency;
3. Continuing confusion about the interventions of different governmental, non-profit, and faith-based actors;
4. Uncertainty about the meaning of collaboration;
5. Profound sadness and exhaustion; and
6. Anxiety about organizational, societal, and personal change.

One of the major realizations stemming from the analysis of this first group of data was that the non-profit community along the Gulf Coast has been severely taxed due to the disaster response and the level of unmet needs in the communities that were hard-hit by Katrina's devastation. Interviewee imparted a sense that the task that each individual was handling was too large and the size and scale of needed interventions was overwhelming. Amongst many actors there was a feeling of bitter resignation, helplessness, and personal sadness about how and why our well-developed societal infrastructure for disaster response is continuing to fail to meet needs in New Orleans.

Organizational Resilience and the Action Research Methodology

As a result of this analysis, an ancillary action research project was designed to facilitate the organizational, societal (at the level of communities), and personal change demanded by the evolving situation on the Gulf Coast. Non-profit organizations are struggling to re-build, re-make, and re-invent themselves in order to function as the backbones of community resilience and provide for unmet needs. An action research project will test an extendable resilience-building model for Gulf Coast non-profit organizations capable of creating complex, systemic change and innovation, promoting community development, and maximizing the knowledge and skills of organizational members through a participatory process.

The Action Training and Research Model guiding this project is a well-recognized method of developing highly-effective change strategies. The basis for this form of organizational intervention is the development of collaborative relationships between researchers, educators, and practitioners. This participatory approach means that people within the organization become part of the exploration of the reasons for and means of change. Participatory leadership by an outside change management team helps to set the stage for creativity, productivity, and innovation amongst the members of the group. This process is founded on the development of a deep level of trust between the intervening parties and the client organization and openness about the values and biases all parties have about individual effectiveness, the organization at hand, and the community/society at large.

Future Work

Phase I of this project has been carried out and consisted of 49 interviews with institutional actors in one large New Orleans disaster non-profit. A diagnostic retreat with organizational members was held and an agenda for organizational change was identified by participants in the process. Phase II of this process is currently being designed and will be elaborated in future work. It involves a specific consensual program to take action on the issues that organizational members designated as the focus of a change agenda. Approaches that are appropriate to each issue are currently being crafted by the action research project team. Some of the resources that will be needed to bring about the resolution of the identified issues have been identified and will be the object of Phase II continuing work. These include training on scenario and policy planning, management and executive coaching, process consulting, team-building, the development of alternative organizational cultural traits, support groups for traumatized responders, and expertise applied to resource scarcity. A second retreat is planned for the future in order to consolidate gains made by the action research project in developing a resilient community inside the organization.

References

- Bankoff, Greg. (2005): The Tale of the Three Pigs: Taking Another Look at Vulnerability in the Light of the Indian Ocean Tsunami and Hurricane Katrina. In: *[Online forum and essays] – Social Science Research Council*. <<http://understandingkatrina.ssrc.org/>>, Dec. 12, 2005.
- U.S. Census Bureau. (2000): *U.S. Census Data for New Orleans, Louisiana*. <http://factfinder.census.gov/home/saff/main.html?_lang=en>.

- Clarke, Lee. (2005): Worst Case Katrina. In: *[Online forum and essays] – Social Science Research Council*. <<http://understandingkatrina.ssrc.org/>>, Sept. 12, 2005.
- Clarke, Lee. (2005): Worst-Case Thinking: An Idea Whose Time Has Come. In: *Natural Hazards Observer*, pp. 1-3.
- Cutter, Susan L. (2005): The Geography of Social Vulnerability: Race, Class, and Catastrophe. In: *[Online forum and essays] – Social Science Research Council*. <<http://understandingkatrina.ssrc.org/>>, Sept. 23, 2005.
- Cutter, S.; Emrich, C.; Mitchell, J.; Boruff, B.; Gall, M.; Schmidtlein, M.; Burton, C.; Melton, G. (2006): The Long Road Home: Race, Class, and Recovery from Hurricane Katrina. In: *Environment*. Vol. 48, Number 2, pp. 10-20.
- U.S. House of Representatives Select Bipartisan Committee to Investigate the Preparation for and Response to Hurricane Katrina (2006): *A Failure of Initiative*. U.S. House of Representatives, Washington, D.C. <<http://katrina.house.gov/>>.
- De Waal, Alex. (2005): An Imperfect Storm: Narratives of Calamity in a Liberal-Technocratic Age. In: *[Online forum and essays] – Social Science Research Council*. <<http://understandingkatrina.ssrc.org/>>, Sept. 12, 2005.
- Dominguez, Virginia R. (2005): Seeing and Not Seeing: Complicity in Surprise. In: *[Online forum and essays] – Social Science Research Council*. <<http://understandingkatrina.ssrc.org/>>, Sept. 19, 2005.
- Dynes, R.; Rodriguez, H. (2005): Finding and Framing Katrina: The Social Construction of Disaster. In: *[Online forum and essays] – Social Science Research Council*. <<http://understandingkatrina.ssrc.org/>>, Oct. 21, 2005.
- Emanuel, K. (2005): Are There Trends in Hurricane Destruction? In: *Nature*. Vol. 438, no. 22, pp. 29.
- Enarson, Elaine (2005): Women and Girls Last? Averting the Second Post-Katrina Disaster. In: *[Online forum and essays] – Social Science Research Council*. <<http://understandingkatrina.ssrc.org/>>, Nov. 15, 2005.
- Federal Emergency Management Agency. (2006): *Recovery Support Center Daily Status Report – July 18, 2006*. FEMA, Washington, D.C.
- Frickel, Scott (2005): Our Toxic Gumbo: Recipe for a Politics of Environmental Knowledge. In: *[Online forum and essays] – Social Science Research Council*. <<http://understandingkatrina.ssrc.org/>>, Oct. 6, 2005.
- Frymer, P.; Strolovitch, D.; Warren, D. (2005): Katrina's Political Roots and Divisions: Race, Class, and Federalism in American Politics. In: *[Online forum and essays] – Social Science Research Council*. <<http://understandingkatrina.ssrc.org/>>, Sept. 28, 2005.
- Fussell, Elizabeth (2005): Leaving New Orleans: Social Stratification, Networks, and Hurricane Evacuation. In: *[Online forum and essays] – Social Science Research Council*. <<http://understandingkatrina.ssrc.org/>>, Sept. 26, 2005.
- Gardner, Neely (1974): Action Training and Research: Something Old and Something New. In: *Public Administration Review*. Vol. 34, no. 2, pp. 106-115.
- Gilman, Nils (2005): What Katrina Teaches about the Meaning of Racism. In: *[Online forum and essays] – Social Science Research Council*. <<http://understandingkatrina.ssrc.org/>>, Sept. 14, 2005.
- Graham, Stephen (2005): Cities Under Siege: Katrina and the Politics of Metropolitan America. In: *[Online forum and essays] – Social Science Research Council*. <<http://understandingkatrina.ssrc.org/>>, Sept. 12, 2005.

- Harrald, John R. (2006): Agility and Discipline: Critical Success Factors for Disaster Response. In: *The Annals of the American Academy for Political and Social Science*. vol. 604, special issue: Sheltering from the Storm: Repairing the National Emergency Management System after Hurricane Katrina.
- Hogue, H.; Bea, K. (2006): Federal Emergency Management and Homeland Security Organization: Historical Developments and Legislative Options. The Congressional Research Service, Washington, D.C.
- Hurlbert, J.; Beggs, J.; Haines, V. (2005): Bridges Over Troubled Waters: What are the Optimal Networks for Katrina's Victims? In: *[Online forum and essays] – Social Science Research Council*. <<http://understandingkatrina.ssrc.org/>>, Oct. 12, 2005.
- Jackson, Stephen (2005): Un/natural Disasters, Here and There. In: *[Online forum and essays] – Social Science Research Council*. <<http://understandingkatrina.ssrc.org/>>, Sept. 12, 2005.
- Jasper, James M. (2005): Political Floodwaters. In: *[Online forum and essays] – Social Science Research Council*. <<http://understandingkatrina.ssrc.org/>>, Oct. 11, 2005.
- Kahn, Matthew E. (2005): The Death Toll from Natural Disasters: The Role of Income, Geography and Institutions. In: *Review of Economics and Statistics*. vol.87, no. 2, pp. 271-284.
- Kaufman, Sarah (2005): Criminalization of New Orleanians in Katrina's Wake. In: *[Online forum and essays] – Social Science Research Council*. <<http://understandingkatrina.ssrc.org/>>, Oct. 18, 2005.
- Krause, Monika (2005): New Orleans: The Public Sphere of Disaster. In: *[Online forum and essays] – Social Science Research Council*. <<http://understandingkatrina.ssrc.org/>>, Sept. 21, 2005.
- Lakoff, Andrew (2005): From Disaster to Catastrophe: The Limits of Preparedness. In: *[Online forum and essays] – Social Science Research Council*. <<http://understandingkatrina.ssrc.org/>>, Sept. 30, 2005.
- Logan, John R. (2006): *The Impact of Katrina: Race and Class in Storm-damaged Neighborhoods*. Brown University, Providence. <<http://www.s4.brown.edu/Katrina/report.pdf>>
- Lukes, Steven (2005): Questions about Power: Lessons from the Louisiana Hurricane. In: *[Online forum and essays] – Social Science Research Council*. <<http://understandingkatrina.ssrc.org/>>, Oct. 3, 2005.
- Mitchell, James K. (2005): Empowering Knowledge: A Modest Proposal for a Broader Social Science Research Agenda in the Wake of Katrina. In: *[Online forum and essays] – Social Science Research Council*. <<http://understandingkatrina.ssrc.org/>>, Oct. 4, 2005.
- Molotch, Harvey (2005): Death on the Roof: Race and Bureaucratic Failure. In: *[Online forum and essays] – Social Science Research Council*. <<http://understandingkatrina.ssrc.org/>>, Sept. 20, 2005.
- Mulcahy, Matthew (2005): Hurricanes, Poverty, and Vulnerability: An Historical Perspective. In: *[Online forum and essays] – Social Science Research Council*. <<http://understandingkatrina.ssrc.org/>>, Sept. 12, 2005.
- Muro, M.; Schmer, R. (2005): *New Orleans after the Storm: Lessons from the Past, a Plan for the Future*. The Brookings Institution Metropolitan Policy Program, Washington, D.C. <http://www.brookings.edu/metro/pubs/20051012_NewOrleansES.pdf>.
- United States Government Accountability Office, GAO. (2006): *Federal Emergency Management Agency: Factors for Future Success and Issues to Consider for Organizational Placement*. GAO, Washington, D.C. <<http://www.gao.gov/new.items/d06746t.pdf>>.
- Oliver-Smith, Anthony (2005): Disasters and Forced Migration in the 21st Century. In: *[Online forum and essays] – Social Science Research Council*. <<http://understandingkatrina.ssrc.org/>>, Sept. 12, 2005.
- The Gallup Organization (2005): *American Red Cross Feedback from Katrina Evacuees*. American Red Cross, Washington, DC.

- Perrow, Charles (2005): Using Organizations: the Case of FEMA. In: *[Online forum and essays] – Social Science Research Council*. <<http://understandingkatrina.ssrc.org/>>, Oct. 26, 2005.
- Pielke Jr., R.; Agrawala, S.; Bouwer, L.; Burton, I.; Chagnon, S.; Glantz, M.; Hooke, W.; Klein, R.; Kunkel, K.; Miletti, D.; Sarewitz, D.; Thompkins, E.; Stehr, N.; von Storch, H. (2005): Clarifying the Attribution of Recent Disaster Losses: A Response to Epstein and McCarthy. In: *Bulletin of the American Meteorological Society*. pp. 1481-1483.
- Quarantelli, E. L. (2005): Catastrophes are Different from Disasters: Some Implications for Crisis Planning and Managing Drawn from Katrina. In: *[Online forum and essays] – Social Science Research Council*. <<http://understandingkatrina.ssrc.org/>>, Sept. 26, 2005.
- Scanlon, Joseph (2005): Two Cities, Two Evacuations: Some Thoughts on Moving People Out. In: *[Online forum and essays] – Social Science Research Council*. <<http://understandingkatrina.ssrc.org/>>, Sept. 12, 2005.
- Smith, Neil (2005): There's No Such Thing as a Natural Disaster. In: *[Online forum and essays] – Social Science Research Council*. <<http://understandingkatrina.ssrc.org/>>, Sept. 26, 2005.
- Sturken, Marita (2005): Weather Media and Homeland Security: Selling Preparedness in a Volatile World In: *[Online forum and essays] – Social Science Research Council*. <<http://understandingkatrina.ssrc.org/>>, Oct. 5, 2005.
- Sze, Julie (2005): Toxic Soup Redux: Why Environmental Racism and Environmental Justice Matter after Katrina. In: *[Online forum and essays] – Social Science Research Council*. <<http://understandingkatrina.ssrc.org/>>, Oct. 24, 2005.
- Tierney, Kathleen (2005): The Red Pill. In: *[Online forum and essays] – Social Science Research Council*. <<http://understandingkatrina.ssrc.org/>>, Oct. 6, 2005.
- Townsend, Frances Fragos (2006): *The Federal Response to Hurricane Katrina: Lessons Learned*. The White House, Washington, D.C.
- Wachtendorf, T.; Kendra, J. (2005): Improvising Disaster in the City of Jazz: Organizational Response to Hurricane Katrina. In: *[Online forum and essays] – Social Science Research Council*. <<http://understandingkatrina.ssrc.org/>>, Sept. 21, 2005.
- Weick, Karl E. (1969): *The Social Psychology of Organizing*. Addison-Wesley Publishing Company, Reading, Mass.
- Wisner, B.; Blaikie, P.; Cannon, T.; Davis, I. (1994): *At Risk. Natural Hazards, People's Vulnerability and Disasters*. Routledge, New York.
- Yin, Robert K. (2003): *Case Study Research: Design and Methods*. Sage Publications, Thousand Oaks, California.

Acronyms

BRGM	Bureau de Recherche Geologique et Miniere
CAN	Nacional Water Comisión (Comisión Nacional del Agua)
CDE	Centre for Development and Environment
CHS	Commission on Human Security
CNA	Comisión Nacional del Agua; National Water Commission.
COCEI	Coordinadora Obrero Campesina Estudiantil del Istmo; Union of Workers, Students and Farmers of the Isthmus
COCEO	Coordinadora de Obreros, Campesinos y Estudiantes de Oaxaca; Union of Workes, Farmers and Studens of Oxaca.
DBO5	Biochemical Demand of Oxygen (Demanda Bioquímica de Oxígeno)
ENSO	El Nino Southern Oscillation.
FD	Federal District (Distrito Federal)
GCP	Ground Control Point
GPS	Global Positioning System
INE	Nacional Ecology Institute (Instituto Nacional de Ecología)
INEGI	Instituto Nacional de Estadística, Geografía e Informática; National Institute of Stadistic and Geography
LA RED	La Red de Estudios Sociales en Prevención de Desastres en América Latina; Network of Social Studies on Disaster Prevention in Latin America.
NASA	National Aeronautics and Space Administration
PEMEX	Petroleos Mexicanos; Mexican National's Oil Company.
PSUM	Partido Socialista Unido de México; United Socialist Party of Mexico
PRI	Partido Revolucionario Institucional; Revolutionary Institutional Party.
RTF	Radar Technologies France
SACM	Mexico City Water System (Sistema de Aguas de la Ciudad de México)
SAR	Synthetic Aperture Radar
SEDESOL	Ministry of Social Development (Secretaría de Desarrollo Social)
SEMARNAT	Ministry of Environment and Natural Resources (Secretaría del Medio Ambiente y Recursos Naturales)
SES	Socio-ecological system
SRTM	Shuttle Radar Topographic Mission
UNHCR	United Nations High Commissioner for Refugees
UNICEF	United Nations Children's Fund
UNITAR	United Nations Institute for Training and Research
UNOCHA	United Nations Office for the Coordination of Humanitarian Affairs
UNOPS	United Nations Office for Project Services
UNOSAT	UNITAR Operational Satellite Applications Programme
USGS	United States Geological Survey

Index

A

abeyance 75
absorptive capacity 63
accumulated garbage 89
adaptation 2, 22, 28, 50, 56, 57, 58, 59, 63, 71, 75, 116
adaptive capacity 54, 70
alerts 78
analysis of systems 63
Andean valleys 64
anthropology 2, 3, 8, 48, 62, 70
aquifer system 64
At Risk 8, 16, 21, 26, 33, 36, 39, 51, 70, 75, 82, 103, 112, 116, 124
atmospheric circulation 86
authorities 25, 72, 73, 77, 78, 81, 85, 86, 89, 95, 103, 104, 105, 108, 109, 110, 111, 112
authority 25, 51
ayllu systems 69

B

Big Easy 13, 72

C

capabilities 19, 30, 54, 56, 70
capacity 16, 20, 26, 31, 32, 38, 41, 47, 52, 54, 62, 63, 69, 70, 78, 82, 88, 89, 100, 105, 107, 110, 114, 115, 116, 118
casework 120
catastrophe 48, 115, 116, 118, 119, 122, 123
catastrophes 14, 124
Center for the Study of the Public 118
cities 4, 51, 59, 64, 71, 74, 78, 85, 87, 89, 90, 103, 104, 110, 122, 124
City of Savannah 40, 41, 42, 43, 44, 46
clientelism 84, 88
climate change 2, 9, 16, 21, 22, 28, 33, 53, 57, 58, 59, 73, 96, 115
climate changes 70
climatic conditions 89
climatic events 84
Coastal erosion 18
coastal hazards 16
Cochabamba 13, 62, 64, 65, 66, 69, 71

cohesion 73, 82, 88
coincidental 44, 75
community 8, 13, 20, 27, 38, 41, 52, 64, 65, 66, 68, 69, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 104, 115, 118, 121
competition 55, 56, 68, 69
constraints 56, 57, 73, 116
coping 8, 14, 16, 18, 26, 47, 54, 56, 57, 63, 68, 114, 119
coping strategies 16, 68
coterminous 75
coupling 31
crises 9, 71, 90
crisis 4, 22, 28, 29, 34, 45, 50, 51, 58, 71, 73, 94, 95, 101, 124
cultural 3, 8, 9, 10, 14, 19, 26, 36, 37, 38, 39, 40, 44, 46, 47, 48, 56, 72, 73, 74, 78, 81, 84, 118, 121
cultural communities 37
cultural factors 10, 72, 73

D

damage 25, 28, 42, 84, 87, 100, 104
dangers 32, 74, 79, 113
decision makers 9, 37, 39, 103, 106, 108
decision-makers 24, 25
demographic 9, 90
demographic groups 9
Dengue 52, 53, 58
desertification 64
desirability 63
destruction 73, 119, 122
devastating 25, 52, 72, 73
Diarrhoeal diseases 53
Disaster Prevention 22, 85, 125
disaster recovery 14, 22, 73, 116
disasters 2, 8, 9, 11, 13, 14, 15, 18, 21, 22, 24, 25, 26, 30, 32, 33, 34, 35, 36, 37, 44, 45, 47, 48, 62, 63, 71, 73, 74, 84, 85, 87, 90, 91, 103, 104, 105, 112, 116, 118, 119, 123, 124
disease 15, 16, 28, 50, 52, 53, 59, 95
diseases 17, 50, 52, 53, 58, 111
distribution of drinking water 104, 110, 111
drainage 18, 45, 46, 51, 89, 98, 107, 109, 110, 111
drought 8, 16, 52, 74
dwelling 36, 37, 38, 40, 46, 47, 75

E

Ecological Stability 31, 34
economic 2, 8, 9, 14, 15, 16, 17, 18, 20, 21, 22, 27, 34, 37, 38, 43, 44, 47, 48, 50, 51, 53, 54, 56, 62, 64, 69, 71, 72, 73, 74, 75, 78, 79, 86, 96, 103, 104, 105, 106, 107, 110, 111, 112, 114, 116, 117, 120
economic restructuring 64
ecosystems 64, 71, 82, 111
efficacy 69, 100
emergence 54, 90
empirical analysis 24, 29
engineering 8, 16, 35
environment 2, 8, 9, 16, 17, 20, 22, 24, 26, 27, 28, 30, 34, 35, 37, 38, 39, 44, 46, 47, 49, 53, 57, 58, 70, 71, 84, 96, 101, 104, 108, 113, 116, 122, 125
environmental 2, 3, 4, 8, 10, 14, 15, 16, 17, 19, 21, 26, 30, 33, 35, 37, 38, 39, 40, 42, 45, 46, 50, 51, 53, 54, 57, 58, 59, 62, 63, 70, 71, 84, 104, 111, 112, 114, 115, 122, 124
environmental degradation 15, 16, 17
environmental scarcities 63
Evacuation 13, 72, 73, 77, 78, 79, 80, 81, 82, 115, 117
evidence 39, 48, 63, 68, 82, 100, 108, 112
exaggeration 24, 74
Expectations 25, 36, 38, 39, 42, 46, 47
Exposure 13, 18, 46, 47, 51, 52, 53, 54, 63, 75, 81, 103, 104, 105, 109, 110, 111, 112, 114, 115, 116, 118

F

factors 8, 9, 10, 13, 15, 16, 18, 37, 41, 43, 50, 51, 52, 53, 57, 61, 65, 72, 73, 74, 75, 78, 84, 106, 112, 117, 118, 123
famines 59, 63, 71
feasibility 59, 69
field 2, 4, 9, 14, 18, 20, 28, 40, 44, 45, 53, 54, 55, 56, 58, 62, 63, 66, 88, 94, 101, 116, 119
flood 8, 10, 16, 25, 28, 30, 33, 34, 40, 41, 42, 43, 44, 45, 46, 47, 53, 74, 82, 89, 99, 100, 115
flood protection 25, 28, 30
flooding 16, 40, 41, 42, 43, 44, 46, 52, 80, 115
fragmentation 51, 87
framework 10, 17, 22, 39, 49, 50, 53, 54, 56, 59, 62, 63, 64, 69, 70, 71, 118
frameworks 10, 13, 14, 16, 17, 20, 23

G

gender 8, 17, 18, 19, 21, 22, 75, 77, 82, 116
Geographical Systems 105
geography 2, 3, 8, 22, 32, 33, 34, 35, 57, 58, 59, 113, 115, 116, 122, 123, 125
geologic risks 86
geospatial 3, 10, 94, 95, 97, 100, 101
geostrategic position 84, 85
global 3, 8, 21, 24, 27, 32, 33, 35, 48, 50, 57, 58, 59, 64, 70, 71, 83, 91, 95, 103, 113, 125
Global Positioning System 95, 125
globalization 34, 71, 73
governmental actions 105
groundwater 64, 65, 95, 101
Gulf Coast 115, 118, 119, 120, 121

H

Habitus 56, 58
hazard research 24, 25, 26, 30, 35, 53
hazards 9, 16, 17, 18, 21, 24, 25, 26, 29, 30, 31, 32, 33, 35, 36, 37, 38, 46, 47, 53, 62, 63, 70, 74, 75, 81, 82, 84, 105, 107, 108, 112, 114, 115, 122, 124
health 10, 13, 17, 18, 19, 21, 50, 51, 52, 53, 55, 56, 57, 58, 59, 78, 82, 107, 110, 111, 112, 117, 118, 119
hindrances 73
Hispanic Community 13, 72, 73, 74, 75, 77, 78, 81
households 40, 51, 54, 62, 64, 65, 66, 67, 69, 71, 107, 109, 116
human 2, 3, 8, 9, 10, 14, 15, 16, 17, 21, 22, 24, 25, 28, 33, 34, 35, 37, 38, 39, 42, 47, 48, 49, 50, 51, 52, 53, 54, 56, 57, 58, 59, 62, 64, 65, 67, 70, 71, 72, 73, 74, 83, 103, 109, 110, 113, 114, 115, 116, 118
Human Dimensions 39, 70, 71
humanitarian 3, 21, 94, 95, 96, 97, 99, 101, 102, 125
humidity 86
hurricane fatigue 72
Hurricane Katrina 10, 13, 42, 48, 72, 73, 75, 83, 115, 117, 118, 121, 122, 123, 124
hurricane roulette 72
hurricanes 16, 18, 41, 44, 82, 84, 86, 87, 118, 119, 123
hybrid systems 63
hydraulic 103, 104, 105, 107, 109, 110, 111, 112
hydrological exploration methods 100
hydrology 8, 101, 102

- I**
- ignorance 2, 24, 27, 28, 29, 30, 31, 32, 34, 35, 36
 - immigrants 10, 72, 73, 74, 75, 76, 78, 82
 - impact 16, 18, 26, 41, 42, 44, 46, 53, 58, 68, 70, 73, 87, 91, 97, 105, 111, 115, 116, 117, 118, 119, 123
 - implications 20, 25, 28, 35, 69, 99, 102, 124
 - inability 9, 14, 40, 66, 69
 - independent variables 66, 67
 - Inefficiencies 13, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112
 - information 9, 18, 20, 27, 28, 30, 31, 36, 37, 39, 40, 45, 46, 51, 56, 72, 73, 74, 75, 77, 78, 79, 80, 81, 85, 95, 96, 101, 102, 105, 107, 113, 118, 119
 - infrastructure 51, 59, 64, 65, 74, 85, 95, 99, 104, 105, 107, 109, 110, 111, 112
 - Integrated Water Resources Management 103
 - integrative analysis 63
 - interpretational sovereignty 31
 - interventions 11, 115, 120, 121
 - invasions 84
 - Irrigation System 88
- K**
- knowledge 2, 8, 9, 10, 11, 13, 14, 16, 20, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 42, 44, 45, 47, 48, 103, 105, 112, 115, 121, 122, 123
 - knowledge society 24
- L**
- LA RED project 85
 - landfall 78, 79, 80, 81, 115
 - life world 29, 30
 - livelihoods 17, 19, 21, 22, 58
 - llapas 68
 - losses 16, 22, 25, 98, 103, 104, 110, 114, 118, 124
- M**
- maladaptation 31
 - maladaptive 36, 39, 43, 47
 - malaria 52, 53, 57
 - marginalization 72, 73, 119
 - market 10, 43, 62, 63, 64, 65, 66, 67, 68, 69, 70
 - memory 10, 36, 38, 40, 41, 42, 43, 44, 45, 47, 48, 82, 116
 - meta-knowledge 27, 31
 - Mexico City 3, 4, 13, 22, 103, 104, 105, 106, 108, 109, 110, 111, 112, 125
 - migrants 51, 64, 65
 - migration 2, 8, 16, 27, 45, 53, 73, 123
 - mitigation 2, 40, 41, 42, 43, 44, 45, 83
 - monitoring 2, 38, 40, 42, 45, 46, 47, 111, 112
 - monsoonal climate 51
 - multiple stressors 9, 10, 14, 15, 19
- N**
- natural hazard 24, 25, 26, 35, 72, 74
 - natural hazards 16, 17, 18, 21, 24, 25, 26, 30, 31, 33, 35, 62, 70, 74, 112, 115, 122, 124
 - natural threat 72
 - natural threats 10, 72, 73
 - nature 2, 28, 31, 32, 34, 42, 87, 88, 98, 119, 122
 - networks 3, 8, 14, 22, 30, 31, 36, 38, 40, 44, 47, 55, 63, 73, 77, 78, 117, 118, 119, 122, 123
 - New Orleans 10, 13, 16, 42, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 115, 116, 117, 120, 121, 122, 123
- O**
- oligopoly 65
 - outcome variables 67
- P**
- PAR model 84
 - paternalism 88
 - perspectives 5, 8, 13, 14, 24, 32, 48, 59
 - perturbation 68, 114
 - Phenomenon 41, 54, 56, 72, 82, 84, 86, 104, 110
 - political ecology 54, 62, 70, 84
 - political factors 84
 - political militancy 84, 88, 89
 - political system 29, 85
 - pollution 52, 88, 103, 111
 - poverty 8, 9, 14, 15, 21, 22, 26, 35, 38, 50, 53, 59, 63, 64, 71, 75, 88, 107, 115, 116, 117, 123
 - practice 6, 10, 26, 43, 56
 - presentism 37, 49
 - protection 16, 21, 25, 28, 30, 72, 73, 116
 - public 4, 9, 16, 18, 20, 25, 35, 40, 41, 42, 45, 46, 47, 48, 51, 59, 71, 73, 78, 81, 89, 90, 95, 107, 109, 110, 111, 115, 116, 118, 122, 123
 - public policy 25, 35
 - public understanding 9, 20

Q

quality 15, 17, 19, 39, 50, 51, 52, 59, 63, 64, 65, 95, 98, 99, 100, 104, 105, 107, 109, 110, 111, 112
quantitative data 64, 67
quantity 51, 67, 109, 110, 111

R

rainwater 65, 67, 68
reflexive modernization 27, 28, 31
refugee 10, 13, 94, 95, 96, 97, 99, 100
repartitions 84
research 1, 2, 3, 4, 6, 8, 9, 10, 13, 14, 15, 16, 18, 19, 20, 22, 24, 25, 26, 27, 28, 30, 32, 33, 34, 35, 36, 37, 39, 40, 46, 47, 48, 50, 53, 54, 56, 57, 58, 59, 62, 63, 66, 70, 71, 73, 74, 105, 108, 115, 116, 118, 119, 120, 121, 122, 123, 124, 125
resilience 8, 10, 13, 14, 16, 18, 22, 31, 34, 39, 47, 62, 63, 64, 66, 67, 68, 69, 70, 71, 72, 73, 75, 82, 114, 115, 116, 118, 119, 121
resource 9, 20, 22, 24, 25, 26, 35, 52, 56, 63, 66, 103, 120, 121
resource acquisition 63, 66
risk 2, 3, 4, 8, 10, 13, 14, 15, 16, 17, 19, 20, 21, 22, 24, 25, 26, 27, 28, 29, 33, 34, 35, 36, 38, 39, 41, 42, 49, 50, 51, 52, 53, 54, 55, 58, 70, 74, 75, 78, 81, 82, 83, 84, 85, 87, 90, 101, 103, 104, 105, 108, 109, 110, 111, 112, 113, 114, 115, 116, 124
risk exposure 13, 54, 103, 104, 105
Risk Perception 16, 39, 104, 108, 110
river basins 87
robustness 13, 62, 63, 64, 66, 67, 68, 69, 70, 71

S

sanitation 8, 57, 59, 71, 94, 103, 113
scarcity 3, 9, 10, 13, 15, 17, 50, 51, 52, 62, 64, 65, 66, 67, 68, 69, 70, 71, 94, 120, 121
science 2, 3, 4, 6, 8, 9, 18, 19, 20, 21, 22, 24, 25, 28, 29, 33, 34, 48, 49, 53, 54, 58, 59, 62, 63, 71, 82, 102, 113, 121, 122, 123, 124
security 2, 8, 9, 16, 17, 21, 27, 40, 48, 49, 50, 56, 57, 59, 70, 72, 73, 78, 79, 82, 95, 105, 107, 110, 119, 123, 124
sensitivity 54, 97
shocks 2, 9, 10, 14, 15, 16, 17, 18, 62, 63
Shuttle Radar Topographic Mission 95, 125
social 2, 3, 5, 6, 8, 9, 10, 11, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 24, 26, 27, 28, 29, 30, 31, 33, 34, 36, 37,

38, 47, 48, 50, 51, 53, 54
social aspects 87
Social Capital 10, 13, 22, 72, 82
social memory 10, 82
social networks 3, 14, 30, 73, 77, 78, 117, 118, 119
social systems 10, 16, 20, 22, 48, 62, 64, 81, 82, 116
social vulnerability 2, 5, 6, 8, 9, 10, 11, 13, 14, 15, 16, 17, 18, 19, 20, 21, 33, 36, 37, 50, 53, 54, 55, 56, 57, 62, 63, 64, 70, 72, 73, 74, 75, 81, 84, 103, 105, 114, 115, 116, 118, 122
societal mechanisms 84
societal strata 31
society 9, 10, 11, 14, 15, 16, 18, 20, 22, 24, 25, 26, 27, 28, 33, 34, 43, 48, 55, 63, 66, 70, 73, 74, 75, 84, 85, 87, 91, 112, 113, 114, 115, 116, 120, 121, 124
socio-ecological systems 62, 70, 71
socioeconomic group 78
sociology 2, 8, 21, 22, 33, 34, 57
solidarity 10, 72, 81, 82
storm 18, 42, 43, 44, 45, 46, 72, 115, 117, 118, 119, 122, 123
storm surge 42, 43, 44
stressors 9, 10, 14, 15, 16, 18, 19, 52, 54, 56, 62, 63, 114
Subsidies 69
superiority 25
surprise 36, 37, 38, 39, 40, 41, 43, 44, 46, 47, 48, 82, 122
sustainability 3, 8, 17, 20, 21, 49, 59, 69, 70, 71
sustainable development 15, 16, 17, 18, 22, 95
Synthetic Aperture Radar 95, 96, 125
systemic condition 75

T

tapstand system 65, 66, 68, 69
Tehuantepec, Mexico 13, 84
temporal knowledge 37, 39
temporality 36, 37, 38, 39, 41, 46, 47, 48
threat 14, 17, 43, 44, 65, 72, 116

U

unawareness 44
undesirability 63
urban 2, 3, 4, 10, 13, 18, 50, 51, 52, 58, 62, 64, 65, 69, 70, 71, 84, 88, 89, 90, 104, 110, 116, 119, 120
urban growth 64
urban water scarcity 10, 13, 62, 64, 69, 70, 71

urbanisation 50

urbanization 53, 59, 84, 87, 89

V

Villa Israel 62, 65, 66, 67, 68, 69, 70

violence 17, 18, 58

vulnerability 2, 5, 6, 8, 9, 10, 11, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 24, 25, 26, 27, 28, 29, 32, 33, 34, 35, 36, 37

W

wadi 94, 97, 98, 99, 100, 101

Wadi Dalal 94, 97, 98, 99, 100, 101

water 3, 8, 9, 10, 13, 15, 17, 18, 42, 47, 50, 51, 52, 53, 55, 56, 57, 58, 59, 62, 64, 65, 66, 67, 68

water acquisition 62, 64, 66

water availability 8, 51, 52

water complex 50

water contamination 52

water distribution systems 62, 64, 66, 69

water management 10, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113

water potential 13, 94, 95, 96, 97, 100, 101

water resources 10, 52, 53, 64, 69, 70, 101, 103

water stress 50, 51, 52, 53

Water World Commission 103

water-related risks 9, 57, 105

SOURCE

ISSN: 1816-1154

- No. 1/2005** *Threats, Challenges, Vulnerabilities and Risks in Environmental and Human Security*, by Hans Günter Brauch, September 2005. ISBN: 3-9810200-4-9 (printed version); ISBN: 3-9810200-5-7 (electronic version)
- No. 2/2006** *Components of Risk. A Comparative Glossary*, by Katharina Thywissen, March 2006. ISBN: 3-9810582-0-8 (printed version); ISBN: 3-9810582-1-6 (electronic version)
- No. 3/2006** *International Environmental Governance. Issues, Achievements and Perspectives*, by Andreas Rechkemmer, June 2006. ISBN: 3-9810582-2-4 (printed version); ISBN: 3-9810582-3-2 (electronic version) 1. edition, 2000 copies
- No. 4/2006** *Vulnerability: A Conceptual and Methodological Review*, by Juan Carlos Villagrán de León, August 2006. ISBN: 3-9810582-4-0 (printed version); ISBN: 3-9810582-5-9 (electronic version) 1. edition, 2000 copies; August 2006
- No. 5/2006** *Measuring the Un-Measurable. The Challenge of Vulnerability*. by Joern Birkmann & Ben Wisner ISBN: 3-9810582-6-7 (printed version); ISBN: 3-9810582-7-5 (electronic version) 1. edition, 1000 copies; October 2006
- No. 6/2007** *Perspectives on Social Vulnerability*. Edited by Koko Warner ISBN: 978-3-939923-00-8 (printed version); ISBN: 978-3-939923-01-5 (electronic version) 1. edition, 1000 copies; February 2007

"SOURCE" series is distributed free of charge.

Please address orders and inquiries by fax and email only.

UNU-EHS Publications

Fax: ++49 (0)228 815-0299

E-Mail: info@ehs.unu.edu

roberts@ehs.unu.edu

UNITED NATIONS UNIVERSITY
Institute for Environment
and Human Security
(UNU-EHS)

UNU-EHS reflects the overall mission of UNU: 'Advancing Knowledge for Human Security and Development'. UNU-EHS explores threats to human security from environmental degradation, unsustainable land use practices, and from natural and man-made hazards. The Institute spearheads UNU's research and capacity building activities in the broad interdisciplinary field of 'risk and vulnerability'.

Within this framework UNU-EHS aims to:

- **Foster better understanding of forces and processes of environmental degradations and their influence on hazard magnitude and frequency and subsequent disasters;**
- **Explore links between different hazard events as well as creeping processes such as climate change, soil erosion and their impact on the inherent risk and vulnerability;**
- **Contribute to development, testing and verification of vulnerability indicators, and investigate relationships between risks, vulnerability and coping capacity.**

Its activities focus on:

- **Generating knowledge;**
- **Building capacity, with focus on young professionals and institutions in developing countries;**
- **Disseminating knowledge to decision makers.**



UNITED NATIONS UNIVERSITY
Institute for Environment and Human Security (UNU-EHS)
UN Campus
Hermann-Ehlers-Str. 10
D - 53113 Bonn, Germany

Tel: ++ 49 (0) 228 815-0202
Fax: ++ 49 (0) 228 815-0299
E-Mail: info@ehs.unu.edu
Website: www.ehs.unu.edu