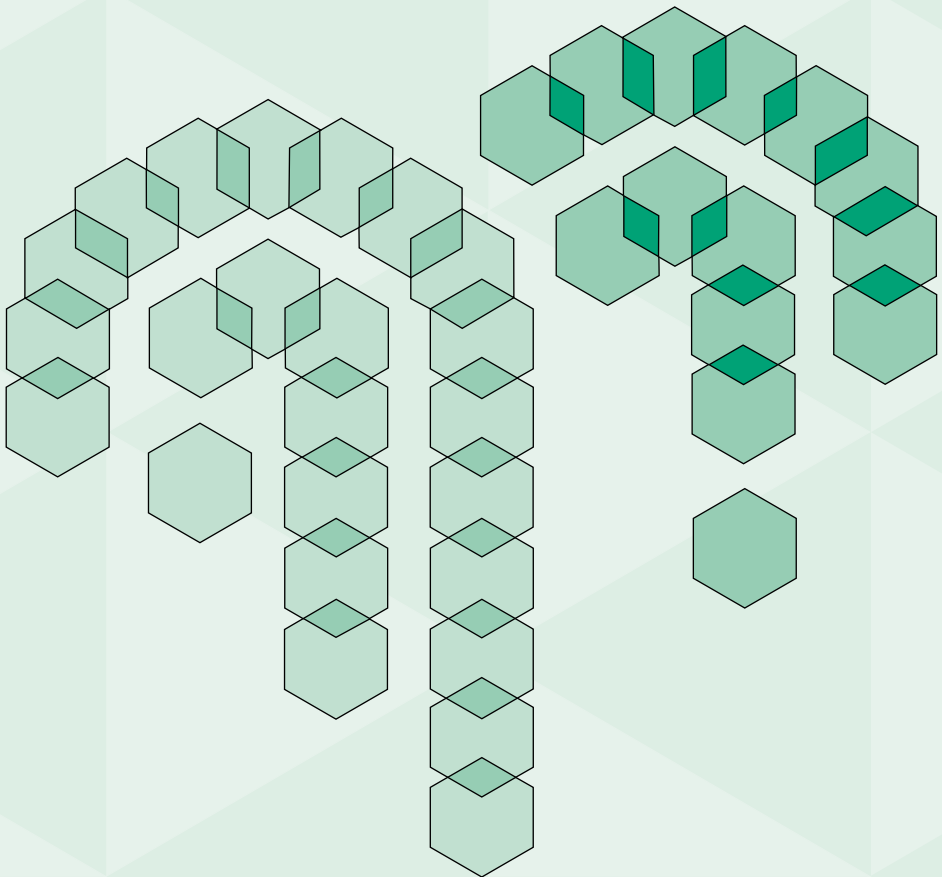
UNITED NATIONS UNIVERSITY
UNU-EHS
Institute for Environment and Human Security

Munich Re Foundation
From Knowledge to Action

# Tipping Points in Humanitarian Crisis: From Hot Spots to Hot Systems

Edited by
Xiaomeng Shen, Thomas E. Downing and Mohamed Hamza



**SOURCE**

'**S**tudies **O**f the **U**niversity: **R**esearch, **C**ounsel, **E**ducation' - Publication Series of UNU-EHS

No.13/2010

**SOURCE**

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

Publication Series of UNU-EHS

No. 13/2010

*United Nations University*
*Institute for Environment and Human Security (UNU-EHS)*

*UN Campus*
*Hermann-Ehlers-Str. 10*
*D-53113 Bonn, Germany*
*Tel.: +49 (0) 228 815-0200*
*Fax: +49 (0) 228 815-0299*
*E-Mail: info@ehs.unu.edu*


*Cover design by Gerd Zschäbitz*
*Layout: Andrea Wendeler*

*Printed at Druckerei Paffenholz, Bornheim, Germany*
*July 2010, 1000 print run*



*ISBN: 978-3-939923-36-7*
*e-ISBN: 978-3-939923-37-4*

*ISSN: 1816-1154*

## About the Editors

*Dr Xiaomeng Shen*

**Dr Xiaomeng Shen** serves as an Associate Academic Officer in the Environmental Migration, Social Vulnerability and Adaptation Section at the United Nations University Institute for Environment and Human Security (UNU-EHS). She is the project manager of the Munich Re Foundation (MRF) funded Chair Project on Social Vulnerability which initiates policy relevant research and capacity-building in the respective area. She is also the focal point for cultural and social dimensions of social vulnerability, comparative risk perception and culture-sensitive bottom-up approaches to enhance risk management and social resilience especially in developing countries. She earned her PhD in Geography at the University of Bonn, Germany. Her current research focuses on disaster risk management in different cultural settings, institutional vulnerabilities and environmentally induced migration.

*Prof. Thomas E. Downing*

**Prof. Thomas E. Downing** is a Munich Re Foundation Chair on Social Vulnerability at UNU-EHS and the Executive Director of the Oxford centre of the Stockholm Environment Institute (SEI) and coordinates the SEI Risk, Livelihoods and Vulnerability Programme. He is the director of the Centres for Climate Adaptation, a new collaborating programme with the UN Environment Programme (UNEP) (and other agencies). He also holds visiting positions with UNU-EHS, York University and Oxford University's School of Geography and Environment and Queen Elisabeth House. He was formerly Reader in Climate Policy in the Environmental Change Institute of the University of Oxford and director and science advisor to the UK Climate Impacts Programme. His first post-doctoral fellowship was with the National Center for Atmospheric Research in Boulder, Colorado. He has been a long-standing fellow of the Royal Geographical Society and was recently elected a fellow of the Royal Society for the encouragement of Arts, Manufactures & Commerce (RSA). His major interests are vulnerability and adaptation to climate change and climatic hazards, with an emphasis on actor-oriented and participatory methods. He has published over 100 papers, books, reports and book reviews, including in 2006 the Atlas of Climate Change (with Kirstin Dow). Recent projects include agent-based simulation modelling in support of integrated water management in Europe (FIRMA, NeWater), adaptation of livelihoods in southern African to multiple stresses, using seasonal climate forecasts (CLOUD) and local institutions (CAVES), and an open access platform for vulnerability and adaptation to climatic hazards and climate change (wikiADAPT).

*Prof. Mohamed Hamza*

**Mohamed Hamza** is Professor of Disaster Risk Management and Vulnerability Studies at Lund University, Sweden and The Centre for Emergency and Development Practice (CENDEP), Oxford Brookes University, UK. His primary areas of professional expertise and research work are: disaster risk and vulnerability reduction, post-disaster reconstruction and recovery, shelter in disasters, climate change impact and adaptation, environment and migration, urbanization and urban risk, capacity development and training and facilitation. Prof. Hamza is a Senior Research Fellow at the SEI and Munich Re Foundation Chair of Social Vulnerability at UNU-EHS. Professionally, Prof. Hamza is a Senior Advisor to the Swedish Civil Contingency Agency (MSB), and to UNDP, the Bureau for Crisis Prevention and Recovery (BCPR) and the United Nations International Strategy for Disaster Reduction (UN/ISDR). He has long experience with international development organizations – World Bank, UNDP, UN/ISDR, United States Agency for International Development (USAID), UK Department for International Development (DFID), International Federation of Red Cross (IFRC), Sida, ActionAid, Swedish Red Cross,

MSB and the Near East Foundation, and undertook consultancies in Afghanistan, Bangladesh, Egypt, Eritrea, India, Indonesia, Jordan, Liberia, Nigeria, Pakistan, Saudi Arabia, Sierra Leone, Sri Lanka and Sudan

## About the Authors

**James Morrissey** completed his undergraduate degree in Ocean and Atmosphere Science with an Honours degree in Environmental and Geographical Science at the University of Cape Town (UCT). He subsequently worked for the Disaster Mitigation for Sustainable Livelihoods Programme at UCT before living in Mozambique and working on a large dam proposed for the Zambezi River. He then went on to complete his Masters Degree in Development Studies at Oxford University where he is currently undertaking his DPhil (PhD). His doctoral thesis is entitled "A comparative political ecology of migration in highland Ethiopia". The work attempts to politicize the debate on "environmental refugees" by explicitly incorporating a political economy analysis into an assessment of ecologically motivated migrations.

*James Morrissey*

**Ali Asjad Naqvi** is currently a candidate for PhD in Economics at the New School for Social Research (New York). His primary research interest includes analysing the impact of natural disasters on regional economies using agent-based models. More specifically understanding, simulating and identifying the critical thresholds beyond which a regional economic system becomes unstable and thus requires interventionist policies to stabilize it are especially in focus.

*Ali Asjad Naqvi*

**Maureen Biermann** is a PhD candidate in the Department of Geography at the Pennsylvania State University, USA. Her research interests include climate change adaptation, local institutions, East Africa and participatory methodologies. She is currently a research assistant for a project on anticipatory learning, climate change adaptation and resilience.

*Maureen Biermann*

*Vivek Prasad*

**Vivek Prasad** is a PhD candidate in the Environmental Science and Public Policy Program at George Mason University VA, USA. He has worked in the Environmental and Development issues for more than seven years in India. His work ranges from grass-root environmental activism to providing consultancy in the community-based natural resource management. His current research focuses on understanding human dimensions of climate change, primarily aiming to assess climate change vulnerability and adaptations strategies leading to policy recommendations. Additionally, he is looking at the strategies to integrate climate change issues with community development. He has been conducting his field research in Jharkhand state of India. He has also been engaged in teaching undergraduate courses, such as human dimensions of climate change, quantitative techniques in research and introductory environmental science. Currently he is working with the Social Dimensions of Climate Change team in The World Bank D.C.

*Kanako Iuchi*

**Kanako Iuchi** is a PhD candidate at the University of Illinois, USA, at Urbana-Champaign in the Department of Urban and Regional Planning. Her PhD research aims to understand key planning decisions and processes that would lead to better resettlement of disaster-affected communities. For that purpose, Chuetsu Region, Niigata, Japan, where a devastating earthquake occurred in 2004 and depopulation continues to be the trend, is selected for in-depth study. From her working experience in the international development sector for a decade, she is keenly interested in having policies and planning that better influence community resilience, particularly for disadvantaged areas. She earned her Master of Regional Planning (MRP) degree from Cornell University and BSc degree from Tsukuba University, Japan.

*Cilli Sobiech*

**Cilli Sobiech** is a PhD candidate in the Department Human Dimension of Coastal Areas at GKSS Research Centre Geesthacht, Germany. Her thesis deals with multi-agent simulation, social distribution of risk, storm surges and climate change. She holds a diploma in Geography from Leibniz University Hannover, Germany. As a student assistant she contributed to the BMBF-funded research project KRIM *(*Climate Change and Preventive Risk and Coastal Protection Management on the German North Sea Coast) at the Franzius-Institute for Hydraulic, Waterways and Coastal Engineering, Leibniz University Hannover. In Latin America she worked on community-based prevention strategies in urban and rural areas as well as on regional environmental management in close collaboration with GTZ/El Salvador and the Water Resources Department at the University of Concepción/Chile. As a member of the Federal Agency for Technical Relief (THW) she also contributes to the implementation of disaster management in Hamburg, Germany.

**Matthias Garschagen** is a Research Associate at UNU-EHS and a PhD candidate at the Department of Geography at the University of Cologne, Germany. He is working within the German-Vietnamese WISDOM project (Water-related Information System for the Sustainable Development of the Mekong Delta). His specific research focus lies on urban vulnerability, coping and adaptation with respect to water-related hazards and climate change in Can Tho, Mekong Delta, and on related coupling processes between Can Tho and its peri-urban and rural hinterland. Matthias studied Geography, Anthropology and Economics at the University of Cologne and at the Simon Fraser University in Vancouver, Canada.

*Matthias Garschagen*

**Stacy Lynn** is a PhD candidate in the Graduate Degree Program in Ecology at the Colorado State University (CSU), based at CSU's Natural Resource Ecology Laboratory. Stacy also works as a Program Coordinator at Colorado State University's Center for Collaborative Conservation. Her PhD research explores the implications of increasing cultivation by Maasai livestock herders for both Maasai livelihoods and migratory wildlife in Simanjiro, Tanzania. Stacy also received her MSc in Rangeland Ecosystem Science at CSU studying Conservation Policy and Human Welfare in Ngorongoro Conservation Area and Loliondo Game Controlled Area, Tanzania. Her research interests are focused on finding balance between conservation and livelihoods in arid and semi-arid lands in Africa through multi-disciplinary approaches and community-based collaborative processes.

*Stacy Lynn*

**Georgina Drew** is a PhD candidate in the Department of Anthropology at the University of North Carolina, Chapel Hill. She holds M.A. degrees in Anthropology and International Relations. Her research interests include human-nature relations, gendered ecologies, development and the socio-cultural dimensions of climate change. Since 2001, she has worked with numerous international organizations on water sustainability and the political ecologies of natural resource management. Her dissertation research addresses climate change and development along the primary tributary of the Ganges River with a focus on women's responses to environmental challenges in the Indian Himalayas.

*Georgina Drew*

## Acknowledgements

Thomas E. Downing and Mohamed Hamza shaped the programme for the 2009 Summer Academy, and the other MRF Chairs on Social Vulnerability – Hans Georg Bohle, Susan Cutter, Anthony Oliver-Smith and Ursula Oswald Spring – helped participants accomplish one of the main outcomes of the Academy: a shared viewpoint on Tipping Points in Humanitarian Crises (the first paper in this collection). We thank Glenn Dolcemascolo from the UN/ISDR for his special mentoring role during the academy.

The partnership with the MRF 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. We appreciate the collaboration of MRF in preparing and executing the Summer Academy. Christian Barthelt strongly supported organizational and logistical arrangements for the Academy, not least working with Xiaomeng Shen to produce a provocative newsletter mid-way through!

We are deeply grateful to Janos J. Bogardi, former Director of UNU-EHS and former Vice-Rector a. i. in Europe, and Thomas Loster, Chairman of MRF, for their vision and leadership in bringing together three "generations" of scientists to push the frontiers of research and practice. Their personal involvement breathed vigour and momentum into a creative process and represents a lasting contribution to applied science. We also thank SEI and the Swedish International Development Cooperation Agency (Sida) for their support of the Transformations in Risk project.

Additionally, we must thank the people behind the report production: Therese Rosenfeld for her assistance with copy-editing, and the peer reviewers for their critiques of individual papers. And even more so, the fantastic group of participants who challenged orthodoxy and our own preconceived notions to produce an enjoyable week in Hohenkammer and this benchmark report!

# *Tipping Points in Humanitarian Crisis: From Hot Spots to Hot Systems*

*Edited by*
*Xiaomeng Shen, Thomas E. Downing*
*and Mohamed Hamza*

*Outcomes of the 4th UNU-EHS*
*Summer Academy of the*
*Munich Re Foundation Chair*
*on Social Vulnerability*

*26 July – 1 August 2009*
*in Hohenkammer, Germany*

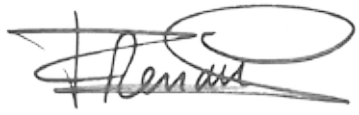
## Foreword

This SOURCE issue, entitled "Tipping Points in Humanitarian Crisis: From Hot Spots to Hot Systems", reflects the outcomes of the fourth Summer Academy, which was conceptualized under the leadership of Prof. Thomas Downing and Prof. Mohamed Hamza and organized by UNU-EHS and MRF. It is my pleasure to introduce this publication with innovative contributions from the Academy participants.

The goal of the Academy was to discuss and develop a new way of thinking about climate change, resilience, vulnerability and uncertainty: the hot system approach was introduced. Under the guidance of the MRF Chairs on Social Vulnerability and other international experts, 25 PhD scholars and practitioners participated in an unique thinking process which resulted in this new concept (see the lead chapter) for examining social vulnerability and preventing humanitarian crisis. Building on the "hot spot" concept developed by ecologists, this system-focused framework considers the consequences of climate change and other perturbations for socio-economic and ecosystem vulnerability in differing geographic locations. The hot system approach investigates the relationships between biophysical and social processes and how combinations of events and conditions in geographically disparate systems can lead to humanitarian crisis. Combined with the concept of tipping points, the hot system approach helps recognize the impact of multiple disturbances and enhance prevention of humanitarian crises.

In addition to this main outcome of the 2009 Summer Academy, this SOURCE also includes eight scientific papers from participants originating from different countries and working in various disciplines. These papers debate around issues associated with climate change, migration and social vulnerability and provide us with interdisciplinary approaches to tackle the respective problems. Starting with a paper, which critically investigates the concepts of tipping points and humanitarian crises from a social science perspective and highlights that both of the concepts are useful tools for vulnerability assessment, this SOURCE continues by offering insights into various methodologies such as agent-based models for exploring the dynamics of vulnerability. Case studies conducted in Vietnam, Tanzania, the Ganges Basin, East Africa and Japan illustrate a wide range of issues in these regions in the context of environmental change and analyse how the interplay of coupled social-ecological systems increase vulnerability or resilience deploying hot system thinking. All these papers contribute to the discussion on the effective prevention of system collapses and humanitarian crises.

As an outcome, the Academy participants recommended that policy relevant research, such that will appear in the IPCC's 5th Assessment Report, should take the hot systems approach into account to support improved decision making on climate change and social vulnerability. I hope that our readers will benefit from this publication, as it presents new findings in the area of climate change and complex system analysis of social vulnerability.



Fabrice Renaud
Director a.i. UNU-EHS

## Foreword

The Munich Re Foundation, like Munich Re itself, deals with global risks. Since one of the foundation's main objectives is to support people at risk and improve their living conditions, the need to estimate loss potential is as crucial to the foundation as to Munich Re.

Risk assessment is based in part on the ability to comprehend processes and trends, whether in the field of catastrophe, climate or migration research, and it is thus important to find out as much as possible about the risk parameters and their mechanisms. There are many cases where sudden and unforeseen factors or wild cards "upset the apple cart", where models abruptly accelerate or completely change direction. Disruptive events can have either a positive or a negative impact, and tipping points are significant in this respect since they can trigger a crisis by bringing about a rapid change in the expected course of events. For example, the Lehmann Brothers bankruptcy or "non-rescue" in 2008 sparked the world's worst financial crisis for nearly 80 years.

Climate change research is also increasingly focused on tipping points, many of which have already been identified. Examples such as the gradual abatement of the warm Gulf Stream current or the melting of the glaciers in Greenland can have a tremendous impact on regional climate and sea levels. Similarly, tropical forest systems are liable to break down suddenly, and this can affect the global climate for decades, or even change it irreversibly.

By contrast, research into the tipping points of social systems and social vulnerability is still in its infancy. This is a complex, highly volatile field, where wide-scale interdisciplinary research will be needed to achieve tangible results. We and the UNU-EHS invite young researchers and specialists to our annual Summer Academies to discuss current issues, present recent studies and share experiences. The 2009 Academy was chaired by renowned climate researcher Tom Downing, who is also the present holder of the Chair in Social Vulnerability at the UNU in Bonn. As well being involved with tipping points through his work for the IPCC, for a number of decades Tom Downing has also been researching climate change impacts, more recently in connection with migration research. Thus, the 2009 Academy addressed fascinating issues and brought new knowledge to light. What climate conditions have the potential to trigger humanitarian crises? What are the social factors involved and how are they interconnected? The hot systems approach developed at the Academy enables us to see things from a different perspective. It overcomes disciplinary barriers and gives us a clearer understanding of the different factors behind social, economic and political rifts. Provided we can generate sufficient knowledge and identify the underlying trends early enough, we will be able to find efficient, sustainable solutions.

You are invited to read the best Academy papers, written by authors working at the interface between climate research and social vulnerability.

I sincerely hope you enjoy them.

Thomas Loster
Chairman of the Munich Re Foundation

## Preface

The fourth Summer Academy on Social Vulnerability (2009) took a somewhat different approach to learning. The topic of the Academy was climate change and humanitarian crises – following conceptual approaches rooted in complexity, coupled socio-ecological systems and tipping points (among others). This sort of issue is one where the science is difficult, projections of the future conditions nearly impossible and solutions still emerging, at best. Where the knowledge basis is still formative, learning modes (the pedagogical principles) of classical lecture-student format or dialogue-facilitation are inadequate. Much of the conceptual foundations, common wisdom and solution space is and needs to be examined with fresh eyes, contested with rigorous thinking.

With this understanding, we prepared the Academy as an extended simulation. Not the kind of simulation where we all play the role of someone else - whether an expert or a vulnerable person. Rather a simulation where we are convened to produce a real-world outcome. The outcome is simulated – the real world is not necessarily waiting for the outcome of the Academy. But it is a real framework for learning, and one that is the most common model for professional working groups (but not the most common form of academic meeting).

The charge to the participants was posed as a mandate given to us: "The Technical Support Unit (TSU) of the Intergovernmental Panel on Climate Change (IPCC), Working Group II, has requested the Academy to prepare a scoping paper for inclusion in the planning for the fifth assessment report, just now getting underway. Therefore the aim of the Academy is to prepare an assessment plan for understanding the nature of tipping points of climate change related to forced migration and humanitarian crises, the potential vulnerability and impacts (including costs) and the range and effectiveness of adaptation strategies and measures." (Downing and Hamza)

This mandate was not formally endorsed by the IPCC Bureau or governing bodies. However, it was discussed with the TSU and in fact is a reasonable request that would benefit the IPCC as it gears up its sixth assessment report (launched in 2009). Our Academy did not follow strict IPCC rules of engagement (representation invited from all parties, lots of formal presentations by presumed experts). We provided quite a bit of material for the Academy participants, and much more is online of course. However, the Academy needed to re-create its own frames of reference and working groups.

We planned four outputs from the Academy. In the end, our aims were adjusted. One feature of a simulation of this sort is to expect surprise, and use those moments creatively.

This output is the volume of papers on climate change and tipping points, forced migration and humanitarian responses that we proposed as the main achievement (and a regular outcome of each Academy). It includes what we initially called a background scoping paper that was intended to identify the key topics in an assessment, to review the most appropriate methodologies and to map stakeholder interests and engagement strategies. Rather it became a more concise statement of founding principles and strategic directions – not a full background paper but far more inventive in reflecting the conceptual paradigm that would underpin the planned assessment.

The subsequent papers are drawn from the drafts that each participant brought to the Academy, reviewed and revised. A further contribution is planned – an InterSecTions (another UNU-EHS publication series) that reviews lines of evidence in climate-crises and ways forward in negotiation solutions. And we have contributed to a book on climate and crises organized by the Japan International Cooperation Agency (JICA).

We asked several participants to reflect on what they learned, and offer our own comments. Each Academy has done a participant review as well. We asked the participants to rate five objectives of the Summer Academy: "learning", "skills", "usefulness", "networking" and "creativity" by marking on an arrow which ranges from 1 (worst score) to 10 (best score) how they evaluated the effectiveness of learning. The results are: learning 8, skills 7, usefulness 9, networking 9, creativity 8.

Our headline reflection is simple: "We learned!" We collectively navigated through issues of static vulnerability to socio-institutional change: "From hot spots to hot systems". The Academy coordinators learned some of the fine arts of facilitation - when to trust the process, how to intervene:

Patience: "What if the working groups aren't doing what I told them to do, can't they read the instructions?"

Encouragement: "I didn't anticipate Tom leaving the academy agenda so much open space, but it worked!"

Letting go: "Aren't you worried that your [the facilitator's] reputation is on the line? What if we [the participants] don't produce!" And much more.

**Stories from the Participants**

"The UNU-EHS/Munich Re Foundation 4th Summer Academy brought together a group of researchers and practitioners that crossed a broad spectrum of disciplinary, organizational, and work-location expertise. The participants also represented a diverse set of ethnic and regional origins. The combination of practical and personal diversities necessitated an open-minded and truly collaborative approach to our discussion of tipping points in humanitarian crises. Whether we entered the discussion from an economic/development standpoint, an ecological standpoint, a human rights standpoint, from the shoes of one who has grown up or lived in a developing country and is concerned about the impacts for friends and family, or some combination of these, our eyes were opened to both the interests and the approaches of others. If we, the global community, are to properly address the impacts that climate change is having and will continue to have for human security, this is precisely the approach that we need to take. Without collaboration across the multitude of political, economic, ecological and social conditions that exist, the most vulnerable populations will continue to be just that."

"From day one, we were charged with a task that seemed insurmountable: getting 20+ strong-minded people from different disciplines and backgrounds to come to a consensus about the most urgent issues surrounding tipping points in humanitarian crises. What was ensued was at times painful, but always rewarding, and definitely an experience that I can take with me into the real world. This type of policy-oriented research can't (and shouldn't) be done alone, and naturally requires both conflict and cooperation. The Summer Academy was a great opportunity to explore what real-life, high-stakes collaborative work is like."

"The Academy gave me great insight into the processes of creation and deliberation that constitute climate change knowledge and practice at the global extent. Interacting with the diverse group of participants, both within and outside of formal academy sessions, gave me valuable inspiration for my own work and a better idea of the scope of the most current climate change research. The challenge of writing and thinking as a group on theoretically difficult topics illuminated for me both the potential strengths of collaboration and the distances we collectively have yet to go."

"What did I carry away from the Summer Academy? Well, I learned quite a lot of new things like always: new ideas, new concepts and insights. On top of that, I had the opportunity to work with brilliant people. Yet, to me the most valuable experience at this academy lies beyond acquiring new knowledge and working with exciting people. The true uniqueness of this academy lies in the concept of empty space which allowed me to see things which I had never expected to see. Instead of a strictly structured programme the free space at the academy intended to give all participants the opportunity to think and act freely. Yet, freedom became the very challenge. Empty space made me feel lost, made me feel out of control and forced me to move beyond my own boundaries. Confused and frustrated I couldn't help but reflecting on my way of thinking: do I really enjoy freedom or do I feel more comfortable within defined frameworks? Does freedom make me feel free or do I have to free myself to enjoy the freedom? On the last day of the Academy, I believe I had a fraction of a second of enlightenment. I am still struggling with my constraints, but thanks to this Academy, I have had a unique insight into

myself which makes me realize from time to time that there is something beyond what we see and what we do everyday. If I can manage to go beyond my own boundaries, I will open another door and discover a brave new world."

This comment captures an enduring image. The visual style horror vacui, fear of empty spaces, was a common feature of picture galleries in Victorian palaces. Every section of a long wall was filled with pictures, nothing was left as background. Wikipedia notes that Mario Praz used it to describe the suffocating atmosphere and clutter of interior design. How much more it captures the suffocation of intelligence in wall-to-wall powerpoint meetings. Xiaomeng Shen noted that Chinese art has a similar art history – white space in a painting or ideogram is intentional.

A final conclusion: the relations between climate change and humanitarian crises cannot be solved by gathering more "evidence". We simply do not have current experience of all the ways in which climate might affect resources and economies, of the myriad of behaviours from people and institutions that might avert or tip into crises. Accept this. The way forward then is to create distributed communities of practice, motivate social entrepreneurs and learning spaces where solutions can be formulated and fomented. This is the task ahead for the Climate Change, Environment and Migration Alliance (www.ccema-portal.org). It is our privilege to have had a small part in that social project through the Academy and as we continue to work together.

Thomas E. Downing & Mohamed Hamza
Oxford

## Table of Contents

## Lead Chapter
## Introducing a "Hot System" Approach to Tipping Points in Humanitarian Crises

*Stacy Lynn, Matthias Garschagen, Shabana Khan, Jessica Lehman, Georgina Drew, Vivek Prasad, Johnson Nkem, Josphat Mushongah, and the 4th Munich Re Foundation/UNU-EHS Summer Academy participants (Listed in Acknowledgements)*

### Introduction

This scoping paper is the outcome of the 4th Munich Re Foundation/UNU-EHS Summer Academy on Social Vulnerability (26 July – 1 August 2009, Hohenkammer, Germany) that dealt with "Tipping Points in Humanitarian Crises". The multi-disciplinary team of participants comprised graduate students and practitioners representing both natural and social sciences. The aim of this Academy was to explore tipping points in humanitarian crises related to climate change, and to promote the assessment of these tipping points by both the scientific and political communities paying particular attention to the assessments and recommendations developed by the IPCC.

### Principle

If not responded to adequately, the direct and indirect effects of climate change on complex coupled social-ecological systems (Berkes et al. 2003; Folke 2006; Walker et al. 2006; Walker et al. 2004; Turner et al. 2003) have the potential to trigger humanitarian crises, but these linkages are inadequately understood (Global Humanitarian Forum 2009; Thow and de Blois 2008). Climate change related risk is a function of both the physical characteristics and outcomes of climatic events and trends, and societal (inherent and dynamic) characteristics that may increase susceptibility to climate change related hazards or stresses (IPCC 2001; Brooks 2003; Lovbrand 2004). Humanitarian crises that may result from these compounded conditions can have dramatic and long-term negative impacts at all levels of society. Work studying the complexity of the bio-physical system has demonstrated the conceptual value of tipping points in explaining the systemic but potentially surprising and chaotic changes that result from a combination of small and large perturbations. The logical next step is to apply the concept of tipping points to explain the onset of humanitarian crises in coupled social-ecological systems (Lenton et al. 2008).

### Rationale

The complexity already referred to and the potential for unexpected events have major implications for decision-making and power relations. Thus, a review of such processes and how they may layer to create tipping points in human vulnerability may enable preventive decision-making and more effective interventions when and where vulnerability is greatest. Invoking the concept of tipping points – which can imply disproportionately negative impacts – helps to recognize the additive effects of multiple perturbations, and to expand utility to the prevention and/or better management of humanitarian crises (Scheffer et al. 2009). Our argument is that the perturbations themselves are not always manageable, and more value can be gained from accepting the challenge of identifying and addressing the frequently chaotic and surprising chain-effects of these perturbations. How exactly this notion can then be translated into decision-making and management is still open to discourse – and to start tackling this question is a likely next step for future research, and something that we suggest the IPCC needs to deliberate.

Since perturbations in social processes are in particular the expression of inequity and vulnerability, it is important to look into these issues. Inequity and vulnerability associated particularly with age, gender, ethnicity, income or resource access contribute to the preconditions for tipping points (Global Humanitarian Forum 2009). It has been also noted that agriculture and food production system will be severely affected by the climate change that may create issues around food security across the world (Brown and Funk 2008). This has the potential to trigger humanitarian crises in the areas of severe inequity and vulnerability (having origins in local and global relations), and therefore it gives a rationale for assessing these relationships.

### Key Concepts and Terms

The concepts of "tipping points" and "humanitarian crises" are both used to describe multiple phenomena. They are thus ambiguous and can be value laden (Kriegler et al. 2009). For the purposes of this paper we employ the term humani-

tarian crisis in a broad sense to refer to an event or series of events which represents a critical threat to the health, safety, security, well-being and/or dignity of a community or other large group of people, usually over a wide area (based primarily on WHO 2007). We are following Lenton at al.´s (2008) definition of tipping points to refer to the critical point at which the future state of a socio-ecological system is qualitatively altered. Pimm (2009) suggests that for ecological systems a change that results from reaching a tipping point may be rapid and complex, but that it does not necessarily need to be irreversible. For tipping points that lead to humanitarian crises, this is also the case (Pimm 2009). It is largely the magnitude, rapidity, and complex layering of changes – potentially in both the bio-physical but also socio-economic spheres – that are the root of crisis.

This paper introduces the concept of a 'hot system' as unit of analysis for identifying systems at risk of reaching a tipping point in or towards humanitarian crisis. The hot system approach departs from the more typical geographic focus expressed by the term "hot spot", which was developed by Norman Myers in the 1980s (Myers 1983; Myers 1988). Myers suggested that priorities of conservation should be based upon a combination of biological attributes, ecological attributes, genetic attributes, economic values, cultural and aesthetic values, and species and exceptional value ecosystems. Biodiversity hot spots – areas of exceptional plant and animal species concentrations facing exceptional degrees of threat – are a distinctly spatial unit, the identification of which is dependent upon a combination of biotic richness and deforestation risk from land use and climate disruption (Myers 1988).

The hot system concept builds on the hot spot concept to consider the consequences of climate change and other perturbations for socio-economic as well as ecosystem vulnerability in disparate geographic locations (which was recognized as important by Adger et al. (2009)). Commonalities among disparate locations may be due to local similarities of conditions. They can also be due to important linkages formed between system components as a result of expanding markets and flows of resources, people, information and power relations (Adger et al. 2009; Leichenko and O'Brien 2008). The hot system approach promotes a focus of research on the relationships between biophysical and social processes with the goal of elucidating the manner in which particular combinations of events and conditions in geographically disparate systems can lead to humanitarian crises, recognizing that a crisis potentially can be manifested in locations other than the location of origin.

Vulnerability is a state of susceptibility to harm that results from a combination of exposure and sensitivity to economic, social and environmental changes, combined with capacity to anticipate, respond and adjust to those changes (Adger et al. 2009). A hot system will likely be characterized by the interplay of, on the one hand, dynamic overlapping vulnerabilities (caused by, for example, poverty, unstable political and economic contexts, ecosystem degradation and limited livelihood opportunities) and, on the other hand, changing hazard exposure due to climate change. Even apparently minor changes can lead to bewilderingly complex ecological responses (Pimm 2009), and the ensuing humanitarian condition may be equally as complex due to the layering of biophysical and socio-economic processes.

Feedbacks are an important concept in the discussion of tipping points. They describe a process by which these overlapping effects accumulate and reinforce or magnify each other to push a system over a tipping point, thereby changing the state or mode of functioning of the system (Kinzig et al. 2006; Walker and Meyers 2004; Renaud et al. 2009). Because feedbacks can lead a series of small effects or events to have an unexpected and disproportionately large impact, they often result in uncertain and unforeseeable outcomes (Lenton et al. 2008; Russil and Nyssa 2009). Furthermore, because the magnitude of the impact could be much larger than the inputs that cause it, effects may be difficult to predict in due time and, for all practical reasons, become impossible to reverse. Finally, biophysical and social interactions across scales could cause a localized crisis to trigger similar shifts and crises beyond its immediate boundaries (Oxfam International 2007).

While there is a substantial body of evidence of social vulnerability in specific regions and populations, as well as evidence of vulnerability to environmental hazards and climate change, little information exists about how combinations of social vulnerability and exposure to hazards and climate change impacts may lead to humani-

tarian crises (Erhart et al. 2008). While multiple examples of complex relationships between social and biophysical systems exist in the literature, the detailed functioning of overlapping effects, feedbacks, surprise, irreversibility, and cross-scale interactions is mostly unexamined. These complex interrelations need to be acknowledged and explored to identify hot systems, or combinations of social and biophysical factors that collectively present a risk of a humanitarian crisis. Ideally, once these systems at risk have been identified, the capacity to anticipate, respond and adjust to anticipated changes will be improved.

**Assessment Strategy**

The use of tipping point terminology has become very prominent in the climate change discourse, largely due to acknowledgment of the threats posed by abrupt transitions, non-linearity, threshold crossing, positive feedbacks, and potential irreversibility (Russil and Nyssa 2009). The key to successful intervention and preparedness strategies that prevent climate change stressed systems from tipping into humanitarian crises is strategic, dynamic, multi-dimensional and cross-scale assessment. Vulnerability assessments systematically integrate and examine interactions between humans and their physical and social environments; this then facilitates the evaluation of adaptive capacity given potential future conditions (Hahn et al. 2009). Vulnerability assessments can be used to determine appropriate entry and intervening points to anticipating and preparing for what otherwise would have been a surprise event due to some combination of the above-mentioned threats related to non-linearity, tipping and potential irreversibility (Norway Government and ISDR 2008).

Research on vulnerability and adaptive capacity is required at various scales, as outlined by Adger (Adger and Brooks 2003; Adger et al. 2009) and the Fourth Assessment Report (Yohe et al. 2007). Scaling is critical to this process for various reasons: a) to scale up preparedness and intervention studies as a means of climate protection and adaptation, b) to bring local specifics into a global context and vice versa, c) to allow up- and down-scaling of baseline vulnerability assessments, d) to link future scenarios to present and past conditions, and e) to recognize the feedbacks that occur from the local, to regional, and even global scales. Liverman (2008) emphasized the importance of utilizing an ensemble of climate models to better represent uncertainty of future conditions. Moreover, the use of a variety of seemingly disparate methodologies that incorporate both quantitative and qualitative methods can build transdisciplinary bridges, overcome weaknesses inherent to individual methods, and optimize strengths (Salick and Ross 2009).

A meta-analysis of existing vulnerability indexes not only would establish the baselines of current social and biophysical vulnerability, but also would reveal the breadth and strengths/weaknesses of existing methodologies. These collective indexes would provide a framework for assessing the relative vulnerabilities of systems and the populations associated with them. A new rigorous vulnerability index to identify hot systems would select and integrate the existing methods that are most reflective of the current and future needs and conditions of populations, thereby creating a novel, innovative and cross-cutting decision-making frame.

The dynamic nature of vulnerability means that the baseline must not be considered static, and should be updated as new data become available (Smit and Wandel 2006). Similar to Hahn et al. (2009), the hot system vulnerability assessment frame will be designed to be flexible so that analyses can be refined and focused on specific geographic areas, yet it must also be standardized enough to allow for assessment at multiple scales, facilitating flexibility in the boundaries of the hot systems to allow for their contraction and expansion as conditions change. In addition, continual reassessment will allow the tracking of change trajectories and reclassification of population vulnerability as new social and biophysical data become available. Finally, as new methods and technologies are developed, the hot system vulnerability assessment frame should be adapted and improved. In order to ensure the highest possible validity, we advocate a review of existing vulnerability framework critiques and an integration of the considerations presented (McLaughlin and Dietz 2008; Yamane 2009; Patt et al. 2005).

The use of the above-mentioned approach requires working within existing data sources and collaborating with stakeholders who work in fields that deal directly with both biophysical and social issues. These data sources can be

augmented with future climate and other scenario outcomes to reveal potential ranges of biophysical and socio-economic conditions, but care needs to be taken in recognizing the reasonable use of predictive data. Ideally, the identification of hot systems in critical conditions will allow decision makers and stakeholders in various spheres and at various scales of the hot system to respond with appropriate interventions to the risk of tipping into humanitarian crises by offering adaptation options to targeted populations in need and by taking action to address and reduce threats and root-causes when possible (Thorton et al. 2009; Bogardi and Warner 2009).

Of particular importance to creating accurate vulnerability assessments is context specificity. Increasing the level of local participation in vulnerability assessments is one critical factor for obtaining accurate and meaningful information. Such public participation broadens the set of interests and issues to be considered, because of the differing values of various stakeholders (Lebel et al. 2006). Climate change may be a global phenomenon, but human responses will be primarily at the local scale (Salick and Ross 2009). A society's ability to manage adaptive capacity is based upon the society's actors, social networks and institutions, most of which function at local to regional scales (Lebel et al. 2006). Conversely, the hot system as the unit of analysis will also allow consideration of the fact that, as Adger et al. (2009) emphasize, while these local assessments are essential, understanding interrelated vulnerabilities in disparate locations will be an important task for future research.

Assessments should also focus attention on adverse structural contexts that, through formal and informal policies and institutions, exacerbate social differentiation, exclusion, and discrimination (Heltberg et al. 2009). Social variables such as age, gender, income and land tenure require additional attention in risk reduction. Vulnerability assessments should therefore use a wider gender concept, one that includes vulnerable populations such as women, children, elders, indigenous groups and minorities (Oswald Spring 2009). Recommended strategies include analysing aspects of quality, quantity and scale across vulnerability differentials to promote overall equity, understood as equitable access to resources and opportunities. Feminist analyses are imperative because they take into consideration axes of difference which are inadequately reflected in assessment strategies due to cultural barriers, postcolonial politics and epistemologies, or other constraints to their integration (Hyndman 2008).

Vulnerability assessment requires both quantitative and qualitative social data. Quantitative data may include census data, Human Development Index (HDI), Gender Development Index (GDI) and social capital through network analysis. Qualitative data may be collected by using methods that include Community Risk Assessment (CRA) research, Participatory Rural Assessment (PRA), workshops on equity, and narratives (Downing and Patwardhan 2002; van Aalst et al. 2008). Assessments of biophysical entities include the stocktaking of ecosystem services, and trends in these services (Millennium Ecosystem Assessment 2005). This stocktaking can enhance the understanding of resource distribution, accessibility, entitlement and equity, and how these impact livelihoods.

Extreme events have the potential to influence how stakeholders and institutions hold each other accountable for the causes and consequences of humanitarian crises, and the responsibility of finding possible solutions. The IPCC needs to support research on decision-making, perceptions, governance and accountability. It also needs to gather evidence on how climatic and non-climatic shocks have changed structures of accountability in the past, and how these structures likely will affect the future under different scenarios of accountability and under a range of climate projections.

It is not feasible to conduct case studies in all localities to provide data for hot systems analysis. However, we argue that it is reasonable at times to further develop and apply methods for using expert knowledge to extrapolate data from case studies to known similar systems. This would make best use of available data, and would compensate for the limited time and monetary resources available for data-collection (Murray et al. 2009). The extrapolation process would involve identifying locations and systems that are comparable to existing case studies and making explicit decisions on how and to what extent information from these case studies is transferrable to the analogous locations. Extrapolation of data,

particularly social data, can prove to be tricky, so it is extremely important to recognize that there will be regions of missing data where extrapolation is not appropriate, and that all extrapolations need to be revealed and qualified when they are made (see Murray et al. (2009) for an application in predicting species distributions, and Weir-Smith and Schwabe (2001) and Jackson et al. (2004) for social and land degradation issues respectively). The goal is to enhance the identification of hot systems, not to complicate the process or void its utility.

The composition of the IPCC as an intergovernmental scientific body with representatives from multiple nations creates a distinctly effective institution for the linking of worldwide climate change and vulnerability research networks and information. The role of the IPCC is "to assess on a comprehensive, objective, open and transparent basis the scientific, technical and socio-economic information relevant to understanding the scientific basis of human-induced climate change risk, its potential impacts, and options for adaptation and mitigation." (Pachauri 2004, p.13) The hot systems approach will aid in identifying combinations of biophysical and socio-economic processes that, in combination with climate change, create a risk of reaching tipping points in human vulnerability. This will aid in the targeting of identified hot systems for the prioritization of both adaptation and mitigation options, potentially revealing systems at risk that would not otherwise be identified, and increasing the efficiency of humanitarian crisis prevention and response.

**Conclusions and Recommendations**

- We advise the IPCC to trace the use of the term 'tipping point' in both the social and natural sciences to document the different phenomena it has been used to define and to establish a definition suitable to address humanitarian crises.
- We recommend that the IPCC collates case studies that explore the occurrence of humanitarian crises in an attempt to identify the connections in the socio-economic and biophysical sub-components that together constitute "hot systems".
- Because social systems are vulnerable to seemingly minor biophysical and socio-economic changes, we suggest that the IPCC continues to mandate the participation of social scientists in its assessments. We encourage the IPCC to consult thoroughly with non-governmental organizations (NGOs), international non-governmental organizations (INGOs) and local actors to facilitate exchange of information that can augment overall expertise in the interplay between biophysical and socio-economic systems at multiple scales.
- In light of the complexity and surprise created by tipping points, we recommend that the IPCC seeks to develop innovative, interdisciplinary methods and approaches to understanding and assessing vulnerability through a review of the existing and ongoing work on preparedness, uncertainty, social vulnerability and interventions.
- We recommend that the IPCC convenes a series of workshops on upscaling context specific, local findings to aid in the adoption of the hot system approach to identifying systems at risk of tipping into humanitarian crisis.

**Acknowledgements**

The authors of this paper wish to recognize the further participants of the 4th MRF/UNU-EHS Summer Academy, who helped to lay the conceptual foundation for this paper: Maureen Biermann (Department of Geography, Penn State University), Temesgen Tadesse Deressa (Center for Environmental Economics and Policy in Africa, University of Pretoria, South Africa), Rahmawati Husein (Department of Social and Political Sciences, University of Muhammadiyah, Yogyakarta, Indonesia, and Texas A&M University), Kanako Iuchi (Department of Urban and Regional Planning, University of Illinois, Urbana-Champaign), Kaun-Hui Elaine Lin (Department of Geography, National Taiwan University), James Morissey (Development Studies, Oxford University), Sebnem Sener (Crisis, Disaster and Risk Management Institute of the Department of Engineering Management and Systems Engineering, George Washington University, USA), Cilli Sobiech (Department of Human Dimensions of Coastal Areas at GKSS Research

Center, Geesthacht, Germany), Marc Stal (UNU-EHS until December 2009), Till Sterzel (Potsdam Institute for Climate Impact Research), Ian Verhaeghe (Oxford Brookes University) and Monica Verhaeghe (Oxford Brookes University).

Therese Rosenfeld and Xiaomeng Shen provided assistance with literature and editing. Christian Barthelt, Benjamin Zhu, Angelika Boos, Wesley Crock, Patrick Voit, Pallavi Mathur and Miriam Wong formed the support team for the Summer Academy, and their logistical support and commitment to the process and the group was beyond measure. Koko Warner and Xiaomeng Shen acted as Academic and Associate Academic Officers for UNU-EHS. Heather Lazrus and Elizabeth Marino facilitated the Summer Academy, and their contributions and insights from the 3rd Summer Academy were exceedingly helpful.

Finally, we would like to thank the IPCC Nominated Co-chairs of the Summer Academy, Professors Thomas Downing (MRF, Oxford Centre of SEI, the Centres for Climate Adaptation and UNU-EHS) and Mohammed Hamza (Lund University, Sweden, and Centre for Emergency and Development Practice, Oxford Brookes University, UK), along with the other Experts and Advisors of the Summer Academy: Professor Janos Bogardi (UNU and University of Bonn, Germany), Professor Hans-Georg Bohle (MRF and University of Bonn, Germany), Thomas Loster (MRF), Professor Anthony Oliver-Smith (MRF and University of Florida), Professor Ursula Oswald Spring (MRF and National University of Mexico), Professor Susan Cutter (University of South Carolina, USA), and Glenn Dolcemascolo (UN/ISDR). The guidance from these mentors truly helped to create a productive learning and team-building atmosphere for the participants to apply their diverse disciplinary and cultural backgrounds and experiences to create a fully integrative approach to the problem of humanitarian crisis in the face of climate change.

**References**

Adger, N.; Brooks, N. (2003): Does Global Environmental Change Cause Vulnerability to Disaster? In: Pelling, M. (Ed.): *Natural Disaster and Development in a Globalizing World*, Routledge London. pp. 19-43.

Adger, W. N.; Eakin, H.; Winkels, A. (2009): Nested and teleconnected vulnerabilities to environmental change. In: *Frontiers in Ecology*. vol. 7, no. 3, pp. 150-157.

Berkes, F.; Colding, J.; Folke, C. (2003): Introduction. In: Berkes, F.; Colding, J.; Folke, C. (Ed.): *Navigating Social-Ecological Systems. Building Resilience for Complexity and Change*. Cambridge University Press, N.Y. pp. 1-29.

Bogardi, J.; Warner, K. (2009): Here comes the flood. In: *Nature Reports Climate Change*. Issue 1, January 2009, pp. 9-11.

Brooks, N. (2003): *Vulnerability, Risk and Adaptation: A Conceptual Framework*. Report Tyndall Centre Working Paper No. 38. Tyndall Centre for Climate Change Research, Norwich, UK.

Brown, M. E.; Funk, C. C. (2008): Food security under climate change. In: *Science*. vol. 319, pp. 580-581.

Downing, E. T.; Patwardhan, A. (2002): *Vulnerability Assessment for Climate Adaptation*. Adaptation Planning Framework Technical Paper. Oxford, UK.

Erhart, C.; Thow, A.; de Blois M.; Warhurst, A. (2008): *Humanitarian Implications of Climate Change. Mapping Emerging Trends and Risk Hot Spots.* CARE international.

Folke, C. (2006): Resilience: the emergence of a perspective for social-ecological systems analyses. In: *Global Environmental Change-Human and Policy Dimensions*. vol. 16, no. 3, pp. 253-267.

Global Humanitarian Forum Geneva (2009): *Human Impact Report: Climate Change: The Anatomy of a Silent Crisis*, Geneva. <http://www.ghfgeneva.org/Portals/0/pdfs/human_impact_report.pdf>, 16 December 2009.

Hahn, M. B.; Riederer, A. M.; Foster, S. O. (2009): The Livelihood Vulnerability Index: A pragmatic approach to assessing risks from climate variability and change – A case study in Mozambique.

In: *Global Environmental Change*. vol. 19, no. 1, pp. 74–88.

Heltberg, R.; Siegel, P. B.; Jorgensen, S. L. (2009): Addressing human vulnerability to climate change: towards a 'no-regrets' approach. In: *Global Environmental Change*. vol. 19, no. 1, pp. 89–99.

Hyndman, J. (2008): Feminism, conflict and disasters in post-tsunami Sri Lanka. In: *Gender, Technology and Development*, vol. 12, no. 1, p. 101.

IPCC (2001): *Climate Change 2001. Synthesis Report*. A Contribution of Working Groups I, II, and III to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, New York, p. 398.

Jackson, L.; Bird, S.; Matheny, R.; O'Neill, R.; White, D.; Boesch K.; Koviach, J. (2004): A regional approach to projecting land-use change and resulting ecological vulnerability. In: *Environmental Monitoring and Assessment*. vol. 94, no. 1-3, pp. 231-248.

Kinzig, A. P.; Ryan, P.; Etienne, M.; Allison, H.; Elmqvist, T.; Walker, B. H. (2006): Resilience and regime shifts: Assessing cascading effects. In: *Ecology and Society*. vol. 11, no. 1, pp. 23.

Kriegler, E.; Hall, J. W.; Held, H.; Dawson, R.; Schellnhuber, H. S. (2009): Imprecise probability assessment of tipping points in the climate system. In: *Proceedings of the National Academy of Sciences*. vol. 106, no. 13, pp. 5041–5046.

Lebel, L.; Anderies, J. M.; Campbell, B.; Folke, C.; Hatfield-Dodds, S.; Hughes, T. P.; Wilson, J. (2006): Governance and the capacity to manage resilience in regional social-ecological systems. In: Ecology and Society. vol. 11, no. 1, p. 21.

Leichenko, R.; O'Brien, K. (2008): Environmental Change and Globalization – Double Exposures. Oxford, New York.

Lenton, T. M.; Held, H.; Kriegler, E.; Hall, J. W.; Lucht, W.; Rahmstorf, S.; Schellnhuber, H. J. (2008): Tipping elements in the Earth's climate system. In: Proceedings of the National Academy of Sciences. vol. 105, no. 6, pp. 1786-1793.

Liverman, D. (2008): Assessing impacts, adaptation and vulnerability: Reflections on the Working Group II Report of the Intergovernmental Panel on Climate Change. In: *Global Environmental Change*. vol. 18, no. pp. 4-7.

Lovbrand, E. (2004): Climate impacts, vulnerability and resilience – exploring trends in adaptation research. In: *The ESS Bulletin*. vol. 2, no. 2, pp. 27-32.

McLaughlin, P.; Dietz, T.; (2008): Structure, agency and environment: Towards an integrated perspective on vulnerability. In: *Global Environmental Change*, vol. 18, no. 1, pp. 99-111.

Millennium Ecosystem Assessment (2005): *Ecosystems and Human Well-Being: Current State and Trends: Findings of the Condition and Trends Working Group*. <http://www.millenniumassessment.org/en/Condition.aspx.>, 16 December 2009.

Murray, J. V.; Goldizen, A. W.; O'Leary, R. A.; McAlpine, C. A.; Possingham, H. P.; Choy, S. L. (2009): How useful is expert opinion for predicting the distribution of a species within and beyond the region of expertise? A case study using brush-tailed rock-wallabies Petrogale penicillata. In: *Journal of Applied Ecology*. vol. 46, no. 4, pp. 842-851.

Myers, N. (1983): A priority-ranking strategy for threatened species? In: *The Environmentalist*. vol. 3, no. 2, pp. 97-120.

Myers, N. (1988): Threatened biotas: "Hot Spots" in tropical forests. In: *The Environmentalist*. vol. 8, no. 3, pp. 187-208.

Norway Government; UN/ISDR (2008): *Proposal for an IPCC Special Report on Managing the Risks of Extreme Events to Advance Climate Change Adaptation*.<http://www.preventionweb.net/files/8150_IPCCNorwayISDRsystemProposal1.pdf>, 16 December 2009.

Oswald-Spring, U. (2009): A Huge Gender Security Approach: Towards Human, Gender, and Environmental Security. In: Brauch, H. G.; Spring, U. O.; Grin, J.; Mesjasz, C.; Kameri-Mbote, P.; Behera, N. C.; Chourou, B.; Krummenacher, H. (Eds.): *Facing Global Environmental Change: Environmental, Human, Energy, Food, Health, and Water Security Concepts*. Springer, Berlin. pp. 1157-1181.

Oxfam International (2007): *Climate Alarm: Disasters Increase as Climate Change Bites*,

Oxfam Briefing Paper. <http://www.oxfam.org.uk/resources/policy/climate_change/downloads/bp108_weather_alert.pdf>, 16 December 2009.

Pachauri, R. K. (2004): *Intergovernmental Panel on Climate Change: 16 Years of Scientific Assessment in Support of the Climate Convention*. Report IPCC Secretariat, Geneva, Switzerland.

Patt, A.; Klein R. J. T; de la Vega-Leinert, A. (2005): Taking the uncertainty in climate-change vulnerability assessment seriously. In: *Geoscience*. vol. 337, no. 4, pp. 411-424.

Pimm, S. L. (2009): Climate disruption and biodiversity. In: *Current Biology*. vol. 19, no. 14, pp. R595-R601.

Renaud, F.; Birkmann, J.; Damm, M.; Gallopin, G. (2009): Importance and difficulties in threshold characterisation of coupled-social ecological systems exposed to external shocks. In: *Natural Hazards* (submitted).

Russill, C.; Nyssa, Z. (2009): The tipping point trend in climate change communication. In: *Global Environmental Change*. vol. 19, no. 3, pp. 336-344.

Salick, J.; Ross, N. (2009): Traditional peoples and climate change. In: *Global Environmental Change*. vol. 19, no. 2, pp. 137-139.

Scheffer, M.; Bascompte, J.; Brock, W. A.; Brovkin, V.; Carpenter, S. R.; Dakos, V.; Held, H.; van Nes, E. H.; Rietkerk, M.; Sugihara, G. (2009): Early-warning signals for critical transitions. In: *Nature*. vol. 461, no. 7260, pp. 53-59.

Smit, B.; Wandel, J. (2006): Adaptation, adaptive capacity and vulnerability. In: *Global Environmental Change*. vol.16, no.3, pp. 282–292.

Thornton, P. K.; Jones, P. G.; Alagarswamy, G.; Andresen, J. (2009): Spatial variation of crop yield response to climate change in East Africa. In: *Global Environmental Change-Human and Policy Dimensions*. vol. 19, no. 1, pp. 54-65.

Thow, A.; de Blois, M. (2008): *Climate Change and Human Vulnerability: Mapping Emerging Trends and Risks Hotspots for Humanitarian Actors.* Summary for decision makers. Bath: Maplecroft.

Turner, 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.

Van Aalst, M. K.; Cannon, T.; Burton, I. (2008): Community level adaptation to climate change: The potential role of participatory community risk assessment. In: *Global Environmental Change*. vol. 18, no. 1, pp. 165-179.

Walker, B.; Gunderson, L.; Kinzig, A.; Folke, C.; Carpenter, S.; Schultz, L. (2006): A handful of heuristics and some propositions for understanding resilience in social-ecological systems. In: *Ecology and Society*. vol. 11, no. 1, Art. 13.

Walker, B.; Hollin, C. S.; Carpenter, S. R.; Kinzig, A. (2004): Resilience, adaptability and transformability in social-ecological systems. In: *Ecology and Society*. vol. 9, no. 2, p. 9.

Walker, B.; Meyers, J. (2004): Thresholds in ecological and social-ecological systems: A developing database. In: *Ecology and Society*. vol. 9, no. 2, p. 3.

Weir-Smith, G.; Schwabe, C. (2001): *Spatial Interpolation vs. Neural Network Propagation as a Method of Extrapolating from Field Surveys*. Paper, Fourth Biennial International Conference of Society of South African Geographers, July, Rawsonville.

WHO (2007): *Risk Reduction and Emergency Preparedness. WHO Six-year Strategy for the Health Sector and Community Development.* <http://www.who.int/hac/techguidance/preparedness/emergency_preparedness_eng.pdf> 27 December 2009.

Yamane, A. (2009): Climate change and hazardscape of Sri Lanka. In: *Environment and Planning*. vol. 41, no. 10, pp. 2396-2416.

Yohe, G. W.; Lasco, R. D.; Ahmad, Q. K.; Arnell, N. W.; Cohen, S. J.; Hope, C.; Janetos, A. C.; Perez, R. T. (2007): Perspectives on Climate Change and Sustainability. In: Parry, M. L.; Canziani, O. F.; Palutikof, J. P.; van der Linden, P. J.; Hanson, C. E. (Eds.): *Climate Change 2007: Impacts, Adaptation and Vulnerability.* Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK. pp. 811-841.

## Arbitrary, Ambiguous and Political: Tipping from What to What?

*James Morrissey*

### Introduction

In the last 10 years there has been a growth in literature from within the physical, geographical sciences regarding concern over the potential for non-linear responses in complex systems. Concern pertained to the potential for non-linear responses to manifest as "tipping points" wherein linear patterns of forcing may result in non-linear responses manifest as large scale, rapid changes in the physical system. Research in this area focused mainly on the more deterministic, physical systems where the impacts of rapid, large scale changes to the physical environment were the cause for concern, given the impacts they might have on the social systems dependent on them. However in addition to this, social scientists, cognizant of the complexity of social systems and the manner in which they interact with the physical environment, have begun to wonder if the notion of "tipping points" might be usefully translated into analysis of social systems. Of particular concern has been the potential for rapid changes in social structures (generated by the combined impacts of social and physical processes) which result in the rapid generation of humanitarian crises. As a result there has been interest in assessing the usefulness of linking the concepts of "tipping points" and "humanitarian crisis" to "tipping points in humanitarian crisis".

This paper reflects on the potential usefulness of the conceptual linkage of "tipping points in humanitarian crisis". It does so by comparing the Ethiopian experience of the Sahelian drought of the 1980s with the current (2005 – 2009 GC[1] ) drought being experienced in the region. The paper points out that despite the drought of the 1980s being regularly conceived of as a humanitarian crisis and the drought today generally described in terms of its developmental challenges, both periods display more similarities than they do differences. As such the paper seeks to explore how such similar events are effectively described using entirely different discourses: "humanitarian crisis" in the 1980s and "development" in the contemporary period. In doing so the paper highlights the ambiguous and arbitrary nature of "humanitarian crises" as well as highlighting the discursive political importance of the concept. It then goes on to show the degree to which the diametrically opposed discourses, just mentioned, were (and are) being strategically deployed in order to justify ongoing intervention in a community in northern Ethiopia. Following this the paper describes the ambiguous and arbitrary nature of the concept of "tipping points" before pointing out the narrative importance of the concept in making claims about truth. Finally the paper concludes by reflecting on the usefulness of popularizing the notion of "tipping points in humanitarian crises" in the public's imagination.

### Humanitarian Crises

When discussing the general case of "humanitarian crises", one cannot help but find authoritative definitions hard to come by. Little agreement exists, little is concrete in the definition and different groups tend to use the term to describe a variety of different events in a variety of contexts. That said, the term is generally used to refer to an event in which the safety, security and/or dignity of a recognized community or other large group of people is threatened.

With such a loose definition it becomes important to acknowledge that the term "humanitarian crisis" is both arbitrary and ambiguous. The term is arbitrary principally due of issues of scale. This is because in terming any event a "humanitarian crisis" one has to ask: at what point is a sufficiently large number of people affected, to a sufficiently deleterious degree, so as to warrant the term "crisis"? Regarding both the number of people affected and the intensity of that effect we must acknowledge that any claim of "crisis" must be based on arbitrary delineations. In addition to issues of scale though, one also has to consider what we mean by using the terms human "safety", "security" and "dignity". Such issues of definition become increasingly complex when we acknowledge that in order to invoke the idea of a threshold being crossed

[1] *GC refers to 'Gregorian calendar'. It should be noted that the Gregorian calendar is distinct from the Ethiopian Calendar which lags the Gregorian calendar by approximately 7 years. For the sake of convention all dates subsequently mentioned in this paper will refer to the Gregorian calendar.*

(so that a situation of concern can become a "crisis") we need definitions of "safety", "security" and "dignity" which allow for a breaking down of these concepts into constituent parts. Any such breaking-down process necessarily requires reification and thus involves an element of arbitrary conceptual delineation.

The implications of such arbitrary issues of scale and conceptual delineation are compounded if we acknowledge that "safety", "security" and "dignity" are concepts which are not absolute. People's safety, security and dignity are always under threat, and what we are in fact doing when we try to define thresholds at which any one of them is compromised is to make claims about what we understand to be acceptable levels of threat or risk. Any talk of an acceptable level of risk or threat must then acknowledge that, due to the wide variety and changing nature of the physical and social conditions in which societies exist, we will almost certainly find that what constitutes "acceptable levels" of "safety", "security" and "dignity" will both vary across cultures and be dynamic within them.

Due to the fact that "humanitarianism" is a concept which, by definition, applies to all peoples at all times and yet what is accepted to constitute it is variable across societies and over time, it necessarily follows that the application of arbitrary points defining concepts of human safety, security and dignity is ambiguous. They are ambiguous because different societies and institutions with different values will apply different, yet equally defensible, definitions of "humanitarian crises". The result is that there can theoretically be an infinitely large number of equally defensible claims about what constitutes a humanitarian crisis. This in turn opens a space for spurious claims of humanitarian crisis on the grounds of cultural relativism.

With all this in mind it is important that we also acknowledge the immense discursive importance of "humanitarian crisis" in political considerations. Their existence, as defined as a threat to human security, serves two major political ends. The first is in the name of political exceptionalism and the second is in the name of political legitimacy. In the case of political exceptionalism, exceptional threats to human security can be used to legitimize the exceptional centralisation of power in the state, thereby justifying extra-constitutional acts. In the case of political legitimacy, since one of the state's foundational claims is that of affording and protecting human security, the term "humanitarian crisis" forms a powerful critique of any incumbent government's claim to legitimacy. As such the term "humanitarian crisis" forms a powerful discursive tool which potentially enables a variety of parties at the highest levels of state power. The deployment of 'humanitarian crisis' rhetoric is only made easier by the necessarily ambiguous and arbitrary nature of the concept described above.

Having made theoretical claims about the arbitrariness, ambiguity and instrumentality of the term "humanitarian crisis", I now turn to the case of northern Ethiopia where, through a comparison of the drought in the mid-1980s and today, I will show concrete examples that highlight the importance of recognizing the elements of the term described above.

**The Ethiopian Case**

The fieldwork providing data for this paper took place in Tigray, the northern-most National Regional State in Ethiopia. The working area was on the Atsbi Plateau, located about 100 kilometres north-north-east of the regional capital, Mekele.

**The Drought of the Mid-1980s**

The Ethiopian drought of the mid-1980s was part of the climatic event that lead to widespread rainfall failures across much of the Sahel. The northern, mountainous parts of Ethiopia were hit particularly hard by the drought where the impacts of crop failure were compounded by the conflict between the Tigray People's Liberation Front (TPLF) and Ethiopian government, Derg, forces.

Respondents from the study area indicated that although the fighting made life difficult they remained able to work their farms and it was not until the rains failed that they found themselves in need of, and receiving, external support. During this period the two major "internal" responses were the sale of household assets and/or migration. Regarding "external" interventions there were three: Red Cross-sponsored (UN-coordinated) food aid, a TPLF-coordinated refugee movement into The Sudan and the Derg's forced resettlement policies.

**The Situation Today**

Today the study area is definitively peaceful. The TPLF defeated the Derg in 1991 and now runs the country in a coalition government termed the Ethiopian People's Revolutionary Democratic Front (EPRDF). For the last three years, however, northern Tigray has been experiencing a drought. At the time of fieldwork the rains were late, potentially beginning a fourth year of poor rainfall. During this drought "internal" responses remained the sale of household assets and/or a mix of temporary and permanent migration. "External" responses have not been specific to this drought as households have received permanent support in the form of food (and occasionally cash) for work projects since the early 1990s, the vast majority of which continue to be funded international donors.

**Comparing Two Droughts**

In comparing the conditions in the 1980s with those of today it is not my intention to suggest that the conditions in Tigray today are identical to those of the 1980s. The major difference is that while food aid is now distributed to virtually all households, every year and with relative success, in 1984 food support was only available in the administrative centre of Wukro. Accessing food aid in Wukro was difficult during this period as it required a 40 kilometres walk during which one might encounter harassment by both Derg and TPLF forces. Additionally, once in Wukro one ran the risk of being resettled by the Government, an event to which the Tigrinya people's strong sense of regionalism, and mistrust of the Derg, left them very much opposed. As such many families were reluctant to access the humanitarian food aid and suffered major consequences of hunger, starvation and in some cases (usually among the sick and the elderly) even death.

While bearing these differences in mind, in assessing the situation today one cannot help but notice that farmer's accounts of the two periods cast them as remarkably similar – characterizing them in terms of severe drought and a chronic reliance on external food support. National-level characterizations on the other hand cast them as almost diametric opposites in which the 1980s are understood in terms of humanitarian crisis and the contemporary situation in terms of sustainable development. Because of this, it is thought useful to highlight the similarities between the two periods it forces one to ask questions of the political interests which might have motivated the vastly different national-level discourses.

In the case of the 1980s, the specific "external" responses to both the drought and the conflict in the area were justified by a language of humanitarian crisis, invoked by a number of actors. At the international level, the involvement of the Red Cross was an explicit reaction to the crisis (Jansson et al. 1987). From the TPLF side, the refugee movement to The Sudan was founded on a claim that the Derg was persecuting the people of Tigray in a fashion which compromised their basic requirements of human safety. Finally, the Derg's forced resettlement programme claimed that the carrying capacity of northern Tigray had been exceeded and that the drought was the product of an environmental failure (Clay and Holcomb 1986). Thus all the parties invoked the exceptional case of humanitarian crisis to legitimize their exceptional policies of food aid, asylum and forced resettlement respectively.

These responses seem reasonable. The Red Cross offered food aid to a population left unable to grow its own crops as a result of drought and conflict. Similarly, the response of the TPLF seemed reasonable, as many people whose crops had failed were unwilling to collect food aid for fear of political persecution at the collection point. Since they could not grow food for the drought and could not collect it for fear of persecution it made sense to suggest that they collect their food aid in the Sudan out of the reach of a predatory state. On the part of the Derg, northern Tigray is widely considered one of the most severely degraded landscapes in the country (Elias and Fentaye 2000; Nyssen et al. 2004; Munro et al. 2008; Hurni 1983; Feoli et al. 2002) with high background rainfall variability (Rosell and Holmer 2007) and widely recognized demographic pressures (Nyssen et al. 2004; Kloos and Adugna 1989). From this perspective it seems reasonable to move people from an overpopulated region and settle them in a more fertile and less densely populated one. It further made sense to resettle those people receiving food aid as it was clearly these groups whose land holdings had the problem of being too small and/or too degraded.

However, if we look more closely at these events, we see a number of different interests at play. On the part of the Derg it should be noted that they initially tried to deny the existence of a crisis altogether (Clay and Holcomb 1986). Famine-induced "humanitarian crisis" was a sensitive topic for the Derg who had in part come to power on the back of the famine experienced ten years earlier during which they had highlighted the illegitimacy of the Halie Sellasie regime and its feudal structure of land ownership. In the 1980s, once media reports forced the Derg to acknowledge the seriousness of the situation in the north of the country, there can be no doubt that their response (focusing on resettlement) had more to do with depopulating the region of food producers and making rebellious elements of the rural populace dependent on the state, than it did development or food security (Clay and Holcomb 1986).

Similarly, TPLF's coordination of a refugee movement to The Sudan, although likely more concerned with the welfare of the people of Tigray, was not simply about addressing the "humanitarian crisis" in the region. There can be no doubt that it was partly about countering the Derg's attempt to subdue rebellious elements in the region, as well as claim, internationally, both the illegitimacy of the Derg government (Clay and Holcomb 1986), and the legitimacy of itself as protector of the people of Tigray (Jansson et al. 1987).

Today the situation on the ground is not unlike that of the 1980s. The difference, as mentioned above, is that support is now much more readily available through government structures. Notable though, in a context in which people are receiving external support, much like they were from the Red Cross in the 1980s, is that instead of a discourse of humanitarian crisis we have one of development. The permanent food support provided in Tigray today is underpinned by a discourse which resonates quite remarkably with the Derg's 1980s logic of environmental crisis in that it blames food insecurity on indigence, premodern farming practices and environmental degradation. As such it claims that external food supplies form part of a sustainable development strategy. The development logic runs as follows: food-for-work schemes address indigence (and the associated developmental challenges of "poverty traps") by insulating households from environmentally induced shocks which would otherwise force them to sell their productive assets (their cattle). In addition, the work done on the food-for-work schemes constitutes a "rehabilitation" of the environment through the construction of terraces and the digging of wells. With the environmental quality improved and desperate poverty avoided the belief is that poor farmers will not desperately "mine" the soils thereby generating environmental security and allowing for the modernization of the agricultural sector. It is thus believed that food security will be achieved from the resultant increased agricultural yields.

While the claims of the EPRDF today reflect a plausible scenario, a closer examination of the current situation reflects that Tigray's chronic reliance on food aid is not simply a product of poor rainfall and an exhausted environment. The EPRDF is faced with the problem of demographic pressures in the region, like the Derg before them. Such pressures have lead to very small landholdings in the region as the TPLF-lead constitutional reforms in 1993 failed to include reform of the state's claim to ownership of all land and the prohibition on a transfer of use rights by private sale. As such the EPRDF government has had to follow the practice of centralized land redistributions of all the land in Tigray to persons considered old enough to farm it. The result has been a severe fractionalization of land holdings so that today individual land holdings in Tigray are incredibly small. The severity of these conditions is apparent when it is pointed out that during the fieldwork not one of the households interviewed could claim that, even with theoretically perfect climatic conditions, the output from their land would be sufficient to sustain them. With this in mind, and while one should acknowledge the government's claim that its decision regarding land tenure was taken to prevent economic landgrabs, there can be no doubting the control that such a structure of land ownership has afforded the State in a country comprised of 85 per cent subsistence farmers, and in which urban areas spawn the most coherent and organized forms of political opposition.

The current situation in rural Tigray is one in which poverty is endemic. Households are unable to grow sufficient produce on their land, and legislation prevents them from acquiring

larger land holdings on which to grow more or produce or support greater numbers of cattle. Additionally, households maintain low levels of cash as this is the only benchmark for accessing food-for-work programmes. Finally, since capital cannot be raised through the sale of land, people are hesitant to try and take on life in the urban areas where the cost of both settling in and living are prohibitively high. Since households cannot produce enough food to cover their own consumption needs, people, stuck in rural areas, are necessarily reliant on the state for their survival. This empowers the government through their coordination of food-for-work projects, access to which, it was claimed by respondents, had been coercively deployed to achieve a number of political ends.

Thus what we see is that the State has a vested interest in creating the conditions which keep people in a state of food insecurity not unlike that of the temporary food insecurity created by the drought and conflict of the mid 1980s. The state needs to justify this policy as the food aid on which these groups are so dependent, comes from international donors. As such the government has dropped its discourse of "humanitarian crisis" (invoked when it was in the form of the TPLF) and now employs a discourse of "development" in which the deterministic quality of the environment, pre-modern farming practices and poverty are cast as the major barriers to be overcome.

Remarkable here is that despite the majority of interview respondents describing the conditions now and in 1980 as quite similar, the opposing discourses of "humanitarian crisis" and "sustainable development" have been effectively deployed by the state in the different periods to both garner international support and justify exceptional policies of rights to land and resettlement.

**Tipping Points in Humanitarian Crises**

I have thus far shown the political importance of the rhetoric of humanitarian crisis. In so doing, I have sought to highlight the implications of the ambiguous and arbitrary elements inherent in the concept. I now reflect briefly on the concept of "tipping points" and warn of the potential problems of employing such a concept in relation to "humanitarian crises".

The concept of tipping points centres on the idea of a significant shift in some variable, or collection of variables, over a relatively short period of time. However, like humanitarian crises, the concept is currently ambiguous and a number of its definitions mean the concept is inherently arbitrary. Taking a public understanding of the term "tipping point" from a Wikipedia definition, we can see that the term is ambiguous in that way it is used to describe three distinct phenomena. The first is the moment at which a relatively rare event becomes relatively common. The second is the moment at which the occurrence of an event begins to increase and the third is a combination of the first two so that it describes the moment at which a collection of dynamically interacting variables "change state" so that either until then rare events become common, or positive feedbacks come to dominate the system (Wikipedia 2009).

The importance of ambiguity in the first two definitions, and therefore in the third, is that the point at which we consider the "tipping" to take place is different with different definitions – to highlight: the moment an event becomes "common" may be well after it began to increase. In addition to this the first definition of a tipping point, and thus in certain instances the third definition, is (like humanitarian crises) bound by the issue of scale. For in defining the moment at which a rare event becomes common we are forced to ask: what constitutes "rare" and "common" events?

In addition to being both arbitrary and ambiguous, the concept of a tipping point contains other elements that are worthy of discussion. The first is that tipping points describe the beginning, middle and end of a process. They form, therefore, in two words, powerful narratives for explaining a host of relationship(s) between variables. This means that even though the description of a tipping point might reference the relationship between only a few variables, its narrative strength means it can be easily incorporated into dominant discourses which seek to explain the relationship between much more complex processes involving many more variables. The second characteristic of tipping points is that the language of cause-and-effect inherent in them allows for their easy deployment in discursive explanations which seek to describe events as "natural", apolitical inevitabilities.

Finally, the fact that "tipping point" comprises only two words means that all its narrative strength can be applied in a sound-bite-form, amendable to media statements through which the public generally engages with issues that pertain to claims of state legitimacy.

These qualities of the "tipping point" concept mean that the term can be easily deployed to describe 'truth' in a fashion that is effectively cast as apolitical. Given this and the degree to which I have argued the concepts of tipping points to be ambiguous and arbitrary, we should be particularly aware of the potential for highly political claims about humanitarian crises to be depoliticized and leant legitimacy through a media-friendly discourse of "tipping points" which would operate on a scale, and in a fashion, which could serve to undermine effective public engagement on a multitude of topics. With this in mind, when thinking about the competing interests in the Ethiopian context that I describe above, it is terrifying to think how (should the concept have been part of the popular lexicon) the concept of a "tipping point in this humanitarian crisis" might have been effectively deployed to muddy the waters of international debate on the crisis. Surely it would have only further dramatized the claims of the different parties, raising the stakes surrounding intervention and potentially making more vulnerable those groups exposed to the combined pressures of drought and conflict.

**Conclusion**

I have argued here that the concepts of "humanitarian crises" and "tipping points" both contain elements of ambiguity and arbitrariness. In addition, and in spite of these issues, I have argued that claims about "humanitarian crises" are of great political significance while the narrative character of "tipping points" means they can be deployed to make strong claims to particular kinds of truth. I argued then that we should be weary of popularizing the notion of "tipping points in humanitarian crisis" in the public imagination where this conceptual linkage could be used by different parties to make claims on issues of international importance in a fashion which serves only to obfuscate effective public engagement.

With all this in mind, in pointing out the limitations of the terms and the potential implications of popularizing them in the public imagination, I am not claiming that neither "tipping points" nor "humanitarian crises" actually exist, nor that the concepts are without use. Both tipping points and humanitarian crises can be useful conceptual tools. That they are ambiguous, arbitrary and politically-informed does not invalidate them. Regarding events for which we can find legitimate political motivations about which to be concerned, rare events becoming common are socially important. Similarly the moment at which events of concern begin to increase, or the moment at which a rapid change in state of a collection of interacting variables occurs, can all be important to identify. Likewise (and precisely because we choose to value humanitarianism) in humanitarian crises an attempt to protect human safety and security while ensuring human dignity is entirely justifiable.

What I suggested then is that because of the ambiguity, arbitrariness, political importance and discursive power inherent in the conceptual linkage surrounding "tipping points in humanitarian crisis" we need to be absolutely clear about what we mean by both, when we invoke such concepts. We need to be clear about which definitions of the concepts we are using, as well as being clear about how and why our political values are influencing our decisions regarding the arbitrary elements of these concepts. We should also regard with scepticism individuals or institutions that invoke these concepts without providing such clarity. Finally we would do well, both when encountering, and making, claims about "tipping points in humanitarian crises", to reflect on the implications of such claims and how they might buttress power among certain groups.

**Acknowledgements**

This paper forms part of a DPhil Thesis at Oxford University which would not be possible without the generous financial support of The Rhodes Trust, The Royal Geographical Society (Slawson Award), The Research Council of Norway, The Scatcherd Scholarship and New College, Oxford.

**References**


Clay, J., Holcomb, B. (1986): *Politics and the Ethiopian Famine 1984-1985, Cultural Survival*, Cambridge, MA.

Elias, E.; Fentaye, D. (2000): Managing fragile soils: A case study from North Wello, Ethiopia. In: *Managing African Soils*, vol. 13.

Feoli, E.; Gallizia, L.; Woldu, V.; Woldu, Z. (2002): Processes of environmental degradation and opportunities for rehabilitation in Adwa, Northern Ethiopia. In: *Landscape Ecology*, vol. 17, pp. 315-325.

Hurni, H. (1983): Soil erosion and soil formation in agricultural ecosystems: Ethiopia and Northern Thailand. In: *Mountain Research and Development*. vol. 3, no. 2, Workshop on the Stability and Instability of Mountain Ecosystems. Berne-Riederalp, 14-19 September 1981, pp. 131-142.

Jansson, K.; Harris, M.; Pensrose, A. (1987): *The Ethiopian Famine*. Zed Books Ltd., London.

Kloos, H.; Adugna, A. (1989): The Ethiopian Population: Growth and Distribution. In: *The Geographical Journal*. vol. 155, no. 1, pp. 33-51.

Munro, R. N.; Deckers, J.; Haile, M.; Grove, A. T.; Poesen, J.; Nyssen, J. (2008): Soil landscapes, land cover change and erosion features of the Central Plateau region of Tigrai, Ethiopia: Photo-monitoring with an interval of 30 years. In: *CATENA*, vol. 75, no. 1, pp. 55-64.

Nyssen, J.; Poesen, J.; Moeyersons, J.; Deckers, J.; Haile, M.; Lang, A. (2004): Human impact on the environment in the Ethiopian and Eritrean highlands. In: *Earth-Science Reviews*. vol. 64, no. 3-4, pp. 273-320.

Rosell, S.; Holmer, B. (2007): Rainfall change and its implications for Belg harvest in South Wollo, Ethiopia. In: *Geografiska Annaler: Series A, Physical Geography*. vol. 89, no. 4, pp. 287-299.

Wikipedia (2009): *Tipping point (Sociology)*. <http://en.wikipedia.org/wiki/Tipping_point_%28sociology%29>, 30 November 2009.

## Simulating Humanitarian Crises and Socio-Economic Vulnerability: Application of Agent-Based Models

*Ali Asjad Naqvi, Cilli Sobiech*

**Abstract**

The possible causes of vulnerability to disasters are diverse. So are its effects that can lead to a humanitarian crisis. Nevertheless, it is possible to identify certain patterns in terms of socio-economic vulnerability, feedback effects and social tipping points that can help improve our understanding of outcomes that result from interactions in a complex system that represents a society. Based on the example of the 2005 earthquake in northern Pakistan, this paper looks at the patterns observed in a crisis scenario in more detail and analyses it using agent-based models (ABMs). This simulation-based approach aims at understanding the dynamic relationship between the individual actions of agents at the micro level and the outcomes at the macro level. The first part of the paper explains the general strengths of using ABMs for exploring the dynamics of vulnerability to crisis situations, whereas the second part focuses on the analysis of socio-economic effects of exogenous shocks in small rural-urban economies. The agent-based model presented in this paper builds upon the replicated patterns of a regional Pakistani economy and simulates the impact of a shock on migration patterns and the resulting market dynamics. The aim of this paper is to highlight the importance and efficacy of using ABMs to better understand the complex interplay of individual agents and market systems in crises situations which goes beyond structuralistic analysis and linear models.

**Introduction**

In the past decade, the incidence of natural disasters has increased severely and due to the nature of their impact on local population many of them have been declared as "humanitarian crisis". A humanitarian crisis situation can vary in its social impact and origin ranging from immediate one-time shocks like earthquakes, flash floods, tsunamis, to recurring ones like floods and landslides to ones that manifest over an extended period of time where their effects have only recently started to become visible in the form of environmental changes and trends like global warming, environmental changes and coastal erosion as some of the examples. The interactions between the natural and the human system – both contributing to the origin and the impacts of crises scenarios – can be described as structurally complex because they involve many elements and subsystems on different scales such as the global climate system with its atmospheric or oceanic subsystems, different emitter groups, etc. (Acosta-Michlik and Espaldon 2008: 554). Especially the global climate change has challenged our "traditional" cause-effect-model conceptualizing disasters due to a triggering event and a limited number of root causes. The importance of considering these interactions becomes evident when human society has to mitigate or adapt to the multi-sectoral effects and where the severity of impacts depends on the underlying vulnerability and the adaptive capacity of the affected population (Farmer and Foley 2009; Cardona 2004). After outlining the theoretical framework and methodological approach, this paper looks at the impact patterns observed in crises scenarios in more detail as it takes into account a rural-urban economy system and analyses it from the perspective of agent-based modelling. While the focus in this paper is on humanitarian crises in small rural-urban economies where local population suffers from an immediate shock, the analysis can be extended or adapted to humanitarian crisis of various different natures.

In the last few years alone several crisis scenarios have occurred most of which happened in areas with rudimentary economies. Examples include several massive earthquakes (e.g., Pakistan 2005, China 2008, Indonesia 2009), floods (Bangladesh 1998, Mozambique 2007, India 2008) and disasters of other nature like landslides (Venezuela 1999, Philippines 2006), droughts and famines (North Korea 1996-98) which in the past have intermittently disrupted regions prone to these hazards. One such example that we will look in detail is the earthquake that hit northern Pakistan in October 2005 and has been labelled as one of the deadliest earthquakes in recorded history. This calamity officially killed over 73,000, critically injured around 100,000 and displaced over 3.3 million people within the span of a few days (ERRA-UN 2006: 3). Forced migration is one major consequence of disasters – in 2008 a total of approximately

36 million people were displaced globally as a result of sudden onset of natural disasters (UN-OCHA/IDMC 2009: 9). Such displacement on a massive scale not only causes a major shuffling of the local economy, it can lead to regional and transnational feedback effects as well which require a major policy oversight in order to reconstruct and resettle the lives of the displaced back to normal. Although data records usually exist for the amount of people displaced in the immediate aftermath of the disaster, there is a lack of information about migration patterns in the subsequent periods afterwards (UN-OCHA/IDMC 2009: 14). The simulation approach proposed in this paper offers the possibility to incorporate migration decisions and movements – both in the short-run and the long-run – to better understand and analyse the entire scope of the migration scenario including feedback effects on markets and regional population distribution. And hence it provides another way of analysing complex crisis interactions which can be done quite reasonably using agent-based models. According to the theory of complexity, behavioural complexity refers to the evolving and changing of systems over time, i.e. the system's history, due to the interactions of the constituent elements (Manson 2001: 406; Ratter 2009) which allows us to monitor how these variable evolve in a complex system.

The next step in understanding humanitarian crises in terms of which interactions may cause population displacement and migration is by defining the term "vulnerability". Vulnerability in general is the likelihood that a society will be exposed to and adversely affected by an exogenous shock due to its physical, socio-economic, ecological and political-institutional conditions which can vary over space and time. From an economics point of view, vulnerability is defined as the lack of ability to hedge against income shocks which are likely to happen in crisis situations. For example, in northern Pakistan, the economic impact of the earthquake on local population was immense: approximately 50-60 per cent of household income in that area comes from small rural agrarian farming most of which were destroyed or disrupted during the disaster. According to the initial assessment, the crop damages were estimated to be in the range of $ 300 million (ADP-World Bank 2005: 3) whereas this number went up significantly over the years (see for example ERRA-UN 2006; Zaidi et al. 2008).

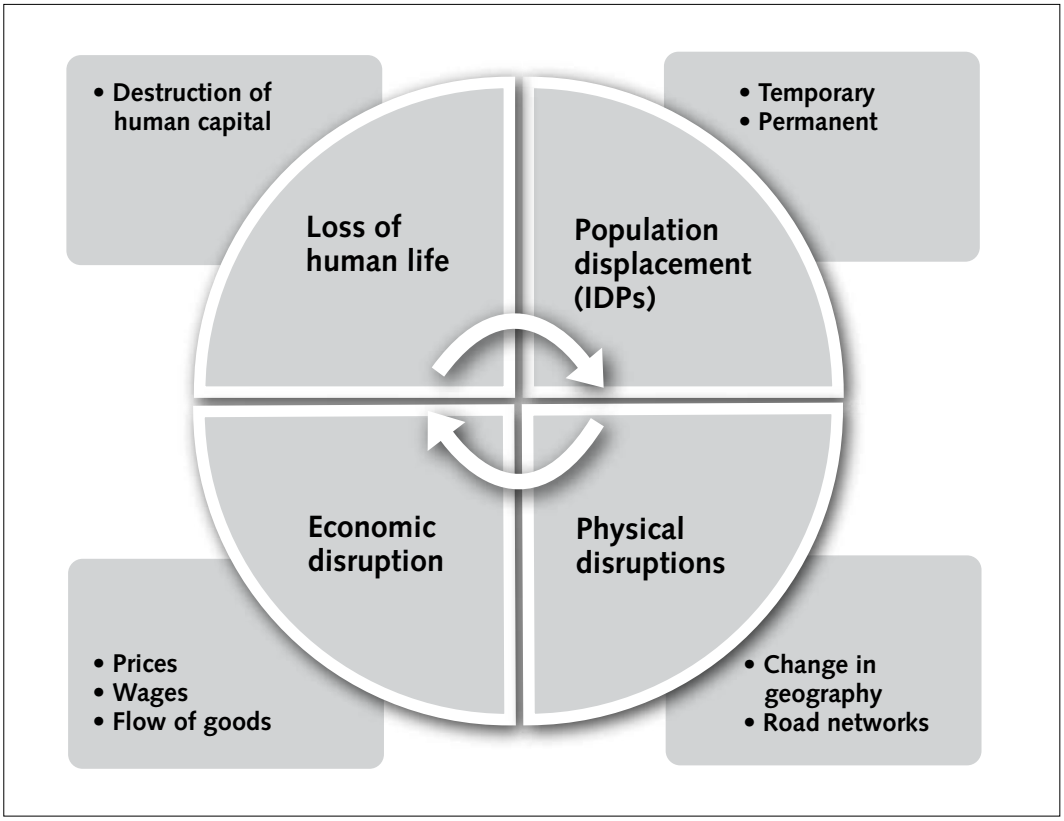



*Figure 1: The Feedback Effects of Exogenous Shocks on a Rural-Urban Economy Model (Source: Naqvi 2009)*

Disruptions caused by such shocks can feedback into economic activities (see Figure 1). For example, one type of disruption can be the reduction of labour power due to loss of human life which can then affect markets affecting prices, wages and flow of goods. This factor of vulnerability can also be extended to encompass physical disruptions especially of buildings and road infrastructure or in a more severe form, physical changes in geography. In northern Pakistan, the damage to the infrastructure was massive with over 500 health facilities and 6000 educational institutes destroyed or rendered non-functional (ERRA-UN 2006: 3). Physical damage to road networks was also immense where a large proportion of road networks were destroyed or blocked due to landslides. This paralysed relief activities and stymied population flows further escalating the situation.

On another note, although populations can be rendered vulnerable in the presence of an exogenous shock, vulnerability itself does not have to be a function of exposure to this shock; it is also shaped by individual human behaviour (Acosta-Michlik and Espaldon 2008: 554). Thus, vulnerability can vary from person to person and that is why vulnerability assessments are often conducted at the individual or household level. This concept of vulnerability stems from the very micro foundations of the society. Adapted to our example, it follows that if an individual does not have the means to sustain him- or herself in terms of consumption smoothing during a crisis situation and does not have the ability to ensure future income streams, this individual can be labelled vulnerable. These factors might eventually lead to forced migration where individuals move in search of economic opportunities for at least basic sustenance. This can also be substituted by external relief efforts as a form of providing alternative means for income flows. If such internal displacement does occur on a massive scale, it will inevitably lead to feedback effects across all sectors of the affected economy and these ripple effects might even spillover to unaffected areas such that the whole system might take time to settle down in the long-run. If these affected regions are unable to respond to such a shock both at the individual level and at the regional level, then these regions can also be labeled vulnerable. Moreover, if these feedback effects are very strong to the point that these regions become unsustainable in terms of unstable markets, this situation would eventually result in – or tip into – a humanitarian crisis which then requires external intervention.

Such feedback effects can quite reasonably be replicated in an agent-based modeling framework. By programming a small artificial society and subjecting it to various shocks we are able to monitor how it adjusts and settles down ex-post the shock. One of the strengths of agent-based models is its ability to monitor variables both at the micro individual level and at the macro regional level. Although we know the feedback effects of crises situations from real-disaster situations, the simulation provides a tool to explore the emergence of such macro patterns from the micro behaviour designed through interactions of the individual agents (Sawyer 2003: 329). In order to understand these interactions and thus the behaviour of a complex system it is not sufficient to analyse the system's components through conventional techniques due to another characteristic inherent in such systems: non-linearity. The individual components of a complex system interact in a non-linear way and can give rise to a high-level – so-called emergent – structure which cannot be simply explained from the behaviour of individual components themselves (Lewin 1993: 25). The occurring emergent behaviour evolving through non-linear interactions can differ from the behaviour of the constituent parts of the system and hence, can display surprising properties or unpredictable behaviour (Casti 1994: 40).

**Agent-Based Models**

ABMs allow the representation of complex systems into a simplified computational framework. These models consist of heterogeneous and autonomous agents, the system's constituent parts, which represent individuals, organizations or other social entities that interact within the computer environment (Arthur 1999; Arthur et al. 1997). Considering the concept of agents, research interest lies in the dynamic relationship between individual actions of agents at the micro-level leading to a social structure at the macro-level (Gilbert and Terna 2000: 61; Epstein 2006; Epstein and Axtell 1996). The method of agent-based modelling aims at describing, exploring and explaining social phenomena. Unlike in natural sciences, the principal value of ABMs in social sciences is above all not to specifically

make predictions but theory development, discovery of mechanisms, patterns and rules of the social reality (Gilbert and Terna 2000: 59). In social sciences, motivations to apply ABMs can vary conceptually (Axtell 2000, Axelrod 1997), in terms of theory or evidence-driven model development and validation (Moss 2008), as well as in a more or less accurate spatial representation of the environment.

ABMs are essentially micro simulations using a bottom-up approach. According to Sawyer, "the simulation consists of activating all of the agents and observing the macro behavior that emerges as the agents interact" (2003: 326). Although simulations are based on a theoretical understanding of the agent's behaviour and their interactions, the macro-behaviour generated from the simulation runs cannot always be predicted or derived from individual behavioural rules (Gilbert and Conte 1995: 150). Agents are autonomous, i.e. they act on their own assigned attributes, and through interactions produce social processes. Agents can form artificial societies which are embedded in the model environment. Model developers have to focus on the initial conditions and the dynamics of interactions, as well as compare it to the observed patterns of society to get a better understanding of emerging computational phenomena and the determining processes.

Building ABMs includes the identification of agents and their behaviour as well as agent relations and a theoretical understanding of agent interaction (Macal and North 2005: 9). Considering that agents act on their assigned abilities and features, relevant information about their behaviour and their environment has to be gained in order to explore a previously defined social phenomenon and its dynamics according to the following agent's characteristics and the model environment (Gilbert 2008: 21f.):

- Behavioural Rules of Agents: What is an agent capable to perceive and to perform (motion, communication, action)? How do they interact? What are the agent's goals? Which resources can an agent use to achieve these? How does an agent make decisions?
- Model Environment: What is represented in the environment? Does the model have spatial-temporal aspects? What types of constraints exist for the agents?

Why model vulnerability to exogenous shocks and crises scenarios with an agent-based approach? Agents are heterogeneous, that is they can be equipped with individually different behaviour rules, goals, endowments and resources and hereby may differ in their socio-economic vulnerability. The potential to represent heterogeneity of individuals and thus the dynamics of vulnerability, make it interesting for simulations and in particular for micro simulations (Sobiech 2009). Moreover by being able to integrate multiple agent types with autonomous behaviour and assigned behavioural rules in one model, their interactions can be monitored and evaluated especially in a crisis situation. These behavioural rules can be abstracted from the real world where the focus is kept on the key components the model is assumed to simulate (Epstein 2006: 18). These behavioural rules are easy to modify on the fly allowing the user to monitor sensitivities of parameters across the whole system. Analysing such a process using conventional economic modelling techniques would be cumbersome, for instance by manipulating the elements of stochastic matrices where simulations have to be stopped and elements of matrices have to be readjusted to track changes across parameters.

Another major strength of ABMs lies in the representation of interactions which enables the exploration and understanding of social processes and consequences (Comfort et al. 2004). It permits properties to emerge and thus to generate insights beyond the micro level inputs of the model. Such models are an ideal tool for connecting the micro with the macroeconomic level, and allow the researcher to zoom in and out through different levels of aggregation. Furthermore, computation makes scaling up possible rather than having to assume that simplistic behavioural rules testable under laboratory conditions will hold at higher levels. In virtual experiments different parameters and interactions can be tested in numerous simulation runs and considered for further theory development. Due to the fact that decision rules and thus agent's preferences can be included in the models, tests of different intervention strategies under changing environmental conditions can also be conducted. Recent examples of ABMs include processes of decision-making in land use and in water resources management to simulate the impact of mitigation and adaptation

measures necessary to reduce vulnerability in society (Krebs et al. 2007).

Furthermore, ABMs excel at modelling flows, which are of central interest in studying the impact of natural disasters, especially migration patterns. Temporal and spatial aspects can be taken into account in the environment of ABMs, which gets economic models off from a purely abstract conceptual domain by incorporating historical and geographical dimensions. This is likely to make policy recommendations derived from these models both more case-specific and more pertinent to real-life problems. Moreover, in standard economic analysis, events or parameters are assumed to be normally distributed. However in disaster situations, when these parameters are subjected to shocks, they usually exhibit fat-tailed distributions. Hence the assumption of normality may not adequately represent reality and conventional economic modelling might yield wrong results especially in disaster management analysis. Agent-based modelling can help identify and highlight these distributions where they can be extracted and analysed accordingly.

**Developing a Research Framework**

In this section we look at the processes through which information from regions which have actually faced a humanitarian crisis can be abstracted and converted into simulations. The agent-based model described below is based on certain stylized facts and general patterns from northern Pakistan like regional population, fraction of the population migrating, income levels, market dynamics and interactions. Although this model is very basic in nature, it highlights the efficacy of using ABMs in terms of showing interactions and feedback effects in crisis scenarios. In the next section the possibilities and extensions of developing a larger more complex model to better replicate the economy system will be discussed.

In order to build an agent-based model, certain key factors need to be identified. As the earlier discussion underscored the economic impact of a humanitarian crisis and how it can lead to forced migration and affect local markets and prices. Therefore the aim is to set up a baseline model that allows us to build an artificial economy where these variables can be monitored both at the micro and the macro level. The discussion of migration earlier inherently implies movement of populations from one region to another, hence a spatial dimension is automatically assumed in the model. This is achieved by setting up a model comprising separate market regions which interact with each other through road networks. This allows us to incorporate flows of goods and populations which use these road networks to form the basis of a circulating economy. As these flows take time to settle down and achieve stable trends, a time dimension also exists in the model where rates of adjustment can be monitored especially during crisis scenarios. Moreover, in order to assess the economic impact of a crisis scenario we focus specifically on shocks to markets in this economy.

To set up the model, first the space of the model needs to be defined which we call the environment. This environment is divided into two regions: a rural agrarian sector (villages) and an urban industrialized sector (cities) (see Figure 2). In the next step the agents are defined which in our case represent either workers or capitalists that interact based on their behavioural rules. For example workers harvest, consume and sell wheat in exchange for money in villages to buy a tradable good produced in cities. Capitalists hire workers as labourers and produce the tradable good in urban industries which they consume and sell both in the local market and in a foreign market giving them surplus profits. The labourers are paid wages which they use to buy both the goods produced in the economy. Depending on the location, the behavioural rules can be modified for example workers who are allowed to migrate between villages and cities where they can switch between being cultivators and labourers respectively.

As mentioned earlier, due to the spatial element of the model, a circular flow of goods also comes into play where the consumable good moves to cities and the tradable good moves to villages based on demand signals (see Figure 2). Markets are set up in the model such that a demand and supply mechanisms determines the price of wheat while the price of the tradable good is constant and set exogenously based on the assumption of that the foreign market will absorb all excess capacity forcing local prices to stay at a minimum. On the other hand, the wheat market supply responds to demand signals while prices adjust accordingly such that all the

goods in the market are sold at the current level of demand. Subsequently the demand for wheat responds to price signals and adjusts also. Hence all of the components of the wheat market – demand, supply and prices – cause feedback effects across each other which can eventually settle down showing stable trends. Another important component of the model is the agents' decision to migrate from villages to cities or back which in our case is determined by income differentials. Since this model is looking specifically at the economic side of a crisis situation, it is reasonable to assume that the normal rural-urban migration occurs based on purely better economic opportunities which for simplicity translate in attaining a higher income level. As cultivators earn income from selling wheat and labourers are paid wages from producing goods in cities, real income differentials are easily calculated which allows the agents to determine migration decisions from one region to another. Migration flows occur until real incomes across all regions are equalized. From the perspective of translating this into the model we have to ensure that these decisions are not discrete such that the whole population gets up and moves if an income differential exists. Therefore, probabilistic decisions are incorporated in the model using logistic functions which can be calibrated for speed of adjustment. This gives an interesting insight from the point of view of a humanitarian crisis. Any crisis that causes an income shock in one region of economy will exacerbate income differentials and will naturally lead to increased migration flows. The feedback effects this outcome will be reflected across wages, prices, demand and supply of goods, as they adjust to population flows.

This formulation of a basic economy gives us the platform to shock the system in various ways and allows us to monitor variables across the system. Various configurations of shocks can

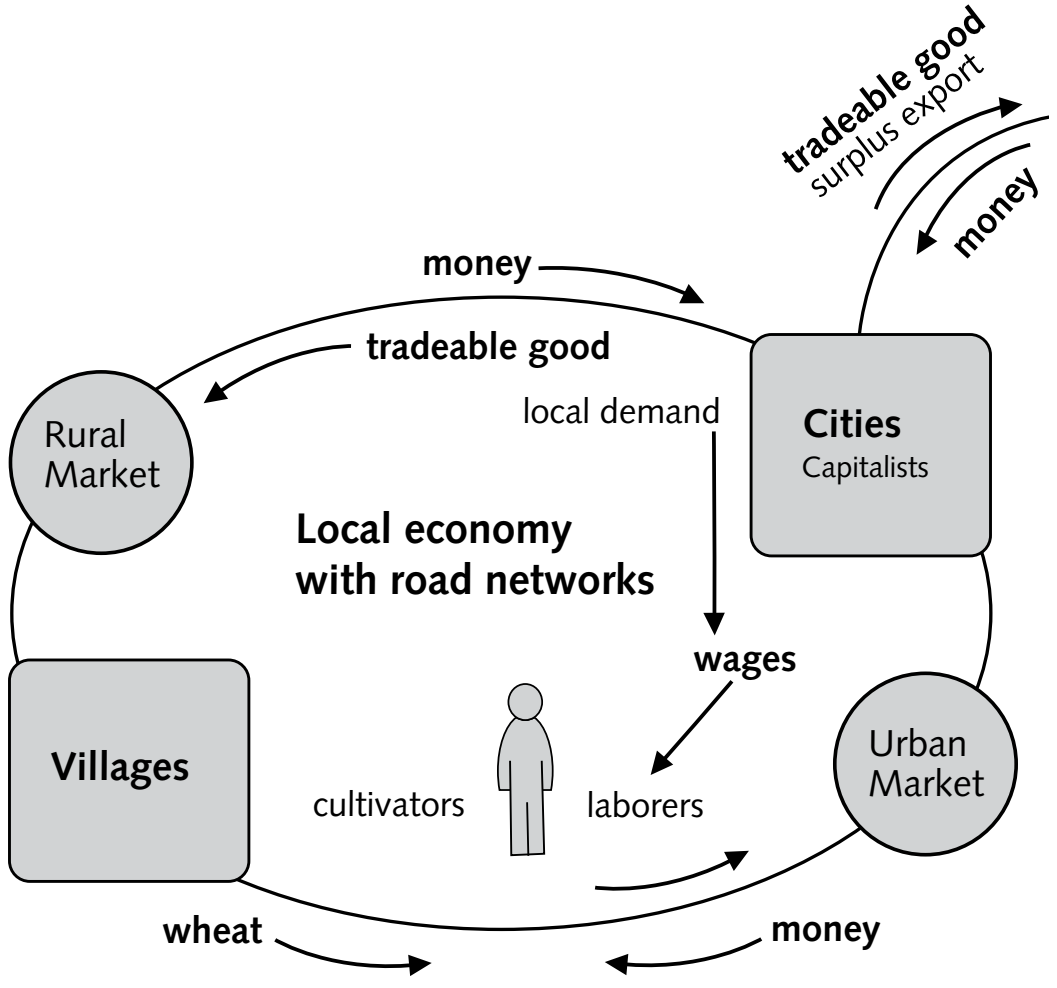



*Figure 2: A Stylized Circulating Capital Economy (Source: Naqvi 2009)*

be tested on the system, like productivity loss in villages, disruption of road networks or physical destruction of regions, chosen as some examples that can influence economic outcomes both in the short-run and in the long-run. Patterns across markets and migration flows can be easily tracked for each type of shock and allows us to track the magnitude and duration of feedback effects. The interplay of all these mechanisms are mapped out in a simulation environment programmed in NetLogo (Wilensky 1999), a software developed for agent-based modelling where variables can be monitored both at the micro agent level and the macro regional level.

**Simulating Shocks: A Simple Experiment**

For the purposes of illustration, one experiment is presented in the model in which wheat productivity is shocked in one village and its impact monitored on migration flows and markets. The structure of the model is a simple 2 village, 2 city economy as shown in Figure 3 below where the model is set up on a 100 by 100 box grid in NetLogo. The regions are shown as circle patches marked as villages or cities, where these regions are connected by lines representing road networks.

Village 1 and city 1 are referred to as region 1, while village 2 and city 2 form region 2. This classification has been made just to distinguish patterns of migration across regions and does not impact any decision-making process. All decisions made in the model are purely economic ones, where a higher income is preferred to a lower one for migration and a market offering a higher price is preferred to a lower one for selling of goods. As mentioned before, these decisions are made probabilistically where higher differentials give a higher weight to regions offering better economic opportunities. In other words, once cultivators decide to migrate, they choose the city to migrate to with a higher chance of selecting the one offering a higher wage (for a detailed description of the model and parameterization of the economy see Naqvi (2009)). Decision-making through probabilities is common in agent-based modelling and is incorporated to avoid discrete jumps which in our case would translate into any slight increase in real income in cities causing the whole village population to migrate.

Once the simulation starts, the system is allowed to reach stable oscillations across markets. Equalization of real income across regions comes about through natural migration flows (see Graph 1). As population flows settle down, prices, demand and supply of goods also stabilize such that no irregular patterns are observed. The system is shocked at day 700 in village 1 where wheat

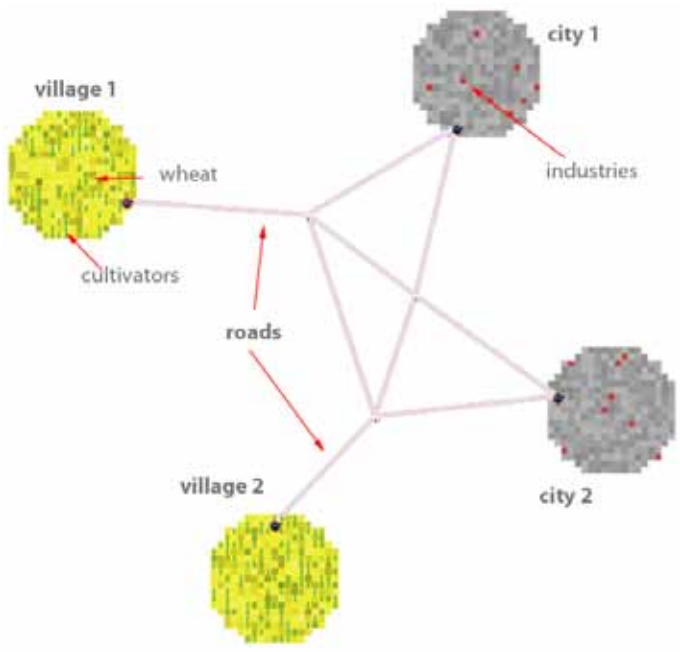
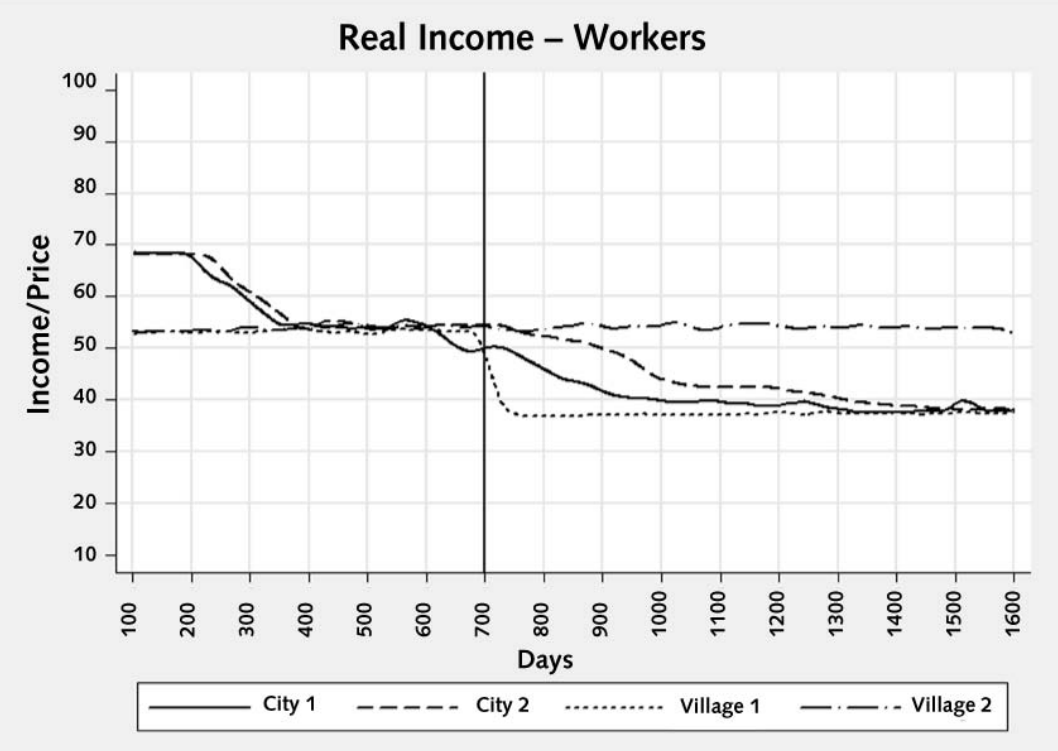



*Figure 3: Simulation Model (Source: Naqvi 2009)*

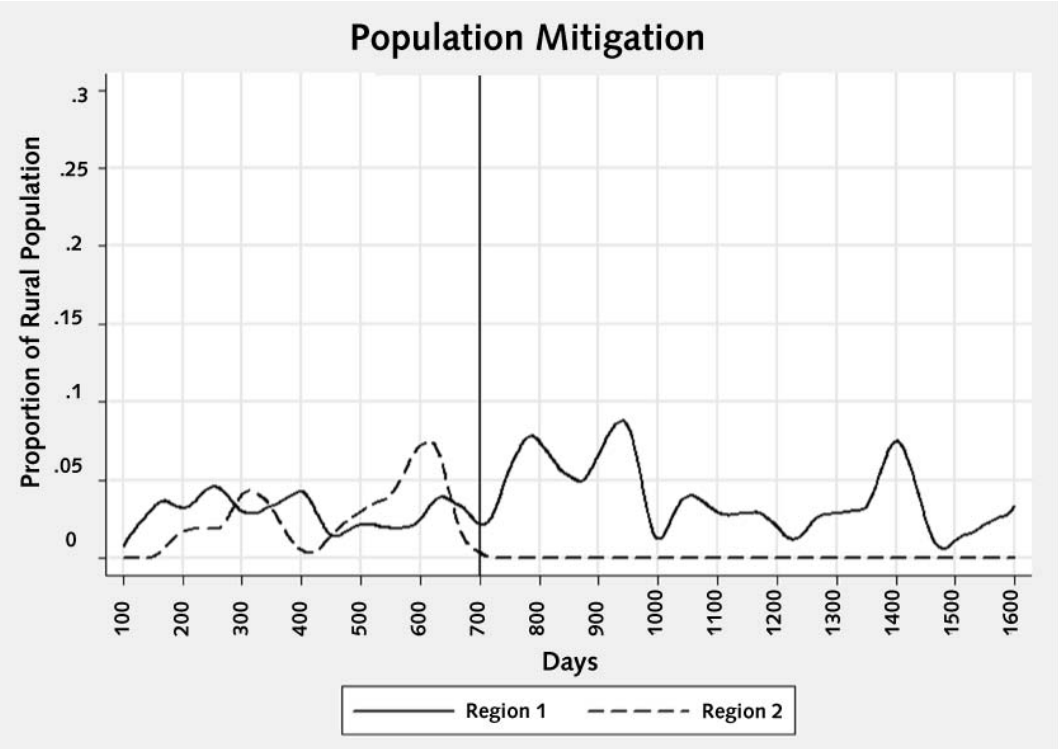
productivity is reduced by half. The results across migration and market variables are discussed below:

**Population Flows:**

Graph 1 shows real incomes across regions. In the first half of the Graph 1, real income is equalized across all regions over time.




*Graph 1: Real Income across Regions*



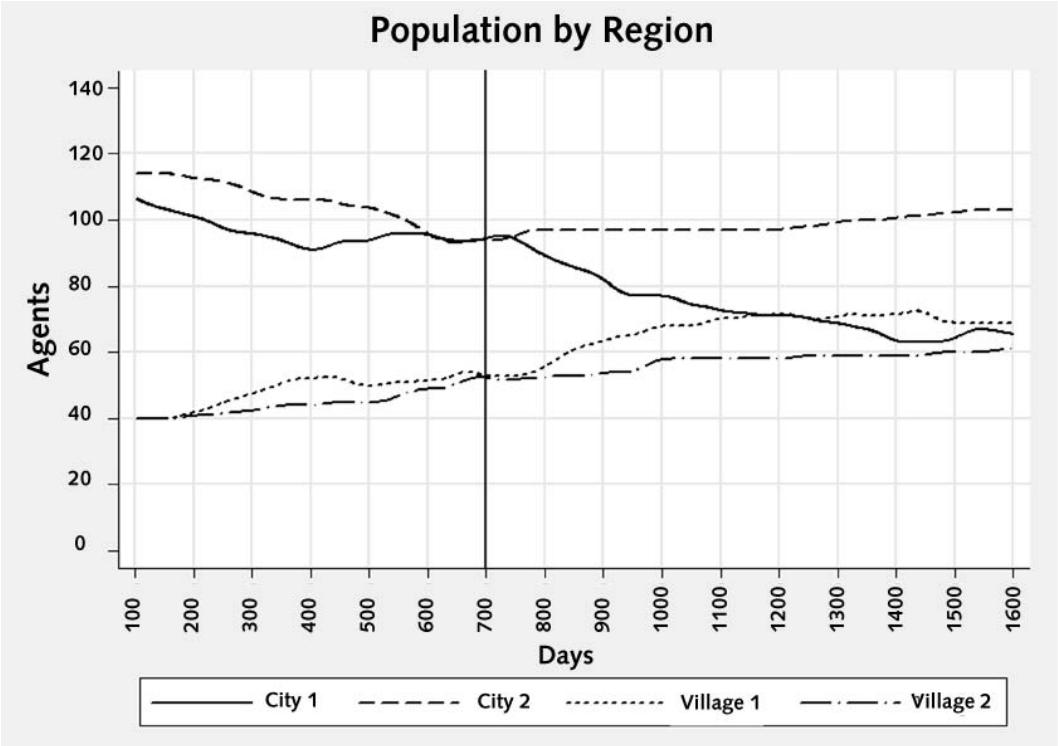

*Graph 2: Proportion of Village Population Migrating*

On day 700, productivity is shocked (reduced to half) in village 1 which causes real income of cultivators in village 1 to drop suddenly.

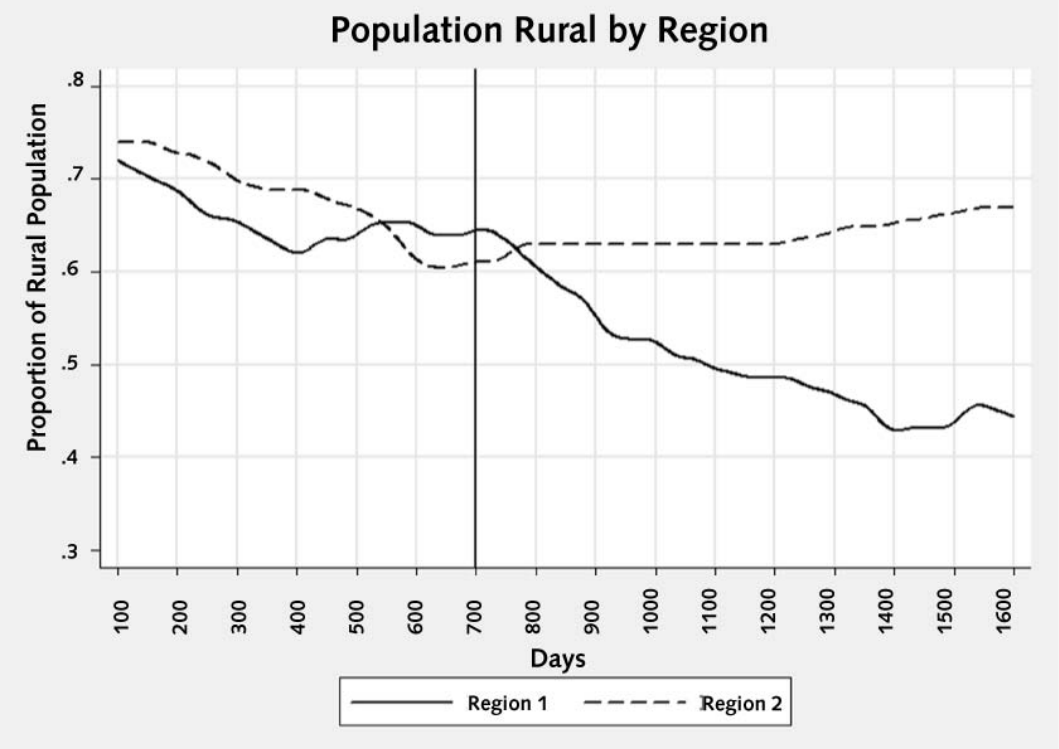
This differential causes the population from village 1 to start migrating to the other two cities decreasing the wages and therefore the real income there as well. As village 2 is unaffected, it ends up having a higher real income than all the remaining regions.

The impact of this is that rural-urban migration from village 2 to cities stops as workers in village 2 no longer have the incentive to migrate. As can be seen in Graph 2 below, the dotted line representing proportion of workers from region 2 migrating from villages to cities goes to zero while populations migrating from village 1 takes over in supplying the labour workforce across the cities. Moreover since this graph represents the percentage of existing village population migrating, the persistent pattern shows more and more forced migration from village 1 to cities. Graph 3 below looks at the absolute populations across these regions which give a clearer picture of flows.

In the long run some interesting population distribution patterns are also observed. Region 1 shows a sharp decline in rural population, while region 2 is forced to accommodate back-migration as increasing population pressure in cities causes real income level to go down. Village 2 in the long run ends up having more population than at initial levels as better income opportunities cause workers to migrate back to this village.



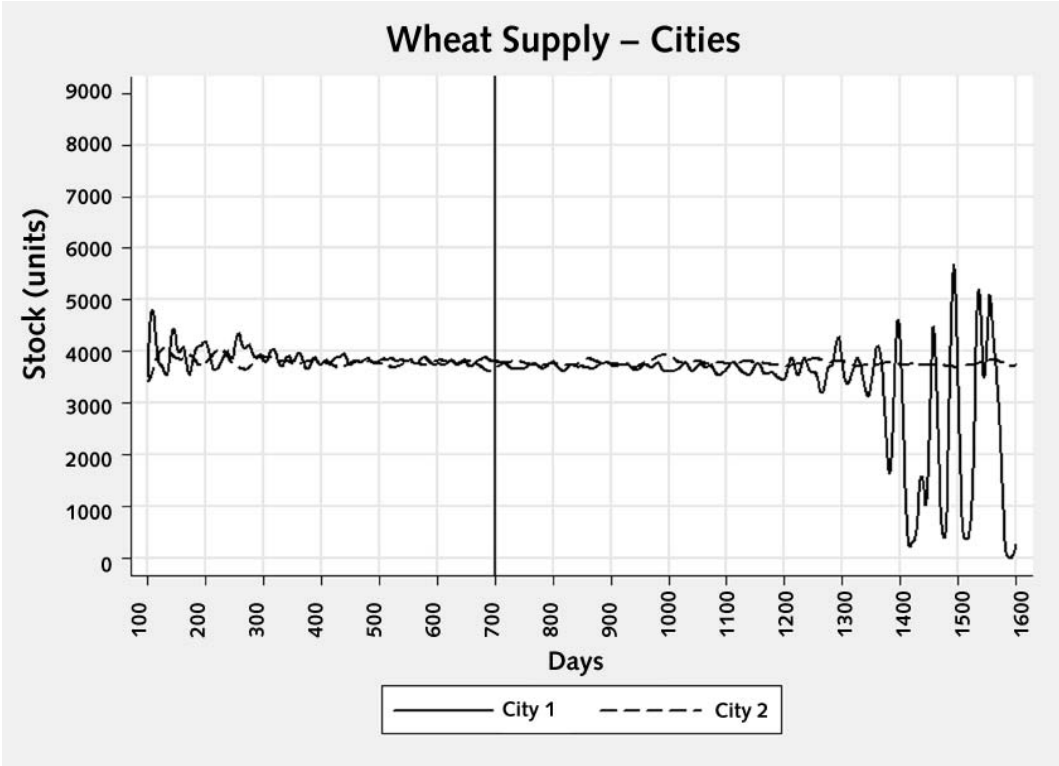

*Graph 3: Populations by Region*



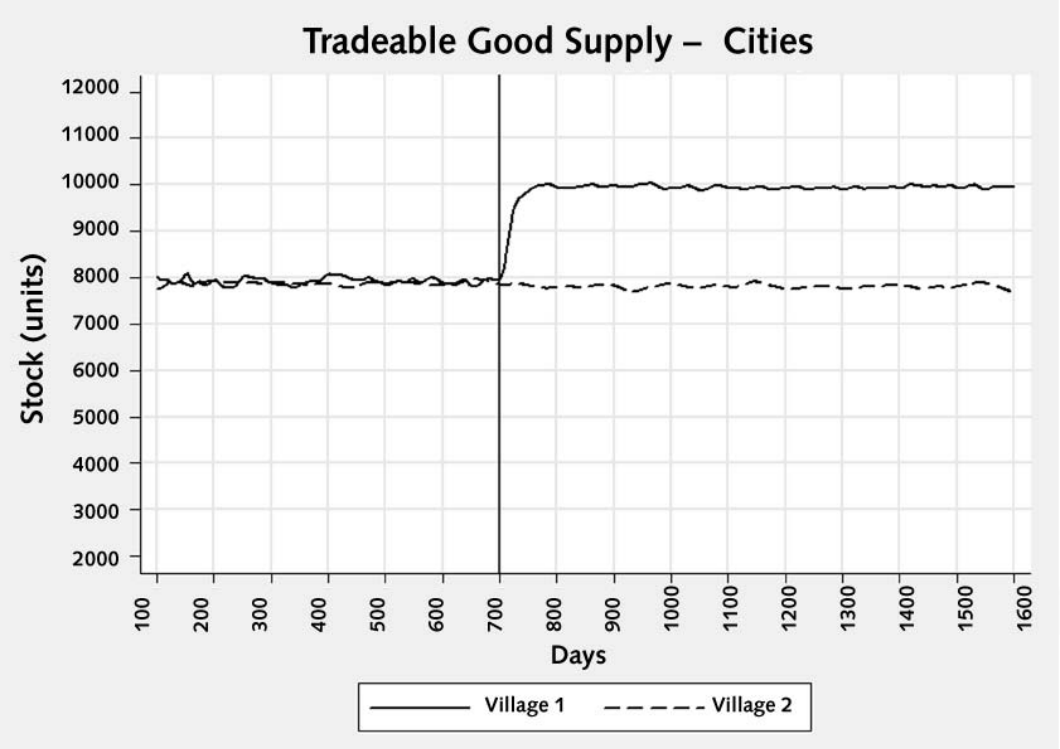

*Graph 4: Proportions of Rural Population*

**Impact on Markets:**

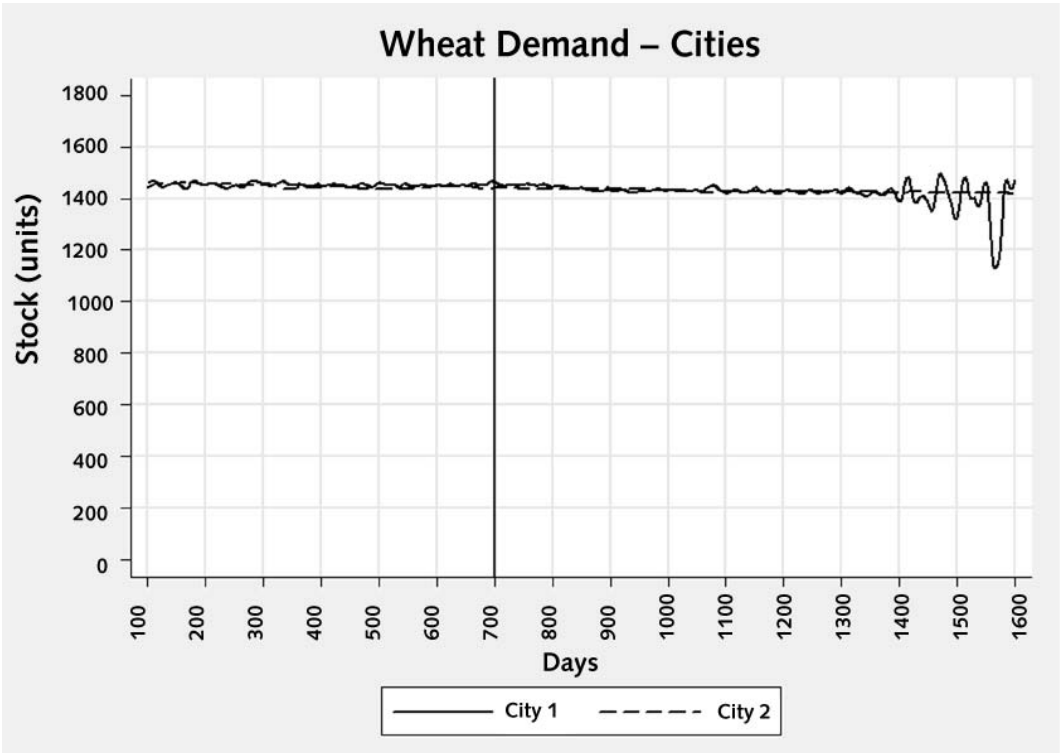
To look at the impact of this shock on goods markets, the wheat market in cities and the tradable good market in villages are monitored. Graph 5 below shows the impact on the supply of each commodity. As there is a loss of productivity in village 1, the supply stream of wheat decreases over time and eventually hits a capacity constraint due to increasing demand in cities caused by rising population (Graph 6).




*Graph 5.1 : Supply of Wheat in the Cities*

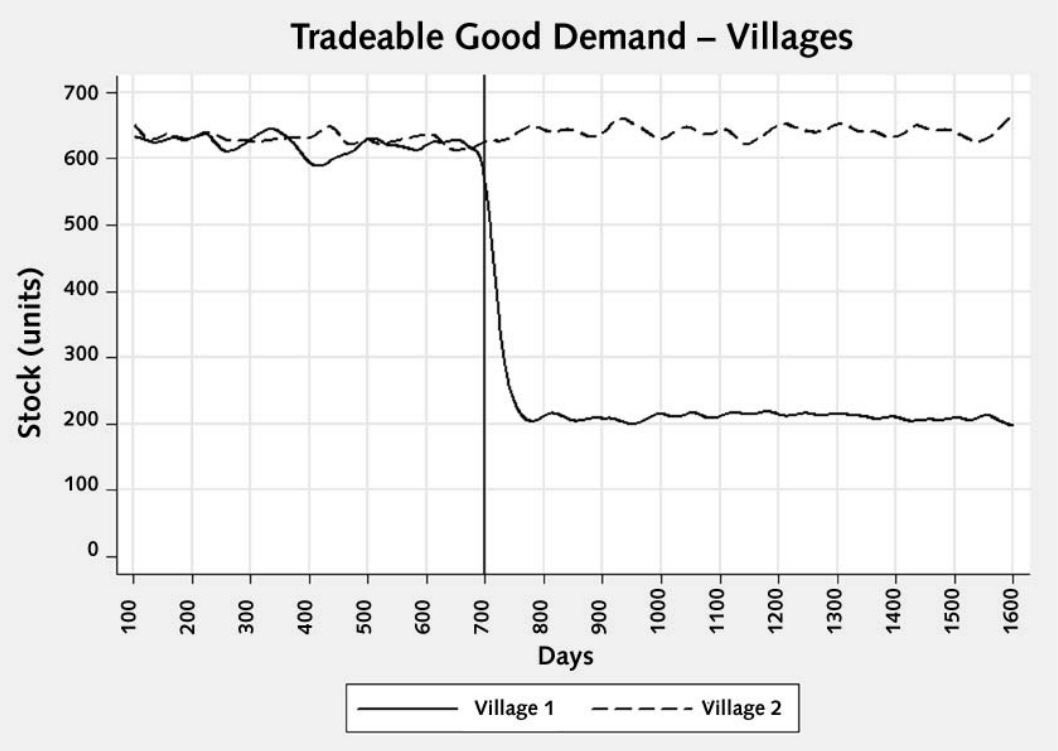



*Graph 5.2 : Supply of Tradeable Goods in the Villages*



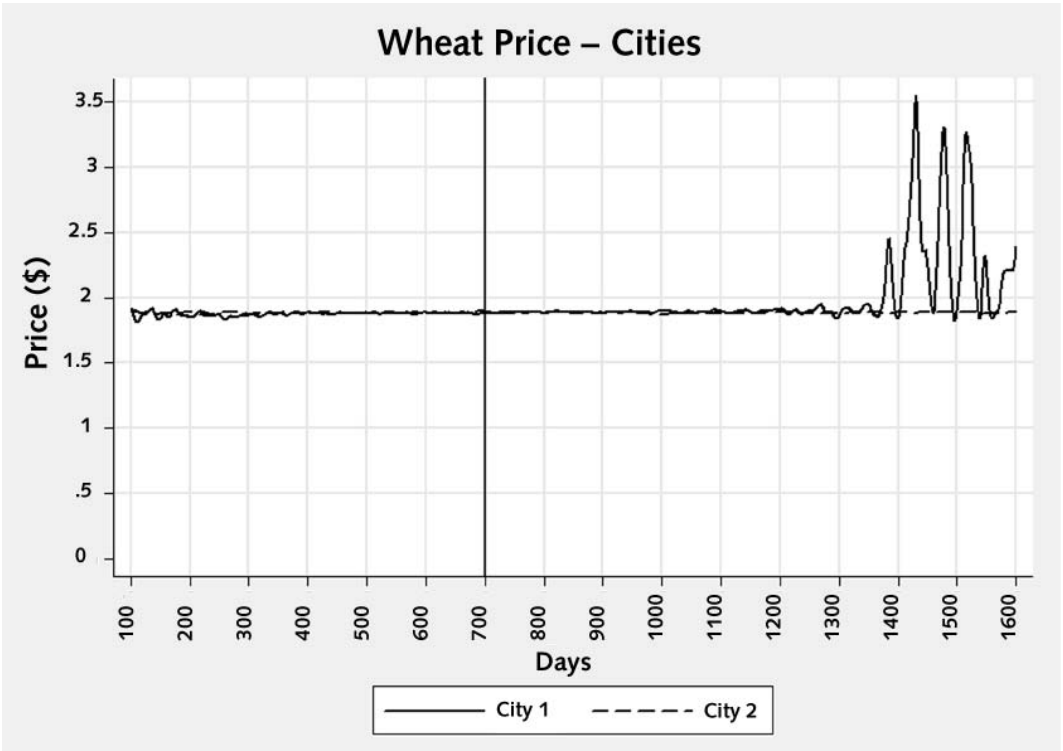

*Graph 6.1: Demand of Wheat in the Cities*

Looking at the demand stream in Graph 6, the tradable good market in village 1 is now over-supplied as a proportion of the population starts migrating to nearby cities. This causes a sharp decrease in demand in village 1 where the existing tradable good stock is now under-utilized.




*Graph 6.2: Demand of Tradeable Goods in the Villages*

As above-mentioned, in this version of the model, prices of the tradable good are assumed fixed. On the other hand, the price of wheat in cities is determined by demand-supply mechanisms in local markets. Since equilibrium conditions dictate that demand should equals supply, to meet this criterion the prices of wheat are set such that they clear the market. All three of these variables are determined endogenously in the system. For wheat the feedback caused by fluctuating demand and supply on prices is monitored in Graph 7 below. The wheat price graph




*Graph 7.1: Wheat Price in the Cities*


*Graph 7.2: Tradeable Good Price in the Villages*

above shows heavy spiking after the shock. The mechanism behind this is simple: a reduction in supply due to loss of production in village 1 causes the prices to increase since wheat demand in cities initially remains the same. This increase in prices causes the demand to decline as workers hit a budget constraint due to falling wages caused by an increasing urban population from the shock-affected village 1. The suppliers respond to the rising wheat price by increasing the supply in urban markets. As the supply increases, the demand initially remains the same and once again prices adjust by going down forcing the demand to go up again. These iterations continually repeat in the form of feedback effects. If the suppliers are unable to meet the local demand due to capacity constraints then the feedbacks become stronger forcing the wheat market to oscillate out of equilibrium as is the case above in our example. This result is not far from reality as spiking of prices of basic commodities is usually observed in crises scenarios highlighting the need for intervention in terms of price regulations or some form of relief through external supply.

**Conclusion**

The application of agent-based modelling for the simulation of humanitarian crises and socio-economic vulnerability has two implications: a technical and a conceptual one. A model has been developed in order to simulate the socio-economic effects of exogenous shocks in small rural-urban economies based on the replicated patterns of a regional Pakistani economic system. The fairly simple rural-urban system was shocked by an extreme exogenous event which caused direct impacts such as experienced during the 2005 earthquake in Pakistan. Before the shock hit village 1, the system was oscillating around a stable equilibrium in terms of real income, migration rates, prices, as well as demand and supply of goods. Changing of one variable (village 1) caused feedback effects in the whole system because of the interactions between the system´s components which were represented as flows of goods and population movements. These feedback effects emerged in the model because the agents interacted on their assigned behaviour rules, i.e. on individual decisions to compensate income differentials. During the simulation a process of overlapping effects affecting all regions could be identified which lead to unexpected impacts. Or in other words, from the micro-behaviour of agents in one region of the system, feedback effects resulted across the whole macro regional economy of the system. These results cannot be understood solely from the behaviour of the constituent parts of the system. Although

the primary rapid system change is provoked by an exogenous shock, as the socio-economic system components interact in the aftermath of the disaster, complex behaviour and feedback effects are produced. The simulation approach thus facilitates the observation of short and long run changes in population distribution patterns after a disaster and shows interesting results such as the increase in population in village 2.

Impacts on markets can also be shown in this simulation example. The rapid redistribution of population leads to feedback effects in demand and supply which are reflected in the spiking of wheat prices, an outcome which can also happen in the aftermath of a disaster in reality. This again shows a counter-intuitive behaviour of the system: the agents in the model decide to migrate in order to compensate their economic vulnerability to the shock but thus feedback effects are produced which cause strong spiking forcing the wheat market to oscillate out of equilibrium. This last example about spiking of wheat prices again showed the dynamic relationship between the micro and the macro level. But it also highlighted that if these interactions were understood more clearly, e.g. with agent-based modelling approaches, social tipping points leading to humanitarian crises may be better prevented. As already mentioned, the importance of considering these interactions becomes evident when human society has to mitigate or adapt to multi-sectoral effects and where the severity of impacts depends on the underlying vulnerability and the adaptive capacity of the affected population. Our example showed that even in fairly simple systems, these interactions can have unexpected effects.

Although the model in this first implementation does not represent a high degree of structural complexity so far, other changes in the natural and human system may be incorporated in a more complex model and may even better represent the interactions in the subsequent periods after the disaster. This could be done for example in the simulation of secondary effects such as the blocking of roads due to landslides. The important thing to realize about using agent-based modelling is that calibration of parameters should resonate with stylized facts to come up with a significant policy analysis – otherwise it just becomes an exercise in programming. The model presented in this paper showed how information from a rudimentary economy, like the one in northern Pakistan, can be abstracted and certain stylized facts can be replicated in a simple simulation. While the aim of this model has been primarily to understand socio-economic vulnerability caused by shocks to the system, ABMs can be set up to incorporate any kind of social or non-social factors that involve feedback effects.

Another natural extension of such models is the integration of Geographical Information Systems (GIS). These simulations can be done on a more accurate geographically referenced scale. As mentioned earlier, the inspiration for the model came from the catastrophic earthquake that hit Pakistan in October 2005 and lead to massive causalities and major displacement of population. There was and still is a lack of a substantive policy planning even though efforts are continually being made. Larger simulation systems with integrated GIS can help with analysing patterns of stocks, flows and population both at the micro and macro level. From a policy perspective, resettling of population is a long-term process which takes years. ABMs allow us to simulate and test various scenarios in one model. Although this approach is unconventional in analysing the impact of humanitarian crises, other disciplines have successfully adapted this tool for analysing crises scenarios. A recent example is Epstein's work on simulating the spread of the H1N1 (influenza subtype) virus through the US and subsequently the whole world with 6.5 billion agents (Epstein 2009). While the model can be developed much further in terms of its complexity, it does highlight the potential power of simulations given the current state of processing capabilities available. Thus ABMs provide an interesting approach to analyse and better understand the interactions in systems and may help in order to better prepare for social tipping points leading to humanitarian crises and other complex disasters such as climate change and environmental migration which challenge the human population.

**References**


Acosta-Michlik, L.; Espaldon, V. (2008): Assessing vulnerability of selected farming communities in the Philippines based on a behavioural model of agent's adaptation to global environmental change. In: *Global Environmental Change*. vol. 18, no. 4, pp. 554-563.

ADB-World Bank (2005): *Preliminary Damage and Needs Assessment*. <http://siteresources.worldbank.org/PAKISTANEXTN/Resources/Publications-and-Reports/CompleteReport.pdf>, 31 October 2009.

Axtell, R. (2000): *Why Agents? On the Varied Motivations for Agent Computing in the Social Sciences*. Working Paper No. 17. Center on Social and Economic Dynamics, Washington DC.,USA. <http://www.brookings.edu/es/dynamics/papers/agents/agents.pdf>, 15 June 2009.

Arthur, W. B. (1999): Complexity and the economy. In: *Science*. vol. 248, pp. 107-109.

Arthur, W. B.; Holland, J.; LeBaron, B.; Palmer, R.; Taylor, P. (1997): The Economy as a Complex Evolving System II. In: Arthur, W.; Durlauf, S.; Lane, D. (Eds.): *Santa Fe Institute Studies in the Sciences of Complexity*. Addison-Wesley, Massachusetts. vol. 27, pp. 15-42.

Axelrod, R. (1997): *The Complexity of Cooperation: Agent-Based Models of Competition and Collaboration*. Princeton University Press, New Jersey.

Cardona, O. D. (2004): 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.; Frerks, G.; Hilhorst, D. (Eds.): *Mapping Vulnerability – Disasters, Development & People*. Earthscan, London. pp. 37-51.

Casti, J. L. (1994): *Complexification. Explaining a Paradoxical World through the Science of Surprise*. Harper Perennial, New York.

Comfort, L. K.; Ko, K.; Zagorecki, A. (2004): Coordination in rapidly evolving disaster response systems: the role of information. In: *American Behavioral Scientist*. vol. 48, no. 3, pp. 295-313.

Epstein, J.; Axtell, R. (1996): *Growing Artificial Societies: Social Sciences from the Bottom Up*. MIT Press, Massachusetts.

Epstein, J. (2006): *Generative Social Science. Studies in Agent-Based Computational Modeling. Princeton Studies in Complexity*. Princeton University Press, Princeton/Oxford.

Epstein, J. (2009): Modeling to contain pandemics. In: *Nature*. vol. 460, pp. 687.

ERRA-UN (2006): *Early Recovery Plan*. <http://www.unicef.org/pakistan/partners_1622.htm>, 28 October 2009.

Farmer, J. D.; Foley, D. (2009): The economy needs agent-based modeling. In: *Nature*. vol. 460, pp. 685-686.

Gilbert, N. (2008): *Agent-Based Models. Quantitative Applications in the Social Sciences 07-153*. Sage Publications, Los Angeles/London/New Delhi/Singapore.

Gilbert, N.; Terna, P. (2000): How to build and use agent-based models in social science. In: *Mind and Society*. vol. 1, no.1, pp. 57-72.

Gilbert, N.; Conte, R. (1995): *Artificial Societies. The Computer Simulation of Social Life*. UCL Press, London.

Krebs, F.; Elbers, M.; Ernst; A. (2007): *Modelling Social and Economic Influences on the Decision Making of Farmers in the Odra Region*. Proceedings of the 4th European Social Simulation Association Conference. Toulouse/France.

Lewin, R. (1993): *Die Komplexitätstheorie – Wissenschaft nach der Chaosforschung*. Hoffmann und Campe Verlag, Hamburg.

Macal, C. M.; North, M. J. (2005): *Tutorial on Agent-Based Modeling and Simulation*. Proceedings of the 2005 Winter Simulation Conference. Orlando/Florida/USA. <http://www.dis.anl.gov/publications/articles/Macal_and_North_ABMS_Tutorial.pdf >, 09 September 2008.

Manson, S. M. (2001): Simplifying complexity: a review of complexity theory. In: *Geoforum*. vol. 32, pp. 405-414.

Moss, S. (2008): Alternative approaches to the empirical validation of agent-based models. In: *Journal of Artificial Societies and Social Simulation*. vol. 11, no. 15. <http://jasss.soc.surrey.ac.uk/11/1/5.html>, 15 June 2009.

Naqvi, S. A. A. (2009): *Simulating Shocks in Small Rural-Urban Economies: An Agent-Based*

*Model*. Ph.D. Dissertation. New School for Social Research / Department of Economics. New York.

Ratter, B. M. W. (2009): Complexity and Emergence. Key Concepts in Non-Linear Dynamic Systems. In: Glaser, M. et al. (Eds.): *Human/Nature Interactions in the Anthropocene: Potentials of Social-Ecological Systems Analysis*. Oekom Verlag, München. (in print)

Sawyer, R. K. (2003): Artificial societies: multiagent systems and the micro-macro link in sociological theory. In: *Sociological Methods Research*. vol. 31, pp. 325-363.

Sobiech, C. (2009): *How Can an Agent-Based Modelling Approach Help to Understand Dynamic Vulnerability Leading to Humanitarian Crises in Complex, Non-Linear Systems*? Paper for the fourth Summer Academy on Social Vulnerability. July 2009.

UN-OCHA/IDMC (2009): *Monitoring Disaster Displacement in the Context of Climate Change*. Findings of a study by the United Nations Office for the Coordination of Humanitarian Affairs and the Internal Displacement Monitoring Centre, Geneva. <http://www.internal-displacement.org/8025708F004BE3B1/(httpInfoFiles)/12E8C7224C2A6A9EC125763900315AD4/$file/monitoring-disaster-displacement.pdf>, 2 December 2009.

Wilensky, U. (1999): *NetLogo*. <http://ccl.northwestern.edu/netlogo>. Centre for Connected Learning and Computer-Based Modeling. Northwestern University, Evanson, IL.

Zaidi, S; Kamal, A; Ishaque, M. A.; Khalil, H.; Sehgol, A. Z.; Shafi, N.; Sharif, Z. (2008): *Ruins to Recovery*. Lahore University of Management Sciences, Lahore

## Crises Prevention and Climate Change Adaptation in the Coupled Social-Ecological Systems of the Mekong Delta, Vietnam: The Need for Rethinking Concepts and Policies

*Matthias Garschagen*

**Abstract**

The Mekong Delta in Vietnam suffers from a double burden as it has a long history of disasters related to natural hazards and is widely considered one of the global hot-spots in terms of climate change related risks. At the same time, the Delta experiences dynamic changes in vulnerabilities owing to comprehensive political, economic and especially ecological transformation processes. Based on ongoing empirical research the paper analyses how far recent conceptual approaches to describe and enhance resilience in coupled social-ecological systems provide useful guidance for decision- making and for steering resilience improvements with the goal of preventing system collapses and humanitarian crises. The paper argues that the concept of adaptive renewal cycles (Holling 1986; Gunderson and Holling 2001; Berkes et al. 2003) provides valuable insight into the development of vulnerabilities in coupled social-ecological systems. However, based on the institutional analysis in the Delta, it is argued that the concept needs to be supplemented and made more specific in order to offer transferable guidance for precautionary adaptation in the context of climate change. An advancement of the concept is, hence, proposed and criteria for improving its transferability discussed.

### Introduction

#### The Mekong Delta's Overlaying Problems of Disaster Risk, Climate Change and Resilience in Coupled Social-Ecological Systems

The Mekong Delta in Vietnam can be described as a series of tightly coupled social-ecological systems in which multifaceted vulnerabilities exist to ecosystem degradation, conventional natural hazards and climate change impacts. These vulnerabilities are highly dynamic as they are shaped by ongoing socio-economic and political transformation processes which affect livelihood capitals in multiple direct and indirect ways. The most important of these developments are, firstly, comprehensive agricultural intensification (Ni et al. 2001); secondly, soaring dependencies on international food prices due to the intensifying export orientation and integration in global commodity markets; and lastly, growing social inequalities and changes in public security nets resulting from the transformation from a centrally-planned to a market-oriented economy (Taylor 2004; Adger 2000).

In addition, the Delta has a long history of being exposed to various natural hazards of which the most important one is flooding. Although people have produced over the centuries substantial local knowledge to cope with, adapt to and protect themselves against their hazardous environment and actually succeeded in turning these pre-conditions into very productive systems, natural hazards remain a major trigger for disasters and humanitarian crises. Between 2000 and 2002, for example, the Mekong Delta experienced nearly 1,000 casualties and substantial economic losses due to floods and storms (Nguyen 2007). Further, recent studies predict that risks associated with environmental hazards are very likely to increase drastically with climate change. As per current population patterns, a sea level rise of one metre would directly affect almost one third of the Delta's area (including roughly 10,000 square kilometres of agricultural land) and over one quarter of its 18 million inhabitants, i.e. around 4.8 million people (see Figure 1) (Carew-Reid 2008). Next to the risk of direct inundation, sea level rise entails the risk of substantial salinization, potentially affecting agricultural production and freshwater supply far beyond the lines of direct inundation. Moreover, climate change is predicted to alter precipitation patterns (i.e. increase in amount and an even stronger concentration in the rainy season), hence, aggravating flood risks (Hoang and Tran 2006; Chaudhry and Ruysschaert 2007). Resulting from an overall rise in air and sea surface temperature, it is further expected that the typhoon activity in the South China Sea is going to intensify (Elsner et al. 2008); therefore, leading to an increase in number and intensity of typhoons making landfall in Vietnam and the Mekong Delta (CSFC 2004).

In combination, the social vulnerabilities and ecological degradation processes on the one hand and natural (climate change related) hazards on the other, create a highly dynamic risk-nexus which potentially can cause so-called

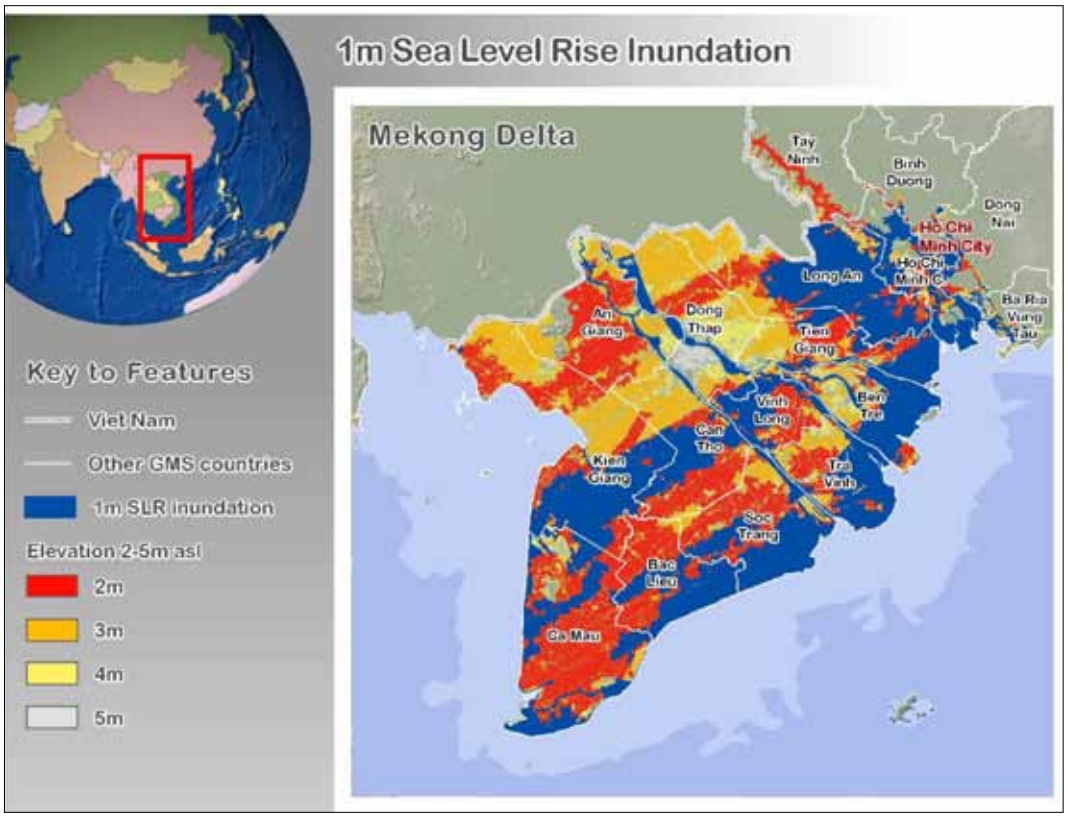



*Figure 1: Impact by Sea Level Rise in the Mekong Delta. Source: adapted from Carew-Reid 2008, p. 28*

complex-emergencies (Müller-Mahn 2005) that could trigger the Mekong Delta to tip into humanitarian crises. However, those crises are not inevitable as system dynamics are strongly shaped by human activity and can in general be changed, thereby, reducing vulnerabilities and improving the systems ability to deal with (external) disturbance and (internal or external) stress. One example for such interrelations are the rising water levels which can be observed over the last two decades in the central parts of the Mekong Delta and which are to great extent to be explained by embankment projects further upstream (own fieldwork and interviews with planners and government officials in Can Tho City and Ho Chi Minh City 2009).

It, therefore, depends on political, social and legal institutions (comprising paradigms, perceptions, laws, formalized organizations, planning and management structures) to mediate between actors and their interests and to shape decisions and strategies which eventually are decisive for possible futures with high or low likelihood of humanitarian crises.

The discourse on resilience has in this context gained substantial attention as it is often referred to as a guiding concept for improving the ability of coupled systems to keep up functionality in spite of perturbation and to reorganize and develop new structures (Walker et al. 2006). Based on the analysis of official policies as well as interviews with decision makers in various planning agencies at province, district and ward level in the province of Can Tho, Mekong Delta, this paper therefore analyses how far existing theoretical frameworks in the field of resilience provide useful guidance for shaping institutions (on the ground). The hypothesis underlying this analysis is that in particular the concept revolving around adaptive renewal cycles in coupled social-ecological systems (Holling 1973, 1986; Gunderson and Holling 2001; Berkes et al. 2003) can be a valuable analytical and didactical tool, given, however, that certain propositions and concept components are supplemented and concretized in order to improve the concept's transferability into decision-making, in particular with respect to climate change conditions.

**Coupled Social-Ecological Systems and Resilience**

Over the last years, the scientific school revolving around the analysis and conceptualization of resilience in coupled social-ecological systems (CSESs) has gained substantial influence in a wide

range of disciplines. Terms and concepts have thereby been taken up and modified by numerous research initiatives with various backgrounds and underlying epistemologies, ontologies and methodologies. Defining the common message or key concept of resilience science in the context of CSESs therefore becomes increasingly difficult. However, referring to the essential and most influential approaches coming out of the ecology-dominated Resilience Alliance (www.resalliance.org), the main underlying thoughts can be summarized as follows (compiled from Folke 2006; Berkes et al. 2003; Walker et al. 2004, 2006):

Human activity shapes ecosystem dynamics from local to global scales. At the same time human societies and economies rely heavily on goods and services provided by ecosystems. Social and ecological systems are therefore tightly interconnected and merge into CSESs. Many of these systems have been observed to pass through an adaptive renewal cycle with the phases and characteristics described in the inner segments of Figure 2. Transitions within such cycles can include sequences of gradual as well as rapid change. Disturbances, instabilities and surprise play an important role in shaping system developments and in triggering systems to enter the next phase or to tip into other modes of functioning. However, conventional resource management has mainly been concerned with stabilities in the exploitation and conservation phases, while collapse and the release of structures and resources enabling renewal and reorganization[2] have to a large extend been ignored; hence, deserving much more attention.

The research on adaptive renewal cycles has heavily influenced the advancement of resilience concepts (see Table 1). The most progressive school of thought defines resilience currently as "the capacity of a system to absorb disturbance and re-organise while undergoing change so as to still retain essentially the same function, structure and feedback" (Walker et al. 2004). As Folke notes, many publications on resilience have emphasized the first half of the definition, i.e. the capacity of systems to withstand shocks and to be robust to disturbance (c.f. Folke 2006). However, in a broader understanding, resilience is also about dynamic adaptive capacity in the sense that disturbance also opens up opportunities for

| Resilience Concept | Characteristics | Focus on | Context |
|---|---|---|---|
| Engineering Resilience | Return time, efficiency | Recovery, constancy | Vicinity of stable equilibrium |
| Ecological/ecosystem resilience and social resilience | Buffer capacity, withstand shock, maintain function | Persistence, robustness | Multiple equilibria, stability landscape |
| Social-ecological resilience | Interplay disturbance and reorganization, sustaining and developing | Adaptive capaity, transformability, learning, innovation | Integrated system feedback, cross-scale dynamic interactions |

*Table 1: Sequence of Resilience Concepts from a Rigid and Re-Active Interpretation to the Broader and more Flexible Understanding Focusing on Innovation and Change. Source: Folke (2006)*

reorganization of the system and for new trajectories (Smit and Wandel 2006; Folke 2006).

The key point with these different understandings of resilience is that they (potentially) contribute heavily to formulating paradigms and strategies for managing systems and for adapting them to internal or external perturbation and stress. In accordance with the idea of structuration, resilience concepts can therefore be understood to have a twofold nature: they are to a large extent emanating from the observation of existing system dynamics; while at the same

[2] *Amongst the most widely used examples are forest fires and the associated release of nutrients which allows for new pathways within the system.*

time they are also agentive as they play a strong role for formulating paradigms that shape these dynamics. Resilience concepts are, hence, closely related to the philosophical question of the interplay between nature and human society (c.f. Casimir 2008; Oliver-Smith 2004) – a contested question which in the Mekong Delta manifests itself in strategy shifts along the (antagonistic continuum between adaptation and control.

**Coupling in the Mekong Delta: From Adaptation to Control (and Back?)**

In very general terms, the Mekong Delta has been undergoing a comprehensive shift from hu-

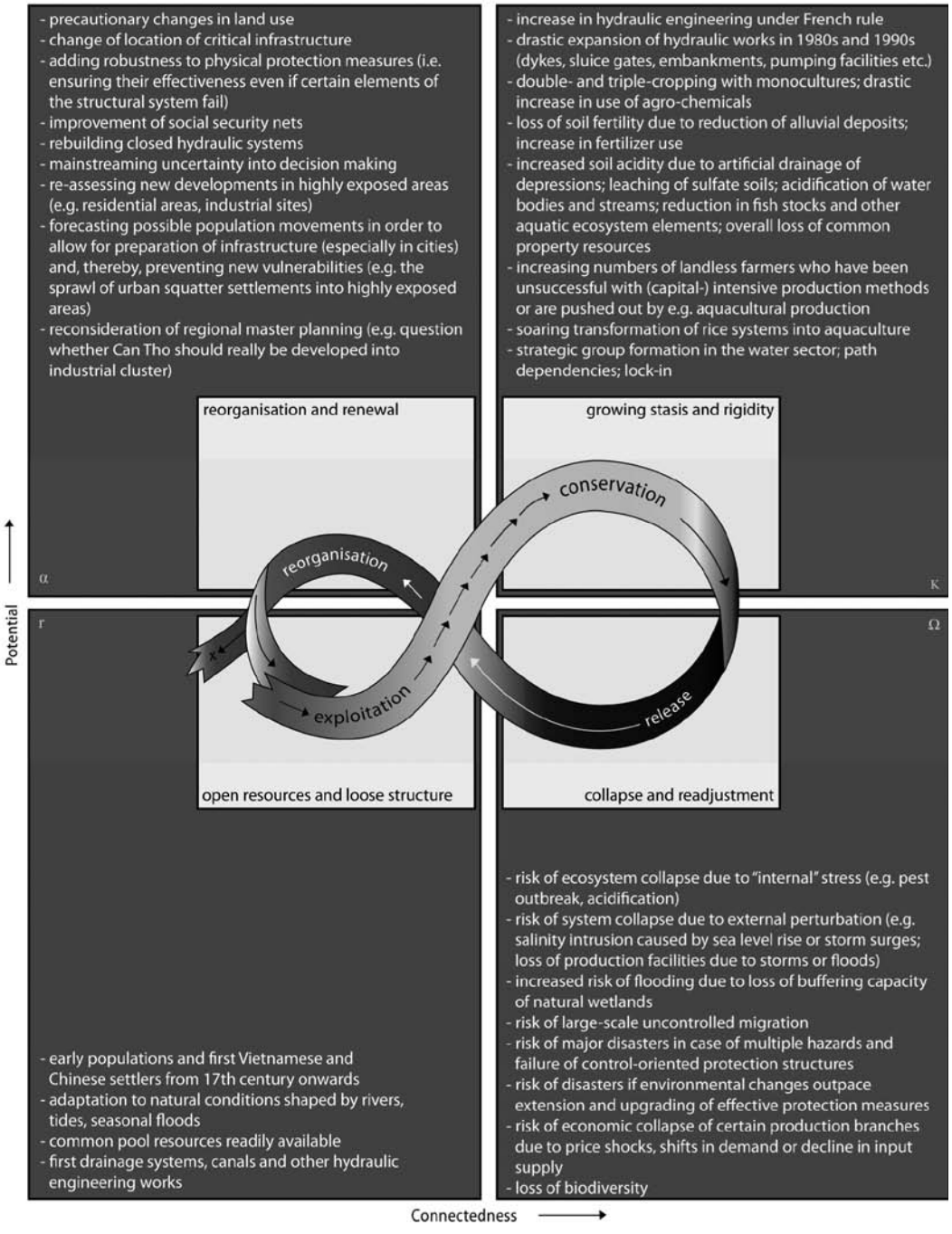



*Figure 2: Adaptive Renewal Cycle in Coupled Social-Ecological Systems in Theory (Inner, Brighter Elements) and the Mekong Delta (Outer, Darker Segments). To be read starting from the inner left bottom quadrant. Source: own draft with inner/conceptual elements based on Gunderson and Holling (2001); Berkes et al. (2003); Walker et al. (2006); outer elements based on own observation and interviews; Käkönen (2008); Ni et al. (2001); Marsh and McAulay (2006); Biggs (2004); Luttrell (2001); Sneddon and Binh (2001); Miller (2003); Evers and Benedikter (2009)*

man adaptation (to the prevailing natural conditions) to human control and taming of nature (Käkönen 2008). After two waves of hydraulic construction expansion (first under French rule and much more intensively since the 1980s) the largest part of the Delta can today be considered hydraulically controlled through dykes, embankments, sluice gates and pumping stations for irrigation, drainage and flood control. The underlying paradigm, in particular for the developments since reunification, has been to "free" rice farming from the seasonal conditions with floods and salinity intrusion; instead enabling double- and triple-cropping under controlled irrigation in almost all parts of the Delta (Käkönen 2008). In the more recent past, the focus has in addition been increasingly expanded to the rapidly growing sector of aquaculture production.

While the nexus of hydraulic control, advocacy of high yield (monoculture) production, expansion of aquaculture systems and market-oriented reform process has allowed the Mekong Delta to develop its high productivity – enabling it to contribute almost half of the country's overall rice output and 72 per cent of the farmed aquatic production (GSO 2009 a,b) – this green and blue revolution (Evers and Benedikter 2009) has also created various environmental and social vulnerabilities (compare the outer elements of Figure 2, particularly K and Ω). It can be said that in particular in those ecosystem goods and services are negatively affected which previously had been in direct or indirect use as common pool resources (e.g., wild fish stocks during the rainy season; water purification; alluvial supply; biodiversity) (c.f. Käkönen 2008; Ni et al. 2001).

As manifested in these developments, Vietnam's policies in the fields of environmental management, economic production and flood protection have been deeply rooted in a control-oriented paradigm over the last decades. Interviews with planners and governmental decision makers in Can Tho Province, as well as the analysis of current official master plans, revealed that this paradigm also serves as basis for future strategies. Even though persistently calling for environmental protection and integrated management approaches, official policies advocate the extension and intensification of hydraulic control by means of even more rigid structural systems for the purpose of sustaining and increasing the agro-industrial output of the Delta as well as for upgrading structural flood protection (see Figure 3). The risk of intensifying already prevalent negative effects (such as salinization or soil degradation) resulting from the control-oriented approach is, therefore, high.

In addition, human-induced climate change drastically changes the preconditions for further efforts of controlling and taming the Delta's physical environment as it adds substantial external perturbations to the existing stress. As indicated in the introduction, climate change will entail a complex mix of creeping as well as sudden onset hazards that affect ecological and social system dynamics of the Delta in various direct and indirect ways. Climate change will, thereby, implicate three major challenges: firstly, the speed and magnitude of many environmental changes will be higher than in any respective "natural" changes so far experienced by modern societies (e.g., sea level rise, changes in precipitation patterns, changes in temperature). Secondly, predicting those changes and the resulting impacts is fraught with high uncertainties (e.g., flooding scenarios or typhoon tracks). Thirdly, climate change will increasingly bring new hazards to the Delta that have so far been of relatively low importance in this region (e.g., temperature increase or typhoons), while it will also increase the likelihood of multiple-hazard-situations (e.g., typhoon with heavy winds and rains plus storm surge plus extreme river flood plus sea level rise)[3].

In combination, these differences strongly challenge the taming-nature-paradigm because, firstly, many of the effects of climate change either cannot be controlled by human interven-

[3] *For first broad-scale modelling assessments of multiple hazard events in combination with man-made structures compare Hoa et al. (2007).*

[4] *A relatively early study by the Asian Development Bank suggested in 1994 that the structural protection of Vietnam's coastline against sea level rise would require 172 million USD annually over the next 20 years (ADB 1994). In comparison, the total budget for soft measures of the National Target Plan for Climate Change Response is roughly 110 million USD for the entire – not precisely defined but rather long-term – planning period (SRV 2008a). Hoa et al. (2007).*

tion and, secondly, thinkable physical response or protection measures would be extremely costly[4], would have to be designed to cope with multiple hazards and would be prone to failure. At the same time, increasing negative feedbacks with respect to internal stresses would have to be expected the more rigid the physical protection measures would become; hence, increasing the risk of "internal" system collapse (e.g., eutrophication) while trying to protect against "external" disturbance (e.g., flooding cycles).

This dilemma is not yet explicitly addressed in the burgeoning field of official climate change adaptation policy in Vietnam or the Mekong Delta. In December 2008, the Prime Minister approved the National Target Programme to Respond to Climate Change. This programme sets out first broad adaptation objectives such as mainstreaming climate change adaptation into general development planning (compare SRV 2008a). However, the programme is very vague on the question on how to achieve these goals. Moreover, it misses the opportunity to pave the way for reviewing and adjusting general development and environmental management paradigms (compare for a more detailed analysis of related shortcomings Garschagen 2009a). Also the special Action Plan Framework for Adaptation and Mitigation of Climate Change in the Agriculture and Rural Development Sector, Period 2008 – 2020 (approved in September 2008) is a rather open collection of broad objectives and statements of intent. Despite mentioning the need for adapting crop cycles and other production systems, it largely refers to intensified structural control measures for enabling these changes (cf. SRV 2008b).

On a similar note, specific action plans or concrete paradigms for urban climate change adaptation have not been developed yet (Garschagen 2009b). However, interviews with urban planners in Can Tho City – the biggest City in the Mekong Delta – revealed that so far physical protection works following the conventional control-oriented disaster reduction paradigm are seen as the favourable or even the only possible strategy for responding to future hazards.

In summary, despite having pushed climate change high up on the political agenda, Vietnam's relatively young discourse on adaptation is not (yet) very explicit on envisaged measures and paradigms (for the Delta). In combination with the overall control-oriented vision, however, this lack of explicit paradigm formulation gives reason to suspect that climate change adaptation will literally build on a rather conventional approach favouring strong belief towards physical protection and control. On the other hand, official policy documents, as well as interviewed planners have repeatedly stated the need to scope new strategies. Moreover, there is substantial international exchange with experts coming from countries with different (more integrated and soft) planning paradigms and approaches such as the Netherlands or Germany. Therefore, good chances remain that strategies and concepts in Vietnam will be reconsidered over the next years, leading to a more integrated adaptation approach that softens structural control strategies and that takes uncertainties, possible failure of physical protection systems and functional as well as spatial reorganization of exposed elements into account.

**Discussion – When Guiding Concepts Meet (in) the Real World**

As Figure 2 illustrates, the Mekong Delta's technocratic transformation over the last 200 years (and in particular since the reunification in 1975) can be quite accurately described with the first two phases of the adaptive renewal cycle. However, when turning to Ω and α the predictions and assumptions of the cycle become more contested. The concept puts strong emphasis on the collapse and release phase (Ω), ascribing to it a key role within the system dynamics for releasing structures and resources which are, in turn, considered a prerequisite for opening up opportunities for reorganization and innovation.

This sequence may have been apparent in all the observed (eco-) systems that led to the development of the concept. Moreover, spelling out a predictive model rightly points important attention to the risk of collapse in exploited systems. However, the analysis of the overlaying risks in the Mekong Delta suggests that this focus of the concept can at the same time be considered its biggest weakness. Despite acknowledging that disasters and crises may also open up opportunities for positive change (Birkmann et al. 2008) it is argued here that the adaptive renewal cycle in fact provides little guidance for the most important question, i.e. how to initiate and implement

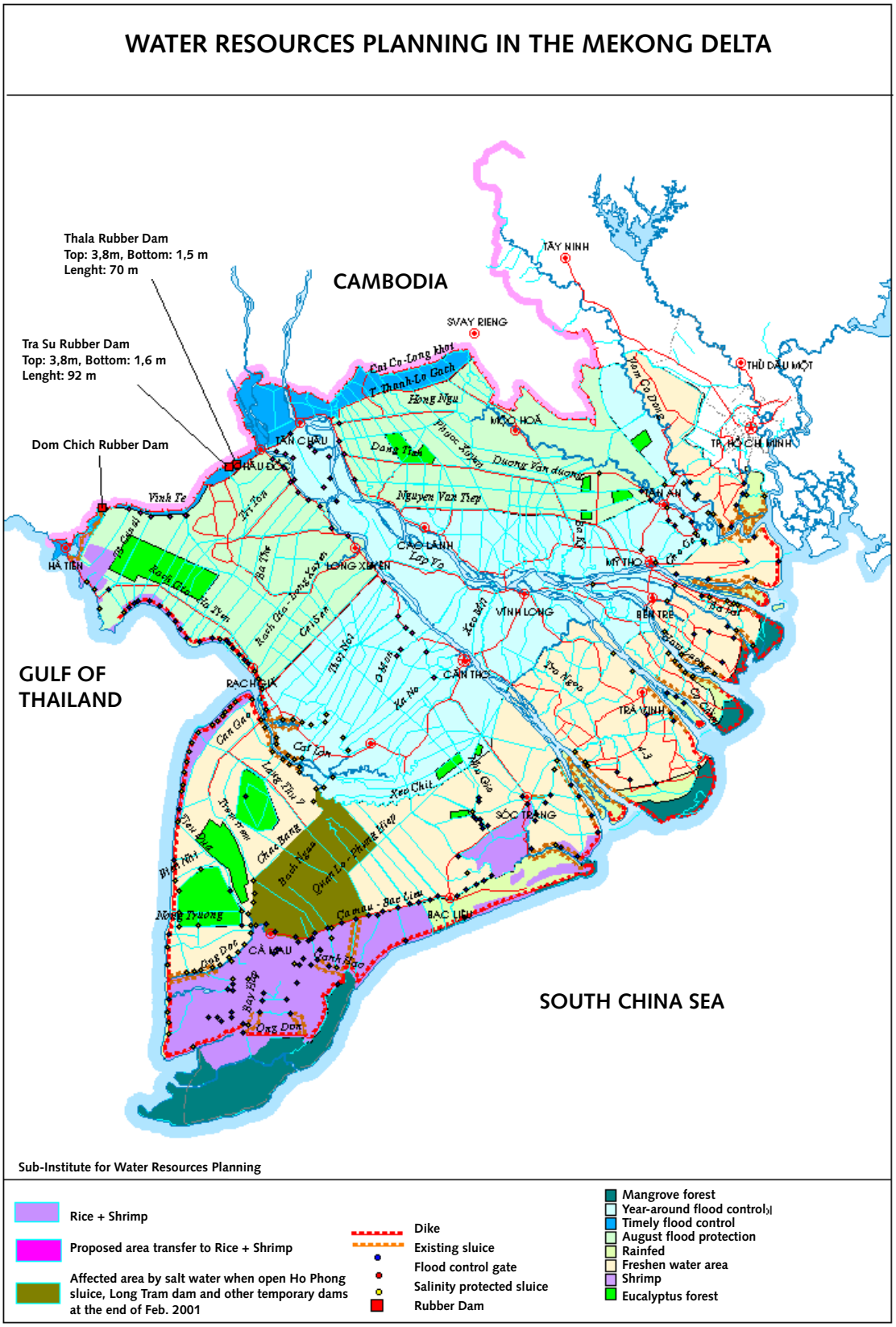



*Figure 3: Planned Hydraulic Developments in the Mekong Delta. Source: SIWRP 2009*

precautionary reorganization that leapfrogs the phase of potentially harmful collapse and unplanned release.

The analysis of coupled systems in the Mekong Delta has clearly shown that collapse would in most cases come at a high price of human suffering – with the biggest harm being most likely amongst those groups that already experienced losses in various capital stocks during the conservation phase; hence, having an increased vulnerability (see Figure 2).

The greatest challenge – deserving most attention in both the scientific and the political arena – is, therefore, not how to reorganize collapsed systems in a more resilient way, but how to trigger precautionary reorganization without having to suffer collapse and related crises. As laid out earlier, climate change has substantially increased the complexity of this exercise by altering the preconditions for collapse and the dynamics of reorganization and by increasing the likelihood of complex crises situations with different overlaying hazards. Climate change adaptation and the resilience of coupled social-ecological systems can, therefore, no longer be discussed (or practically approached) discretely but require an integrated focus. This call includes in particu-

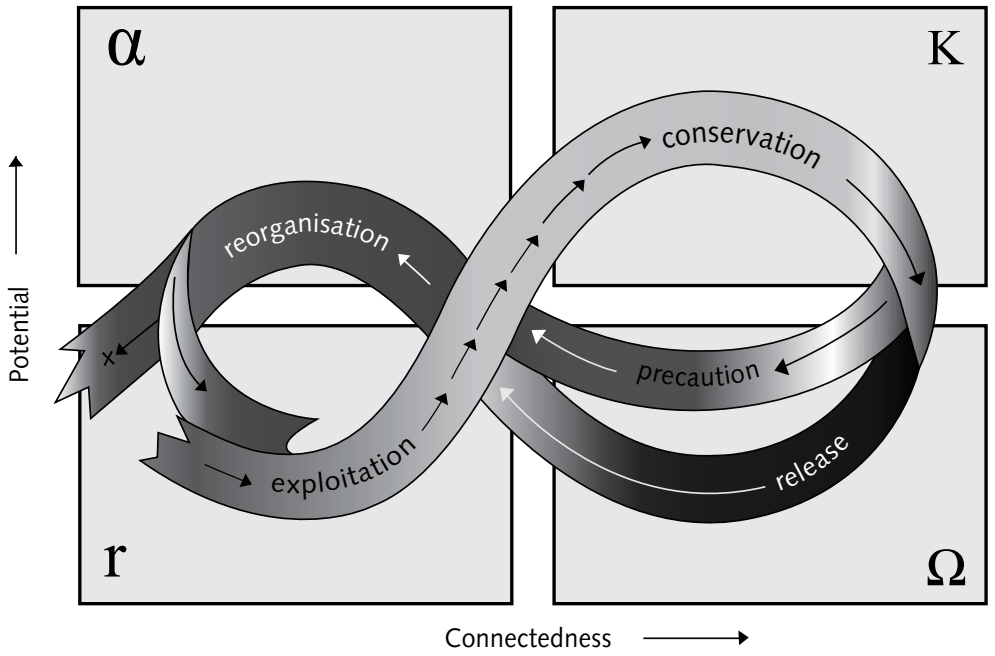



*Figure 4: Adaptive Renewal Cycle with Leapfrog of Collapse and Release Phase through Precautionary Reorganization. Source: own draft adapted from Gunderson and Holling (2001) and Berkes et al. (2003)*

lar conceptual models which have been taken up the course of revealing system dynamics and providing guidance and predictions to policymaking and strategy development.

On that note, it is worthwhile taking a closer look at the transferability of the most progressive resilience understanding (see the bottom row of Table 1) within the context of policymaking for the Mekong Delta. While the notion of interplay between disturbance and reorganization and between sustaining and developing is very coherent and appealing conceptually, these categories are in many cases hard to transfer into concrete decision-making and may in fact stand for rather irreconcilable antipodes in the Delta's reality (in terms of perception, vested interests and action). Currently researched examples of conflicting interests between preservation and sustenance on the one side and change and reorganization on the other include issues of (forced) relocation in flood-prone areas, conflicts between rice

and shrimp farming, restriction of agrochemical application or expansion of industrial zones into flood-prone areas. The conceptual discourse on adaptive renewal cycle and social-ecological resilience, therefore, needs to be augmented to accommodate problems of power relations and stakeholder influence in decision-making and crises prevention – experiences in the fields of political ecology as well as political economy can serve valuable insights and inspiration in this context.

**Concluding Remarks and Outlook**

Using the example of the Mekong Delta, this paper has attempted to analyse the usefulness of recent (and highly popular) conceptual approaches, which are aiming to describe and foster resilience in coupled social-ecological systems, for guiding decision making in view of climate change adaptation and crises prevention. The adaptive renewal cycle has a strong analytical as well as didactical potential for illustrating dynamics that may lead to and follow after collapse or uncontrolled release. However, apart from drawing a scenario of potential collapse – and, thereby, raising awareness – it serves limited guidance of how to shape (political, social, economic and legal) institutions that are able to prevent collapse, reduce vulnerabilities and initiate precautionary reorganization. Tackling these issues implies the need to mediate between different (often opposing) interests and to challenge deeply rooted paradigms which shape system management, the way of interaction with the environment and eventually the dynamic development of vulnerabilities. As the institutional analysis in the Mekong Delta has shown, increased efforts are therefore needed to translate the valuable but highly abstract concepts revolving around renewal and resilience into practical guidelines that can be more easily received by decision makers and that can guide strategies for precautionary reorganization and adaptation in order to prevent system collapse and (humanitarian) crises. First attempts to develop concrete principles and quality criteria for decision-making have been made in the context of synchronizing disaster risk management and climate change adaptation in the Delta (Garschagen et al. 2009); however, they are by far not yet sufficient and need to be extended to also include the policy fields of overall precautionary system management and crises prevention. In this context, increased attention also needs to be paid to the challenging open questions regarding threshold characterization and prediction (Renaud et al. 2009). In particular the resulting question of how far varying threshold assumptions would affect the implementation of the precautionary principle in decision-making – in both positive and negative directions – is of high practical and scientific interest.

**References**


ADB (1994): *Climate Change in Asia: Vietnam – Regional Study on Global Environmental Issues*. ADB, Manila.

Adger, N. (2000): Institutional adaptation to environmental risk under the transformation in Vietnam. In: *Annals of the Association of American Geographers*. vol. 90, no. 4, pp. 738-758.

Berkes, F.; Colding, J; Folke, C. (2003): Introduction. In: Berkes, F.; Colding, J.; Folke, C. (Eds.): *Navigating Social-Ecological Systems: Building Resilience for Complexity and Change*. Cambridge University Press, Cambridge. pp. 1-29.

Biggs, D. (2004): *Between the Rivers and the Tides: A Hydraulic History of the Mekong Delta, 1820-1975*. PhD Dissertation. University of Washington, Department of History.

Birkmann, J.; Buckle, P.; Jäger, J.; Pelling, M.; Setiadi, N.; Garschagen, M.; Fernando, N.; Kropp, J. (2008): Extreme events and disasters: a window of opportunity for change? – Analysis of changes, formal and informal responses after mega disasters. In: *Natural Hazards*, online first publication, in press.

Carew-Reid, J. (2008): *Rapid Assessment of the Extent and Impact of Sea Level Rise in Viet Nam*. International Centre for Environmental Management. Queensland.

Casimir, M. (2008): The Mutual Dynamics of Cultural and Environmental Change: An Introductory Essay. In: Casimir, M. (Ed.): *Culture and the Changing Environment: Uncertainty, Cognition and Risk Management in Cross-Cultural Perspective*. Berghahn, Oxford. pp. 1-58.

CFSC (2004): *National Report on Disaster Reduction in Vietnam*. For the World Conference on Disaster Reduction. Kobe-Hyogo, Japan, 18-22 January 2005. Hanoi.

Chaudry, P.; Ruysschaert, G. (2007): *Climate Change and Human Development in Viet Nam*. Occasional Paper to the Human Development Report 2007/2008. UNDP, Hanoi.

Elsner, J.; Kossin, J.; Jagger, T. (2008): The increasing intensity of the strongest tropical cyclones. In: *Nature*. no. 455, pp. 92-95.

Evers, H.-D.; Benedikter, S. (2009): *Strategic Group Formation in the Mekong Delta – The Development of a Modern Hydraulic Society*. ZEF Working Paper Series, no. 35.

Folke, C. (2006): Resilience: the emergence of a perspective for social-ecological systems analyses. In: *Global Environmental Change*. vol. 16, no. 3, pp. 253-267.

Garschagen, M. (2009a): Challenges and Opportunities of Climate Change Adaptation in High Risk Areas Using the Example of the Mekong Delta, Vietnam. In: *Risk and Planet Earth: Vulnerability, Natural Hazards, Integrated Adaptation Strategies, Conference Proceedings*. 2-4 March, Leipzig, Germany (in press).

Garschagen, M. (2009b): *Urban Climate Change Adaptation in Vietnam: Institutional Challenges and Research Agenda*. Paper for Presentation at ICCUF 2009, International Conference on the Impacts of Climate Change on Urban Flooding. 24-26 June 2009, Ho Chi Minh City, Vietnam.

Garschagen, M.; Binh, N. T.; Thach, L. N. (2009): Vietnam: The Challenge of Integrating Disaster Risk Reduction and Climate Change Adaptation. In: Birkmann, J.; Tetzlaff, G.; Zentel, K. (Eds.): *Addressing the Challenge: Recommendations and Quality Criteria for Linking Disaster Risk Reduction and Adaptation to Climate Change*. DKKV Publication Series, no. 38.

GSO (2009a): *Production of Paddy by Province*. <http://www.gso.gov.vn/default_en.aspx?tabid=469&idmid=3&ItemID=7885>, 03 June 2009.

GSO (2009b): *Production of Farmed Aquatic Product by Province*. <http://www.gso.gov.vn/default_en.aspx?tabid=469&idmid=3&ItemID=7818>, 03 June 2009.

Gunderson, L. H.; Holling, C. S. (Eds.) (2001): *Panarchy. Understanding Transformations in Human and Natural Systems*. Island Press, Washington D.C.

Hoa, L. T.; Nhan, N. H.; Wolanski, E.; Cong, T. T.; Shigeko, H. (2007): The combined impact on the flooding in Vietnam's Mekong River Delta of local man-made structures, sea level rise, and dams upstream in the river catchment. In: *Estuarine, Coastal and Shelf Science*. vol. 71, pp. 110-116.

Hoang, D. C.; Tran, V. L. (2006): Developing various climate change scenarios of 21 century for regions of Viet Nam. In: *Scientific and Technical Hydro-Meteorological Journal*. no. 541.

Holling, C. S. (1973): Resilience and stability of ecological systems. In: *Annual Review of Ecological Systems*. vol. 4, pp. 1-23.

Holling, C. S. (1986): The Resilience of Terrestrial Ecosystems: Local Surprise and Global Change. In: Clark, W. C.; Munn, R. E. (Eds.): *Sustainable Development of the Biosphere*. Cambridge University Press, Cambridge. pp. 292-317.

Käkönen, M. (2008): Mekong Delta at the crossroads: More control of adaptation? In: *AVISO*. vol. 37, no. 3, pp. 205-212.

Luttrell, C. (2001): Historical Perspectives on Environment and Development. In: Adger, N.; Kelly, M.; Ninh, N. H. (Eds.): *Living with Environmental Change: Social Vulnerability, Adaptation and Resilience in Vietnam*. Routledge, London. pp. 234-262.

Marsh, S.; MacAulay, T. (2006): *Land Reform and the Development of Commercial Agricultural in Vietnam: Policy and Issues*. <http://www.agrifood.info/review/2002/Marsh.pdf.>, 25 March 2009.

Miller, F. (2003): *Society-Water Relations in the Mekong Delta: A Political Ecology of Risk*. PhD Dissertation. University of Sydney, Department of Geography.

Müller-Mahn, D. (2005): Von „Naturkatastrophen" zu „Complex Emergencies" : Die Entwicklung integrativer Forschungsansätze im Dialog mit der Praxis. In: Müller-Mahn, D.; Wardenga, U. (Eds.): *Integrative Forschungsansätze*. Leipzig. pp. 69-78.

Nguyen, H. N. (2007): *Flooding in Mekong River Delta, Viet Nam*. Occasional Paper for the Human Development Report 2007/2008. UNDP, Hanoi.

Ni, D. V.; Safford, R.; Maltby, E. (2001): Environmental Change, Ecosystem Degradation and the Value of Wetland Rehabilitation in the Mekong Delta. In: Adger, N.; Kelly, M.; Ninh, N. H. (Eds.): *Living with Environmental Change: Social Vulnerability, Adaptation and Resilience in Vietnam.* Routledge, London. pp. 122-135.

Oliver-Smith, A. (2004): Theorizing Vulnerability in a Globalized World: A Political Ecological Perspective. In: Bankhoff, G.; Frerks, G.; Hilhorst, D. (2004): *Mapping Vulnerability: Disasters, Development and People.* Earthscan, London. pp. 10-24.

Renaud, F.; Birkmann, J.; Damm, M.; Gallopin, G. (2009): Importance and difficulties in threshold characterisation of coupled social-ecological systems exposed to external shocks. In: *Natural Hazards* (submitted).

Smit, B.; Wandel, J. (2006): Adaptation, adaptive capacity and vulnerability. In: *Global Environmental Change*. vol. 16, no. 3, pp. 282-292.

Sneddon, C.; Binh, N. T. (2001): Politics, Ecology and Water: The Mekong Delta and Development of the Lower Mekong Basin. In: Adger, N.; Kelly, M.; Ninh, N. H. (Eds.): *Living with Environmental Change: Social Vulnerability, Adaptation and Resilience in Vietnam*. Routledge, London. pp. 234-262.

SRV (2008a): *Decision on Approval of the National Target Programme to Respond to Climate Change.* Decision No: 158/2008/QD-TTg. Hanoi.

SRV (2008b): *Issuance of the Action Plan Framework for Adaptation to Climate Change in the Agriculture and Rural Development Sector 2008 – 2020.* Decision No: 2730/2008/QD-BNN-KH-CN. Hanoi.

Taylor, P. (2004): *Social Inequality in Vietnam and the Challenge of Reform*. Nias Press, Singapore.

SIWRP (2009): *Water Resources Planning and Climate Change in the Mekong Delta.* Presentation at the First National Mekong Delta Climate Change Forum. Can Tho. 12-13 November 2009.

Walker, B. H.; Holling, C. S.; Carpenter S. R.; Kinzig, A. P. (2004): Resilience, adaptability and transformability in social-ecological systems. In: *Ecology and Society.* vol. 9, no. 2, art. 5.Walker, B.; Gunderson, L.; Kinzig, A.; Folke, C.; Carpenter, S.; Schultz, L. (2006): A handful of heuristics on some propositions for understanding resilience in social-ecological systems. In: *Ecology and Society.* vol. 11, no. 1, art. 13.

## The Role of Local NGOs in Fostering Adaptive Capacity

*Maureen Biermann*

**Abstract**

The convergence of new and shifting vulnerabilities related to changing climate conditions could lead populations to reach a tipping point in which they experience irreversible economic, social, political or environmental collapse. To avoid this, adaptation must move beyond reactive and outcome-oriented analyses to become proactive and anticipatory. Focus must be shifted to adaptive capacity, a system's ability to cope with, adapt to and shape change. While research exists on the ways that institutions foster adaptive capacity, the role of local non-governmental organizations (NGOs) remains largely unexplored. This paper seeks to fill this gap by examining how local NGOs in Arusha, Tanzania, facilitate or constrain the adaptive capacity of their partner communities. Lessons learned shed light on to the important role local NGOs can play in identifying, avoiding, or responding to tipping points in humanitarian crises.

**Keywords: non-governmental organizations; local institutions; climate change; adaptation; anticipation; Africa**

**Introduction**

Because the local context in which adaptation occurs determines its effectiveness in a given place, adaptation to climate change is an inherently local process (Agrawal 2008; Füssel and Klein 2006). This is reflected in research that increasingly points to the importance of bottom-up and community-based adaptation approaches (Fabricius et al. 2007; Huq and Reid 2007; Pouliotte et al. 2009; Ziervogel et al. 2006). However, the majority of the proposed approaches rely on vulnerability and adaptation assessments that measure or estimate the outcome of response strategies, and are therefore responses to changes that have already occurred or to changes that are perceived as "likely" in the future. These assessments leave little room for proactive and anticipatory engagement with the issue of adaptation under circumstances of uncertainty and increasing variability and extreme climate events. Such assessments may therefore provide information appropriate for dealing with individual, isolated events, but may leave a social system ill-prepared to address multiple, uncertain or extreme events, leaving the system more vulnerable to reaching a tipping point that leads to system collapse.

Tipping points are reached when enough small changes force a system across a critical threshold, leading to positive feedback and abrupt, often irreversible large-scale change (Lenton et al. 2008). In the example of climate change, shifting temperature and precipitation patterns, increasing variability and growing numbers of severe and sudden-onset climate events may converge with existing vulnerabilities, leading populations to reach a tipping point in which they experience irreversible economic, social, political or environmental collapse – in short, a humanitarian crisis (McGrath et al. 2007). In order to prevent this, tipping points must be identified, anticipated and avoided. Retrospective and outcome-oriented assessments must therefore be replaced with proactive and anticipatory measures.

In order to move beyond retrospective or outcome-oriented adaptation assessments, it has been shown that the focus must be on building adaptive capacity (Füssel and Klein 2006). Adaptive capacity is the ability of a system to cope with, adapt to and manage change. Increasingly, attention is paid to the role of institutions and organizations in facilitating adaptation and adaptive capacity, and a number of publications have specifically recommended that institutional and organizational structures should be both a focus of further research, and a priority for building adaptive capacity (Berkes 2007; Cash et al. 2006; Eakin 2005; Reid and Vogel 2006). However, outside of a comprehensive study of local institutions and climate change adaptation prepared for the World Bank (Agrawal 2008), little research exists that examines the practical ways that local institutions facilitate or constrain adaptive capacity. In particular, local NGOs are in a key position to help communities build adaptive capacity by creating opportunities for collective learning and providing linkages between communities and external systems (Huq and Reid 2007). However, research on the specific and practical ways how local NGOs address climate change adaptation is scarce. This paper seeks to fill this gap by examining how three local NGOs in rural Tanzania facilitate the adaptive capacity of the communities they work with.

**Adaptation, Adaptive Capacity and Resilience**

Building adaptive capacity, rather than simply implementing adaptation strategies, is a way of responding to climate change and at the same time making systems more resilient. Enhancing system resilience means improving a system's "ability to absorb perturbations without being undermined or becoming unable to adapt and learn" (Tompkins and Adger 2004: 10). The capacity of a system to adapt directly impacts its ability to absorb perturbations and reorganize – in other words, its system resilience. Governance and institutional structure have both been identified as forces that shape adaptive capacity and system resilience (Eakin 2005; Folke 2006; Reid and Vogel 2006). A resilience perspective in governance and decision-making, according to Carl Folke, "shifts policies from those that aspire to control change in systems…to managing the capacity of social-ecological systems to cope with, adapt to, and shape change" (2006: 254).

Research suggests that certain attributes and practices contribute to adaptive capacity and promote resilient systems, including flexible institutional structures, cross-scale interaction and knowledge sharing, and opportunities for collective and future-oriented learning (Adger et al. 2003; Agrawal 2008; Kelleher 2005). Local organizations can create an environment that enables actors to flexibly adjust to changing climatic stressors, or one that leaves actors with few options or opportunities to adapt (Eakin 2005). They may be particularly well-situated to mediate between stakeholders at different scales and to channel external information and resources for adaptation (Cash et al. 2006). Organizations can also promote collective learning that can lead to innovative ways of dealing with change (Armitage et al. 2008; Pelling et al. 2008).

**Methods**

In order to understand what specific practices help NGOs to facilitate adaptive capacity in the communities they work with, there is a need to identify how and why they promote or inhibit flexibility in adaptation options, opportunities for cross-scale interactions and spaces for collective and anticipatory learning in communities. This approach is applied to a case study of three local NGOs in the Arusha region of northern Tanzania. Data collection in the field took place from June until August 2008. It involved a combination of qualitative methods, including semi-structured interviews, focus groups, mapping activities and participant-guided tours with NGO employees. The research goal was to identify how the NGOs understand climate change, how this understanding shapes their agendas and how these agendas translate to concrete projects at the community level. NGO agendas and projects were then analysed in terms of their impact on community adaptive capacity by facilitating institutional flexibility, opportunities for cross-scale interactions and collective and future-oriented learning.

**Green Arusha Society**

Green Arusha Society (GAS) is a small local NGO working with fifteen rural communities in the Arusha region. GAS staff includes six part-time, volunteer employees. The organization's main focus is to promote environmental responsibility through activities such as tree planting, education and responsible waste management. The organization understands the problem of deforestation to be the main driver of climate change, and therefore reforestation is seen as the best way to reverse climate change – they believe deforestation has triggered a positive feedback loop of warming and drying of the local climate, resulting in less and less forest growth over time. The increasing severity of droughts in the past thirty years is taken as evidence of this. According to GAS, the vicious cycle can only be reversed through reforestation. The primary activity of GAS is therefore tree planting.

The organization has three tree planting projects targeted towards school children, women's groups and village governance committees. In situations where a community has other pressing needs, such as securing water sources, GAS does not modify its practices. This is predominately because deforestation and the resulting climate change are seen as the primary problems from which other environmental and economic problems stem. Thus, if deforestation is taken care of, secondary problems such as water shortages will also be solved.

Implicit in GAS's approach is the understanding that climate change is occurring as a result of local behaviour (deforestation), and therefore can be controlled and reversed by "greening" the

local environment. GAS believes that targeted environmental conservation efforts (tree planting) will effectively regulate the system. Under this paradigm, adaptation is useful only in the form of short-term coping mechanisms, until the recent warming and drying tendencies can be reversed through reforestation projects. Building adaptive capacity is not viewed as necessary because of the perceived control over the climate through the medium of tree planting. No surprises are anticipated, so that no organizational flexibility, interactions beyond the local scale, or collective, future-oriented learning is necessary.

**Maasai Women Development Organization**

Maasai Women Development Organization (MWEDO) is a larger local NGO that works with the Maasai, a pastoralist group located throughout north central Tanzania and south central Kenya. MWEDO has between thirty and forty paid and voluntary employees. The organization's main focus is on economic development and education of Maasai women. Climate change is of interest in so far as it impacts Maasai women's ability to survive and prosper.

MWEDO views climate change as one factor in a complex system of stressors that impact the vulnerability of Maasai communities. The organization's overall goal is to reduce this vulnerability by promoting sustainable livelihoods in Maasai communities. MWEDO does this by targeting women's education, economic development and health. This broad framework translates to flexible community-specific strategies and activities that are determined by MWEDO staff along with their partner communities.

While MWEDO programmes are not specifically targeting climate change, they are promoting adaptation and building adaptive capacity in the face of a complex nexus of social, economic and environmental stressors by helping the Maasai broaden their livelihood base to include flexible livelihood options and by facilitating the flow of knowledge and resources between local and external scales. Furthermore, MWEDO is aware that because of changing environmental patterns, traditional knowledge alone may not suffice. Equipping communities with a wider array of options to manage this new future "knowledge gap", where reliable environmental predictions no longer exist, is one outcome of the organization's programmes and projects. These options include both possibilities for collectively generating new knowledge and for accessing information from new external sources (through schools, health workers and other organizations).

**Pastoralists' Alliance for Climate Change Adaptation and Development**

The Pastoralists' Alliance for Climate Change Adaptation and Development (PACCAD) is a fledgling organization. As of December 2008, two founding members were in the process of obtaining official NGO status for the organization. Once they acquire NGO status, the organization will begin activities toward achieving its main goals of facilitating interaction and the flow of knowledge and resources between other NGOs working with pastoralist communities. The PACCAD founders are trying to fill a perceived gap in local NGOs' access to information and resources about climate change.

The organization has a clear mission: to access and share knowledge and information about climate change adaptation. The strategy of PACCAD will be to create formal linkages between local NGOs and sources of climate change information and adaptation funding centres, and also provide platforms for the NGOs to share information amongst themselves. By targeting a wide variety of local organizations, PACCAD hopes to provide NGOs with the capacity to flexibly respond to the needs of their partner communities as these needs shift in response to changing climate conditions.

Climate change is understood by the director of PACCAD as being a process that occurs across scales and represents a distinct gap in current development and livelihood projects in local organizations. But rather than to implement a new organization that works directly with communities, the objective of PACCAD is to mainstream climate change adaptation in the agendas of NGOs already working on a variety of issues. This approach targets the underlying institutions and organizations that already shape adaptive capacity at the community level, with the goal of improving this capability. While PACCAD understands that information flow is a key to building adaptive capacity, the NGO has still not solved one fundamental question: how can lo-

cal organizations access information generated in global arenas, by governments, international organizations and scientists? PACCAD already has ideas about linking together local organizations in meetings, training sessions, discussion groups and centres for sharing resources and knowledge. However, the organization is still uncertain about how to make linkages and sharing information with stakeholders across scales.

**Discussion**

Organizations can facilitate community adaptive capacity by building flexibility into institutions, promoting interactions across scales and providing spaces for collective and future-oriented learning. These organizational characteristics assist communities in building the capacity to prepare for and respond to a range of potential future stressors (both climatic and others), rather than retroactively responding or "learning by shock" (Deshler 1988). Based on the case study examples, a few important conclusions can be drawn about how NGOs might best facilitate adaptive capacity.

Targeting climate change through a discourse that situates it as a distinctly local phenomenon may lead NGOs to unnecessarily limit the adaptive capacity of their partner communities, as seen in the case of GAS. By recognizing the global social and environmental contexts that shape how climate change occurs and how local communities may prepare for and respond to change, NGOs account for both contextual complexity and system uncertainties that shape a community's adaptive capacity. Couching climate change adaptation in a broader host of agenda items may therefore offer organizations more flexibility to shift their focus as contextual circumstances dictate, as seen in the situation of MWEDO. However, this requires accurate and scale appropriate information about climate change and environmental science, which may need to be accessed from outside sources. Facilitating cross-scale interactions is therefore an important tool for fostering adaptive capacity. However, local NGOs alone may not be able to access resources or translate information without assistance, and may therefore need to work closely with larger organizations or stakeholders that can function as gatekeepers to resources and information at other scales. What local NGOs do have to offer, however, are strong localized networks that link multiple communities and other local organizations.

Flexibility in options, opportunities for collective learning, and facilitating cross-scale interactions can increase the adaptive capacity not only of partner communities, but of the organizations themselves. This may be the basis for local NGOs successfully assisting with identifying, anticipating and avoiding tipping points that lead to humanitarian crises. One key set of challenges in dealing with humanitarian crises centres on the problematic of access to and usability of climate information (Morinière et al. 2009). Local NGOs that have strong horizontal linkages with communities and other local NGOs, as well as vertical linkages with broader-scale scientific, governmental or non-governmental organizations, can address information challenges by functioning as a conduit of knowledge. This may mean transmitting scientific information to communities, but it can also mean transmitting local knowledge and needs back to broader institutions, in order to guide future decision-making, planning, disaster risk reduction or adaptation strategies. Moreover, while "demands on humanitarian assistance require above all mental flexibility to anticipate rapidly implemented interventions" (Morinière et al. 2009: 47), arguably of equal importance is the ability of local institutions and organizations to rapidly assist in both this anticipation and the resulting implementation of interventions. Local NGOs with high institutional flexibility may be well situated to act quickly to divert a suspected impending humanitarian crisis. Likewise, collective learning within local organizations can allow innovative solutions to be found (Pelling et al. 2008). This may be of vital importance when a tipping point is reached beyond which traditional solutions or institutions no longer suffice, and novel approaches become necessary to break the downward spiral of humanitarian crisis.

**Acknowledgements**

This research was possible thanks to funding from Ruby S. Miller Endowment for Geographic Excellence. My acknowledgment goes also to Dr Petra Tschakert for her support of this project, and to the participants and organizers of the 2009 Summer Academy on Social Vulnerability.

**References**


Adger, W. N.; Brown, K.; Fairbrass, J.; Jordan, A.; Paavola, J.; Rosendo, S.; Seyfang, G. (2003): Governance for sustainability: towards a 'thick' analysis of environmental decisionmaking. In: *Environment and Planning A*. vol. 35, pp. 1095-1110.

Agrawal, A. (2008): *The Role of Local Institutions in Adaptation to Climate Change*. International Forestry Resources and Institutions Program Working Paper 081-3.

Armitage, D. R.; Marschke, M.; Plummer, R. (2008): Adaptive co-management and the Paradox of Learning. In: *Global Environmental Change*. vol. 18, pp. 86-98.

Berkes, F. (2007): Understanding uncertainty and reducing vulnerability: lessons from resilience thinking. In: *Natural Hazards*. vol. 41, pp. 283-295.

Cash, D. W.; Adger, W. N.; Berkes, F.; Garden, P.; Lebel, L.; Olsson, P.; Pritchard, L.; Young, O. (2006): Scale and cross-scale dynamics: governance and information in a multilevel world. In: *Ecology and Society*. vol. 11, no. 2, pp. 8-19.

Deshler, J. D. (1988): Working with our publics: in-service education for cooperative extension. In: *Module 7. Techniques for Future Perspectives*. Kellogg Foundation: Battle Creek, MI.

Eakin, H. (2005): Institutional change, climate risk, and rural vulnerability: cases from Central Mexico. In: *World Development*. vol. 33, no. 11, pp. 1923-1938.

Fabricius, C.; Folke, C.; Cundill, G.; Schultz, L. (2007): Powerless spectators, coping actors, and adaptive co-managers: a synthesis of the role of communities in ecosystem management. In: *Ecology and Society*. vol. 12, no.1, pp. 29-44.

Folke, C. (2006): Resilience: the emergence of a perspective for social-ecological systems analyses. In: *Global Environmental Change*. vol. 16, pp. 253-267.

Füssel, H.-M.; Klein, R. J. T. (2006): Climate change vulnerability assessments: An evolution of conceptual thinking. In: *Climatic Change*. vol. 75, pp. 301-329.

Huq, S.; Reid, H. (2007): *Community-Based Adaptation: A Vital Approach to the Threat Climate Change Poses to the Poor*. International Institute for Environment and Development, London, UK.

Kelleher, A. (2005): A personal philosophy of anticipatory action-learning. In: *Journal of Future Studies*. vol. 10, no. 1, pp. 85-90.

Lenton, T.; Held, H.; Kriegler, E.; Hall, J.; Lucht, W.; Rahmstorf, S.; Schellnhuber, H. (2008): Tipping elements in the Earth's climate system. In: *Proceedings of the National Academy of Sciences*. vol. 105, no. 6, pp. 1786–1793.

Magrath, J.; Bray, I.; Scriven, K. (2007): *From Weather Alert to Climate Alarm*. Oxfam Briefing Paper 108.

Morinière, L.; Taylor, R.; Hamza, M.; Downing, T. (2009): *Climate Change: Human Consequences*. SEI Working Paper.

Pelling, M.; High, C.; Dearing, J.; Smith, D. (2008): Shadow spaces for social learning: a relational understanding of adaptive capacity to climate change within organizations. In: *Environment and Planning A*. vol. 40, pp. 867-884.

Pouliotte, J.; Smit, B.; Westerhoff, J. (2009): Adaptation and development: livelihoods and climate change in Suburnabad, Bangladesh. In: *Climate and Development*. vol. 1, no. 1, pp. 31-46.

Reid, P.; Vogel, C. (2006): Living and responding to multiple stressors in South Africa – Glimpses from KwaZulu-Natal. In: *Global Environmental Change*. vol. 16, pp. 196-206.

Tompkins, E.; Adger, W. N. (2004): Does adaptive management of natural resources enhance resilience to climate change? In: *Ecology and Society*. vol. 9, no. 2, pp. 10-23.

Ziervogel, G.; Bharwani, S.; Downing, T. (2006): Adapting to climate variability: pumpkins, people and policy. In: *Natural Resources Forum*. vol. 30, pp. 294-305.

## Climate Change and Conservation in the Himalayas: Prospects for Resilience in a Regional Hot System

*Georgina Drew*

**Abstract**

With over 400 million people living along the Ganges River, changes in water resources from Himalayan glaciers are not just a scientific debate. While the IPCC's (2007) regional prediction of rapid glacial melt by mid-century now looks unwarranted by the evidence, glaciers are still threatened by rising global temperatures and black carbon. Glacier-fed rivers such as the Ganges are further endangered by development projects and polluting activities. In light of these concerns, this paper explores the application of the "tipping point" concept in a region that the author argues is part of a "hot system" in the Ganges Basin. Resource challenges are then highlighted to explore human vulnerabilities and prospects for resilience.

**Keywords: Himalayas, water, climate change, Ganges Basin hot system, resilience**

### Glacial Retreat in the Himalayas: A "Tipping Point"?

The Himalayas – or "abode of snow"– are home to thousands of glaciers with an area of some 33,000 square kilometres. The vast icescapes of the Himalayas are the largest freshwater reserve after the polar ice caps. Runoff generated by these glaciers feeds seven of Asia's greatest rivers, providing water and supporting the production of food for millions of people. Water from the Himalayan glaciers also feeds a "hotspot" of biodiversity with some 10,000 plant species, an estimated 300 mammals, and almost 1,000 types of birds (CI 2008). Alarmingly, many Himalayan glaciers are retreating. Their decline could have a significant impact on localized ecologies and downstream livelihoods. The extent of retreat and the possible reasons for glacial melt, however, are subject to debate. The contention is exacerbated by a paucity of scientific data.

Concerns over the scope and rate of Himalayan glacial melt were augmented when the IPCC gave a "very high" probability that the Himalayan glaciers might "disappear" by the year 2035 (2007: 493). Scientists and politicians in countries like India critiqued this timeline. Some even characterized the prediction as baseless (Raina 2009). In late 2009, officials from the IPCC admitted that the 2035 estimate was based on unsound scientific data that most likely came from a report of the World Wide Fund for Nature (WWF) in 2005. A group of international experts that convened to address the error acknowledged that, while many Himalayan glaciers are shrinking in area and thickness, the "extent and nature" of retreat has not changed significantly in the last 100 years (UNEP 2009: 2). To improve scientific understandings of glacial movements, their report stressed the urgent need for enhanced data collection and analysis efforts.

Although the mid-century estimates for glacial melt have downsized, the threat of quantitative and qualitative shifts in glacial mass remains. The wealth of scientific data compiled and synthesized by the IPCC (2007) still indicates that the coming years will witness a rise in global temperatures and a proliferation of dust and black carbon deposits that can impact the integrity of glacial bodies and their ecosystems. The precautionary principal mandates that, even as we relax our short-term predictions for glacial melt, we still need action to enhance climate mitigation and adaptation initiatives in places like the Himalayas. This is especially important for reducing the likelihood of ecological tipping points that leave little time to adjust and can trigger humanitarian crises. This paper aims to reduce human vulnerability to climatic shifts by proposing a regional frame to address tipping points. Prospects for resilience are then offered for places such as the Indian Himalayas where the author conducted ethnographic fieldwork from 2008 – 2009.

### Tipping Point, Tipping Element, or Hot System?

The tipping point concept draws concern for the potential such phenomenon pose to spin systems out of balance (Russill and Nyssa 2009). Acknowledging the need to integrate studies with policy and early warning efforts, Lenton et al. (2008) promote a "tipping elements" approach to address subsystems that are at least subcontinental in scale and can switch into qualitatively different states due to small perturbations (Lenton et al. 2008: 1786). They consider the tipping of Arctic sea-ice and the Greenland

ice sheet to be the greatest threats (Lenton et al. 2008: 1792.) Within South Asia, qualitative changes in the summer monsoon are listed as one of several phenomena that could also constitute a tipping element. Their report does not address melting Himalayan glaciers. This omission, combined with a lack of consensus on glacial movements and their potential impact on the river flows, suggests that the region's shifting water balance may not qualify as a tipping point or element. The location-specific prospects for resilience, noted below, also indicate that there is scope to prevent ecological change from tipping into a humanitarian crisis. Although the environmental challenges may be manageable, they are still a source of grave concern. According to India's National Action Plan on Climate Change, up to 51 million Himalayan residents are vulnerable to climatic shifts and reduced water availability (2008). In light of these vulnerabilities and other ecological concerns downstream, I argue that the loss of glacial mass in the Himalayas is part of a Ganges Basin "hot system" that demands urgent policy attention.

Formulated during the fourth Summer Academy on Social Vulnerability, the hot system approach identifies areas threatened by extreme environmental and social change. A hot system is characterized by the interplay of dynamic overlapping vulnerabilities and exposure to hazards in a changing climate where complex biophysical and socio-economic forces influence geographically disparate locations (Lynn et al., this volume). This analytic frame can focus research on the relationships between and within biophysical and social processes so as to understand the manner in which a combination of events and conditions might result in a humanitarian crisis. Drawing from these guidelines, I identify the Ganges Basin as a hot system based on shifting water availability in the Himalayas; basin-wide erratic monsoon precipitation (Basishta et al. 2009); and sea level rises in the Bay of Bengal.

An intrinsic argument of the hot systems approach is that policies to address the biophysical and socio-economic forces that drive tipping points and humanitarian crises need to be holistic. At the same time, it is important to retain context specificity for policy formation and implementation in diverse locations. In the Ganges Delta, for instance, altered river flow from the Himalayas and irregular rainfall will increase dependence on groundwater supplies. Efforts to address this will demand specific responses based on the high arsenic content of many such sources (Samadder and Subbarao 2007) and other regional water quality concerns. The degradation of water supplies will be compounded by heightened resource stress related to migration from rising sea levels (Warner et al. 2009: 13). This will likely exacerbate social instabilities that require targeted responses. The scale and scope of the problems therefore mandate interdisciplinary collaborations between natural and social scientists. Such efforts must consider the water cycle, ecosystem loops and social landscapes from the Himalayas to the Bay of Bengal to develop viable mitigation efforts.

To begin such an effort, I turn to the environmental challenges and prospects for resilience along the primary stretch of the Ganges River. While the regional focus only elucidates one component of the Ganges Basin hot system, it is a hopeful step towards engagement with scientists and policymakers working on other parts of the system.

**Environmental and Livelihood Challenges along the Ganges River**

Flowing 2,500 kilometres and supporting the livelihoods of nearly half a billion people, the Ganges River is one of India's most important freshwater sources (Chapman and Thompson 1995). Disturbingly, the 30.2 kilometres long Gangotri glacier that feeds the Ganges and supports human lifeways retreated significantly in the twentieth century (IPCC 2007). While the scope of retreat and the implications for glacial melt on surface water is inconclusive, many residents living along the primary tributary of the Ganges, the Bhagirathi, presented qualitative feedback to the author that flows are increasingly erratic. In addition to irregular glacial runoff and the impacts of hydroelectric development projects, the alterations are likely related to the reduction of winter snow and rainfall patterns. Warming temperatures and a change of vegetation quality and quantity in the Himalayas influence the noted trends (Basishta et al. 2009). If precipitation continues to falter and winter flows in the river are further reduced, the region's water cycle will be impaired. In such a scenario, millions of people and multitudes of non-human life will

face livelihood challenges that may exacerbate existing socio-economic and gender inequities (Denton 2001).

In countries like India, water inequities are highly gendered with economically disadvantaged women bearing the brunt of resource allocation shortages (Lahiri-Dutt 2006). Along the primary stretch of the Ganges in the ethnolinguistic Himalayan region of Garhwal, women have arduous domestic and agricultural workloads that are compounded by a lack of economic opportunities and outward male migration (Mehta 1996). Because daily lives are heavily dependent upon the resource base, the projected water availability decline endangers women's livelihoods as well as the welfare of the children and animals under their care. For some, such concerns call for a gender security approach that highlights the disparate impacts of climate change on gendered groups such as women and children (Oswald 2009: 1157)[5] .

For men and women, a number of environmental initiatives channel the growing sentiment of insecurity into action. Several groups, for instance, target hydroelectric dams along the river's course to contest what they charge are unsustainable resource management practices in a fragile, zone five area of seismic activity with frequent landslides (Dharmadhikary 2008: 25). Others, such as the Ganga Safai Abhiyan (Movement to Clean the Ganges), address pollution along the river in an effort to reduce environmental degradation. Active in the campaigns to improve the river's health, rural and semi-urban women are particularly effective at raising awareness by drawing attention to the river's significance as a cultural heritage that deserves protection.

In response to pressure from civil society to revise management polices along the Ganges, the Government of India declared it a "national" river in 2008. The decision established a regulatory body, the Ganges River Basin Authority, tasked with reviving the 'lifeline' of India (CSE 2008). The government's National Action Plan on Climate Change, noted earlier, is also working to promote climate adaptation initiatives that will ideally extend to the river's banks.

**Prospects for Resilience**

Despite challenges, a number of trends hold promise for the resilience of Himalayan ecologies. In the Himalayan region of Garhwal where pine monocultures contribute to erosion and compound wildfire challenges, tree plantations of diverse species offer hope for ecological integrity. Village-based reforestation efforts, NGO tree nurseries, and state forest department programmes operate at multiple scales and diverse locations to rebuild the fragile environment with regionally appropriate tree varieties. These reforestation projects strengthen soil and water retention while supporting mountain biodiversity. Broad-leafed trees also contribute to the water cycle by expiring moisture into the air through evapotranspiration. In some cases, such as the Gangotri-Gaumukh Conservation Project, tens of thousands of high altitude trees and medicinal plants are grown in nurseries below the river's glacial source.

Policies also aim to protect and conserve the region's resources. Since 2008, a cap of 150 tourists per day regulates entry into the park leading to the glacier. Downstream in the district capital of Uttarkashi, a ban on plastics reduces the amount of polythene that clogs sewers and chokes the banks of the river. Although the environmental regulations are promising, much more can be done to improve the ecological condition of the Himalayas and the corresponding levels of social welfare.

**Policy Recommendations**

A pressing need to address ecological change in the Himalayas is the expansion of socially engaged environmental education programmes. Misunderstandings about the science of climate change abound and more education is needed to delineate the issues as well as the behaviours that can mitigate deleterious ecological shifts. Although many illiterate and moderately literate people living along Ganges know about the retreat of the river's glacial source, they are less informed about the local, regional and global forces that cause such phenomenon. While they may cite polluting activities as a driver for the environmental changes they witness, they are likely to link these behaviors to the rise of sin that defines the current époque of kali yug. This

[5] *Oswald's (2009) approach entails a broad concept of gender that includes women, children, elders, indigenous, and other minorities.*

yug, or period, is one of four cycles of time in the Hindu cosmology and it is characterized by extreme moral, social, and ecological degeneracy. Within this worldview, some believe that the Goddess Ganga – the river diety – is mad with human misconduct in the world and is retreating back to the heavens to show displeasure. While cosmologically revealing, such explanations can have the undesirable effect of deflecting personal responsibility. By providing culturally sensitive information on climate change, education efforts can elucidate interplays between human behaviour and the environment. Doing so will foster personal accountability in the sustainable management of Himalayan resources.

While environmental education is needed, many Himalayan residents are keen to the signs of change they observe and they are among the most qualified to develop appropriate responses. The daily managers of their resource base, Himalayan residents have authority to speak to resource problems and solutions. Forming regional strategies for resilience, however, involves equal gender participation in decision-making processes and hazard reduction efforts (Mehta 2009). Since many Himalayan women are already burdened with the bulk of domestic chores, agricultural labour and animal husbandry, a way to promote inclusion is to work with preexisting mahila mandaldal or "women's committees" that are found in many villages. These are critical sites for dialogue, planning and decision-making.

At the state and national level, the policy of building large hydroelectric dams near Himalayan glaciers needs to be reassessed based on current and projected hydrological data. To meet increasing energy demands, more work is required to explore the viability of small hydroelectric projects that involve less ecological interference and promote regional prosperity through employment generation. Given the predictions of glacial retreat and irregular runoff, it is also important to expand the production of power by tapping into renewable solar and wind resources. These efforts, combined with micro-credit schemes and entrepreneurial activities, can promote regional economic resilience.

For sustainable livelihoods, water harvesting projects in rural and mountainous areas of the Himalayas must be promoted. These initiatives should expand upon preexisting pond and tank storage technologies while encouraging innovation. In the broader context of surface water decline and erratic rainfall patterns, rainwater harvesting is a viable adaptive strategy to mitigate water stress. To maximize available water supplies, an urgent need is to expand the production of crops that grow with minimal water resources. This will help cultivators meet the coming environmental challenges with strains of millet and other grains that can flourish with nominal rainfall.

Finally, national and international responses to glacial melt and ecological change can help mitigate vulnerabilities by recognizing that environmental shifts in the Himalayas are part of a broader problem: a regional hot system that spans the length of the Ganges Basin. Addressing regional phenomena as part of a holistic system will help improve mitigation efforts. This paper explored some aspects of resilience along the river's primary stretch. More work is needed to understand the dynamic ecological and social feedbacks between glacial melt, changing monsoon patterns and sea level rise.

**Acknowledgements**

The author would like to thank the Chairs of the fourth Summer Academy on Social Vulnerability for their comments and suggestions. Support for research came from the Fulbright Hays Doctoral Dissertation Abroad Fellowship and the National Science Foundation (award number 0851193).

**References**

Adger, N. W.; Eakin, H.; Winkels, A. (2009): Nested and teleconnected vulnerabilities to environmental change. In: *Frontiers in Ecology and the Environment*. vol. 7, no. 3, pp. 150-157.

Bates, B. C.; Kundzewicz, Z. W.; Wu, S.; Palutifkof, J. P. (Eds.) (2008): *Climate Change and Water. Technical Paper of the Intergovernmental Panel on Climate Change*. IPCC Secretariat, Geneva.

Basishta, A.; Arya, D. S.; Goel, N. K. (2009): Analysis of historical changes in rainfall in the Indian Himalayas. In: *International Journal of Climatology*. vol 29, pp. 555-572.

Chapman, G. P.; Thompson, M. (1995): *Water and the Quest for Sustainable Development in the Ganges Valley.* Mansell, New York.

CI (2008): *Biodiversity Hotspots*. <http://www.biodiversityhotspots.org/xp/hotspots/himalaya/Pages/biodiversity.aspx>, 25 June 2009.

CSE (2008): *Will Ganga Get Its Life Back?* <http://www.cseindia.org/misc/ganga/ganga_action.htm>, 15 May 2009.

Denton, F. (2002): Climate change, vulnerability, impacts, and adaptation: why does gender matter? In: *Gender and Development*. vol. 10, no. 2, pp. 10-20.

Dharmadhikary, S. (2008): *Mountains of Concrete: Dam Building in the Himalayas.* International Rivers, Berkeley, CA.

IPCC (2007): *Climate Change 2007: Climate Change Impacts, Adaptation, and Vulnerability, Summary for Policy Makers.* Contribution of the Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, February 2007. IPCC, Brussels.

Khoday, K. (2007): *Climate Change and the Right to Development: Himalayan Glacial Melt and the Future of Development in the Tibetan Plateau.* United Nations Development Program, Human Development Report: Fighting Climate Change: Human Solidarity in a Divided World. UNDP, Human Development Report Office.

Lahiri-Dutt, K. (Ed.) (2006): *Fluid Bonds: Views on Gender and Water.* Stree Publishers, Kolkata.

Lenton, T. M.; Held, H.; Kriegler, E.; Hall, J. W.; Lucht, W.; Rahmstorf, S.; Schellnhuber, H. J. (2008): Tipping elements in the Earth's climate system. In: *Proceedings of the National Academy of Sciences*. vol. 105, no. 6, pp. 1786-1793.

Mehta, M. (1996): Our Lives Are No Different from that of Our Buffaloes: Agricultural Change and Gendered Spaces in a Central Himalayan Valley. In: Rocheleau, D.; Thomas-Slayter, B.; Wangari, E. (Eds.): *Feminist Political Ecology: Global Issues and Local Experiences.* Routledge, New York. pp. 180-208.

Mehta, M. (2009): Reducing Disaster Risk through Community Resilience in the Himalayas. In: Enarson, E.; Chakrabarti, P. G. D. (Eds.): *Women, Gender, and Disaster: Global Issues and Initiatives*. Sage, New Delhi. pp. 57-74.

National Action Plan on Climate Change (2008): Prime Minister's Council on Climate Change. Government of India, New Delhi.

Oswald Spring, U. (2009): A Huge Gender Security Approach: Towards Human, Gender, and Environmental Security. In: Brauch, H. G.; Spring, U. O.; Grin, J.; Mesjasz, C.; Kameri-Mbote, P.; Behera, N. C.; Chourou, B.; Krummenaher, H. (Eds.): *Facing Global Environmental Change: Environmental, Human, Energy, Food, Health, and Water Security Concepts*. Springer, Berlin. pp. 1157-1181.

Rees, G. H.; Collins, D. N. (2006): Regional differences in response of flow in glacial fed Himalayan rivers to climatic warming. In: *Hydrological Processes.* vol. 20, pp. 2157-2169.

Russill, C.; Nyssa, Z. (2009): The tipping point trend in climate change communication. In: *Global Environmental Change*. vol 19, no. 3. pp. 336-344.

Samadder, S. R.; Subbarao, C. (2007): GIS approach and risk assessment of areas affected by arsenic pollution in drinking water. In: *Journal of Environmental Engineering.* vol. 133, issue 7, pp. 742-749.

Warner, K.; Ehrhart, C.; de Sherbinin, A.; Adamo, S.; Chai-Onn, T. (2009): *In Search of Shelter: Mapping the Effects of Climate Change on Human Migration and Displacement*. <http://www.careclimatechange.org>, 1 December 2009.

WWF (2005): *An Overview of Glaciers, Glacier Retreat, and Subsequent Impacts in Nepal, India, and China.* WWF, Nepal.

## Crisis Aversion in an Uncertain World: Cultivation by East African Pastoralists

*Stacy J. Lynn*

**Abstract**

In multi-sector socio-ecological systems, the implementation of mechanisms to improve resilience in one sector may increase vulnerability in another. Pastoralism has been practiced alongside wildlife in semi-arid East Africa for millennia, but conflict is intensifying between wildlife conservation policy and Maasai pastoral land use. In Simanjiro, northern Tanzania, key resources were excised from Maasai use and incorporated into Tarangire National Park (TNP) in 1970 with the goal of wildlife conservation. The elimination of these important areas from the Maasai repertoire has been devastating during droughts and, from the Maasai perspective, conflicts with wildlife on village lands are difficult to reconcile with wildlife's exclusive use of perennial water inside TNP.

Despite regionally high temporal and spatial variability of rainfall, most Simanjiro Maasai have diversified their land use to cultivate. This study finds that cultivation profits are largely positive, raising some below-subsistence pastoralists above the subsistence threshold and others toward it. Resilience is increased as a product of both intermittent food production and a quick potential food pulse following drought while livestock populations recover. Cultivation success is correlated with herd wealth in two villages. Data from a third village showed widespread crop failures across the entire wealth gradient, demonstrating that success is also highly variable across space, likely due to uneven rainfall. The opportunity to cultivate may prove increasingly important if rainfall variability increases as predicted by climate change models. Future wildlife conservation may either enhance or compromise pastoral resilience. Strictly limiting cultivation in Simanjiro would remove a subsistence alternative, but allowing use of key restricted resources during drought would help communities mitigate risks associated with climate change. Policymakers should involve local pastoral stakeholders and incorporate objective predictions of both wildlife and livelihood impacts to best maintain system resilience.

**Keywords: Vulnerability, resilience, diversification, livelihoods, pastoralism, wildlife, Tanzania**

### Introduction

In multi-sector socio-ecological systems attempts to improve resilience in one sector may in fact increase vulnerability in another. Such a situation is occurring in East Africa as conservation policymakers establish national parks, and then attempt to extend their management influence to areas outside parks with the goal of maintaining migratory wildlife populations. Land managers worry that the intensity of human impacts on ecosystems will be amplified as populations increase. Land use decisions involve weighing consequences of use for both meeting short-term human demands and maintaining ecosystem function (DeFries et al. 2004). These decisions also need to balance the resilience and vulnerabilities of both social and ecological system components.

Ecological resilience theory was developed by C. S. Holling (Holling 1973) to describe trajectories of change in ecological systems and their response. Resilience "determines the persistence of relationships within a system and is a measure of the ability of systems to absorb changes of state variables, driving variables, and parameters, and still persist [in its current form]" (Holling 1973: 17). Over the years the ecological resilience discourse has continued to refine this definition; however the fundamentals have remained unchanged.

In more recent years the resilience discourse has expanded to embrace the social component of ecosystems, as humans participate in determining the structure function of most ecosystems. In fact, the first step in managing for resilience is to recognize that people and their institutions are integral components of ecological systems (Chapin et al. 2004). The importance of governance, and its contribution to a society's ability to manage resilience, resides in its actors, social networks and institutions and how they function and make decisions (Lebel et al. 2006). It has been found that oftentimes governance structures and processes actually pass over the needs of livelihoods and minorities in the interests of maintaining ecological resilience (Lebel et al. 2006); these decisions are based upon priorities among social and environmental objectives that are weighed in a necessarily political arena (Goldman 2004).

Vulnerability is defined as a state of susceptibility to harm from exposure to stresses associated with multi-scaled environmental and other changes, combined with an absence of capacity to adapt to these changes (Adger et al. 2009). The vulnerability of systems is the balance between accumulated resilience derived from social and ecosystem services, and the shorter-term sensitivity to social and ecological change (Chapin et al. 2004). Vulnerabilities are nested, so that changes and shocks at the global scale (such as climate change) cascade down to the local level to impact livelihoods and human welfare, and likewise local responses to change may trigger vulnerabilities in other locations (Chapin et al. 2004).

Across much of East Africa, relations between land users and governments/conservation agencies are characterized by controversy regarding the impacts of land use on the landscape, wildlife and biodiversity in general (Brockington 2002). The potential for conflict is perhaps greatest in regions that border protected areas (PAs) in arid to semi-arid lands (ASAL) where migratory wildlife often share the landscape with people. Declines in wildlife populations have been found in many areas of East Africa (Homewood et al. 2001). But per-capita livestock holdings also appear to be declining (Kijazi et al. 1997; McCabe et al. 1997; Lynn 2000; Boone et al. 2006). The long-term sustainability of both livelihoods and wildlife on pastoral lands is in question.

Rainfall is a dominant driver of semi-arid land cover, constraining human land use. Extensive livestock grazing is well-suited to the bimodal pattern of rainfall found in East African ASAL (Ellis and Galvin 1994), as livestock can convert unpalatable forage materials into foods for human consumption (Pratt and Gwynne 1977; Dyson-Hudson 1980; Lamprey 1983) and make it possible to exploit areas that are too marginal for most other human uses (Galaty and Johnson 1990). Both domestic and wild animals track resources spatially and temporally across the ASAL landscape by moving to access these resources where and when they occur.

Drought and unpredictability are fundamental characteristics of ASAL and both wildlife and humans have developed coping mechanisms to accommodate changes ranging in scale from the annual rainfall cycle to more serious inter-annual shocks. Along with movement, pastoral populations tend to herd multiple species to spread risk and use social programmes such as stock associations and wealth to redistribute resources from wealthy to poor in times of need (Potkanski 1999). Herd size is opportunistically increased in semi-arid and non-equilibrial systems in anticipation of future losses, buffering herdowners from drought and disease die-offs (Campbell 1981; Sandford 1982; Ellis and Swift 1988; Galaty and Johnson 1990; Swift et al. 1996; Schwartz 1999).

But climate change is expected to increase both the frequency and magnitude of extreme weather events in many parts of East Africa, particularly savannas (Barker 2003; Boko et al. 2007). While pastoralists and wildlife are accustomed to fluctuations of well-being in these non-equilibrial ecosystems, an increasingly extreme climate regime may compromise the capacity of the system to recover between shocks. After a single year of drought, animals (domestic and wild) will not only suffer the ill-effects of drought-past, but will also become more vulnerable to future events, whether a cold rainfall (Ellis 2001) or another year of drought. Add to this a diminished capacity to relocate because of changes in landscape and resource structure (e.g., cultivation or fencing), availability (e.g., water diverted for irrigation), or access (e.g., conservation policy or other political boundary), and there is enormous potential for the system to "tip" into a condition where the sustainability of East African pastoral systems becomes doubtful.

**The Tarangire-Manyara Ecosystem**

The Tarangire-Manyara Ecosystem (TME) is located in northern Tanzania and incorporates two national parks – Tarangire National Park (TNP) and Lake Manyara National Park – as well as the village lands of the Simanjiro Plains to the east (see Figure 1). The primary shift in land use in Simanjiro villages has been an increase in cultivation over recent decades, and this appears to be accelerating (Voeten and Prins 1999; TMCP 2002). Hostility and resentment among various stakeholders have escalated due to both real and perceived violations of pastoral land rights, the fear of future violations and a potential crash of the migratory wildlife and/or pastoral livestock populations.

Diversification may increase resilience of populations by providing alternative pathways that allow people to cope with adversity. Alternative subsistence pathways may prove to be particularly important if climate change exacerbates adversity. Actions to diversify are simply attempts to compensate for or pre-empt anticipated changes in the ability to maintain livelihoods through pastoralism alone, in either the long- or short-terms. The rationale for diversification varies across wealth classes; poor herders are pushed into diversification to survive, the wealthy diversify as an investment scheme, while mid-wealth herders lack either the need or motivation to diversify and are likely the last to do so (Little et al. 2001). Opportunity, need and local conditions must come together to make diversification an attractive and viable option. A widespread perception of increasing vulnerability by Simanjiro Maasai may be a key factor in changing local attitudes towards cultivation.

The risk of crop failure is high in Simanjiro. But residents uphold that cultivation helps maintain their livelihoods. Policymakers are concerned that increasing cultivation has the potential to negatively impact wildlife, particularly migratory species that alternate residence between Park lands in the dry season and pastoral lands in the wet season. Since the creation of TNP, wildlife have continued to migrate between these two zones, but livestock are now restricted to Simanjiro year-round, compromising pastoral livelihoods (Igoe and Brockington 1999; Goldman 2003). In Simanjiro, stress is felt particularly during drought. Additional land use restrictions, including cultivation limitations, are now proposed for many parts of Simanjiro as part of village-based land use plans (Goldman 2003).

Since the early 1990s Simanjiro Maasai have also diversified into the tanzanite gem trade (McCabe 2009). Herdowners typically sell a

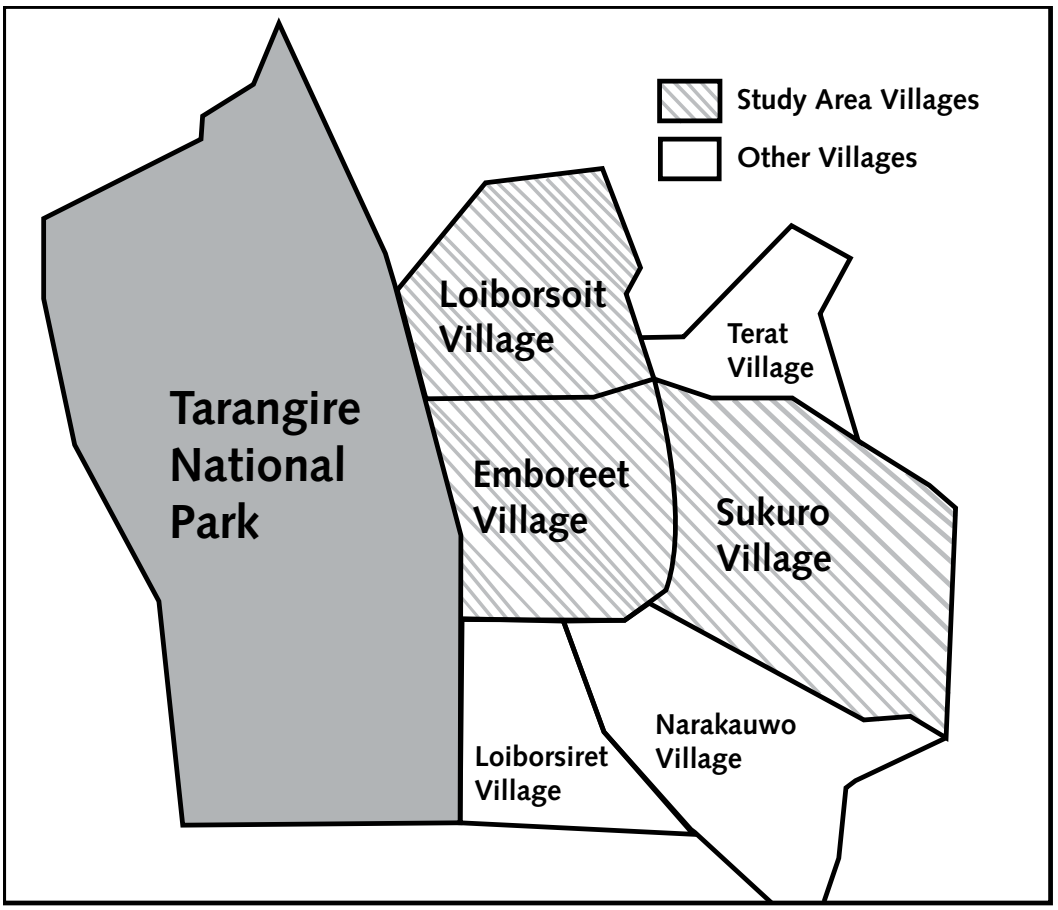



*Figure 1: Reference Map of TNP and nearby Maasai Villages*

sheep or goat for cash to purchase stones from a digger, then resell the stones to cutters. The gem trade is of interest to this study because of the potential contribution of profits to land use change. Both cultivation and gem trading may spread economic risk, reducing vulnerability to fluctuations in the livestock sector. This will become increasingly important as resource use becomes more limited by changes in landscape structure, access and availability.

**Research Questions**

The objective of this study is to determine the contributions of livelihood diversification activities to Maasai households in the Simanjiro Plains of the Maasai Steppe. Several research questions are addressed:

- Does livestock herding remain the most important income-generating activity for Simanjiro households?
- Does cultivation make a positive net contribution to household economies?
- Is cultivation success correlated with household herd wealth?
- Is the gem trade facilitating increased cultivation?

The answers to these questions will contribute information important to future conservation and land use policy, as well as to village and household-level land use decision-making. Quantifying the role of cultivation in modern Maasai livelihoods allows the incorporation of human welfare needs into the complicated equation of conservation in this pastoral ecosystem.

**Household Data Collection**

For the purpose of this study, a household is defined as a male herdowner, his wives and children, plus any other dependent family members (following Lynn 2000; Galvin et al. 2001; Galvin et al. 2002; Thornton et al. 2003). Bomas, or settlements, consist of one or more male herdowners and their associated households. Bomas are grouped into subvillages, and villages are formed of multiple subvillages (see Figure 2). Three villages (Sukuro, Loiborsoit and Emboreet) were selected for study.

A census of bomas was compiled with the assistance of each village's leaders, and a stratified-random sample was selected for detailed interviews. A total of 70 bomas were selected, 31 in Sukuro (33 per cent of bomas, 96 interviews total), 28 in Loiborsoit (20 per

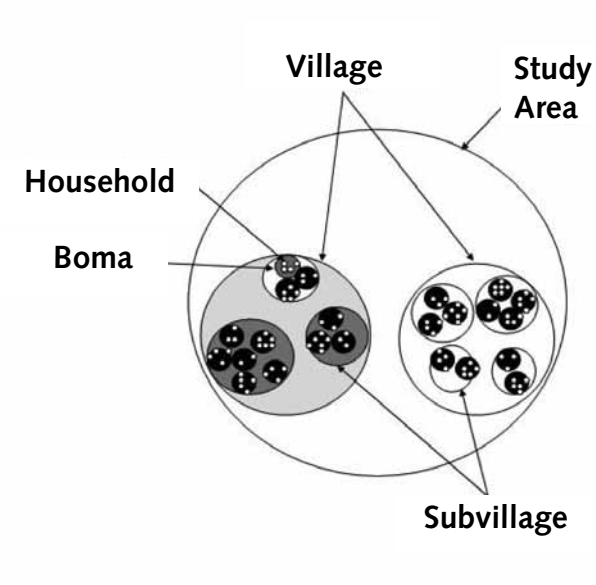



*Figure 2: Schematic of the Interview Design, Stratified to Allow Analysis at the Household, Boma, Subvillage, and Village Levels.*

cent of bomas, 65 interviews total), and 11 in Emboreet (25 per cent of bomas, 46 interviews total). Interviews were stratified across subvillages. A long version was conducted with at least one herdowner per boma (n=107), and a shorter version (n=100) with all other available herdowners.

**Data Analysis**

Livestock numbers were converted to Tropical Livestock Units (TLUs) to standardize cattle, goats and sheep. One TLU is equal to one 250 kilograms animal. The equivalencies used to convert to TLUs were 1 head of cattle = 0.71 TLU, and 1 head of smallstock (sheep and goats) = 0.17 TLU (McCabe et al. 1997; Lynn 2000; Galvin et al. 2002). Households (within bomas) that shared resources were pooled for analysis. Relative rankings of household income sources and expenditures were assessed, and net household income from cultivation calculated.

Two years of cultivation production data were collected via recall from each interviewee. Total harvest information (kg) was recorded for one good year (2001 – 2002) and one marginal (2002 – 2003) year. Herdowners who participated in the gem trade were asked to detail their cumulative profits and losses, and classified into five categories: "loss" (invested money in attempting to trade, and never regained it), "broke even" (regained investment, but did not profit), "small profit" (regained investment and then enough to buy a few livestock or some food), "large profit" (made enough profit to purchase a large number of livestock, into the hundreds of animals, and/or to plow large fields), and "very large profit" (made enough money to purchase not only livestock or to cultivate, but also vehicles such as land rovers or tractors that often led to continuing profits from renting out vehicle services).

Statistical tests were conducted using SPSS version 17.0 for Windows (SPSS, Inc., Chicago, IL). A variety of tests were used to analyse data. One one-way Analysis of Variance (ANOVA) was performed to determine if the mean acres cultivated differed by village. Frequency analyses were used to rank the economic importance of various household activities. Kruskal-Wallis tests were performed on non-parametric data when the goal was to compare group means and determine the significance of their differences. Both parametric and non-parametric linear regressions were performed to investigate the strength of relationship between continuous variables. A linear regression was performed to investigate the relationship between herd wealth (per-capita TLUs) and the number of acres cultivated.

**Results**

Maize and beans were the only crops grown by the households interviewed. 93 per cent of study informants (n=193) cultivated at minimum a small garden, with many cultivating several acres and two Sukuro households cultivating fields of 200 acres. Mean acreage per household was small at the inception of cultivation (3.15 acres) regardless of the year cultivation was started, but in 2003 the average household cultivated 13.5 acres. This suggests that individuals tend to increase plot size over time. Mean acreage was highly variable, but not significantly different between villages (p=0.419).

**Does Livestock Herding Remain the Most Important Income-Generating Activity for Simanjiro Households?**

While Maasai are diversifying, they still specify that livestock are most important to them, both economically and culturally. In the wet season, 64 per cent of respondents ranked livestock as their primary source of income, and 32 per cent ranked it second (see Table 1). Cultivation was reported as the primary wet season income source by 36 per cent of households, and second by 62 per cent. While 47 per cent of households participated in the gem trade, it was ranked as the least important income source by nearly everyone. In the dry season, as milk becomes scarce and fields are harvested, cultivation becomes more important to household income through both food production and cash from sales. 49 per cent of households ranked cultivation as the most important dry season income source, and 38 per cent ranked it second. 44 per cent of respondents ranked livestock as most important, and 51 per cent ranked it second (see Table 1). The importance of gem trade to income increased in the dry season to 6 per cent ranking it as their primary source of income, and 8 per cent ranking it second.

| Relative Importance of Income Activities | | | | | | |
|---|---|---|---|---|---|---|
| | Wet Season | | | Dry Season | | |
| RANK | Livestock | Agriculture | Mining | Livestock | Agriculture | Mining |
| 0 | 0,0% | 0,9% | **53,3%** | 0,90% | 7,5% | **54,2%** |
| 1 | **63,6%** | 35,5% | 0,9% | 43,9% | **48,6%** | 5,6% |
| 2 | 31,8% | **61,7%** | 5,6% | **50,5%** | 38,3% | 8,4% |
| 3 | 4,7% | 1,9% | **40,2%** | 4,7% | 5,6% | **31,8%** |

*Table 1: The relative importance of income activities was ranked by herdowners (n=107), where 0=No Participation, 1=Most Important, 3=Least Important.*

The three most important household expenses across all seasons were supplemental food, livestock and cultivation (see Table 2). Supplemental food purchases were ranked the most important household expense for both wet and dry seasons, which indicates that food insecurity is an issue across the year despite diversification. Livestock is still ranked as the most important income source, but is inadequate to sustain the average household's food needs.

| Additive Rankings of Households Expenditures | | | |
|---|---|---|---|
| | Wet | Dry | Average |
| **Livestock** | **421** | **455** | **438** |
| **Agriculture** | **448** | **17** | **232** |
| **Supplemental Food** | **465** | **583** | **524** |

*Table 2: Additive values were calculated for the relative rankings of livestock, agriculture and supplemental food expenditures for the wet and dry seasons. Higher values connote greater perceived contributions to household expenditures.*

**Does Cultivation Make a Positive Net Contribution to Household Economies?**

All cultivating households planted crops in both 2001 – 2002 (average) and 2002 – 2003 (dry), but the crop failure rate was much greater in 2003. The number of acres cultivated per household did not change from 2002 to 2003. However mean household harvest totals decreased dramatically (see Table 3). Mean net production (combined maize and beans) of 126 kg/acre in 2003 was nearly half the 237 kg/acre harvested in 2002. Maize appears to be quite sensitive to rainfall, as the difference from 2002 (1915 kilograms per household) to 2003 (810 kilograms per household) is striking. Approximately 40 per cent of the variation in total harvest between these two years can be attributed to the difference in year ($r2 = 0.408$, $p<.001$).

The total amount of grain consumed each year and proportion from supplemental food were calculated using reports of kilograms eaten (versus sold or saved for seed) and kilograms purchased. Harvest quantity and proportion of total diet made up of supplemental foods were inversely related. The ratio of purchased to harvested foods increased from 33 per cent in 2002 to 58 per cent in 2003, demonstrating high variability in food security across years as a function of rainfall.

| Mean Household Production (KG) | | | |
|---|---|---|---|
| | | **2002** | **2003** |
| **Maize Produced** | | **1915** *n=189* | **810** *n= 192* |
| **Beans Produced** | | **890** *n=118* | **688** *n= 103* |
| **Total Harvest** | | **2445** *n=191* | **1176** *n= 192* |

*Table 3: The relative importance of income activities was ranked by herdowners (n=107), where 0=No Participation, 1=Most Important, 3=Least Important.*

Low production comes at high cost, including lost investment (i.e. plowing costs, labour diverted from livestock, and caloric cost of labour), less to eat, less surplus to sell, and outlays for more supplemental food. Mean market prices for both maize and beans increased greatly from 2002 to 2003. The price of maize rose from $ 0.09/kg to $ 0.14/kg, and the price of beans rose from $ 0.21/kg to $ 0.25/kg, negatively impacting those households that did not produce grain. Food and other expenses in these households had to be covered by herd sales.

**Is Cultivation Success Correlated with Household Herd Wealth?**

Cultivation success in Loiborsoit and Emboreet did vary across years, but 90 per cent of households in these villages broke even or made a profit in the end (see Figure 3). Cultivation success was correlated with herd wealth in these two villages ($r = .50$, $p<.001$). Six TLUs per person is a common reference for pure pastoral subsistence (Brown 1973; Lynn 2000; Galvin et al. 2002), but Simanjiro Maasai are not pure pastoralists. Some unit of livestock can be subtracted from this number for each equivalent unit of grain produced, and these equivalencies will vary according to markets and livestock condition. However, cultivation lifts a number of households above the subsistence threshold.

Four classes of households may be distinguished from Figure 3: Segment A households are wealthy and do not need to cultivate, but do anyway (and are making a decent profit at it). Segment B households are lifted into subsistence by cultivating. Segment C households made a profit cultivating but remain below subsistence. Segment D households not only have insufficient herd wealth to maintain a purely pastoral existence, but also are losing money to cultivation. Herd wealth may initially facilitate cultivation, but because cultivation profits often feed back into the livestock sector, cause and effect cannot be assumed.

In Sukuro there was much more widespread crop failure, with only 44 per cent of households breaking even over the course of two years (see Figure 4). In fact, the population segmentation demonstrates that there are a number of households in Sukuro that dropped into negative subsistence as a result of cultivation during these two years. No correlation was found between herd wealth and cultivation success in this village ($r2 = 0.035$, $p=0.198$). This emphasizes the impact that spatial variability of rainfall has across this system. While herds can be moved to access spatially-variable forage and water, cultivation cannot, and is thus more susceptible to drought or patchy rainfall. While harvest success may be greater for wealthier households, as demonstrated in Loiborsoit and Emboreet, cultivation provides no guarantees due to the patchiness of rainfall distribution and timing.

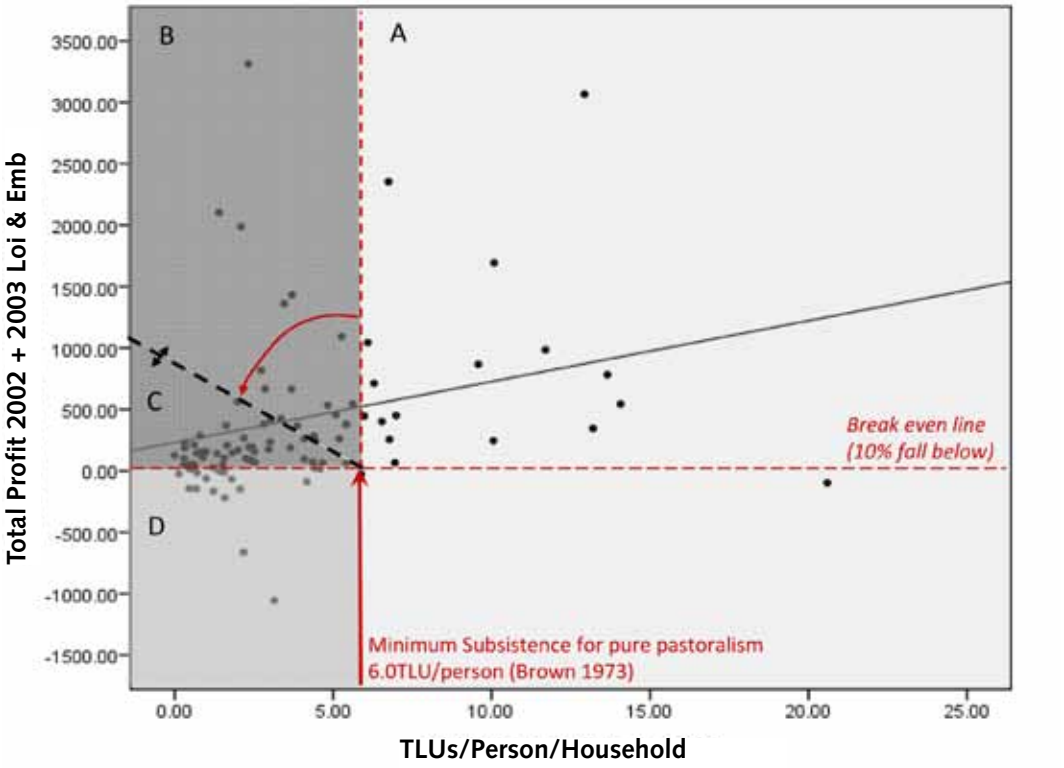



*Figure 3: Cultivation in Loiborsoit and Emboreet is correlated with herd wealth (r2= .25, p<.001). Most households that have >6 TLUs/person (A) made a two-year profit. Some households were lifted into subsistence through cultivation profits (B). Others remained below subsistence but their livelihoods improved (C). Some of the poorest households lost further money through cultivation.*

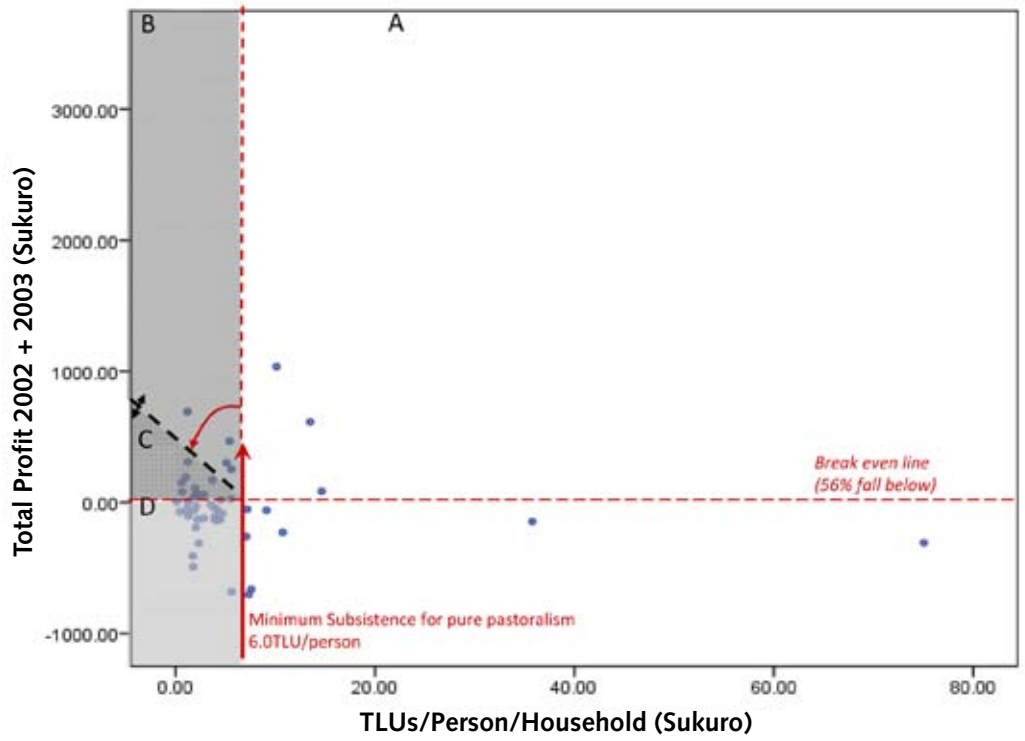



*Figure 4: Cultivation in Sukuro is not correlated with herd wealth (r2= .035, p=.198). Some households were lifted into subsistence through cultivation profits (B). Others remained below subsistence but their livelihoods improved (C). Some of the poorest households lost further money through cultivation (D). Many wealthier herdowners lost money to cultivation (A).*

**Is the Gem Trade Facilitating Increased Cultivation?**

Approximately 50 per cent of study households participated in gem trading, most breaking even or making a small profit. Gem trading has become an important cash source in Simanjiro, despite the fact that many individuals give up because the effort is not worth the profit. Only 2 per cent of interviewees gained a very large gem trade profit. While these individuals invest in large-scale village projects such as shops, dams, schools and dispensaries, the purchase of tractors is the means through which one person's profits have the potential to impact land use change across a village as purchased tractors are rented to other villagers to cultivate their own plots.

Nearly all respondents (96%, n=171) indicated that they used a tractor to cultivate their fields in 2003, the year the interviews were conducted, with the remainder using either a hand-plow or oxplow. Most people began plowing in the late 1980s and 1990s. While tractors were available as early as the 1960s, tractors purchased with gem trade profits increase availability, allowing individuals to cultivate larger plots at their initial onset of cultivation (i.e. they "start bigger"). A one-way ANOVA indicates that plowing method at cultivation onset is significantly related to the number of acres cultivated at that time ($p<.0001$). The maximum number of acres cultivated at the onset of cultivation was 7 for handplows, 5 for oxplows, and 40 for tractors. The proportion of households breaking their first fields with plows declined as the initial use of tractors increased. The timing of this coincides with the onset of the gem trade in the early 1990s (see Figure 5).

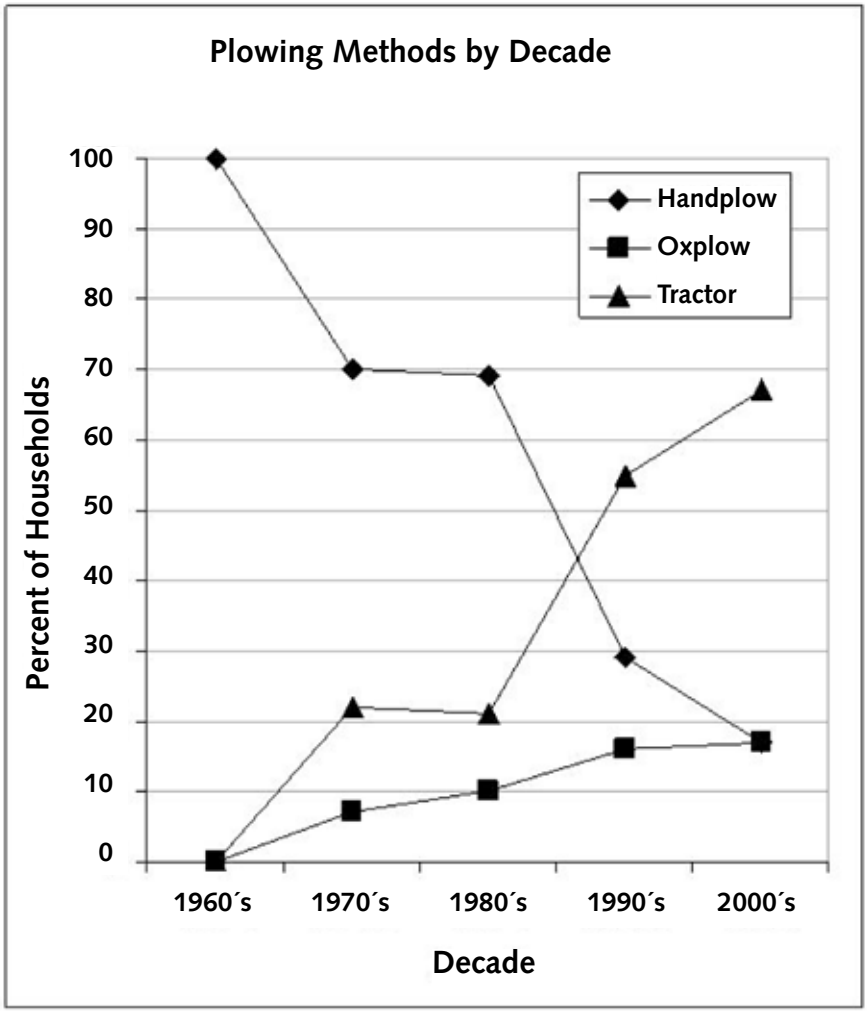



*Figure 5: A steep increase (1980s to 1990s) in the proportion of new fields cultivated with tractors, and decrease in the use of handplows, coincide with the onset of the gem trade in the early 1990s.*

Nearly all respondents who traded gems ranked this as their least important income source. However, the cumulative value of gem trading to some of these households cannot be underestimated, and the contribution to land use change through tractor purchases appears to be quite important. Maasai with resources to hire a tractor to plow their fields are more likely to have large fields than if they had to plow by hand or with an oxplow. Most respondents estimated that they would be able to plow two to three acres without a tractor, in contrast to the actual average of 13.5 acres. Available cash appears to be the factor most limiting household plot size, as most interviewees indicate they would plow more acres if they "became lucky". The implications of this are important. 45 per cent of respondents indicated that they plan to cultivate their entire land allocation, 45 per cent plan to divide their allocation between cultivation livestock, and only 2 per cent plan to use their allocation exclusively for livestock. The mean acres (2003) cultivated by the 39 respondents who would "cultivate it all" was 14.6. The mean land allocation assigned to these interviewees was 35.8. Cultivating the entire allocation would more than double the current area under current household cultivation. At this time the gem trade is the most likely source of resources adequate to reach this goal.

**Discussion**

In ASALs of East Africa varying degrees of change are occurring in population growth, land tenure, land use and excision from use. All of these factors act to increase the vulnerability of pastoral populations and their livestock to extreme events such as drought by restricting movement possibilities. Wildlife populations are also threatened by area loss and landscape changes that are a result of human population growth and land use change. Low net primary productivity and high variability are characteristic of these ecosystems (Colding et al. 2003), but both wildlife and nomadic and semi-nomadic pastoral systems evolved over millennia to utilize widespread forage and water through extensive movement, mitigating these risks. Historically, smallstock are important means to recovery as they reproduce more quickly than cattle.

Economic diversification is a risk management technique commonly used by East African pastoralists to cope with this increasing vulnerability of the livestock sector (Little et al. 2001). Both cattle and smallstock herds decrease during drought as a result of increased outputs (particularly deaths, but also sales and slaughters as animals lose condition and need to be culled before they become useless) combined with decreased inputs (primarily births and purchases).

ASAL conditions make cultivation an unpredictable and risky enterprise, the success and failure of which is determined largely by the quality and timing of each rainy season (Ellis and Swift 1988). In good years of adequate and timely rainfall and minimal pest destruction (wildlife or insect), net income can be quite high, particularly for wealthier pastoralists. Maize can be either grown or purchased. If it is grown successfully then livestock do not need to be sold to purchase it. Respondents frequently commented that cultivation not only provides food directly for consumption, but also has the effect of maintaining herds. But when crops fail the plowing investment is lost, market prices increase, and households struggle to find cash to meet their food needs. Since the productivity of a given year cannot be forecasted at the onset of the growing season, variations in production must be offset by an increase or decrease in compensatory grain purchases (see also Galvin et al. 2004). Purchases are usually financed through livestock sales. The financial implications of cultivation are thus many.

The relationship between the three income-generating activities of livestock, cultivation and gem trading is synergistic (see Figure 6). Livestock enables cultivation by increasing plowing potential. Cultivation provides income for animal purchases and animal drugs (which in turn reduce disease deaths), and by decreasing sales to purchase grain foods. Individual success in the gem trade facilitates livestock and cultivation sectors within the household, but also throughout the village. Though only a small fraction of people obtain enough money to purchase a tractor, many hire the tractors purchased with the gem trade profits of a few.

The economic, social and ecological dimensions of sustainability and adaptation should be balanced for conservation strategies to succeed in places where the needs of these dimensions intertwine and conflict (Munasinghe and Swart 2005; Yohe et al. 2007). Wildlife and pastoral livestock

herds depend largely on the same resources for survival, and as space becomes more limited, political competition for these resources is escalating. Ecosystem structure and function are bound to change with land use, and this will likely have implications for wildlife, but the shared need for pasture and water should provide common ground for management.

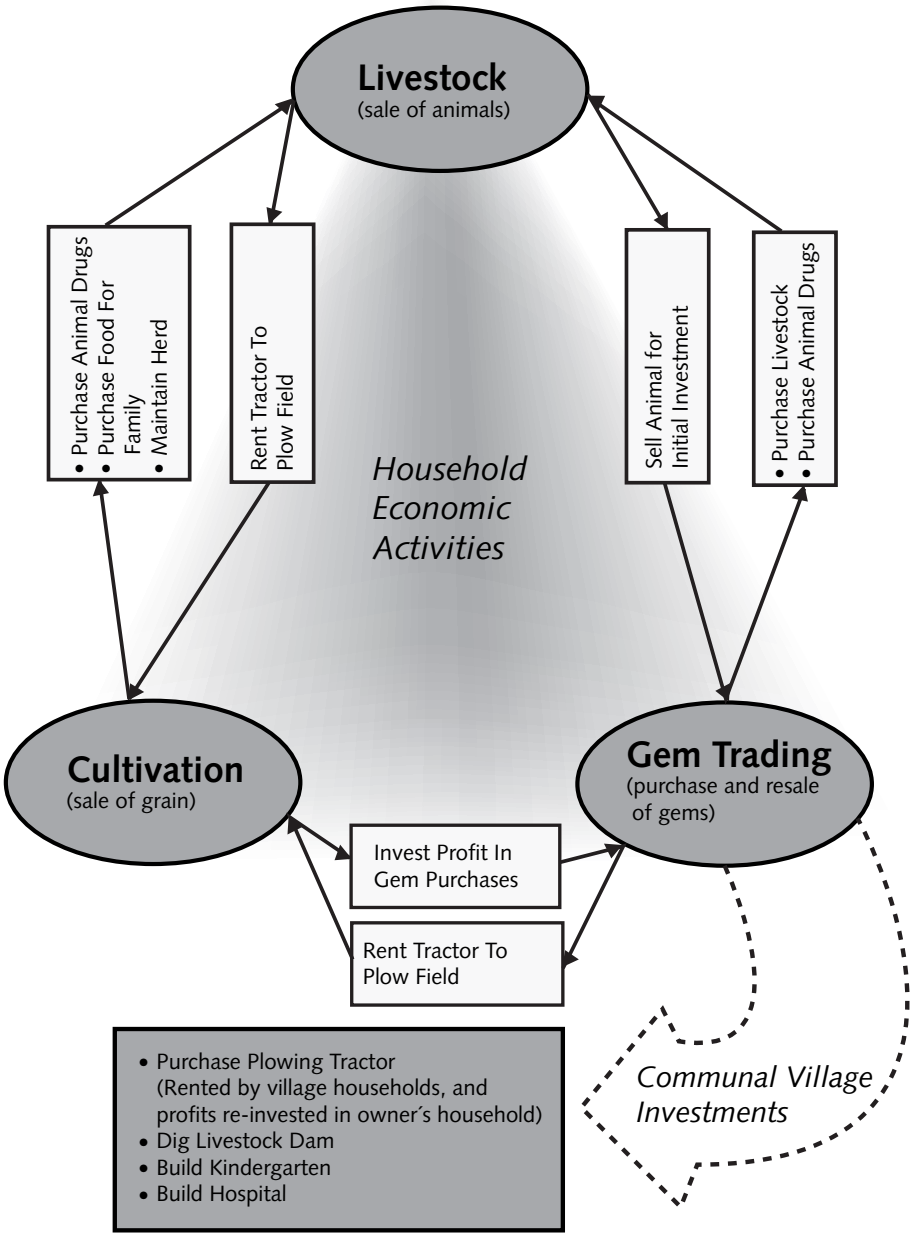



*Figure 6: Simanjiro's three primary income-generating activities are economically synergistic, each supporting the other. Large gem trading profits were invested in several things that benefited village communities as a whole.*

Pastoralists and wildlife have adapted to the inherent and historical risk of climate variability in ASAL. However, land excisions and other restrictions on resource access present new risks that decrease resilience and system stability. Research has shown that, depending on regional economic activity, expansion of national parks and other protected areas actually may reduce both the degree of wildlife conservation and local human welfare (Johannesen 2006). Climate change is expected to increase variability, further amplifying these risks. Maasai pastoralists of Simanjiro bear these layers of risk by relying on three livelihood sectors that form pillars of risk mitigation (traditional pastoralism cultivation and gem trade). If stability of any of these pillars of support is compromised, the system may destabilize from the weight of layered risk. Future land use and conservation policies may either present an additional layer of risk, further restricting mitigation options (thereby increasing vulnerability) or provide an additional support for pastoral livelihoods by assisting with risk mitigation (thereby increasing resilience) (see Figure 7). Strictly limiting cultivation in Simanjiro would remove a subsistence alternative, but allowing use of key restricted resources during drought would help communities mitigate risks associated with climate change futures. Policymakers should involve local pastoral stakeholders in management decision-making and incorporate objective predictions of both wildlife and human impacts to best maintain system resilience, and reduce vulnerability to change.

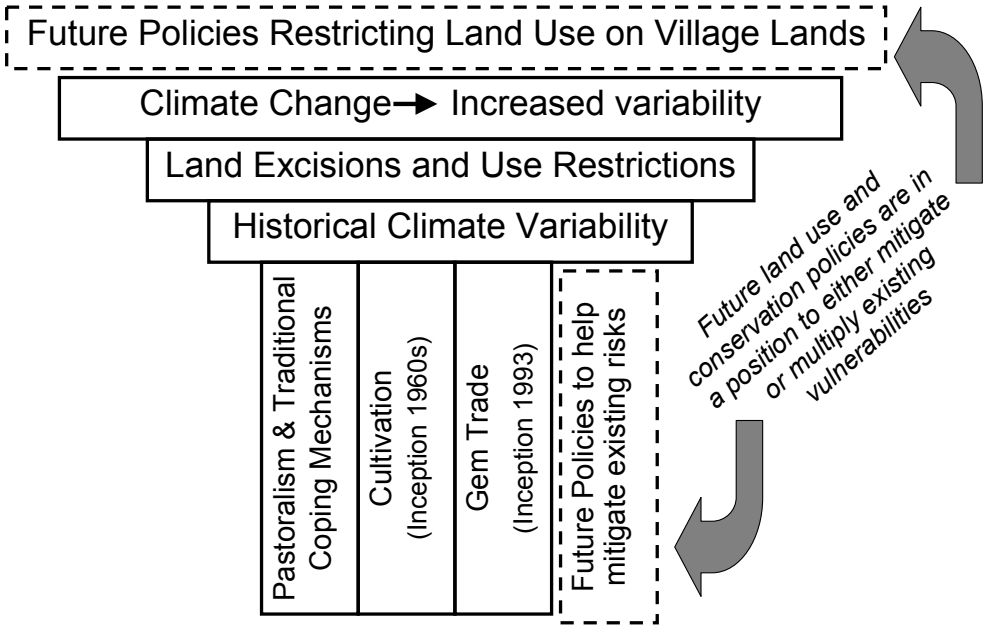



*Figure 7: Future Land Use and Conservation Policies Are in a Position to either Mitigate or Multiply Existing Layers of Vulnerability*

**Acknowledgements**

This research was partially supported by the POLEYC Project, a component of Global Livestock Collaborative Research Support Program (GL-CRSP) which was funded in part by USAID Grant No. PCEG-00-98-00036-00, and a USAID GL-CRSP Jim Ellis Mentorship Award (2003).

- Other support provided by NREL James E. Ellis Memorial Scholarship 2005 & 2007, The International Livestock Research Institute.

- Travel grant for the 2009 UNU-EHS Summer Academy provided by Environmental Governance Working Group at Colorado State University.

**References**

Adger, W. N.; Eakin, H.; Winkels, A. (2009): Nested and teleconnected vulnerabilities to environmental change. In: *Frontiers in Ecology*. vol. 7, no. 3, pp. 150-157.

Barker, T. (2003): Representing global climate change, adaptation and mitigation. In: *Global Environmental Change*. vol. 13, no. 1, pp. 1-6.

Boko, M.; Niang, I.; Nyong, A.; Vogel, C.; Githeko, A.; Medany, M.; Osman-Elasha, B.; Tabo, R.; Yanda, P. (2007): Africa. In: Parry, M. L.; Canziani, O. F.; Palutikof, P. J.; van der Linden, P. J.; Hanson, C. E. (Eds.): *Climate Change 2007: Impacts, Adaptation and Vulnerability.* Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK. 433-467.

Boone, R. B.; Galvin, K. A.; Thornton, P. K.; Swift, D. M.; Coughenour, M. B. (2006): Cultivation and conservation in Ngorongoro Conservation Area, Tanzania. In: *Human Ecology.* vol. 34, no. 6, pp. 809-828.

Brockington, D. (2002): *Fortress Conservation: The Preservation of the Mkomazi Game Reserve, Tanzania.* Indiana University Press, Indiana.

Brown, L. H. (1973): Pastoral People and Conservation. In: Brown, L. H. (Ed.): *Conservation For Survival – Ethiopia's Choice*. Haile Selassie, Addis Ababa, Ethiopia. pp. 67-76.

Campbell, D. J. (1981): Land-use Competition at the Margins of the Rangelands: An Issue in Development Strategies for Semi-Arid Areas. In: Norcliffe, G.; Pinfold, T. (Eds.): *Planning African Development*. Westview Press, Boulder, Colorado. pp. 39-61.

Chapin, F. S.; Peterson, G.; Berkes, F.; Callaghan, T. V.; Angelstam, P.; Apps, M.; Beier, C.; Bergeron, Y.; Crepin, A. S.; Danell, K.; Elmqvist, T.; Folke, C.; Forbes, B.; Fresco, N.; Juday, G.; Niemela, J.; Shvidenko, A.; Whiteman, G. (2004): Resilience and vulnerability of northern regions to social and environmental change. In: *Ambio*. vol. 33, no. 6, pp. 344-349.

Colding, J.; Elmqvist, T.; Olsson, P. (2003): Living with Disturbance: Building Resilience in Social-Ecological Systems. In: Berkes, F.; Colding, J.; Folke, C. (Eds.): *Navigating Social-Ecological Systems. Building Resilience for Complexity and Change*. Cambridge University Press, N.Y. pp. 163-186.

DeFries, R.; Foley, J.; Asner, G. (2004): Land-use choices: balancing human needs and ecosystem function. In: *Frontiers in Ecology and Environment.* vol. 2, no. 5, pp. 249-257.

Dyson-Hudson, N. (1980): Strategies of resource exploitation among East African savanna pastoralists. In: Harris, D. R. (Ed.): *Human Ecology in Savanna Environments.* Academic Press, London. pp. 171-184.

Ellis, J. E.; Galvin, K. A. (1994): Climate patterns and land-use practices in the dry zones of Africa. In: *BioScience*. vol. 44, pp. 340-349.

Ellis, J. E.; Swift, D. M. (1988): Stability of African pastoral ecosystems: Alternate paradigms and implications for development. In: *Journal of Range Management.* vol. 41, pp. 450-459.

Ellis, J. E. (2001). *Personal Communication*.

Galaty, J.; Johnson, D. (1990): Pastoral Systems in Global Perspective. In: Galaty, J. G.; Johnson, D. L. (Eds.): *The World of Pastoralism: Herding Systems in Comparative Perspective*. The Guilford Press, New York. pp. 1-32.

Galvin, K.; Boone, R.; Smith, N.; Lynn, S. (2001): Impacts of climate variability on East African pastoralists: linking social science and remote sensing. In: *Climate Research*. vol. 19, pp. 161-172.

Galvin, K.; Ellis, J.; Boone, R.; Magennis, A.; Smith, N.; Lynn, S.; Thornton, P. (2002): Compatibility of Pastoralism and Conservation? A Test Case Using

Integrated Assessment in the Ngorongoro Conservation Area, Tanzania. In: Chatty, D.; Colester, M. (Eds.): *Displacement, Forced Settlement and Conservation.* Berghahn, Oxford. p. 304.

Galvin, K. A.; Thornton, P. K.; Boone, R. B.; Sunderland, J. (2004): Climate variability and impacts on East African livestock herders: the Maasai of Ngorongoro Conservation Area, Tanzania. In: *African Journal of Range and Forage Science*. vol. 21, no. 3, pp. 183-189.

Goldman, M. (2003): Partitioned nature, privileged knowledge: community-based conservation in Tanzania. In: *Development and Change.* vol. 34, no. 5, pp. 833-862.

Goldman, M. (2004): Imperial Science, Imperial Nature: Environmental Knowledge for the World (Bank). In: Jasanoff, S.; Martello, M. L. (Eds.): *Earthly Politics: Local and Global Environmental Governance.* Massachusetts Institute of Technology, Cambridge, MA, USA. pp. 55-80.

Holling, C. (1973): Resilience and stability of ecological systems. In: *Annual Review of Ecology and Systematics.* vol. 4, pp. 1-23.

Homewood, K.; Lambin, E. F.; Coast, E.; Kariuki, A.; Kikula, I.; Kivelia, J.; Said, M.; Serneels, S.; Thompson, M. (2001): Long-term changes in Serengeti-Mara wildebeest and land cover: Pastoralism, population, or policies? In: *Proceedings of the National Academy of Sciences of the United States of America.* vol. 98, no. 22, pp. 12544-12549.

Igoe, J.; Brockington, D. (1999): *Pastoral Land Tenure Series.* Report Funded by Royal Danish Ministry of Foreign Affairs (DANIDA).

Johannesen, A. B. (2006): Protected areas, wildlife conservation, and local welfare. In: *Ecological Economics.* vol. 62, no. pp. 126-135.

Kijazi, A.; Mkumbo, S.; Thompson, D. (1997): Human and livestock population trends. In: Thompson, D. M. (Ed.): *Multiple Land-Use: The experience of the Ngorongoro Conservation Area.* The World Conservation Union (IUCN), Gland, Switzerland. pp. 169-180.

Lamprey, H. F. (1983): Pastoralism yesterday and today: The overgrazing problem. In: Goodall, D.W. (Ed.): *Ecosystems of the World: Tropical Savannas.* Elsevier Scientific Publishing Co., Amsterdam.

Lebel, L.; Anderies, J. M.; Campbell, B.; Folke, C.; Hatfield-Dodds, S.; Hughes, T. P.; Wilson, J. (2006): Governance and the capacity to manage resilience in regional social-ecological systems. In: *Ecology and Society*. vol. 11, no. 1, pp. 21.

Little, P.; Smith, K.; Cellarius, B.; Coppock, D. L.; Barrett, C. (2001): Avoiding disaster: diversification and risk management among East African herders. In: *Development and Change*. vol. 32, pp. 387-419.

Lynn, S. J. (2000): *Conservation Policy and Local Ecology: Effects on Maasai Land Use Patterns and Human Welfare in Northern Tanzania*. M.Sc. Thesis. Colorado State University, Department of Rangeland Ecosystem Science.

McCabe, J. T. (2009): *Personal Communication*.

McCabe, J. T.; Schofield, E. C.; Pedersen, G. N. (1997): Food Security and Nutritional Status. In: Thompson, D. M. (Ed.): *Multiple Land-Use: The Experience of the Ngorongoro Conservation Area*. The World Conservation Union (IUCN), Gland, Switzerland. pp. 285-302.

Munasinghe, M.; Swart, R. (2005): *Primer on Climate Change and Sustainable Development Facts, Policy Analysis and Applications.* Cambridge University Press, Cambridge.

Potkanski, T. (1999): Mutual Assistance among the Ngorongoro Maasai. In: Anderson, D. M.; Broch-Due, V. (Eds.): *The Poor Are Not Us.* Ohio University Press, Athens, OH. pp. 199-218.

Pratt, D. J.; Gwynne, M. D. (1977): *Rangeland Management and Ecology in East Africa.* Hodder and Stoughton, London.

Sandford, S. (1982): Pastoral Strategies and Desertification: Opportunism and Conservatism in Dry Lands. In: Spooner, B.; Mann, H. S. (Eds.): *Desertification and Development: Dryland Ecology in Social Perspective.* Academic Press, London. pp. 217-246.

Schwartz, M. W. (1999): Choosing the appropriate scale of reserves for conservation. In: *Annual Review of Ecology and Systematics.* vol. 30, pp. 83-108.

Swift, D. M.; Coughenour, M. B.; Atsedu, M. (1996): Arid and Semi-Arid Ecosystems. In McClanhan, T. R.; Young, T. P. (Eds.): *East African Ecosystems and Their Conservation.* Oxford University Press, New York. pp. 243-272.

Thornton, P. K.; Galvin, K. A.; Boone, R. B. (2003): An agro-pastoral household model for the rangelands of East Africa. In: *Agricultural Systems*. vol. 76, pp. 601-622.

TMCP (2002): *Analysis of Migratory Movements of Large Mammals and Their Interaction with Human Activities in the Tarangire Area in Tanzania as a Contribution to a Conservation and Sustainable Development Strategy.* University of Milano/Oikos/EC/TANAPA. Report Tarangire-Manyara Conservation Project Final Report, Arusha, Tanzania.

Voeten, M. M.; Prins, H. H. T. (1999): Resource Partitioning between Sympatric Wild and Domestic Herbivores in the Tarangire Region of Tanzania. In: *Oecologia*. vol. 120, no. 2, pp. 287-294.

Yohe, G. W.; Lasco, R. D.; Ahmad, Q. K.; Arnell, N. W.; Cohen, S. J.; Hope, C.; Janetos, A. C.; Perez, R. T. (2007): Perspectives on Climate Change and Sustainability. In: Parry, M. L.; Canziani, O. F.; Palutikof, J. P.; van der Linden, P. J.; Hanson, C. E. (Eds.): *Climate Change 2007: Impacts, Adaptation and Vulnerability.* Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK. pp. 811-841.

## Reducing Vulnerabilities through Resettlement Planning in Disaster-Affected Communities: Relocation or Repopulation?

*Kanako Iuchi*

**Abstract**

Relocation or repopulation? This is a critical question posed to policymakers and planners managing long-term resettlement planning after sudden environmental change. Paralleling to increasing number of populations affected by environmental change world-wide (UNHCR 2006), more and more communities are forced to make resettlement decisions; however, the methods to achieve resettlement successfully are not well explored. As a first step to identify key planning decisions and processes to reduce vulnerabilities in post-disaster resettlement, this paper aims to show complex dynamics of resettlement planning by observing a case that experienced an earthquake followed by resettlement process involving relocation and repopulation. Although the case observed is triggered by an earthquake event, other climate-induced disasters, such as hurricanes, reveal similar needs of a planning concept toward successful resettlement after environmental change. Consequently, further effort on understanding resettlement dynamics and vulnerabilities is essential to adopt in policies and planning.

### The Question of Relocation and Repopulation: Its Growing Importance

"To return or not to return" is a critical question posed to disaster-affected communities that are forcibly displaced either temporarily or permanently. Although migration brought about by environmental change is not new, larger numbers of communities are faced with such decision with aggravated vulnerabilities and threats by a combination of transformed social, physical, and climate patterns from previous times (Lonergan and Swain 1999; UNHCR 2006). Policymakers and planners supporting recovery of the affected areas also face a similar dilemma. Relocation provides opportunities to improve the livelihood of the affected by better access to employment and public services while reducing vulnerability due to geo-physical environment, it may, however, disrupt existing community networks as well as economic and monetary stability (Aberle 1993; Bartolome 1993; Cernea 2000). Repopulation, on the other hand, may preserve community systems and stability, yet would not mitigate or increase future vulnerability under certain circumstances; for instance, regional decline and geological hazards could be intensified in the post-disaster period, thereby increasing the vulnerability of communities. Because disasters often exacerbate social inequalities of pre-disaster state (Bolin and Stanford 1998), the ultimate goal of recovering by reducing future vulnerability has to be achieved by careful plans (Haas et al. 1977; Ingram et al. 2006). In order to do so, extreme care must be exercised in making relocation or repopulation decisions and plans.

While reducing vulnerability is the underscored goal in post-disaster recovery, there is no universal concept of vulnerability due to the complex social system and processes (Hilhorst and Bankoff 2004; Manyena 2006). Additionally, vulnerability cannot be treated as a global concept across different societies, as the social dynamics vary in each (Alcantara-Ayala 2002). Research in this area, however, can be roughly distinguished into three categories: measuring exposure of biophysical hazard, measuring strength of society to hazards, and measuring both hazard exposure and strength of society (Cutter et al. 2003). Yet study on social vulnerabilities is still lagging due to their complexities, although studies on vulnerabilities in biophysical and built-up environment are quite prevalent (Cutter et al. 2003; Levine et al. 2007; Mileti 1999). On a similar note, strategies to better physical conditions rather than social environments are predominant in post-disaster policies; governments and aid providers tend to adopt short-term physical improvement programmes in post-disasters aiming to meet immediate to medium-term needs and reduce further threats.

The question of relocation or repopulation is further complicated when the pre-disaster state of communities is vulnerable; such as a community that is on a decline prior to a disaster. Relocating to a new place often disrupts community's solidarity and livelihood, as well as nurtures distrust between residents and the government as exemplified by the result of Sri Lankan buffer-zone policy (Ingram et al. 2006; Klein 2007). Returning to the original community, however, may not always be a better solution, particularly if the region is declining, for an example. Difficulty in

living will intensify after returning, unless population and regional sustainability are expected. It is therefore important to understand the dynamics of resettlement in vulnerable areas, while exploring effective planning decisions and actions through the choice of resettlement to reduce future vulnerabilities in such situations.

**Research Rationale, Objectives and Methods**

The case observed in this paper is affected by an earthquake, a type of environmental change, which forced communities to displace temporarily or permanently. It draws a line between other types of increasing disasters induced by climate change, exemplified by droughts, storms, floods and coastal erosion (The World Bank 2009). Differences between the migration drivers of i) less advanced stage of gradual environmental change, ii) advanced stages of gradual environmental change, iii) extreme random environmental events, and iv) development projects (Bronen et al. 2009), may vary in timings, durations and processes for decisions and actions of resettlements. However, unexpected and sudden displacements are often identified upon drastic environmental change, when extreme random events occur.

Hurricane Katrina, as an example of climate-induced disaster, provides a good example of how affected communities in New Orleans were unexpectedly displaced and forced to decide on relocating or returning by an extreme event. Almost all residents were displaced upon flooding caused by the hurricane landfall, and after about a month, a small portion of population gradually began returning to the city. By the end of 2007, the population was estimated to reach 70 per cent of the pre-Katrina level (Sastry 2009). A precise return rate is unknown, however, as the composition of population has drastically changed after Katrina (Warner 2006). Some evacuees believed that displacement was going to be short-term, but financial issues made it difficult for them to return. Other populations just decided to leave the area, as the region was rapidly degrading caused by poverty ex-ante the storm (Sastry 2009). Furthermore, poorer segments of the population have not yet finalized their permanent residency as they continue to receive federal disaster housing assistance away from home[1].

In brief, hurricane-induced displacement and the following resettlement process is no different from the earthquake-induced long-term resettlement as further explained later. As a consequence, learning about the role of policies and planning decisions by observing its influence to resettlement procedures is important, to support communities to successfully reorganize their livelihood after any large-scale random events.

Keeping such rationale in mind, this paper aims to show the complexities of resettlement planning in practice within the framework of planning in post-disaster communities. Particularly, the paper aims to underscore that the resettlement decisions are influenced by planning processes and policies affecting speed, livelihood preservation and participation. Techniques to explain planning processes through narratives and rationales of decisions and actions (see Flyvbjerg 1998; Forester 1999) are used for this purpose. Archival research, open-ended interview and direct and participant observation methods are adopted in the fieldwork conducted between 2008 and 2009. The work was carried out in Chuetsu Region, Niigata, Japan, which is still recovering from an earthquake that struck in October 2004. The target area includes Higashiyama and Yamakoshi districts, which are under the jurisdiction of Ojiya City and Nagaoka City, respectively. This research employs comparative case study methods that are useful to understand contemporary sets of real-life events in chronological order as well as to cross-examine the outcomes of resettlement decisions (Yin 2003).

**Chuetsu Region and Nijumurago Area: 2004 Chuetsu Earthquake and Resettlement Process**

**Region Prior to the Earthquake**

Chuetsu region of Niigata prefecture, where Nijumurago area locates, is historically prone to disaster[2]. People, however, chose to continuously live in the area to sustain 1,200 years of its history until recent years (Nagaoka City 2008). Nonetheless, changes in Japanese society with modernization and ageing after the 1950s have begun to influence urban-rural balance. Road development and motorization particularly fostered the migration of the younger generation leaving villages behind, which resulted in higher concentration of aged in rural areas.

With such phenomenon nationwide, villages, towns and cities encountered two phases of government mergers – the big amalgamations of Showa (1953-56) and of Heisei (1999-2006) (Rausch 2006) to retain sufficient functions of government. Nijumurago area is not an exception. Nijumurago area had been under Koshi County from 1889 to 1954[3] up until Higashiyama district and a part of current Kawaguchi Town decided to leave the County to merge with Ojiya City and Kawaguchi Town. The remaining district, Yamakoshi district, sustained its independence until 2005, when it had no choice but to merge with Nagaoka City, discontinuing the history of Koshi County. Currently, former Nijumurago area is administered by two cities of Ojiya and Nagaoka, where the districts of Higashiyama and Yamakoshi belong respectively (Niigata Prefecture 2009; Special Reporters for Chuetsu Earthquake & Research Center for Hokuriku Region Development 2007). Nijumurago's peculiar geographic conditions, represented by mountains and rivers dividing the land, are one of the major factors that caused the area to fragment administratively. Yet, such constitutions contributed to nurture variations in agriculture by enabling rice terraces and carp breeding ponds on hillsides, while developing special cultural heritage, such as bullfights[4].

Aligning with the national trend, depopulation and ageing of Nijumurago has been serious even prior to the 2004 earthquake. In Yamakoshi district, for an example, total population declined by 37 per cent in 20 years from 1980 (3,508) to 2000 (2,222), while proportion of the aged, over 65 years old, has increased from 24 to 34.6 per cent in 10 years between 1990 and 2000 (Nagaoka City 2005). Higashiyama district is experiencing a similar trend. These demographic and working force declines are directly affecting the regional economy, with other factors such as sharp decline of carp breeding industry.

**2004 Chuetsu Earthquake and Displacement**

**Earthquake Impact**

The 6.8 magnitude earthquake on the Richter scale struck Chuetsu region on 23 October 2004. It devastated the region with damage to approximately 120,000 buildings, while killing 59 and injuring 4,805 (Cabinet office, Government of Japan 2006; Niigata Nippo 2006). The casualties were much smaller than that of Kobe earthquake that struck urban Japan in 1995; however, the number of people affected was enormous compared to the size of causality, totaling 100,000 evacuees at its peak. Furthermore, lifelines and important facilities were damaged tremendously by landslides and sedimentation disasters occurring at many mountainous locations (Cabinet office, Government of Japan 2006)[5].

Nijumurago area was one of the most severely affected areas in Chuetsu region[6]. With a feeling of devastation, Mr. Nagashima decides to enforce the evacuation order to all households in his district on the very next day, and evacuated villagers with the assistance of national self-defense force (Special Reporters for Chuetsu Earthquake & Research Center for Hokuriku Region Development 2007; Yoshita-Yamakoshi 2006). Similarly, Mr. Seki, former mayor of Ojiya City, administering the Higashiyama district, enforced evacuation advisory a day after the earthquake (Niitaga Nippo 2005).

**Displacement**

The displacement process of the affected population is quite linear. Relying on Quarantelli's model on housing recovery (1982), emergency and temporary sheltering stage lasted up to two months and temporary housing stage lasted up to three years. In the stages of emergency and temporary sheltering, total evacuees reached 100,000 at its peak in the first few days. The number, however, gradually decreased to 80,000 after a week, and then to 6,500 after a month. People without any alternative place to go remained in shelters to the end of December 2004. Displaced population began moving into temporary housing in November 2004, about a month after the earthquake, and completed the following month[7]. The population in temporary housing then decreased at constant rate from November 2004 until December 2006, leaving approximately 560 households for a year until the end of December 2007 (Niigata Prefecture 2007)[8].

One of the efforts to highlight is the way how affected communities and local governments managed to secure community's function while living under conditions of displacement. In the case of post-Kobe earthquake, lack of knowledge on recovery resulted in many unexpected so-

cial issues, one of which is the "lonely death" of elderly (Olshansky 2006). This lesson taught local governments about the importance of sustaining communal function, even in the face of temporary displacement. As a result, many village communities in Chuetsu region were brought together and given temporary housing as a group as a way to exchange pleasantries and share the struggles of their daily lives, which successfully minimized "lonely death" (Watanabe 2007).

**Displacement to Resettlement in Higashiyama and Yamakoshi Districts**

Although two districts of Nijumurago area share similar chronology on displacement, there are some variations on resettlement decisions and actions. Particularly, i) location of displaced, ii) evacuation order and advisory, and iii) resettlement strategies are major identified differences, which have been caused perhaps by being administered by two different local governments.

**Displaced Location**

On the very next day of the earthquake, a large number of the Higashiyama villagers were displaced to Ojiya City (population of about 40,000), approximately 10 kilometres away from the district center. Meanwhile, the majority of Yamakoshi villagers were evacuated to Nagaoka City (population of about 283,000), approximately 20 kilometres away. Temporary shelters and housing were then constructed in cities where district villagers were administered. Villagers then lived in the area where they were displaced for two to three years until a new permanent residence was reestablished. Although villagers from both districts perhaps had a difficult time adapting to urban life from rural one while coping with post-earthquake stresses, their temporary displaced location was precious in imagining urban displacement or rural repopulation for permanent resettlement.

**Evacuation Order and Advisory**

Both Higashiyama and Yamakoshi districts received evacuation enforcement on the next day of the earthquake, on 24 October. However, Higashiyama received more lenient evacuation enforcement under advisory, while Yamakoshi district received stricter evacuation as an order. The rationales for these divergent enforcements are different; the former Ojiya City mayor made the evacuation enforcement an advisory one realizing the need of flexible mobility of his citizen due to the varied level of damages across the city (Niigata Nippo 2006). On the other hand, the former Yamakoshi village mayor decided to make it a compulsory order to reduce additional damage and loss from the earthquake (Yoshita-Yamakoshi 2006) and to promote a shared consensus among the villagers to return at once (Special Reporters for Chuetsu Earthquake & Research Center for Hokuriku Region Development 2007).

The ability of villagers to return home temporarily or permanently was largely affected by this distinctive evacuation enforcement provided by each local government. Many Higashiyama residents initially tried to remain at their home to protect their assets, including bulls and carps, under lenient evacuation enforcement until aftershocks further damaged their properties (Special Reporters for Chuetsu Earthquake & Research Center for Hokuriku Region Development 2007). However, even after they moved into the temporary housing in Ojiya City, villagers returned home from time to time to feed their animals and to maintain their home. This was particularly useful during the first winter when snow accumulated more than usual – which could have further destroyed houses. On 22 July 2005, about nine months after the earthquake, the advisory was lifted in seven communities, leaving only two Higashiyama communities still under evacuation advisory. The advisory in the rest of the communities was lifted about five months later from the first one, or a year and two months after the earthquake, on 26 December 2005. All displaced population was then resettled to new or reconstructed permanent homes by the end of the second year from the day of the earthquake.

Yamakoshi villagers were put in a different situation with stricter evacuation order. Although a two-hour temporary visit was allowed five days after the earthquake, it reconfirmed the devastation wrought by the earthquake and provided reasons against frequent home visits. Because most of the villagers had initially understood evacuation as staying away for just a few days, people were less prepared for long-displacement. With time for temporary home visit extended until six months later on 28 April 2005, many could not do much to protect their assets

– preventing their house from collapsing due to snow accumulation on the roof during the winter, or feeding carps and bulls. The first evacuation order was lifted in some village communities on 22 July 2005, nine months after the earthquake. However, the majority of Yamakoshi communities did not receive permission to return until two years and five months after the earthquake, on 1 April 2007. Last group members of displaced population left temporary housing by the end of 31 December 2007. In other words, Yamakoshi communities needed one more full year to initiate reestablishing their lives than Higashiyama communities.

**Relocation and Repopulation**

In addition to differences on displaced location and evacuation enforcement, resettlement strategies for Higashiyama and Yamakoshi districts were completely different. Ojiya City supported households of the Higashiyama district to collectively relocate to urban land using collective relocating programmes, while it provided no additional support to households that individually relocated or moved back to original land. On the other hand, Yamakoshi district under Nagaoka City supported returning households of most devastated areas, and did not support households that relocated out from the district (Sawada and Hirai 2007). Rationales of such decisions by each government were different; Ojiya City primarily underscored risk reduction of future vulnerabilities underlined by demographic decline and aging, thereby supporting communities relocating to flat land; on the contrary, Nagaoka City emphasized repopulation in securing sustainability of rural communities, thereby supporting returning households. In either case, financial incentives were provided with programmes [9].

**Discussion**

More than four years after the earthquake, Niigata prefecture (2008) reports that the Chuetsu region is rehabilitated for the most part. The region has not only reconstructed housing and infrastructures, but also reinitiated consensus building and actions toward community development [10]. Surprisingly, however, resettlement strategies of the Ojiya and Nagaoka city governments adopted in the Nijumurago area did not make much difference to the resettlement decision. Both Higashiyama and Yamakoshi districts in the area had a 52 per cent return rate of the households, despite the fact that two different strategies, to relocate and to repopulate, were promoted (Sawada 2008).

This unique outcome reveals that relocation and repopulation policy itself was not as functional as local governments intended. Rather, different planning processes, represented by the timing of evacuation enforcement, location of the displaced, and perhaps the consensus building process aligned with the conditions while temporarily displaced, are intertwined to result in an unexpected outcome of post-earthquake resettlement. These areas of processes are particularly critical to observe in a post-disaster resettlement scheme, because first, speed influences the quality of planning as well as its goal – acting quickly will directly help, alleviating post-disaster hardships, but will recreate pre-disaster problems without deliberation (Olshansky 2005). Second, participation is essential to understand, because it influences the quality of planning processes and resettlement outcomes (ADB 1998; Cernea 2003; Oliver-Smith 1991). Livelihood preservation of how social and economic everyday routine was kept closer to normality while displaced would also contribute to the condition of post-resettlement communities thereby essential to investigate. By observing the influence and interrelatedness of these planning processes to resettlement decisions and to post-resettlement outcomes, the way to better assist an affected population can be explored for policy providers and planners.

**Final Thoughts**

This paper discussed resettlement planning after a disaster as a phenomenon relating to vulnerability in environmental change. It particularly focused on explaining the complication of resettlement planning after an earthquake in the real-world plan and policymaking. Observation of the case unveiled several interesting suggestions; first, relocation or repopulation policies providing monetary support would not always function as governments intend. Rather, decision of relocating or returning is influenced by the interwoven relationship between planning processes and policies. Second, the case supported that although financial incentives provided by governments are important, the displaced location, timing of evacuation order and advisory's

limiting speed are equally substantial in making resettlement decisions. In other words, influence of speed, livelihood preservation and participation may be the key planning processes to decisions, as well as to the level of post-resettlement vulnerability of communities. This leads to the recommendation that effort to understand successful resettlement planning is essential. By pursuing research aiming to understand the dynamics of post-disaster resettlement planning, a model on successful resettlement can be anticipated. Such model is increasingly in need, because there is not yet a consensus shared among policymakers and planners, although the population affected by environment change is growing ever-greater. Although the case selected was an earthquake issue, climate change induced disasters could also result in a similar resettlement path as examined previously. Consequently, pursuing policy and planning research of this type is useful in finding ways to better resettle communities after any type of sudden environmental change.

Meanwhile, environmentally induced resettlement has broader spectrums of change including gradual ones, besides sudden ones discussed here (see Bronen et al. 2009). Resettlement caused by accumulated risk over a very long period of time, often found under gradual change, may have different contexts; in timings of resettlement decisions and initiations, as well as in displacement type, whether temporary or permanent. Leaving the current area of residence may only be the solution for such case, as the level of risk reaches saturation point, which is distinctive from a sudden environmental change. Policies and planning processes in this context, however, have a similar influence toward post-resettlement outcomes, and thus worthwhile exploring their role and ways in a changing environment.

**Acknowledgements**

This research is partially funded by the National PERISHIP Awards (funded by NSF (National Sciences Foundation), the Public Entity Risk Institute and The University of Colorado Natural Hazards Center).

**Notes**

[1] Because of the affordable housing shortage in New Orleans, LA senators, as of February 2009, are requesting an extension of Federal Disaster Housing Assistance Programme (DHAP) for more than 15,000 low-income disaster affected population. These people are not only displaced in other location from home in New Orleans, but also in Texas (Reckdahl 2009).

[2] For example, the region in the past 200 years experienced various catastrophic disasters averaging a disaster once every few decades (Niigata Prefecture recovery vision committee 2005). Furthermore, two earthquakes, including the 2004 Chuetsu earthquake, hit the region in the first decade of this century.

[3] The modern Japanese government system was established in 1889.

[4] The limited resource of the area, especially during the winter time, particularly made the villagers to take good care of their resources, including the bulls. Their culture of bull-fighting is not only about fights in the ring, but about the relationship they build with bulls and villagers who have a similar interest in breeding bulls. Consequently, the bull-fight is not a severe fight, rather an event that aims to generate and attract people to gather and thus who wins or loses is not particularly important.

[5] Niigata Prefecture estimated the damage amount at nearly US$ 30 billion (Three trillion JPY) (Niigata Nippo 2005)

[6] Mr. Nagashima, the former village mayor of the Yamakoshi district, talks about the impact of the earthquake:

"I begun walking toward the government office a little before dawn; I can't explain the emotion as such word as depressing when I began to see the landscape. I was more than shocked when I saw the mountains – mountains are missing, roads are missing, and houses are missing…from locations where all these are supposed to be found (Special Reporters for Chuetsu Earthquake & Research Center for Hokuriku Region Development 2007: 19)"

[7] In this stage, nine cities, towns and villages constructed and operated 3,460 units of temporary housing (Special Reporters for Chuetsu

Earthquake & Research Center for Hokuriku Region Development 2007).

[8] Nagaoka City removed the last temporary housing, Yokodai temporary housing housed 563 households (1,765 people) at this time (Kyodo Tsushin Newspaper 2007).

[9] Ojiya City provided information on "Collective relocation promoting program for disaster prevention" (Bosai shudan iten sokushin jigyo keikaku: Boshu) of 1972 that aims to relocate communities in hazardous areas while preserving their functions in post-resettlement by providing partial subsidies in rebuilding homes to the affected communities. In contrast, Nagaoka City provided "Small-scale residential district improvement program" (Shokibo jyutaku chikutou kairyo jigyo), a program that intends to improve residential areas having degraded basic infrastructures, by providing subsidies to the displaced communities wishing to return.

[10] People who needed permanent housing have settled into one and most of the industries, whether agricultural, livestock, or commercial, are back in operation. Infrastructure is also rehabilitated, excluding a small portion of Yamakoshi district. Moreover, recovery actions – including consensus building and organizing processes, such as reestablishing agricultural cooperatives, developing programmes of actions to revitalize regions (e.g. eco-tourism projects, product merchandizing projects), and activities toward community development, have been reinitiated in some of these mid-mountainous areas (Niigata Prefecture 2008).

**References**


Aberle, D. F. (1993): The Navajo-Hopi Land Dispute and Navajo Relocation. In: Cernea, M.; Guggenheim, S. E. (Eds.): *Anthropological Approaches to Resettlement: Policy, Practice, and Theory*. Westview, Boulder, Colorado. pp. 153-200.

ADB (1998): *Handbook on Resettlement: A Guideline to Good Practice*. Asian Development Bank, Manila.

Alcantara-Ayala, I. (2002): Geomorphology, natural hazards, vulnerability and prevention of natural disasters in developing countries. In: *Geomorphology*. vol. 47, no. 2-4, pp. 107-124.

Bartolome, L. J. (1993): The Yacyreta Experience with Urban Resettlement. In: Cernea, M.; Guggenheim, S. E. (Eds.): *Anthropological Approaches to Resettlement: Policy, Practice, and Theory*. Westview, Boulder, Colorado. pp. 109-132.

Bolin, R.; Stanford, L. (1998): The Northridge earthquake: community-based approaches to unmet recovery needs. In: *Disasters*. vol 22, no. 1, pp. 21-38.

Bronen, R.; Chandrasekhar, D.; Conde, D. A.; Kavanova, K.; Moriniere, L.; Schmidt-Verkerk, K.; Witter, R. (2009): Stay in place or migrate: a research perspective on understanding adaptation to a changing environment. In: Oliver-Smith, A.; Shen, X. (Eds.). *Linking Environmental Change, Migration & Social Vulnerability. Source*. UNU-EHS, Bonn, Germany. pp.12-19.

Cabinet office, Government of Japan (2006): *White paper on disaster management of Japan, 2006* (heisei 18 nendo ban: Bousai hakusho). Seruko, Tokyo.

Cernea, M. M. (2000): Risks, Safeguards, and Reconstruction: A Model for Population Displacement and Resettlement. In: Cernea, M. (Ed.): *Risks and Reconstruction: Experiences of Resettlers and Refugees* (1st ed.). World Bank, Washington D.C. pp. 11-55.

Cernea, M. M. (2003): For a new economics of resettlement: a sociological critique of the compensation principle. In: *International Social Science Journal*. vol. 55, no. 175, pp. 37-45.

Cutter, S. L.; Boruff, B. J.; Shirley, W. (2003): Social vulnerability to environmental hazards. In: *Social Science Quarterly*. vol. 84, no. 2, pp. 242-261.

Flyvbjerg, B. (1998): *Rationality and Power: Democracy in Practice* (Case-baseret studie af planlægning, politik og modernitet.). University of Chicago Press, Chicago.

Forester, J. (1999): *The Deliberative Practitioner: Encouraging Participatory Planning Processes.* MIT Press, Cambridge.

Haas, J. E.; Bowden, M. J.; Kates, R. W. (1977): *Reconstruction Following Disaster.* MIT Press, Cambridge.

Hilhorst, D.; Bankoff, G. (2004): Introduction: Mapping Vulnerability. In: Bankoff, G.; Frerks, G.; Hilhorst, D. (Eds.): *Mapping Vulnerability: Disasters, Development & People* (1st ed.). Earthscan, UK and USA. pp. 1-9.

Ingram, J. C.; Franco, G.; Rio, C. R.; Khazai, B. (2006): Post-disaster recovery dilemmas: Challenges in balancing short-term and long-term needs for vulnerability reduction. In: *Environmental Science & Policy.* vol. 9, no. 7-8, pp. 607-613.

Klein, N. (2007): *The Shock Doctrine: The Rise of Disaster Capitalism* (1st ed.). Metropolitan Books/Henry Holt, New York.

Kyodo Tsushin Newspaper (2007): *Last Displaced Population Move Out from Temporary Housing: 3 Years from Chuetsu Earthquake* (Kasetsu saigo no jyumin taikyo: Chuetsu jishin kara 3 nen de kaishou). <http://topics.kyodo.co.jp/niigatanaganoquake/>, 31 December 2007.

Levine, J. N.; Esnard, A.; Sapat, A. (2007): Population displacement and housing dilemmas due to catastrophic disasters. In: *Journal of Planning Literature*. vol. 22, no. 3, pp. 3-15.

Lonergan, S.; Swain, A. (1999): Environmental degradation and population displacement. In: *GECHS-Aviso*. vol. 2, no. 1, pp. 1-11.

Manyena, S. B. (2006): The concept of resilience revisited. In: *Disasters*. vol. 30, no. 4, pp. 434-450.

Mileti, D. S. (1999): *Disasters by Design: A Reassessment of Natural Hazards in the United States.* Joseph Henry Press, Washington, D.C.

Nagaoka City (2005): *The Proposal on Regional Recovery Plan.* <http://www.kantei.go.jp/jp/singi/tiikisaisei/dai1nintei/27toke.pdf>, 10 December 2007.

Nagaoka City (2008): *Recovery Record of 6 Village Communities in Yamakoshi* (Yamakoshi 6 shuraku no saisei no kiroku). Nagaoka City, Nagaoka.

Niigata Nippo (2005): *168 Hours of Niigata Nippo* (Niigata Nippo no 168 jikan) (2nd ed.). Niigata Nippo, Niigata.

Niigata Nippo (2006): *Chuetsu Earthquake Public Debate on Recovery* (Chuetsu jishin fukko kouron)(1st ed.). Niigata Nippo, Niigata.

Niigata Prefecture (2007): *Transition of Temporary Displaced Population from Chuetsu Earthquake* (Chuetsu dai shinsai ni kakaru oukyu kasetsu jyutaku nyukyosha jyoukyou). < http://saigai.pref.niigata.jp/content/jishin/higai.html >, 17 January 2008.

Niigata Prefecture (2008): *Mid-Niigata Prefecture Earthquake: Current Recovery Status* (for 2008) (Niigata-ken Chuetsu daishinsai: Fukkyu-fukkou no genjyo (heisei 20 nen). Niigata Prefecture, Niigata.

Niigata Prefecture (2009): *Nijumurago*. <http://www.pref.niigata.lg.jp/HTML_Article/ushi03,1.pdf >, 2 April 2009.

Niigata Prefecture recovery vision committee (2005): *Niigata Chuetsu Earthquake Recovery Vision* (Niigata-ken Chuetsu daishinsai fukkou vision). Niigata Prefecture, Niigata.

Oliver-Smith, A. (1991): Successes and failures in post-disaster resettlement. In: *Disasters*. vol. 15, no. 1, pp. 12-23.

Olshansky, R. (2005): *How do Communities Recover from Disaster? A Review of Current Knowledge and an Agenda for Future Research.* Paper for the 46th Annual Conference of the Association of Collegiate Schools of Planning, Kansas City.

Olshansky, R. (2006): San Francisco, Kobe, New Orleans: Lessons for rebuilding. In: *Social Policy.* vol. 36, no. 2, pp. 17-19.

Quarantelli, E. L. (1982): *Sheltering and Housing after Major Community Disasters: Case Studies and General Conclusions.*

Disaster Research Center, Ohio State University, Columbus.

Rausch, A. (2006): The Heisei dai gappei: a case study for understanding the municipal mergers of the Heisei era. In: *Japan Forum*. vol. 18, no. 1, pp. 133-156.

Reckdahl, K. (2009): End of rent help is a disaster for many. In: *Times Picayune*. 7 February.

Sastry, N. (2009): Tracing the effects of hurricane Katrina on the population of New Orleans: the displaced New Orleans residents pilot study. In: *Sociological Methods & Research.* vol. 38, no. 1, pp. 171-196.

Sawada, M. (2008): *Learning from Domestic Lessons* (Kokunai jirei kara manabu). Unpublished manuscript.

Sawada, M.; Hirai, K. (2007): *Village Rebuilding in the Context of the Recovery Work Following the Niigata Chuetsu Earthquake*. Paper for the 2nd International Conference on Urban Disaster Reduction. Taiwan.

Special Reporters for Chuetsu Earthquake & Research Centre for Hokuriku Region Development (2007): *Recovery of Yamakoshi* (Yamakoshi fukko). Tokyo: Shogakkan.

The World Bank (2009): World Development Report 2010: *Development and Climate Change*. The World Bank, Washington D.C.

UNHCR (2006): *The State of the World's Refugees: Human Displacement in the New Millennium*. Oxford University Press, London.

Warner, C. (2006): Census tallies Katrina Changes: but the changing New Orleans area is a moving target. In: *Times Picayune,* 7 June.

Watanabe, H. (2007): *Creative Recovery from Chuetsu Earthquake: For Sustainable Regional Recovery* (Chuetsu daishinsai karano souzouteki fukkou ni tsuite: Jizoku kanou na chiiki saisei he mukete). Paper for the academy for disaster recovery by People's Government of Szechuan, Szechuan. pp. 1-5.

Yin, R. K. (2003): *Case Study Research: Design and Methods* (3rd ed.). Sage Publications, Thousand Oaks.

Yoshita-Yamakoshi (Ed.) (2006): Lets Go back to Yamakoshi (Kaero Yamakoshi he) (1st ed.). Niigata Nippo, Niigata.

## Integrating Adaptation and Develoment as an Approach to Reduce Magnitude of Migration

*Vivek Prasad, Monique V. Helfrich, Susan A.Crate*

**Abstract**

Human-induced climate change has started showing its impact globally; however, its impact is varied across the globe. Developing countries are experiencing the impact of climate change across a wide range of domains – social, economic, political, cultural and environmental. Adaptation to the impact of climate change is emerging as a viable approach to coping with climate change; however, severity of the impact is high in the developing countries because of the lower adaptive capacity of their societies. Developing countries pay less attention to the need for climate change adaptation because of their preoccupation with pre-existing problems and overarching national polices and plans that are inclined towards development. Divergence in the approaches of dealing with climate change and development exacerbates the impacts of climate change. This divergence also hinders the development process and leads to adaptive failure. Adaptive failure is considered one of the main reasons for human migration and resulting crises. Hence, there is an urgent need for adopting an integrated approach which deals with adaptation and development. Climate change discourse attaches great importance to integrating adaptation with development, but fails to address what needs to be integrated and why. This paper explores the principles and priorities of adaptation that need to be integrated into development to make it successful and the rationale for this integration.

**Keywords: Developing countries, climate change, adaptation, development, adaptive capacity, vulnerability, social capital, integration, social factors, migration**

### Introduction

There has been considerable scientific research to characterize the global and local impacts of climate change. The general consensus of the scientific community is that climate change is affecting the environment and society's use of its resources. There have been changes in precipitation patterns, leading to droughts and floods, which can have serious negative impacts on agriculture and lead to significant challenges for the Global South (Pew Center of Global Climate Change 2005). Climate change impacts are not limited to these physical effects but have also started to have indirect impacts on cultural practices, social structure and political organizations around the world. The impact of climate change is more visible in the developing countries because of its larger population who live in climate-sensitive areas, have low adaptive capacity and lead predominantly natural resource-dependent livelihoods. The international community now increasingly recognizes that environmental degradation and climate change are leading to human population displacement on a large scale (Forced Migration Review 2008). Even the IPCC (2007) has clearly pointed out that people and communities who live in marginal land and whose livelihood is primarily dependent on the natural system are most vulnerable to the impact of climate change. These vulnerable communities are the first to be displaced from their first place.

Although developing countries are relatively more susceptible to the impacts of climate change, their climate change policy is marginalized by their development policies. They give more priority to development policies because of their immediate need for poverty reduction, as well as food and water scarcity, human health and natural resource management issues, and need for energy. Ironically, climate change will exacerbate these pre-existing problems and will also increase the intensity of developmental stresses (Halsnæs and Verhagen 2007). Specifically, as shown by Denton (2002), climate change is not yet a priority policy issue for most developing countries. An example of a policy gap between climate adaptation and development can be seen in the National Rural Employment Guarantee Act of India (Mahapatra et al. 2008). This is one of the most significant examples of the incorporation of the guiding principles of development in legislation, but it does not consider climate change variability and its relation to adaptation issues. This policy gap manifests in the migration pattern of an estimated 20 million people who migrate temporarily each year (Deshingkar 2006). In general, this migration is between rural drought-prone regions to rural areas of irrigated agriculture which require seasonal labour.

Based on the development experience across developing countries, it is being argued that environmentally induced migration is the end result of unsustainable development (Forced Migration Review 2008). Schipper states: "Adaptation to climate change is not as simple as designing projects, drawing up lists of possible adaptation measures and implementing these; it requires a solid development process that will ensure that the factors that create vulnerability are addressed." (2007: 7)

The purpose of this paper, therefore, is to explore principles and priorities of climate change adaptation that can be integrated into development and to identify those aspects of adaptation that can make development strategies more effective in developing countries. This integration will assist in building climate-resilient livelihoods and reducing the magnitude of migration which is considered to be an expression of failed adaptation (Forced Migration Review 2008; Care International 2008).

The approach used in this paper was a literature survey in conjunction with an evaluation of the literature to identify key principles and priorities of both adaptation and development strategies and to propose a framework for integrating these principles and priorities.

**The Dynamic Interactions between Adaptation and Development**

In order to identify aspects of climate change adaptation that can be integrated with development, it is important to understand the interactions between adaptation and development. As part of this understanding, it should be noted that there is a marked difference between historical adaptation and current adaptation of human society to climate change. Because of the increasingly unprecedented nature of climate change, as well as the complexity of strategies to address its impacts, current and future approaches to climate change adaptation require meticulous planning and premeditated strategies. This entails numerous changes and adjustments in livelihood practices, social and community interactions, exchange and market systems, social networking strategies and cultural practices (Schipper 2007).

A cursory review of adaptation and development discourse reveals two broad themes – the adaptation approach to development and the vulnerability approach to development. For a climate change policymaking body, it is easier to adopt the first approach and to integrate vulnerability as an integral component in policy. The argument behind this approach is that if we do not use adaptation to cope with climate change on a priority basis, then climate change impacts will exacerbate already existing problems and will make society more vulnerable. The adaptation approach integrates the core issues and causes of vulnerability and poverty. This approach also integrates environment and development strategies to address sustainable development (Schipper 2007). These general relationships can be modelled using the following diagrams:

---

**Adaptation Approach**

*Adaptation to Climate Change Impacts —> Vulnerability Reduction —> Development*

**Vulnerability Reduction Approach**

*Development —> Vulnerability Reduction —> Impact Reduction —> Adaptation*

---

*Figure 1: Approaches to Linking Adaptation and Development (Schipper 2007: 8)*

The driving factors of vulnerability originate from and are related to many factors, such as socio-economic, institutional, political factors, ecosystem, climate variability and perturbation. They operate collectively, and for a better management of adaptation plans it is important to clearly understand the linkages between all these domains (Downing and Patwardhan 2002).

**Consideration of Social Justice in Vulnerability Assessments of Adaptation and Development**

The UNFCCC (2007) defines vulnerability as "the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity." There are a variety of social, economic and geographical factors which influence vulnerability. It is projected that high mountains, coastal areas, tropical areas and the polar region are most sensitive to climate change impact. Unfortunately, these areas are primarily inhabited by indigenous and traditional communities, who are, therefore, more vulnerable than the other communities and tend to migrate.

Both Crate (2008) and Macchi (2008) note that indigenous and natural resource dependent communities have long had coping strategies that can be used to enable them to be proactively engaged in responding to the effects of climate change rather than remaining victims of its impacts. This history of coping strategies demonstrates the importance of the participatory method and approach to development intervention and the need to incorporate consideration of these types of strategies in vulnerability assessments.

Recognizing and understanding the differential vulnerability is a key to understanding the social justice aspect of climate change. Poor, elderly, sick, women and other marginalized populations in the global south face increased risk of death and illness from more heat and humidity (Kasperson and Kasperson 2001).

It is widely agreed that the participatory and bottom-up approach in vulnerability assessment is the most viable and practical approach in coping with climate change impacts (Schroter et al. 2005; Crate and Nuttall 2009; Downing and Patwardhan 2002; Paavola and Adger 2006). Pioneering work on this subject has been done by Downing and Patwardhan (2002). According to them, the framework of vulnerability assessment includes five tasks:

1. Defining vulnerability, deciding scale and sector – there is no universality acceptable definition of the vulnerability. So the first task of any technical team (stakeholder) is to define mutually agreed definition and decide parameters to assess vulnerability.

2. Defining development baseline and identifying vulnerable group – this task is related to setting benchmarks or reference points. Questions such as who is vulnerable, from what, where, are essential to be considered.

3. Linking and understanding development baseline with climatic risk and hazards – this task is primarily about establishing a linkage between the first two tasks and climatic risk and hazards. Historical climatic risk and hazard data are useful here.

4. Identifying drivers of vulnerability and linking present and future – this task is quantitative in nature and involves the task of identifying what shapes exposure to climatic risks, at what scales and by linking present status to future. These linkages give a snapshot of whether the driver of vulnerability will lead to sustainable development or further increase vulnerability.

5. Developing policy and plan based on outcome of assessment - based on the results of tasks 1 through 4, a comprehensive understating of vulnerability and related issues is developed. This understanding is used for the Adaptation Planning Framework and for policy discussion as well.

Essentially, this method revolves round the principles of the participatory, bottom-up and place-based approach of the development agenda. Again, these are not rigid and structured frameworks for enabling the participatory approach; rather, they are flexible and open, and can accommodate local elements and processes, as well as the dynamics of local relationships.

**Principles and Priorities of Adaptation that Can Be Integrated into a Development Strategy**

The following section is a synthesis of the principles and priorities of adaptation identified during the literature survey, which the authors believe can be integrated into development strategies and produce a more robust and effective approach for problems experienced by the developing countries. This integration will increase people's resilience to the impacts of climate change so that fewer are forced to migrate (Care International 2008)

**Economic Analysis**

According to Callaway (2004), current problems with climate change governance and its linkage to developmental administration is related to the limited understanding of benefit-cost analyses of adaptation options of coping with climate change. The governance structure of climate change is mainly supported by all signatories of Kyoto Protocol and a few non-signatories such as the US. This protocol is highly regulatory and adaptation is based on a benefit-cost analysis of domestic or local scenarios of signatories/ parties.

The benefit-cost analysis also helps in understanding the level of participation of signatories. The least developed countries (LDCs) consider adaptation as a substitute for mitigation and embark on it actively. There are two main focuses on adaptation, one is related to changing management technique in the livelihood practices such as agriculture, fishery, forestry, etc. and the other is adjusting the livelihood practices according to the market forces (Callaway 2004). Hence benefit-cost analysis of adaptation is required and needs to be carried out across scale, from local, regional to international levels, and also across different sectors.

As with other environmental issues in the past, industries and individuals, whose actions are contributing to climate change through the operations of their businesses and vehicles, are not bearing the real costs of the negative externalities associated with their emissions. They make the argument that it would be cost prohibitive to take actions to reduce these externalities. According to a report of OXFAM (2007), the scientific community and policymakers have not yet reached a consensus on the benefit-cost analysis of adaptation; however, a basic conclusion of the Stern Review is that the cost of taking action to address climate change will be less than the cost of addressing the impacts of unmitigated climate change that would result from doing nothing (Stern 2006).

Countries focusing on examining the relationship of development to adaptation need to conduct a robust and detailed analysis of the economics of adaptation. This would give developing countries a firmer basis for integrating adaptation into development plans and budgets. In addition, there is an emerging debate on who should finance adaptation in developing countries. The OXFAM report suggests two ways of financing adaptation projects: developing countries should earmark a specific portion of their development fund to adaptation; and developed countries and blocks such as USA, European Union, Japan and Australia who are major contributors of green house gases, should contribute to the adaptation fund based on the principle of equity and justice.

**Food Security and Agriculture**

In the Global South, agriculture is the mainstay of livelihood and economy, and is significantly dependent on seasonal rainfall and extreme events such as monsoons. As has been noted by Zhang (2007: 3), "[a]chieving environmental sustainability is impossible without solving the livelihood problem of the poor." Agriculture is not only a livelihood activity but also the main source of food for individuals and families. Natural events such as flood, drought and climatic variability have been recognized as one of the most dominant factors of lower food production and availabilities (Gregory et al. 2005). The main concern about climate change and food security is that changing climatic conditions can initiate a vicious circle where infectious disease causes or compounds hunger, which, in turn, makes the affected populations more susceptible to infectious diseases. These diseases can lead to substantial declines in labour productivity and global increases in poverty and mortality (Schmidhuber and Tubiello 2007). Agriculture is inherently related to food security and food security is achieved through efficient management of rural development plans. Agricultural scientists across the world have argued that climate change will continue negatively impacting the agriculture sector and will, therefore,

place food security in jeopardy (Halsnæs and Verhagen 2007). The importance of agriculture and food security can be used as a great motivator in implementing adaptation and development polices and plans. Also, food security is an area where an ideal integration of adaptation and development can be established and examined.

**Technology: Modern vs. Appropriate**

Climate change discourse has led to the recognition that adaptation is place-based and embedded in the local culture. In addition, the process of adaptation is very much influenced and facilitated by the use of technology. Goklany (1995) has observed that "[o]penness to development and utilization of new technologies for sustainable extraction, use, and development of natural resources is key to strengthening adaptive capacity" (Goklany 1995; Smit et al. n.d.: 896). There are two main areas where use of technology has been clearly recognized. The first area is in weather forecasting, while the second is in modifying human activities, such as agriculture and livelihood, natural resource management, food processing and storage, health and nutrition management, human settlement, etc., to the current and expected changes in climate.

As per the report of the UNFCCC (2006) on the Technology for Adaptation to Climate Change, modern and advanced technology is required for weather forecasting and also for short-term and long-term climate change/variability prediction. In addition, human activities that support livelihood require technology which is economically feasible and culturally acceptable. Studies and experiments across the world have proved that technologies which integrate local and traditional knowledge are more easily accepted by the community. In weather forecasting, Roncoli (2006) has rightly pointed out that if the forecasting technique and terminology are blended with the farmer's cultural practices and language, it helps to translate forecasted information into adaptation decisions.

Schumacher (1973) proposed the concept of appropriate technology (AT) in his book, Small Is Beautiful, working definition of AT, proposed by Wicklein (2001: 4) is, "[a]ppropriate technology seeks to aid and support the human ability to understand, operate, and sustain technological systems to the benefit of humans while having the least negative societal and environmental impact on communities and the planet." In the context of adaptation-development integration, use of appropriate technology would be highly suggestive.

**Examining Role of Social Factors in Adaptation-Development Integration**

The impact of climate change is being experienced disproportionately in different social groups. Variability of impacts can be examined across gender, economic groups, farmers and marginalized groups (Dankelman 2002). People of the developing countries are not passive victims. In the past they have had resilience to droughts, floods and other natural events. These historical experiences are useful and pertinent to adaptation development integration.

**Role of Social Capital**

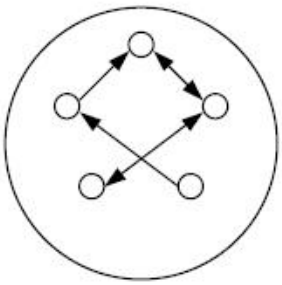
Given the social structure and the history of the collective action in developing countries, it is imperative to understand the concept of social capital and its implication on climate change adaptations. There are many definitions of social capital, but the widely accepted one, which incorporates the core of social capital, is the "feature of social organization such as trust, norms and network that can improve the efficiency of society by facilitated coordinated actions" (Putnam et al. 1993: 167).

There are two circumstances when the role of social capital is vital in adaptive behaviour of society, one is bonding social capital and the other is networking social capital. Bonding social capital is stronger, cohesive and smaller in scale. Normally this is observed in family, community and a village-based group. On the other hand, networking social capital is based on economic and political elements and tends to be weaker, compared to bonding social capital. Within the framework of social capital, the role of the state is also very important; basically the state is one of the representatives of formalized social groups. In the context of adaptation to climate change, the role of the state needs to be assessed and examined. The state controls individual and group behaviour, at the same time, the efficiency of the state (governance) has direct bearing on the effectiveness of short-term and long-term adaptation strategies. Climate change is a transboundary issue and international effort and

cooperation is also required. The role of the state is crucial and political leadership decides the direction and speed of adaptive behaviour as a whole (excerpt from the work of Adger 2001).

These two diagrams demonstrate the two types of social capital and how individuals interact within the social boundaries. They also illustrate how society interacts with the state under different circumstances.

**Bonding social capital**



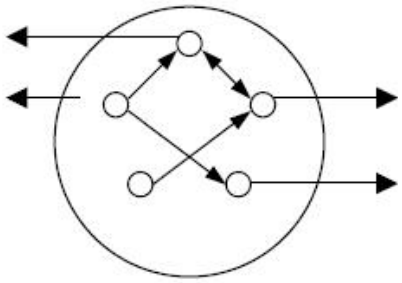
**When important?**

Low income and socially excluded groups
When state provides social security

*Figure 2: Bonding Social Capital*

*Source: Adger 2001*

**Networking social capital**



**When important?**

Dynamic mobile communities
Managing collective resources
Absence of state

*Figure 3: Networking Social Capital*

*Source: Adger 2001*

Normally, decisions regarding adaptation and development are made by individuals, but these decisions need to have social acceptability in the larger context. Again, this acceptability is examined through the lens of social and political institutions, culture and norms, economic structure and history of collectiveness. The interplay of various systems and subsystems, and interaction with core issues of society brings the concept of social capital to the forefront of discussion (Adger 2003).

In developing countries, agrarian, tribal and indigenous people are the most marginalized and deprived group. Over time, these groups have developed very strong synergy within society and are able to withstand environmental stresses. Economic exchange systems such as barter, reciprocity and community farming are a few examples of this synergy. These exchanges have been recognized as an efficient way of coping with current spells of climate change. These experiences of community need to be identified and included in the adaptation-development integration.

**Role of Local Institutions**

Social institutions are another element which needs thorough investigation and inclusion in the adaptation-development integration. Institution is defined as a "humanly created formal and informal mechanism that shapes social and individual expectations, interactions, and behavior" (Ostrom 1990; North 1990; Bates 1981). The role of local institutions in adaptation to climate change and development has been gaining importance. This report is a preliminary attempt to understand this role. Agrawal (2008) broadly identified three main roles in this context – first, structuring impacts and vulnerability; second, defining individual and collective responsibility to adaptation; and third, defining relation with the external agencies.

Adaptation to climate change is highly localized. In this context, the role of the local institution is also very important and it impacts adaptation processes of the local community. The most vulnerable communities such as indigenous groups, farmers, the fishing community and tribes are tied to their local resources and local social dynamics. They have also developed a variety of adaptation strategies to cope with climatic variability and change. However, success and limitations of adaptation will depend on how the local institution is functioning and responding to the climate change issues (Agrawal 2008).

The role of the local institution also needs to be analysed in the context of the relation between development and adaptation. Climate change is leading to an increased exposure to climatic hazards and adversely impacting the livelihood of rural population. There is an urgent need for policy analysis and adaptation strategy formulation based on historical experience and local knowledge. Development efforts need to be inclusive and should pay special attention to the marginalized population. A successful incorporation of social issues such as poverty, inequity, unbalanced regional development and social justice in adaptation plan can be achieved through an effective role of local institutions.

Social structure depends on a variety of factors such as age composition, sex ratio, ethnic affiliation, economic status, etc. Institution is a binder and facilitates interaction across these groups and strata. In addition, adaptation is a place-based and culture-based approach; hence institution helps managing adaptation within society and with external agencies (Agrawal 2008).

**The Role of Gender**

Women constitute more than 70 per cent of the world's population living below the poverty line (Röhr 2006). According to Wisner et al. (2008), women are primarily responsible for household chores and managing food, water, health, etc.; at the same time, when impacts of climate change hit their home and family, they become more vulnerable and responsible for safeguarding their family. Gender influences the response of an individual to the environmental impacts of climate change (Denton 2002) The differences in coping strategies and adaptive capability are due to the vulnerability of women to climate change impacts because of gender differences in socially constructed roles and responsibilities that affect mobility, social networks, access to information, and natural resource dependency as well as access to, control and ownership of assets (Nelson et al. 2002; Sachs 2008). These differences lead to women having a reduced ability to adapt to the effects of climate change.

In contrast to this often unacknowledged difference in vulnerability, there are significant gender differences in knowledge, use and conservation of natural resources as well. Specifically, women are often the keepers of seeds and the gatherers of wild resources, giving them a wealth of environmental knowledge (IDRC 1998). This adaptive capability is often not considered in the development and implementation of policies and plans to address both climate change issues and development goals. In addition, women can play a significant role at the local level, where inclusive collective actions can enhance community adaptive capacity by strengthening local voice and promoting accountable and efficient local governance (Adger 2003).

**The Role of Indigenous People**

Like women in the Global South, indigenous and other traditional people are also marginalized by social and political structures; leading to a vulnerability to climate change impacts as well as adaptive capabilities that are often not incorporated into polices and plans. Indigenous and other traditional people are vital and active parts of many ecosystems and may help to enhance the resilience of these ecosystems. They interpret and react to climate change impacts in creative ways, drawing on traditional knowledge as well as new technologies to find solutions, which may help society at large to cope with the impending changes (Crate 2008; Salick and Byg 2007). In addition, social networks play an important role in the lives of indigenous communities leading to the formation of "support systems of food and labor sharing including exchange, reciprocity, barter or local markets." (Macchi 2008: 17). These types of informal structures can be used to improve the effectiveness and feasibility of strategies to address both climate change impacts, as well as development goals.

**Role of Culture and Value**

In general, discourse and climate change adaptation projects attach great importance to physical, economic and managerial options but fail to recognize the importance of culture in the adaptation process. Culture has provided different tools to human beings since time immemorial (Crate 2008). These tools are tangible and non-tangible. Examples of tangible tools are food processing and storage technique, natural resource management techniques, etc.; examples of intangible tools are cultural practices of weather forecasting, and social norms which decide "do's and don'ts."

On the other hand, Heyd and Brooks (2008) point out that failure to recognize that society is embedded in culture and that those cultural tools are vital for survival and adaptation to changing environment and climate leads to mal-adaptation. This failure also leads to increased vulnerability to climate change and socio-economic stressors. Based on her extensive work with farmers using ethnographic methods, Roncoli (2006) has identified opportunities for communicating weather forecasting and supporting farmer's adaptation related decision-making using cultural framework.

**Governance**

According to the current governance structure, the UNFCCC, Global Environment Facility (GEF), UNDP and the World Bank are emerging as major international players in policy formulation and funding support. These agencies are working closely with the governments of developing countries in the Global South. However, their interactions are still modelled on the blue-print of top-down models of governance. As a result, during the process of negotiations and important decision-making, these international agencies often fail to recognize that developing countries are important stakeholders and that their active participation facilitates successful implementation of development and adaptation projects. Two approaches can be used to improve the interaction between international agencies and developing countries – first, reduce the complexity of decision-making and financial allocation; and second, create an umbrella structure, which provides overarching guidance, under which developing countries can operate with greater autonomy, and focus on their specific problems (Klein and Mohner 2008). In addition, the UNFCCC noted "that the UNFCCC, other Conventions and other international organizations can play a catalytic role in exchange of experiences, and in facilitating the development of region-wide and sector-wide approaches" (2007: 42) and identified specific actions that can be taken to further improve the integration of adaptation and development.

**Limitations and Barriers to Integration**

During the course of the literature survey, a number of obstacles to integration have been identified. These limitations and barriers can be summarized as follows:

- The magnitude of climate change impacts is based on anticipation and uncertainty. Deciding on an adaptation and development approach and mode of operation based on uncertainty limits the scope of the approach (Adger et al. 2008).
- Societal and individual values and judgment that influence the acceptance of a specific adaptation approach depend on cultural, economic and historical factors. Sometimes, these factors act as barrier to adaptation and development (Adger et al. 2008).
- Complexity in governance both nationally and internationally has been a strong barrier to the facilitation and implementation of the integrated adaptation-development agenda (Klein and Mohner 2008).
- On a national level, the lack of cooperation among ministries has been identified as "a major barrier to progress on adaptation" (UNFCCC 2007).

**Future Research and Conclusions**

There is very limited available experience on adaptation to climate change and its integration with development, but the developing countries, especially parts of Asian and African countries, have a large body of knowledge and experience at the local level which provides a platform on which to study and examine principles and priorities that need to be integrated in adaptation-development approach (Alam et al. 2007). Tompkins and Adger (2004) support

this view and add that collaborative resource management, which entails incorporating equity and social justice as core values in climate change policy, will promote successful adaptation, reduce vulnerability, promote development process and increase resilience to the impacts of climate change. Traditionally, it has been held that those who are doing adaptation have contributed less to the causes of global climate change. This debate is valid and will remain in the climate change and policy discourse. More importantly, there is an urgent need to accept adaptation as a viable approach to global climate change issue, and to integrate it strategically with the sustainable development paradigm for wider application and long-term impact (Goklany 2007). Also, the magnitude of future environmentally induced migration depends in part on longer-term environmental and development policies. Institutions must be strengthened so that they can appropriately manage migration linked to environmental change (Forced Migration Review 2008). For successful integration, a few key principles and priorities encompassing social, ecological, cultural, technological and economical realm must be examined and integrated.

**References**


Adger, W. N. (2001): *Social Capital and Climate Change*. Tyndall Centre Working Paper No. 8. University of East Anglia and University College, London.

Adger, W. N. (2003): Social Capital, Collective Action, and Adaptation to Climate Change. In: *Economic Geography*. vol. 79, no. 4, pp. 387-404.

Adger, W. N. et al. (2008): *What Do We Know about Limits and Barriers to Adaptation to Climate Change? A Background paper in Living with Climate Change: Are there Limits to adaptation?* Royal Geographical Society, London.

Agrawal, A. (2008): *The Role of Local Institutions in Adaptation to Climate Change. Social Dimensions of Climate Change*. The Social Development Department, The World Bank, Washington D.C.

Alam, M.; Rahman, A.; Rashid, M.; Rabbani, G.; Bhandary, P.; Bhadwal, S.; Lal, M.; Soejachmoen, M. H. (2007): *Background Paper Impacts, Vulnerability and Adaptation to Climate Change in Asia*. United Nations Framework Convention on Climate Change. <http://unfccc.int/files/adaptation/methodologies_for/vulnerability_and_adaptation/application/pdf/unfccc_asian_workshop_background_paper.pdf>, 10 December 2009.

Bates, R. (1980): *Markets and States in Tropical Africa. The Political Basis of Agricultural Policies*. Berkeley: University of California Press. <http://sitemaker.umich.edu/aid_climate_change/glossary_of_terms> 10 December 2009.

Callaway, M. J. (2004): Adaptation benefits and costs: are they important in the global policy picture and how can we estimate them? In: *Global Environmental Change*. vol. 14, pp. 273–282.

CARE International (2008): *In Search of Shelter: Mapping the Effects of Climate Change on Human Migration and Displacement*. <http://www.ciesin.columbia.edu/documents/clim-migr-report-june09_final.pdf>, 10 December 2009.

Crate S. A. (2008): Gone the bull of winter: grappling with the cultural implications of and anthropology's role(s) in global climate change. In: *Current Anthropology*. vol. 49, no. 4.

Crate, S. A.; Nuttall, M. (Eds.) (2009): *Anthropology and Climate Change: From Encounters to Actions.* Walnut Creek: Left Coast Press ,USA.

Dankelman, I. (2002): Climate change: learning from gender analysis and women's experiences of organizing for sustainable development. In: *Gender and Development, Climate Change.* vol.10, no. 2, pp. 21-29.

Denton, F. (2002): Climate change, vulnerability, impacts, and adaptation: why does gender matter? In: *Gender and Development.* vol. 10, no. 2, pp. 10-21.

Deshingkar, P. (2006): *Internal Migration, Poverty and Development in Asia. Paper for the Asia 2015: Promoting Growth, Ending Poverty.* London, 6–7 March 2006.

Downing, E. T.; Patwardhan, A. (2002): *Vulnerability Assessment for Climate Adaptation.* Adaptation Planning Framework Technical Paper. Oxford, UK.

Forced Migration Review (2008): *Climate Change and Displacement.* Issue 31.<http://www.fmreview.org/FMRpdfs/FMR31/FMR31.pdf> , 10 December 2009.

Goklany, M. I. (1995): Strategies to enhance adaptability: technological change, sustainable growth and free trade. In: *Climatic Change.* vol. 30, pp. 427–449.

Goklany, M. I. (2007): Integrated strategies to reduce vulnerability and advance adaptation, mitigation, and sustainable development. In: *Mitigation Adaptation Strategy Global Change.* vol. 12, pp. 755–786.

Gregory, P. J. et al. (2005): Climate change and food security. In: *Philosophical Transaction of Royal Society B* 360. pp. 2139–2148.

Halsnæs, K., Verhagen, J. (2007): Development based climate change adaptation and mitigation – conceptual issues and lessons learned in studies in developing countries. In: *Mitigation Adaptation Strategies for Global Change.* vol. 12, pp. 665–684.

Heyd, T.; Brooks, N. (2008): Exploring Cultural Dimensions of Adaptation to Climate Change. In: Adger, W.; Lorenzoni, I.; O´Brien, K. (Eds.): *Adapting to Climate Change. Threshold, Values, Governance.* Royal Geographical Society, London.

IDRC (1998): *Guidelines for Integrating Gender Analysis into Biodiversity Research.* <http://www.idrc.ca/uploads/user-S/10267409810gender_biodiversity.pdf>, 10 December 2009.

IPCC (2007): Summary for Policymakers. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability.* Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, pp. 7-22.

Kasperson, R. E.; Kasperson, J. X. (2001): *Climate Change Vulnerability and Social Justice.* Stockholm Environment Institute. Sweden.

Klein, R. J. T.; Mohner, A. (2008): *Governance Limit to Effective Global Financial Support for Adaptation to Climate Change.* Stockholm Environment Institute, Sweden.

Macchi, M. (2008): *Indigenous and Traditional Peoples and Climate Change.* Issue paper IUCN. <http://cmsdata.iucn.org/downloads/indigenous_peoples_climate_change.pdf>, 10 December 2009.

Mahapatra, R.; Sakhuja, N.; Das, S.; Singh, S. (2008): *NREGA Opportunity and Challenges.* Center for Science and Environment, New Delhi, India.<http://www.cseindia.org/programme/nrml/pdf/NREGA_Policy_Paper_2008.pdf>, 10 December 2009.

Nelson, V., Meadows, K., Cannon, T., Morton, J.; Martin, A. (2002): Uncertain predictions, invisible impacts, and the need to mainstream gender in climate change adaptations. In: *Gender and Development.* vol. 10, no. 2, pp. 51–59.

North, D. C. (1990): *Institutions, Institutional Change, and Economic Performance.* New York: Cambridge University Press. <http://sitemaker.umich.edu/aid_climate_change/glossary_of_terms>, 10 December 2009.

Ostrom, E. (1990): *Governing the Commons: The Evolution of Institutions for Collective Action.* Cambridge: Cambridge University Press. <http://sitemaker.umich.edu/aid_climate_change/glossary_of_terms>, 10 December 2009.

OXFAM (2007): *Adapting to climate change. What's needed in poor countries, and who should pay?* Oxfam Briefing Paper. <http://www.oxfam.org/en/policy/briefingpapers/bp104_climate_change>, 10 December 2009.

Paavola, J.; Adger, W. N. (2006): Fair adaptation to climate change. In: *Ecological Economics*. vol. 56, no. 4, pp. 594-609.

Pew Center of Global Climate Change (2005): *Global Warming Basics Fact and Figure.* <http://www.pewclimate.org/global-warming-basics/facts_and_figures/index.cfm>, 10 December 2009.

Putnam, R. D.; Leonardi, R.; Nanetti, R. (1993): *Making Democracy Work: Civic Traditions in Modern Italy.* Princeton University Press, Princeton, USA.

Röhr, U. (2006): Gender and climate change. In: *Tiempo.* vol. 59 (April), pp. 3-7. In: Crate, S. A.; Nuttall, M. (Eds.) (2008): *Anthropology and Climate Change: From Encounters to Actions*. Walnut Creek: Left Coast Press. <http://www.tiempocyberclimate.org/portal/archive/pdf/tiempo59high.pdf>

Roncoli, C. (2006): Ethnographic and participatory approaches to research on farmers responses to climate predictions. In: *Climate Research.* vol. 33, pp. 81-99. <http://www.int-res.com/articles/cr_oa/c033p081.pdf>, 10 December 2009.

Sachs, C. (Ed.): *Women Working in the Environment,* New York: Taylor and Francis, pp. 277–291

Salick, J.; Byg, A. (2007): *Indigenous Peoples and Climate Change*. A Tyndall Centre Publication Tyndall Centre for Climate Change Research, Oxford.

Schipper, E. L. (2007): *Climate Change Adaptation and Development: Exploring the Linkages.* Tyndall Centre for Climate Change Research. UK.

Schmidhuber, J.; Tubiello, F. N. (2007): *Global Food Security under Climate Change*. Pennsylvania State University, University Park, PA, USA.

Schroter, D.; Polsky, C.; Patt, G. A. (2005): Assessing vulnerability to the effect of global change: an eight step approach. In: *Mitigation and Adaptation Strategies for Global Change.* vol. 10, pp. 573–596.

Schumacher, E. F. (1973): *Small is Beautiful: Economics as if People Mattered.* New York: Harper Perennial a Division of Harper Collins Publishers.

Smit, B.; Pilifosova, O. (n.d.): Adaptation to Climate Change in the Context of Sustainable Development and Equity. <http://www.ipcc.ch/ipccreports/tar/wg2/pdf/wg2TARchap18.pdf>, 10 December 2009.

Stern, N. (2006): *The Stern Review on the Economics of Climate Change.* HM Treasury, UK. Cambridge University Press. <http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/sternreview_index.cfm >, 10 December 2009.

Tompkins, E. L.; Adger, W. N. (2004): Does adaptive management of natural resources enhance resilience to climate change? In: *Ecology and Society.* vol. 9, no. 2, p. 10. <http://www.ecologyandsociety.org/vol9/iss2/art10/>, 10 December 2009.

UNFCCC (2006): *Technologies for Adaptation to Climate Change.* Climate Change Secretariat (UNFCCC) Bonn, Germany. <http://unfccc.int/resource/docs/publications/tech_for_adaptation_06.pdf>, 10 December 2009.

UNFCCC (2007): *Climate Change Impacts, Vulnerabilities and Adaptation in Developing Countries.* <http://unfccc.int/resource/docs/publications/impacts.pdf>, 10 December 2009.

Wicklein, R. C. (2001): *Appropriate of Sustainable Living.* University of Georgia <http://wickone.myweb.uga.edu/book.pdf>, 10 December 2009.

Wicklein, R. C.; Kachmar, C. J. (2001): Philosophical Rationale for Appropriate Technology. In: Wicklein, R. C. (Ed.): *Appropriate Technology for Sustainable Living.* pp. 3-21. New York: Glencoe/McGraw-Hill.

Wisner, B.; Fordham, M.; Kelman, I.; Johnston, B. R.; Simon, D.; Lavell, A., Brauch, H. G.; Oswald Spring, U.; Wilches-Chaux, G.; Moench, M.; Weiner, D. (2008): Climate Change and Human Security. In: Crate, S. A.; Nuttall, M. (Eds.) (2008): *Anthropology and Climate Change: From Encounters to Actions.* Walnut Creek: Left Coast Press. <http://www.radixonline.org/cchs.html>.

Zhang, L-Y. (2007): *Climate Change and Sustainable Development: Nexus and Key Linkages.* Presentation to the Financial and Economic Committee of the General Assembly of the United Nations, 13th November 2007. <http://www.un.org/esa/sustdev/natlinfo/nsds/egm_ClimateChange/zhang.pdf> , 10 December 2009.

**Abbreviations**

**ABM**
*Agent-based model*

**ADB**
*Asian Development Bank*

**ANOVA**
*Analysis of Variance*

**ASAL**
*Arid to semi-arid land*

**AT**
*Appropriate Technology*

**BCPR**
*Bureau for Crisis Prevention and Recovery*

**CCEMA**
*Climate Change, Environment and Migration Alliance*

**CENDEP**
*Centre for Emergency and Development Practice*

**CFSC**
*Committee for Flood and Storm Control, Socialist Republic of Vietnam*

**CI**
*Conservation International*

**CRA**
*Community Risk Assessment*

**CSE**
*Centre for Science and Environment*

**CSES**
*Coupled social-ecological system*

**DFID**
*UK Department for International Development*

**DHAP**
*Disaster Housing Assistance Programme*

**EPRDF**
*Ethiopian People´s Revolutionary Democratic Front*

**GAS**
*Green Arusha Society*

**GDI**
*Gender Development Index*

**GEF**
*Global Environment Facility*

**GIS**
*Geographical Information System*

**GSO**
*General Statistics Office*

**HDI**
*Human Development Index*

**IDRC**
*International Development Research Centre*

**IFRC**
*International Federation of Red Cross*

**IPCC**
*Intergovernmental Panel on Climate Change*

**LDC**
*Least developed countries*

**MRF**
*Munich Re Foundation*

**MSB**
*Swedish Civil Contingency Agency*

**MWEDO**
*Maasai Women Development Organization*

**NGO**
*Non-governmental organization*

**NSF**

*National Sciences Foundation*

**PA**

*Protected Area*

**PACCAD**

*Pastoralists´ Alliance for Climate Change Adaptation and Development*

**PRA**

*Participatory Rural Assessment*

**RSA**

*Royal Society for the encouragement of Arts, Manufactures and Commerce*

**SEI**

*Stockholm Environment Institute*

**Sida**

*Swedish International Development Cooperation Agency*

**SRV**

*Socialist Republic of Vietnam*

**TLU**

*Tropical Livestock Unit*

**TMCP**

*Tarangire-Manyara Conservation Project*

**TME**

*Tarangire-Manyara-Ecosystem*

**TNP**

*Tarangire National Park*

**TPLF**

*Tigray People´s Liberation Front*

**TSU**

*Technical Support Unit of the IPCC*

**UN/ISDR**

*United Nations International Strategy for Disaster Reduction*

**UNEP**

*United Nations Environment Programme*

**UNU-EHS**

*United Nations University Institute for Environment and Human Security*

**USAID**

*United States Agency for International*

*Development*

**WWF**

*World Wide Fund for Nature*

**SOURCE**

ISSN: 1816-1154

No. 1/2005 – out of print –
Brauch, H. G. (2005): *Threats, Challenges, Vulnerabilities and Risks in Environmental and Human Security.*
ISBN: 3-9810200-4-9 (printed)
e-ISBN: 3-9810200-5-7

No. 2/2006 – out of print –
Thywissen, K. (2006): *Components of Risk. A Comparative Glossary.*
ISBN: 3-9810582-0-8
e-ISBN: 3-9810582-1-6

No. 3/2006 – out of print –
Rechkemmer, A. (2006): *International Environmental Governance. Issues, Achievements and Perspectives.*
ISBN: 3-9810582-2-4
e-ISBN: 3-9810582-3-2

No. 4/2006 – out of print –
Villagrán de León, J.C. (2006): *Vulnerability: A Conceptual and Methodological Review.*
ISBN: 3-9810582-4-0
e-ISBN: 3-9810582-5-9

No. 5/2006 – out of print –
Birkmann, J.; Wisner, B. (2006): *Measuring the Un-Measurable. The Challenge of Vulnerability.*
ISBN: 3-9810582-6-7
e-ISBN: 3-9810582-7-5

No. 6/2007 – out of print –
Warner, K. (Ed.) (2007): *Perspectives on Social Vulnerability.*ISBN: 978-3-939923-00-8
e-ISBN: 978-3-939923-01-5

No. 7/2007 – out of print –
Birkmann, J.; Fernando, N; Hettige, S. et al. (2007): Rapid Vulnerability Assessment in Sri Lanka.
ISBN: 978-3-939923-04-6
e-ISBN: 978-3-939923-05-3

No. 8/2008 – out of print –
Oswald Spring, U. (2008): *Gender and Disasters. Human, Gender and Environmental Security: A HUGE Challenge.*
ISBN: 978-3-939923-08-4
e-ISBN: 978-3-939923-09-1

No. 9/2008
Villagrán de León, J.C. (2008): *Rapid Assessment of Potential Impacts of a Tsunami. Lessons from the Port of Galle in Sri Lanka.*
ISBN: 978-3-939923-10-7
e-ISBN: 978-3-939923-11-4

No. 10/2008
Bohle, H.G.; Warner, K. (Eds.) (2008): *Megacities. Resilience and Social Vulnerability.*
ISBN: 978-3-939923-12-1
e-ISBN: 978-3-939923-13-8

No. 11/2008
Exner, M.; Klein, G.; Rechkemmer, A.; Schmidt, F. (Eds.) (2008): *Towards Sustainable Global Health.*
ISBN: 978-3-939923-16-9
e-ISBN: 978-3-939923-17-6

No. 12/2009
Oliver-Smith, A.; Shen, X. (Eds.) (2009): *Linking Environmental Change, Migration & Social Vulnerability.*
ISBN: 978-3-939923-24-4
e-ISBN: 978-3-939923-25-1

No. 13/2010
Shen, X.; Downing, T. E.; Hamza, M. (Eds.) (2009): *Tipping Points in Humanitarian Crisis: From Hot Spots to Hot Systems.*
ISBN: 978-3-939923-36-7
e-ISBN: 978-3-939923-37-4

*All publications "out of print" can be downloaded as PDF electronic versions at http://www.ehs.unu.edu/publications*
*"SOURCE" series is distributed free of charge.*

*Please address orders and inquires by fax and e-mail only.*
*UNU-EHS Publications*
*Fax: + 49-228-815-0299*
*e-mail: publications@ehs.unu.edu*

UNITED NATIONS
UNIVERSITY

# UNU-EHS

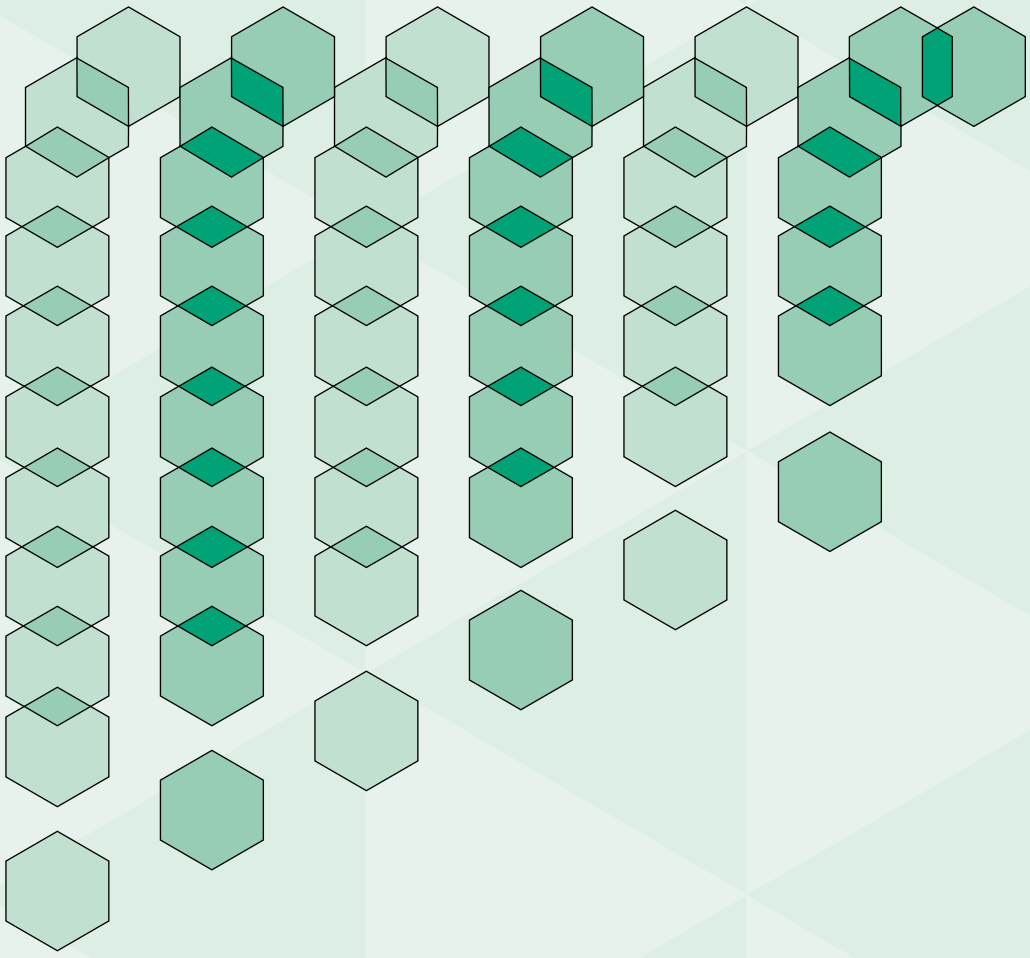
**Institute for Environment and Human Security**

*"Advancing human security through knowledge-based approaches to reducing vulnerability and environmental risks"*

Established by the U.N. General Assembly in 1973, the UNITED NATIONS UNIVERSITY (UNU) is an international community of scholars engaged in research, advanced training, and dissemination of knowledge related to pressing global problems. The UNITED NATIONS UNIVERSITY created the *Institute for Environment and Human Security* (UNU-EHS) to address risks and vulnerabilities that are the consequence of complex – both acute and latent – environmental hazards. It aims to improve the in-depth understanding of the cause – effect relationships to find possible ways to reduce risks and vulnerabilities. The Institute is conceived to support policy and decision makers with authoritative research and information. UNU-EHS is supported by the German Federal Ministry of Education and Research and the Ministry of Innovation. Science, Research and Technology, State of North Rhine-Westphalia, both dedicated to promoting sustainable development and advancing human security. UNU-EHS aims for academic excellence in principal priorities of its programme:

- **Vulnerability assessment**, resilience analysis, risk management and adaptation strategies within linked human-environment systems; and
- Internal displacement and trans-boundary **migration** due to environmental push-factors;

whereby the major drivers such as land degradation, desertification, natural hazard events, gradual human-induced and natural environmental and climatic change and variability, including water depletion and quality deterioration are considered. Preparedness, adaptation, and response are the main dimensions along which human security can be strengthened. A special work focus of UNU-EHS is to conduct research on water relate hazards along big rivers and on deltas. In addition, on behalf of the UNITED NATIONS UNIVERSITY, UNU-EHS is actively engaged in the activities of the International Flood Initiative (IFI) which focuses on research, information networking, education and training, empowering communities, and providing technical assistance and guidance.



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

Tel: +49 (0) 228 815-0200
Fax: +49 (0) 228 815-0299
E-Mail: info@ehs.unu.edu
Website: www.ehs.unu.edu