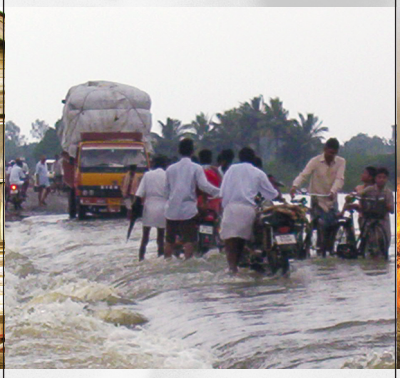
# Measuring Vulnerability to Natural Hazards

## TOWARDS DISASTER RESILIENT SOCIETIES


EDITED BY JÖRN BIRKMANN

# Measuring Vulnerability to Natural Hazards: Towards Disaster Resilient Societies

Edited by Jörn Birkmann

United Nations University Press

TOKYO • NEW YORK • PARIS

# Contents

# Introduction

*Janos J. Bogardi*

## The beginning of a long road

The well-known statistical analysis of the MunichRe Georisk Research Group shows a close to threefold increase in the occurrence of extreme natural hazard events over the last three decades, an approximately sixfold increase in associated economic damages, and a constant number of casualties as a result of these disasters of natural origin. These trends underline the need for still more efforts, more focused disaster management. But they also reveal the necessity to recognise risk and make people aware of and prepared to live with risk, and to respond adequately should they face the occurrence of extreme events.

The World Conference on Disaster Reduction (WCDR) held in Kobe, Japan, in January 2005, was an excellent opportunity to take stock. The Hyogo Framework for Action agreed on during this conference gave the mandate and set the direction for professionals, scientists, individuals, and institutions alike. Among other priorities, it defines the development of indicator systems for disaster risk and vulnerability as one of the key activities enabling decision makers to assess the possible impacts of disasters. The subsequent Strategic Directions compiled by the United Nations International Strategy for Disaster Reduction (ISDR, 2005) should help to set the conference follow-up in motion. While the United Nations, State actors, non-governmental organisations, and many dedicated individuals are emphasising the disaster preparedness and management agenda, Mother Nature has dramatically confirmed this urgency. The

most recent mega-events, the 2004 Indian Ocean tsunami and Hurricane Katrina in 2005, will certainly strengthen the political momentum to act. At this juncture the scientific and professional community is expected to come up not only with concepts and strategies, but also with actions and capacity-building initiatives.

Do we know enough to advise parliaments and Governments how to find the best answers, and where to spend limited funds most efficiently? We have to ask ourselves whether and how fast we can come up with the required risk and vulnerability indicator system, one particular requirement of the Hyogo Framework for Action, with concepts and practical methods that are robust and ready to be used while sound enough to withstand critical scientific scrutiny. Unless the reply is a resounding ''yes'' we had better join forces to map the scientific issues and challenges involved, to debate, to develop, to test methods without losing sight of the mandate and requirements set by the World Conference on Disaster Reduction (WCDR).

There is plenty to debate. But are we well prepared for this process? We face even a terminological cacophony. Vulnerability and many other colloquial terms (risk, hazard, resilience, resistance) found in disaster management concepts are widely used irrespective of the fact that there are still no universally agreed definitions. An array of glossaries have been published to promote the use of a common terminology, or at least to serve as dictionaries for helping experts from different disciplines and schools to understand each other.

While this book also incorporates a comparative glossary, its main objective is to move the whole agenda forward. It documents the efforts being made by the scientific community to address issues well beyond these terminological concerns, by taking stock and summarising the state of the art of measuring vulnerability at the point where scientists and professionals have started the WCDR follow-up process.

## Perspectives worth striving for

Vulnerability is broadly understood as the predisposition to be hurt should an event beyond a certain (though again ill-defined) threshold of magnitude occur and impact the society, its economic assets, the ecosystem, or its infrastructure. This general concept of vulnerability fits well into the ongoing scientific debate on security, and can be associated with the manifold dimensions of human security as defined by UNDP (1994) or represented and championed by the Commission on Human Security as ''freedom from want'' and by the Human Security Network as ''freedom from fear'' (Krause, 2004). As recently as 2005, Bogardi and Brauch

suggested extending the human security concept by introducing a third pillar – ''freedom from hazard impacts'' – thus emphasising the environmental dimension of human security. In this context vulnerability would describe society's (in)security versus natural and human-induced hazards. This book deals with vulnerabilities to hazards of natural origin. We have to acknowledge however that human impact may influence both hazard magnitude and frequency.

Thus vulnerability, once it is properly assessed and preferably quantified, is the crucial feature that could serve to estimate the potential consequences of both rapid onset and/or creeping (natural) hazard events on the affected entities.

By following this line of thought, we can imagine that vulnerability assessment will become the crucial component of disaster preparedness. Monitoring vulnerability may be used to identify those target communities where proactive measures are needed, mostly to pre-empt the devastating consequences of extreme events should they occur. In a longer perspective, vulnerability assessment could become the core of a ''political early-warning'' system, at both national and international levels.

Our ability to assess a population's vulnerability and to use this information in the policy and decision-making sphere would be much easier if only we could develop indicators or indices to encapsulate the notion of vulnerability.

## Some intriguing questions

How can we capture the idea of vulnerability or vulnerabilities? This is especially difficult in the human and social contexts, because vulnerabilities are hardly discernible without also looking at coping capacity, i.e. the ability of the potentially threatened group to overcome its vulnerabilities.

Thus there are a multitude of questions to answer.

- Can vulnerability be measured and quantified, and if yes, how?
- Can vulnerability be aggregated to characterise societies' overall susceptibility to several distinct hazards?
- Can vulnerability and coping capacity be conceived and assessed separately?
- At what aggregation level can vulnerability be measured?
- Could vulnerability assessment results be scaled up or down?
- What could be used as surrogate measures of vulnerability?
- How can vulnerability be assessed in advance of a devastating event?
- What lessons can be learned from retrospective assessment of vulnerability?

The above list is deliberately incomplete. Rather, it offers a sampling of

questions meant to illustrate the great range of problems faced by the scientific community, practising professionals and decision makers alike. In the following chapters more than 40 authors from all corners of the world present the state of the art. They discuss potential developments, attempt to answer some of these questions, and seek to formulate yet more questions.

The book includes five parts, with 24 chapters, which address various aspects and approaches of measuring vulnerability.

Following the introduction, the first part deals with the concept of vulnerability and especially vulnerability indicators. Birkmann introduces different definitions and conceptual frameworks to systematise vulnerability developed and used by different schools of thought, such as the disaster risk community, development research and global change research. The second chapter gives an overview of theoretical aspects and requirements of vulnerability indicators. Both chapters include various links to approaches presented in the book, thus providing an important framework for the chapters that follow. Schneiderbauer and Ehrlich introduce a framework for determining vulnerability at different levels. They also address the question of whether vulnerability should be measured for a specific hazard or whether it should be hazard-independent. Thereafter Queste and Lauwe tackle the crucial question of what indicators are needed from a practitioner's perspective.

The second part gives insight into the relationship between vulnerability and environmental change. The environmental dimension of vulnerability is analysed and outlined by Renaud, then Kok, Narain, Wonink, and Jaeger examine the linkages between human vulnerability and environmental change.

The third part encompasses various approaches to measuring vulnerability and risk at global, national and sub-national scale. In the seventh chapter Pelling reviews the major global disaster risk index projects. Additional information regarding these approaches is presented by authors who were involved in the development of each approach. Thus, the intention and methodology of the Disaster Risk Index is shown by Peduzzi, the hotspots methodology by Dilley and the System of Indicators for Disaster Risk Management in the Americas are described by Cardona. On the basis of the global index projects a European approach of multi-risk assessment is presented by Greiving, followed by a study regarding the measurement of disaster vulnerability at national scale in Tanzania by Kiunsi and Meshack. Finally, Plate proposes a methodology to capture both vulnerability and coping capacity within a single human security index.

The fourth part focuses on approaches at the local level. It encompasses a community-based disaster risk assessment tested in Indonesia and presented by Bollin and Hidajat, as well as an overview of different

methods to measure risk and vulnerability based on the experiences of the Asian Disaster Reduction Centre (ADRC) as explained by Arakida. Villagrán de León outlines a methodology to measure the vulnerability of different sectors illustrated by examples from Latin America. In contrast to quantitative approaches Wisner introduces more qualitative and participatory approaches to assess vulnerability and coping capacity using self-assessment tools. The first results of a study of United Nations University and Institute for Environment and Human Security (UNU-EHS), which uses different methods to measure vulnerability of communities to coastal hazards in Sri Lanka after the devastating tsunami event are presented by Birkmann, Fernando, and Hettige.

Part five deals with specific approaches to capturing and assessing institutional vulnerability, coping capacity and lessons learned. Lebel, Nikitina, Kotov, and Manuta underline the necessity of assessing institutional capacities to reduce risk using the example of flood disaster risk. The complexities of ensuring preparedness of institutions and the public sector for hazard events are also addressed by Mechler, Hochrainer, Linnerooth-Bayer, and Pflug who present a model to measure public sector financial vulnerability. The chapter by Billing and Madengruber focuses on the difficulties of measuring coping capacity, while Krausmann and Mushtaq introduce the approach of lessons learned as illustrated by examples drawn from European experience.

Chapter 23 summarises key aspects discussed in the preceding chapters and Birkmann, the author, draws important conclusions, which could also give some guidance for future research activities and research needs.

Finally, a comparative glossary of key terms in disaster risk reduction is presented by Thywissen, who illustrates the various definitions of the same terms by different institutions and experts.

## Forums, platforms, networks: the UNU-EHS approach

Irrespective of the excellent contributions of so many co-authors to this book, it must be admitted that not all issues were captured, nor all concerns addressed. This book has focused mainly on vulnerability to rapid onset hazard events, whereas the scope and range of vulnerability research are much broader than this. Vulnerability to environmental change, capacity for adaptation, human-induced hazards, and many other areas are also being investigated. The UNU-EHS, which intends to move the scientific debate towards results that have practical applicability and are relevant to policy makers, expects to broaden its coverage in due course. But first it needs a firm conceptual basis.

The human security mandate of the Institute, which also reflects devel-

opments in the political arena worldwide, implies that any extension of the vulnerability debate should keep a strong social focus in mind. The recent establishment of a chair on social vulnerability at UNU-EHS, supported by the MunichRe Foundation, not only underlines the strong appeal of this approach to different stakeholder groups but also provides an excellent opportunity to broaden the interdisciplinary approach of the vulnerability debate.

I am very grateful to Professor Hans van Ginkel, Rector of UNU, for his encouragement to publish this book. It is based to a large extent on the contributions of participants at the first expert workshop on measuring vulnerability organised by UNU-EHS and co-organised and hosted by ADRC in Kobe, Japan, in January 2005. It is my pleasure to thank the many contributors to this book, and fellow scientists and practitioners who joined UNU-EHS in its quest to find answers to the question of how to measure the unmeasurable. My thanks are also due to Dr. Jörn Birkmann, whose enthusiasm and dedication as editor were instrumental in motivating the authors and bringing their contributions together.

We are at the beginning of a very long road. We know, both as scientists and concerned human beings, that we have an obligation to proceed towards better risk preparedness. Recognising our vulnerabilities is perhaps the first important step.

## REFERENCES

Bogardi, J. and H.G. Brauch (2005) ''Global Environmental Change: A Challenge for Human Security – Defining and Conceptualising the Environmental Dimension of Human Security'', in A. Rechkemmer, ed., *UNEO – Towards an International Environmental Organization – Approaches to a Sustainable Reform of Global Environmental Governance*, Baden-Baden: Nomos, pp. 85–109.

Krause, K. (2004) ''Is Human Security 'More than Just a Good Idea'?'', in Bonn International Center for Conversion (BICC) ed., *Brief 30: Promoting Security: But How and for Whom?*, Bonn: BICC, pp. 43–46.

UN/ISDR (International Strategy for Disaster Reduction) (2005) *Strategic Directions for the ISDR System to Assist the Implementation of the Hyogo Framework for Action 2005–2015: Building the Resilience of Nations and Communities to Disasters*, Inter-Agency Task Force on Disaster Reduction, Geneva, available at http://www.unisdr.org/eng/task%20force/tf-meeting-11th-eng.htm.

United Nations University Press
United Nations University, 53-70, Jingumae 5-chome,
Shibuya-ku, Tokyo, 150-8925, Japan
Tel: +81-3-3499-2811 Fax: +81-3-3406-7345
E-mail: sales@hq.unu.edu
general enquiries: press@hq.unu.edu
http://www.unu.edu

United Nations University Office at the United Nations, New York
2 United Nations Plaza, Room DC2-2062, New York, NY 10017, USA
Tel: +1-212-963-6387 Fax: +1-212-371-9454
E-mail: unuona@ony.unu.edu

United Nations University Press is the publishing division of the United Nations University.

Cover design by Mea Rhee

Printed in Hong Kong

ISBN 92-808-1135-5

Library of Congress Cataloging-in-Publication Data

Measuring vulnerability to natural hazards : towards disaster resilient societies / edited by Jörn Birkmann.
p. cm.
Includes index.
ISBN 92-808-1135-5 (pbk.)
1. Natural disasters. 2. Natural disaster warning systems. I. Birkmann, Jörn.
GB5014.M4 2006
363.34—dc22 2006028268

## Measuring Vulnerability to Natural Hazards: Towards Disaster Resilient Societies

### Edited by Jörn Birkmann

**Contributors:**

Hans van Ginkel, Sálvano Briceño, Janos J. Bogardi Jörn Birkmann, Stefan Schneiderbauer, Daniele Ehrlich, Angela Queste Peter Lauwe, Fabrice Renaud, Marcel T.J. Kok, Vishal Narain, Steven Wonink, Jill Jäger, Mark Pelling, Pascal Peduzzi, Maxx Dilley, Omar D. Cardona, Stefan Greiving, Robert Benjamin Kiunsi, Manoris Victor Meshak, Erich J. Plate, Christina Bollin, Ria Hidajat, Masaru Arakida, Juan Carlos Villagrán de León, Ben Wisner, Nishara Fernando, Siri Hettige, Louis Lebel, Elena Nikitina, Vladimir Kotov, Jesse Bacamante Manuta, Reinhard Mechler, Stefan Hochrainer, Joanne Linnerooth-Bayer, Georg Pflug, Simon Horner, Peter Billing, Ulrike Madengruber, Elisabeth Krausmann, Fesil Mushtaq, Katharina Thywissen

A seemingly non-stop series of disasters has shown that societies worldwide seem unprepared for the threats posed by natural hazards: Hurricane Katrina, drought in Africa; flooding in China and Germany; earthquakes in Pakistan and India; a tsunami in South-East Asia; and forest fires in Portugal, Australia and North America.

The tragic impacts of these events drew short-term attention from policy makers, the media and the general public, but their response was too late to prevent serious harm. Societies need to measure their vulnerabilities in advance, and make adequate provisions. To do so, they have to understand the complex relationships between natural hazards and the related social, economic and environmental vulnerabilities. Recognizing and measuring vulnerabilities is the first and perhaps most important step towards disaster resilient societies.

*Measuring Vulnerability to Natural Hazards* presents a broad range of current approaches to measuring vulnerability and contains concrete experiences and examples from Africa, Asia, the Americas and Europe to illustrate the theoretical analyses.

This book is a unique compilation of state-of-the-art vulnerability assessment and is essential reading for academics, students, policy makers, practitioners, and anybody else interested in understanding the fundamentals of measuring vulnerability. It is a critical review that provides important conclusions which can serve as an orientation for future research towards more disaster resilient communities.

**Jörn Birkmann** is an Academic Officer at the United Nations University Institute for Environment and Human Security (UNU-EHS) and Chair of the International Expert Working Group on Measuring Vulnerability.

---

**Ordering information**

**North America, Latin America, Asia & the Pacific:**

**UNITED NATIONS PUBLICATIONS**
2 United Nations Plaza,
Room DC2-853, Dept 174
New York, NY 10017
Tel: 212 963-8302,
800 253-9646 (credit card orders)
Fax: 212 963-3489
E-mail: publications@un.org

**Europe, Africa, and the Middle East:**

**UNITED NATIONS PUBLICATIONS**
Sales Office and Bookshop, Bureau E4
CH-1211 Geneva 10, Switzerland
Tel: 41-22/917-2614, 41-22/917-2613
Fax: 41-22/917-0027
E-mail: unpubli@unog.ch

---

**ISBN 92-808-1135-5**
**400pp US$39.00**

United Nations University Press

53-70, Jingumae 5-chome, Shibuya-ku, Tokyo 150-8925, Japan
Tel +81-3-3499-2811; Fax +81-3-3406-7345
E-mail: sales@hq.unu.edu; http://www.unu.edu