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# Message

On behalf of the IRDR Science Committee it is with great pleasure that we welcome you to the Integrated Research on Disaster Risk (IRDR) Conference 2011 “Disaster Risk: Integrating Science & Practice” in Beijing.

The Conference was conceived to respond to two fundamental questions:

Why, despite advances in the natural and social science of hazards and disasters, do losses continue to increase?

To what extent is the world-wide growth in disaster losses a symptom and indicator of unsustainable development?

In addition, this event should help answer the following questions with regard to disaster risk reduction:

Are we focusing on the most important problems?

Are we digging deep enough to uncover the root causes of disasters?

Are decision-makers in governments, private sector, NGOs, and other stakeholder organizations actually making decisions based on our findings?

This event will focus on characterization of hazards, vulnerability, and risk; understanding decision-making in complex and changing risk contexts; and reducing risk and curbing losses through knowledge-based actions. It will stress the importance of developing resilient societies through disaster risk reduction, based on the guidance provided by the Hyogo Framework for Action (2005-2015): Building the Resilience of Nations and Communities to Disasters. A key outcome of this event is to help identify key research initiatives and ways to promote disaster risk reduction based on good science.

The IRDR aims at promoting and facilitating integrated research that includes all relevant aspects of disasters, with particular interest in social sciences to understand better the formation of social vulnerability that often is at the root of disasters. It also aims at promoting and facilitating policy-oriented research and team efforts among the academic community and government policy-makers.

We trust with your contribution the Conference and its follow-up will help advance the IRDR in these two directions.

We look forward to your active participation and your contribution in moving this forward to make the world a safer place for all as a pre-requisite for a sustainable development.



Gordon McBean  
IRDR Science Committee Chair



Sálvano Briceño  
IRDR Science Committee Chair (Incoming)

On behalf of China Association for Science and Technology (CAST), it is my pleasure to welcome you to the IRDR Conference 2011, which will take place in Beijing, China, from October 31 to November 2, 2011.

China is a country severely suffered from natural disasters, which come in large varieties, extensive geographic coverage, and high frequency and great social damage. Therefore, we attach great importance to the role of scientific research in natural disaster prevention and mitigation and expect broad international cooperation in this regard to not only benefit China in disaster fighting, but also to make contribution to the world as well. Bearing these in mind, we feel grateful to ICSU, ISSC and UN-ISDR, for giving us the opportunity and honor to host Integrated Research on Disaster Risk International Programme Office in China.

It is our pleasure to jointly sponsor this conference, the first important international event of IRDR. I hope that the conference will provide a platform for worldwide experts and scientists to exchange in the field of disaster risk and hence from which to launch trans-disciplinary research alliances aimed at in-depth, practical disaster risk reduction studies.

I look forward to seeing you at the event in Beijing.

Sincerely,

A handwritten signature in black ink, appearing to be 'Zhang Qin', written in a cursive style.

Prof. Zhang Qin  
Executive Secretary  
China Association for Science and Technology (CAST)

# Message

The IRDR International Programme Office would like to welcome you to Beijing and the IRDR Conference 2011. We have designed this conference to afford the opportunity to develop integrated partnership and discuss the various complexities of using science to make our communities more sustainable. Please take advantage of the breaks to meet and discuss with your fellow researchers, practitioners and policy makers on the important issue surrounding disaster risk reduction. These dynamic interactions make the conference a platform to launch trans-disciplinary research alliances aimed at in-depth, practical disaster risk reduction studies.

We would like to thank all our partners at the China Association of Science and Technology (CAST), Chinese Academy of Sciences (CAS), Center for Earth Observation and Digital Earth (CEODE), International Council of Science (ICSU), International Social Science Council (ISSC), and United Nations International Strategy for Disaster Reduction (ISDR) for their support for this event. Thanks also to IRDR JAPAN, IRDR CHINA, United Nations University, CODATA, Monsoon Asia Integrated Regional Study (MAIRS), and World Weather Research Program (WWRP) for convening session or events during the conference. We appreciate IRDR New Zealand, Earth Observatory of Singapore, and Academy of Science in Taipei for sending the IRDR IPO staff for the Conference.

We wish you all a productive conference as we work to bring an integrated, trans-disciplinary approach to disaster risk reduction and work to shift the focus from response/recovery to prevention/mitigation.



Dr. Jane E. Rovins, CEM  
Executive Director  
Integrated Research on Disaster Risk IPO

## **Knowledge Production across Fields, Sectors and National Borders: the Implications and Challenges of Integrated Research**

**Heide Hackmann**  
*ISSC Executive Director*

The IRDR programme has been developed in an international science policy context that increasingly emphasizes new ways of producing knowledge and making sure it gets used. The call is for inter-, cross- and trans-disciplinarity, for internationally comparative, coordinated effort, and for a shift from science for society to science with society. The response — including from the international councils for natural and social sciences, ICSU and ISSC — has been to promote integrated research in priority areas such as disaster risk research. Whilst we may agree on the need for integration, we don't necessarily agree on what integration entails, or how best to accomplish it. This presentation provides a critical examination of the

notion of integration, its implications for our traditional modes of knowledge production, and the challenges it poses for researchers and research managers alike. It unpacks the notion of integration into three policy imperatives: (i) Collaboration across the natural, social and human sciences; (ii) The co-design and production of knowledge with policy makers, practitioners and other user groups; and (iii) International cooperation on the basis of equality. Acknowledging that debates around each of these three imperatives are not new, the presentation identifies current thinking, highlights barriers to integration, and makes practical recommendations for overcoming these.

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## **Disaster Risk: From Research to Practice – a Summary of the IRDR Programme**

**Jane Rovins**  
*IRDR IPO Executive Director*

Why is it that, despite the marked growth over recent decades in our knowledge and understanding of natural hazards, losses associated with disasters have also risen during the same period at a seemingly exponential rate? The Integrated Research on Disaster Risk (IRDR) program looks to answer this question. The complexity of the task requires nothing less than the full integration of research expertise from natural, socio-economic, health and engineering sciences. IRDR is not only multi-disciplinary but will also approach issues of natural and human-induced hazards and disasters from several perspectives – from hazards to disasters and also from human exposures and vulnerabilities back to hazards. The research objectives of IRDR will be attained through successful projects leading to better understanding hazards, vulnerability and risk and an enhanced capacity to model and project risk into the future; decision-making choices that lead to risk and how they may be influenced; and how this knowledge can better lead

to disaster risk reduction. By way of this enhanced capacity and a shift in strategic approaches, there will be a reduction in loss of life, fewer people adversely impacted, and wiser investments and choices made by civil society.

This session will look at issues associated with integrated research on disaster risk and introduce various research projects being implemented to better understand and facilitate the reduction of disaster risk. This will include looking at the Forensic Disaster Investigations (FORIN) initiative. FORIN is intended to be more than a guide for “case studies” in a narrow scholarly or scientific sense. The objective is to dig more deeply into the causes of disasters in an integrated, comprehensive, transparent, investigative or forensic style. The intent of the FORIN programme is that the studies will be designed from the outset to be policy relevant and will aim to provide policy options and evidence-based prescriptions and alternatives.

## Towards Reconstruction after the Great East Japan Earthquake and Tsunami

### Yoshiaki Kawata

*Dean and Professor, Graduate School of Safety Science, Kansai University  
Director, Great Hanshin-Awaji Earthquake Memorial DRI, Kobe*

After the Great East Japan Earthquake and Tsunami Disaster, many problems have been labeled out of bounds and have not been discussed in any great depth. Because this is a compound disaster, comprising an earthquake, a tsunami, and a nuclear disaster, a wide variety of issues have arisen as a result, and many of these issues are being handled badly.

The disaster demonstrated once again the importance of considering the worst-case scenario in which Tokai, Tou-Nankai and Nankai earthquakes could simultaneously occur at any time, and also a Tokyo Metropolitan earthquake could be at risk. The question we are facing now is how we would survive such a time of national crisis. What is at stake here is the very existence of the kind of modern civilization that built our society. The following sections This presentation looks at the results of studies that may offer some solutions to this problem. The topics of these studies include a catastrophic compound disaster, a nuclear disaster, disaster prevention and reduction, reconstruction and regeneration, constructing a new nation and society, and promotion of reconstruction projects and utilization of lessons by the Japanese government. My presentation has six subjects as follows:

#### 1. A Catastrophic Compound Disaster

A "compound disaster", as defined by the author in 1995, has occurred. Japan has been affected by a combination of earthquake, tsunami, and nuclear disaster. To gain a clear understanding of such a huge disaster I have looked at it in terms of nine characteristics as follows: 1) Extent, 2) Compound disaster, 3) Prolonged period, 4) Large-scale tsunami, 5) Social vulnerability, 6) Insufficient measures, 7) Reorganization of municipalities, 8) Lack of expert and 9) Distorted physical distribution system.

#### 2. The Nuclear Disaster

The disaster at the Fukushima No. 1 nuclear power plant was clearly caused by misstep of TEPCO (Tokyo Electric Power Company) immediately after the accident occurred and the sloppy handling thereafter. Although the system (the reactor core isolation cooling system) had the capacity to supply power for eight hours autonomously using DC batteries in the event of loss of all power sources, the eight hours were not used effectively and were wasted. Such sloppy management of the power plant was also revealed in the series of accidents whereby hydrogen gas was generated and caused fire

#### 3. Disaster Prevention and Reduction

The five points summarize the issues that need to be addressed as a result of the Great East Japan Earthquake and Tsunami Disaster from the viewpoint of disaster reduction management.

#### 4. Reconstruction and Regeneration

After witnessing many sites of earthquake and flood disasters, including the Great Hanshin-Awaji Earthquake and those that followed, I am confident that it is crucial to develop reconstruction and city regeneration plans based on the seven concepts.

#### 5. Constructing a New Nation and Society

If we are to construct a safe and secure nation, wisdom and intelligence systems must be established first to manage the regeneration of cities and towns, whereas civil engineering and architecture normally take precedence. Kamaishi in Iwate Prefecture is an example of failure in this respect.

#### 6. Promotion of Reconstruction Projects and Utilization of Lessons by the Japanese Government

It has been decided that the Reconstruction Agency Bill will come into force on June 24. An earthquake disaster reconstruction headquarters will be set up, headed by Prime Minister Kan. It is envisaged that the headquarters will become a reconstruction agency as soon possible, and that it will handle the planning of reconstruction projects, coordination, and financial implementation. The Reconstruction Design Council in Response to the Great East Japan Earthquake and Tsunami, whose establishment was approved at a cabinet meeting in April, has been set up as an advisor to the government and submits recommendations to the reconstruction agency.

Another is The Central Disaster Prevention Council (chaired by Prime Minister Kan) decided to set up the expert panel, and its first meeting was held on May 27. The 17 council members were selected from various fields, such as earthquake, tsunami, seismic movement, construction, local administration, human behavior, and the media. The expert panel has three main duties, including holding ten meetings over six months, preparing a report on the following three issues in October, and preparing an interim report on the first two issues at the end of June:

- (1) Modeling of huge earthquakes
- (2) Modeling of huge tsunamis
- (3) Revising the basic plan for disaster prevention and adding detailed information about tsunami disaster prevention.

## **Emerging Risks: the Case for Integrated Research Science-Humanitarian Policymakers' Dialogues: Opportunities and Constraints**

**Randolph Kent**

*Director, Humanitarian Futures Programme, King's College London*

Across the globe, the types of crisis threats, their dimensions and dynamics, are expanding exponentially. The challenge for the international community will in turn be to expand its capacity to anticipate not only such potential crisis threats but also ways to mitigate them. This challenge will demand that amongst other things those with humanitarian roles and responsibilities engage more systematically and substantively with the sciences to promote more effective prevention, risk reduction and ultimately resilience. This growing need for better "science-humanitarian policymaker dialogues" offers many opportunities, but at the same time must overcome critical barriers in terms of methodologies, language and assumptions about ways to deal with uncertainty and complexity.

While scientists find themselves increasingly in the same room with policymakers, they still do not find themselves at the policymakers' table. All too often, policymakers use the sciences to validate their views and opinions rather than guide them. This is a problem that affects most governments, and

one that was clearly recognised in the March 2011 report by the United Kingdom's Parliamentary Select Committee on Science and Technology, and one which the UK government's Humanitarian Emergency Response Review sought to address.

In part this is a problem that directly relates to the difficulties of that "dialogue;" in part it relates to institutional factors that restrict new information and ideas, compartmentalises rather than integrates cross-disciplinary analysis and fails to reward creativity.

With these issues in mind, Randolph Kent, Director of the Humanitarian Futures Programme, King's College, London, will explore some of the main opportunities and constraints that affect the "science-humanitarian policy dialogue," and also suggest how more integrated research can ultimately help policymakers make their organisations more sensitive to the humanitarian challenges of the future – how to make them more anticipatory, adaptive, innovative, more collaborative and better able to support and sustain strategic leadership.

## Reading International Events in the IRDR Perspective – Hazards and Politics

**John Handmer**  
*RMIT University*

Worldwide we are witnessing increases in the exposure of people and livelihoods to climatic and geophysical phenomena with escalating disaster losses. If science were guiding policy and practice in land-use related decisions, would that make a major difference? The answer to this question could depend on the scale and type of disaster. Perhaps knowledge is being applied at the scale of routine emergencies? However, policy is usually about official processes, and in much of the world there are other forces influencing or controlling development and vulnerability, in particular: the informal economic sector, and crime, corruption and conflict. These informal messy issues receive relatively limited research attention, but often dominate more “rational” processes of evidence based policy. The rapid growth of very large cities is often blamed for increasing risk and losses, but cities occupy an ambiguous position with respect to disasters, both concentrating risk and holding the capacity to reduce it. Informal settlements, often nearly as large as formal settlements, seem to epitomise

the exposure problem as they often occupy areas of obvious hazard. But even where settlement is managed by dedicated professional bureaucracies, avoidance of hazardous areas is limited, with development driven by money and need, not science.

There are reasons for suspicion that the problem will continue to worsen, setting the stage for more large disasters. However, the situation is far from hopeless, and there are opportunities for improvement: we can apply knowledge to reduce risk from routine emergencies; engineering and other technologies can reduce risk and are much more attractive to governments and commerce than preventing exposure through simply limiting land development; and we can combine technology with physical and social science in warning system improvements which continue to offer one of the most cost-effective and potentially most appealing (in that they do not impede settlement) ways of reducing risk to life.

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## Recent Progress of Disaster Risk Research and Mitigation in China

**Guo Huadong**  
*IRDR Chinese National Committee*  
*Center for Earth Observation and Digital Earth*  
*Chinese Academy of Sciences*

China is one of the most frequently affected countries in the world in terms of natural disasters, suffering great economic and environmental damages. The Chinese government has been paying much more attention to disaster prevention and mitigation, and has also taken disaster risk research very seriously. Many large projects were launched such as flood and drought prevention in large river basins, geological disaster prevention and recovery, earthquake prevention and mitigation, and other initiatives. Integrated risk research is given priority in our national key socio-economic development plans and science and technology innovation projects.

We now have experience in applying science and technology to disaster risk research and emergency response at three levels. The first is emergency monitoring and assessment of disasters. This mainly emphasizes timeliness in order to guide rescue work more efficiently, especially in a large, sudden disaster such as an earthquake. Secondly, it is the

assessment of development trends of the disaster. Natural disasters are not isolated and are often in the form of disaster chains such as a typhoon-storm surge-landslide-debris flow chain. The third level is to provide technical support for disaster forecasting and early warning. By establishing a disaster background spatial database, we have developed the statistical models for forecasting and early warning. Space technology is advantageous to all of these because it makes it much easier to grasp hazard and disaster information.

China conducts considerable international cooperation in disaster mitigation, and now hosts the ICSU Program for Integrated Research on Disaster Risk (IRDR). It is an excellent international platform for the world to share the experience in disaster risk research and management. We have the opportunity to share more advanced, practical knowledge of disasters and work together for disaster risk research with international communities.

## Living with Drought: Challenges and Solutions

**Wadid Erian**

*The Arab Center for the Studies of Arid Zones and Dry Lands – ACSAD*

Drought, like all other extreme weather or climate events, is expected to vary from region to region in an absolute sense and possibly in time. But its losses and impacts are not yet systematically captured as there are difficulties regarding drought complexity and data availability, and at the same time differences in countries' capabilities to cope with its consequences.

The studies that have been conducted using different indices and available data are showing so far a medium confidence since the 1960s that some regions of the world have experienced more intense and longer droughts, e.g., southern Europe, West Africa, and East Asia. Meanwhile, there is increased duration and intensity of soil moisture and hydrological drought in some regions of the world, in particular in the Mediterranean, Central North America, and Southern Africa. Simulations indicate also that drought will intensify in the 21st century.

Drought has high risk impacts, especially in countries of the

regions that have fragile ecosystems; low stability or depend on agriculture of high uncertainty, such as rain-fed agriculture and rangelands, for their food security; and where a large portion of the population are living in rural areas. Unfortunately, most countries suffering now from the increased drought frequency, intensity and duration are treating drought with so-called crisis management rather than drought management and are likely to suffer more drought losses and impacts on community stability, agricultural production, rural livelihoods, migration, urban, economic sectors and ecosystem decline.

Therefore there is a need for strengthened commitment for comprehensive disaster risk reduction, especially within and between countries that share common boundaries and resources. This can be achieved through Climate Change Adaptation (CCA) and Disaster Risk Reduction (DRR) in national/regional policies, building resilience, and integrating disaster risk reduction into emergency response, preparedness and recovery.

## Formation of the Disastrous Asian Summer Monsoon Onset Vortex

**Guoxiong Wu, Yue Guan, Yimin Liu, Jinghui Yan, Jiangyu Mao**  
*State Key Laboratory of Numerical Modeling  
for Atmospheric Sciences and Geophysical Fluid Dynamics (LASG)  
Institute of Atmospheric Physics (IAP)  
Chinese Academy of Sciences*

In spring over the southern Bay of Bengal (BOB), a vortex commonly develops, followed by the onset of the Asian summer monsoon. It is usually accompanied by disastrous torrential rain, causing serious loss of life and wealth. Better understanding and improved forecasting are required both for scientific development and societal needs.

An analysis of relevant data and a case study reveal that the BOB monsoon onset vortex is formed as a consequence of air-sea interaction over BOB, which is modulated by Tibetan Plateau Forcing and the land-sea thermal contrast over the South Asian area during spring.

Tibetan Plateau Forcing in spring generates a prevailing cold northwesterly over India in the lower troposphere. Strong surface sensible heating is then released, forming a prominent surface cyclone with a strong southwesterly northwestern BOB. This cyclone induces an in situ offshore current and upwelling, resulting in cooler sea surface temperatures (SSTs). This southwesterly, together with the near-equatorial westerly, results in a surface anticyclone with descending air over most

of BOB and a cyclone with ascending air over the south.

In east-central BOB, where surface wind is weak, intense solar radiation and low energy loss result in the development of a unique BOB warm pool in spring, providing favorable conditions for vortex development. Near the surface, water vapor is transferred from northern BOB and other regions to southeastern BOB, where surface sensible heating is relatively high. The atmospheric available potential energy is converted to kinetic energy, thereby resulting in vortex formation. The vortex then intensifies and moves northward, where SST is higher and surface sensible heating is stronger. Meanwhile, the zonal-mean kinetic energy is converted to eddy kinetic energy east of the vortex, and the vortex turns eastward. Eventually, the southwesterly sweeps over eastern BOB and merges with the subtropical westerly, leading to the onset of the Asian summer monsoon.

Keywords: Air-sea interaction, Upwelling, BOB warm pool, Vortex, Monsoon onset

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## Understanding Decision-Making in the Complex Changing Risk Contexts

**Allan LAVELL**  
*Latin American Social Science Faculty (FLACSO), Costa Rica*

The presentation will outline understanding effective decision-making in the context of risk management, and how the political, institutional, cultural and economic aspects of decision-making and behavior are important and need to be explored. Many forms of risk depend on human actions and decisions. Those forms of human activities may increase, rather than decrease, the damage and danger from natural hazards. From certain perspectives, such decisions may often appear “rational”, and even the only practicable option under the circumstances. Projecting risk into the future will depend, in part, on the choices people make, individually and

collectively, and how they implement these choices. From the background and rationale it is clear that there are barriers to good decision-making that would lead to effective risk-reduction approaches. Through this process, it is expected that improvements could be made to the quality of decision-making process. Decision-making also depends on availability of good information. For example, telecommunications and remote sensing are domains in which gaps between operational and scientific activities are easy to identify and have consequences on decision-making.

## Reducing Risk and Curbing Losses through Knowledge-Based Actions

**Andrew MASKREY**

*Chief of the Disaster Reduction Unit of the UNDP Bureau for Crisis Prevention and Recovery*

This presentation will outline reduction in risk and how it can be achieved through implementing and monitoring informed risk reduction decisions, including modifications of hazards themselves, and through reductions in vulnerability and exposure. It will also explore how the process of human adjustment and adaptation can be used to reduce vulnerability and increase resilience. The combination of factors can vary considerably from place to place, and the wide range of

disasters experienced in the past demonstrates that there is no simple casual explanation. The approaches suggested may be described as diagnostic or forensic. What is not well understood is how these factors work together in different ways and in different places to produce adverse consequences. Reductions in vulnerability can be made through a variety of approaches that are usually grouped into structural and non-structural approaches.

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## Paradigms of Vulnerability Revisited: Examples from European Mountain Regions

**Sven Fuchs**

*Institute of Mountain Risk Engineering, University of Natural Resources and Life Sciences, Vienna, Austria*

The concept of vulnerability is pillared by multiple disciplinary theories underpinning either a technical or a social origin of the concept and resulting in a range of paradigms for either a qualitative or quantitative assessment of vulnerability. However, efforts to reduce susceptibility to hazards and to create disaster-resilient communities require intersections among these theories, since human activity cannot be seen independently from the environmental setting. Acknowledging different roots of disciplinary paradigms, issues determining structural, economic, institutional and social vulnerability are discussed with respect to mountain hazards in Europe. It is argued that structural vulnerability as originator results in considerable economic vulnerability, generated by the institutional settings of dealing with natural hazards and

shaped by the overall societal framework. If vulnerability and its counterpart, resilience, are analysed and evaluated by using a comprehensive approach, a better understanding of the vulnerability-influencing parameters could be achieved, taking into account the interdependencies and interactions between the disciplinary foci. Thereby the overall aim of this paper is not to develop another integrative approach for vulnerability assessment, but rather apply different approaches by using a vulnerability-of-place criterion, and possibilities of a practical implementation are presented. Key issues of vulnerability are reconsidered aiming at a general illustration of the situation in a densely-populated mountain region of Europe.

Keywords: Vulnerability, European mountains, Loss functions, Economics, Human-environment interaction

## Use of Quantitative Risk Assessment in Landslide Risk Management

**Ken K.S. Ho, Thomas H.H. Hui**

*Geotechnical Engineering Office, Civil Engineering and Development Department, The Government of the Hong Kong Special Administrative Region*

The combat of landslides requires the assessment and management of landslide risk. Traditionally, this has often involved qualitative assessments and the use of engineering judgement, without quantifying the risk levels. In recent years, significant advances have been made in respect of the methodology of quantitative risk assessment (QRA), which is now a practicable tool for landslide risk management. In a QRA of a specific site, both the individual risk and societal risk would be evaluated, which are to be compared against the risk tolerability limits in order to assist decision-making on the necessary risk mitigation measures.

An important prerequisite for the successful application of the QRA framework is the availability of suitable risk criteria, which define the tolerable risk levels. For natural terrain landslides, unified risk criteria have been adopted by the geotechnical profession in Hong Kong since the late 1990s and QRA applied in practice.

This paper gives an overview of the roles of QRA in landslide risk management by way of case studies. The findings of a recent review of the risk criteria are also presented.

Keywords: Quantitative risk assessment, Landslide, Risk management

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## Holistic Evaluation of the Disaster Risk in Urban Areas Using Indicators

**Liliana Carreno**

*International Center for Numerical Methods in Engineering (CIMNE)*

Disaster risk is defined as the probability of future damage and loss associated with the occurrence of environmental hazards where levels and types of loss are determined by the levels of exposure and vulnerability of society (UNDRO 1980, Cardona 1990, UNISDR 2004, 2009). Risk is the result of the interactions in time and space of probable physical events with exposed vulnerable elements of the social and environmental systems (Cuny 1984, Davis and Wall 1992). On such interactions, these physical events are transformed into hazards with real potential for contributing to future loss and damage. It is in the latency of risk that the opportunity for risk prevention, mitigation and transfer exists, employing diverse adaptation or disaster risk management principles, strategies and instruments (Lavell 1996, 1999). Disaster risk management may be defined as a social process that searches to reduce, predict and control disaster risk drivers

in a development framework, by means of the design and implementation of appropriate policies, strategies, instruments and mechanisms (Cardona and Barbat 2000).

Indicators or indices could be used to measure risk from a comprehensive and multidisciplinary perspective. Their use intend to capture favourable conditions for direct physical impacts (exposure and susceptibility), as well as indirect and, at times, intangible impacts (socio-ecological fragilities and lack of resilience) of hazard events.

Using this approach based on indicators the risk of different cities has been evaluated. An example is described for the case of Barcelona, involving seismic and flooding hazards. Indicators related to the physical susceptibility, social fragility and lack of resilience of the city have been used. This case study is part of the results obtained in the MOVE project for the European Commission.

## Seismic Risk Reduction in Algeria

**M. N. Farsi, D. Benouar**

*National Centre for Earthquake Engineering (CGS)*

Following the catastrophic earthquake (Magnitude 7.2) that struck El-Asnam (Chlef) in 1980, the Algerian political authorities and the scientific community have been really aware of the importance of seismic risk in Algeria. Since this event, the need to reduce the risk of natural disasters in general and seismic risk in particular has been integrated in the government's agenda. Measures have been taken and an action program for seismic risk reduction was developed. Among these actions that have been conducted by the National Centre of Earthquake Engineering (CGS), we can mention: a) Launching regional seismic hazard studies to

develop the national earthquake hazard map; b) Development of the national accelerographs network for northern Algeria; c) Initiation of seismic micro-zoning studies of urban areas; and d) Initiation of seismic vulnerability studies in the main cities.

The seismic micro-zoning and seismic vulnerability studies are reviewed, indicating for each study the hypotheses considered and the databases used. Also presented will be the seismic disaster scenario for Algiers city that was carried out by the JICA-CGS team following the Boumerdes earthquake of May 2003 (M6.8).

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## Meta-Analysis for Characterization of GEJET Disaster Impacts on Local Coastal Societies in Iwate Prefecture

**Tadashi Nakasu<sup>1</sup>, Kuniyoshi Takeuchi<sup>1</sup>, Shigenobu Tanaka<sup>1</sup>, Ken Yoneyama<sup>2</sup>, Naoki Fujiwara<sup>2</sup>, Toshinori Morita<sup>2</sup>, Junko Sagara<sup>2</sup>**

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This is the first part of the ICHARM-CTI forensic study team's interim report on the Great East Japan Earthquake and Tsunami (GEJET), which occurred on 11 March 2011, focusing on the assessment of the effectiveness of past efforts and experiences of local communities in preventing damage and mitigating the impacts of the GEJET.

In this meta-analysis, the impacts of the GEJET disaster were characterized using statistical data of disaster-affected communities and survey results of other organizations mainly in the public domain. There are numerous municipalities within the GEJET disaster area, but the disaster impacts they experienced varied greatly depending on their physical and

socioeconomic characteristics.

The paper tries to clarify the above-mentioned characteristics by exemplifying the local coastal societies in Iwate Prefecture devastated by the GEJET, including historical experiences of past major events such as the Meiji Sanriku Tsunami in 1896, the Showa Sanriku Tsunami in 1933, and the Chilean Tsunami in 1960. Then, the paper attempts to answer the following inquiries: Why are several local municipalities' human losses so high compared to others? What are the differences between the GEJET and past disasters? Did they learn from past experiences?

Keywords: GEJET, Forensic Investigation, Meta-Analysis

## Scenario Analyses of Concatenation of Mega-disaster Events in Tokyo and Nankai/Tonankai Regions

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This is the fourth part of the ICHARM-CTI forensic study team's interim report on the Great East Japan Earthquake and Tsunami (GEJET), which occurred on 11 March 2011, focusing on the assessment of the effectiveness of past efforts and experiences of local communities in preventing damage and mitigating the impacts of the GEJET.

In this scenario, analysis scenarios for future catastrophic events were developed by projective or predictive forensic investigations. Two scenarios of GEJET-equivalent earthquakes were considered, one in the Tokyo metropolitan area, and the other in the Nankai/Tounankai region of Japan. By utilizing the GEJET survey results and tsunami simulation results, the impacts of such disasters were estimated.

If a GEJET-equivalent earthquake were to occur in the Nankai/Tounankai region at the current level of protection, the damage to lifeline infrastructure such as roads by the triggered tsunami could become greater than that of the GEJET. In the case of Tokyo, the region would not be affected much by a tsunami, but social and economic disruption caused by direct damage to lifelines would be expected to have significant ramifications in Japan and worldwide.

The analyses' results are used to identify critical points of concern and lessons to be applied for future disaster prevention and mitigation measures.

Keywords: GEJET, Forensic investigation, Scenario analysis

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## Practical Utilization of Maps to Construct Common Operational Pictures in Disaster Response - A Case Study of the Eastern Japan Earthquake in 2011

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A magnitude 9.0 earthquake rocked Japan on March 11, 2011, and set off a tsunami causing widespread disaster over several simultaneously affected prefectures. It is very difficult to put a whole picture of the damage together because there were many people engage in a multi-hazard response. Therefore, a mapping function needs to be developed for the emergency response on a nationwide scale to produce consolidated pictures of the situation across multiple afflicted municipalities. As a practical matter, there are many data and a flood of information, but the decision-making body really wants organized, visual information to quickly make decisions just by looking, such as with a map. With that, the Emergency Mapping Team (EMT) was established only one

day after the earthquake occurred to anticipate the situation by utilizing professional knowledge of geo-spatial technology in disaster response. The Emergency Mapping Center (EMC) has long based its activities in the special conference room of the Cabinet Office. Finally, more than a dozen organizations have come together to provide mapping support; EMC published 500 sheets of maps when they held the closing-meeting on April 26th.

Keywords: Common operational picture, Geographic information system, Disaster response, Emergency mapping center, Great east japan earthquake

## Design of a Standardized Management System of the Victims Master Database for Effectively Reconstructing Victims' Lives

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A magnitude 9.0 earthquake shook East Japan on March 11, 2011, called the "Tohoku Region Pacific Coast Earthquake". This earthquake caused a huge tsunami, wide-area liquefaction, and so on. It destroyed many housing structures as well as lives, while the survivors of the disaster have had to reconstruct their lives. The concept of a Victims Master Database (VMDB) has been the best solution to support and manage the process of reconstructing their lives effectively. In this research, we decided to deploy the installation of VMDB into 14 affected local governments in Iwate Prefecture. In this installation, we designed a standardized management system for VMDB based on the result of analyzing the circumstances of widely-affected local governments.

This management system, which is already in development, has four main aspects. First, the system is designed around the work-flow of local responders. This means the system can support their work effectively without interruption. Especially in Japan, almost all local responders manage their work using Microsoft Excel, so the system is Excel compatible. Second,

the system can share all the information stored in VMDB among local responders. This aspect lets local responders develop the big picture of the progress in reconstructing victims' lives, beyond departmental boundaries.

Third, the system is designed for cloud computing. This means it can share standardized functions and services necessary to provide and manage the supporting programs for reconstructing victims' lives. These standardized functions and services can be provided to responders as templates used in their work, and any other local governments can use these templates quickly. Fourth, the system has strong security, because VMDB stores personal information. In this aspect, the system should be established on the LGWAN, which is a closed network and only the staff of local governments can access it. Furthermore, the system can provide appropriate permissions to users.

Keywords: Victims master database, Life reconstruction, Information management system, System design, Cloud computing

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## Key Challenges for Vulnerability and Risk Assessment in the Light of Recent Disasters

Jakob Rhyner

*Vice Rector United Nations University and Director of the UNU-Institute for Environment and Human Security (UNU-EHS)*

The presentation will outline the key challenges for vulnerability and risk assessment in light of recent disasters, such as the Fukushima crises in Japan and the Earthquake disaster in Haiti. In this context, research gaps regarding new systemic risks and cascading effects as well as failures in early warning and risk communication will be discussed. Emphasis will

also be given to question on how spatial scales influence the assessment of vulnerability. Differences between regional approaches that focus on regional averages and local assessments (local hotspots) will be discussed. Additionally, the presentation will underscore the difficulties of predicting short and long-term development trends in vulnerability.

## Various Approaches of Vulnerability Assessments

### Joern Birkmann

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

Measuring vulnerability to natural hazards and climate change stressors is a key issue for effective risk reduction and sustainable adaptation. Assessment approaches deal with methodological and conceptual as well as practical challenges in terms of data availability. The presentation will outline a new approach to assess vulnerability, coping and adaptive capacities as well as exposure to natural hazards and sea level rise at the global and local level. Key components of the index systems will be presented.

Particular emphasis will be given to subjects that are often not sufficiently captured within existing risk indicator and assessment approaches of vulnerability, such as governance,

corruption and violent conflicts. The juxtaposition of the global and local index results underlines that at the local level additional features and characteristics of vulnerability can be assessed compared to the global level. The presentation will deal finally with constraints and problems in assessing vulnerability using indicators.

Furthermore, recommendations on how to capture dynamic changes of vulnerability in crises and disaster situations will be formulated and examples of the Indian Ocean Tsunami Disaster (2004) and the Japan Disaster (2011) will be used to illustrate these aspects as well as the importance of dealing with cascading risks.

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## Vulnerability Assessment in the Context of Disasters and Resettlement Processes

### Nishara Fernando

*Department of Sociology, Faculty of Arts, University of Colombo*

The presentation focuses on disaster vulnerability and its dynamic changes in post-disaster situations, with a special focus on resettlement processes. The author will examine how post-disaster resettlement projects and the relocation of populations in high-risk areas influence the vulnerability of these groups. Compared to standard risk assessment, major emphasis is given to the identification of key aspects of vulnerability that can be measured by quantitative or qualitative

means and that permit comparing the different stages or dynamic phases of post-disaster relocation processes. Based on research in Sri Lanka, emphasis will be given to the differential impacts of relocation processes for different social groups after the Indian Ocean Tsunami. Recommendations on how to reduce the risk that forced relocation becomes a secondary disaster will be formulated.

## Vulnerability Assessment Session

### **Omar Darío Cardona**

*National University of Colombia, Institute of Environmental Studies, Manizales*

The paper deals with the newest review and update of the Disaster Risk Management Indicators Program for the Americas, developed with the support of the Inter-American Development Bank. Within this programme four components or composite indicators have been designed to represent the main elements of vulnerability and show each country's progress in managing risk. The presentation will give special attention to the presentation of the four composite indices,

namely, the 'Disaster Deficit Index', the 'Local Disaster Index', the 'Prevalent Vulnerability Index', and the 'Risk Management Index'. Opportunities and constraints within the development of holistic assessment approaches will be outlined and discussed. At the end, further recommendations on how to improve vulnerability assessments and their applicability in decision making will be formulated.

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## Mission and Operation of the IRDR International Center of Excellence in Taipei

### **Chao-Han Liu**

*Academia Sinica, Chinese Taipei*

The IRDR International Center of Excellence (ICoE) was formally established in Taipei in 2010 to serve as an international platform for conducting disaster risk reduction research, using an integrated, multi-disciplinary approach from the perspective of both of the natural and social sciences, and to establish a partnership network of disaster reduction

research with the relevant institutes of the Academy and domestic universities/research institutions that may enter into cooperation with international organizations and institutions. In this talk, we will report the current status of the IRDR ICoE including recent activities and plans for future projects.

## Adaptation to Climate Change in Asian Coastal Cities

**Roland J. Fuchs, Gordon McBean, Hassan Virji**  
*Cities at Risk*

Asia's coastal cities face an ever growing risk of catastrophic loss of life and infrastructure resulting from the combined effects of climate change (in the form of sea level rise, intensified storms, and storm surges) land subsidence, and rapid urban growth. Global temperature, sea level rise and subsidence in all appear to be increasing at rates substantially higher than the earlier IPCC estimates which formed the basis for identifying 9 Asian cities as among the 10 at highest risk from coastal flooding due to future climate change sea level rise and for estimating that by 2010 a 100 year storm surge could inundate areas in Asia with a population of 300 million. While the dangers of inaction are clear, policy responses in the form of adaptation measures have been slow to develop. To address these issues the East West Center and START with support and sponsorship of APN and IRDR have initiated a series of workshops and conferences under a program entitled Cities at Risk which have involved members of the international science community and academics and representatives of government officials from some 13 Asian coastal cities. Objectives of the program are to:

- Heighten awareness of climate change risks and vulnerabilities in Asian coastal cities
- Examine the status of existing adaptation response
- Analyze barriers to further adaptation including:
  - ✘ Risk characterization, scientific uncertainties in climate change predictions, downscaling and traditional top-down analysis;
  - ✘ Risk communication, lack of public and official awareness of climate change risk and vulnerability;
  - ✘ Difficulties in evaluating adaptation options using traditional cost benefit analysis;
  - ✘ Over-reliance on 'hard engineering' in adaptation strategies;
  - ✘ Failures to integrate risk reduction with urban planning and governance; and
  - ✘ Lack of human and institutional capacities.

Key findings from these workshops are discussed in this paper as well as recommendations for ways forward in research and policy.

## **Centre for Natural Disaster Science (CNDS) – A Swedish Initiative to Improve Security and Disaster Management**

**Sven Halldin**

*Swedish Centre for Natural Disaster Science (CNDS)*

Infrastructures of advanced societies become more complex and the costs of natural disasters grow. Increasing societal complexity often coincides with increased specialization and thus a vulnerability caused by disciplinary and organizational barriers. Since natural disasters occur at the interface between natural hazards and societal vulnerability, the scientific study of such disasters requires interdisciplinary collaboration. CNDS, a Swedish-Government-endorsed strategic research initiative, aims at exploring the scientific interfaces between social, natural, and engineering sciences. The Government's broad objectives of CNDS go from mitigating causes and reducing vulnerabilities to preventing, managing, and rebuilding after disasters. The research focus should be on improved risk assessment and better bases for action plans in order to secure the Swedish society nationally, regionally, and locally. CNDS is a collaboration between Uppsala University (social, earth, and engineering sciences), the Swedish National Defence College (Crisis Management Research and Training – CRISMART), and Karlstad University (Centre for Climate

and Safety – CCS). CNDS recognises the most significant research gaps to be interdisciplinary cohesion and focuses on bringing young scientist together in the beginning of their careers with a clear objective of creating problem-focused interdisciplinary research projects. The core of CNDS is the SENDIM (Swedish Natural Disaster Mitigation) natural disaster science research school that started in September 2011. SENDIM aims at building capacity for the Swedish society and closely collaborates with the original CANDIM research school aiming at capacity-building for Central American universities. The SENDIM research school builds on three fundamentals: (i) careful recruitment of top graduate students, (ii) focus on interdisciplinary projects, and (iii) close contact with Swedish authorities and industry in formulating research problems on (1) design and effective use of early-warning systems, (2) design of systems for decision support and crisis communication, and (3) integration of data, information and expert knowledge in processes of evaluation and change.

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## **The Impact of Climate Change/Variability in Urbanization Areas of Thailand: Case of Extreme Events for Chilling Cold Weather in Upper and Very Heavy Rainfall in Lower Parts of Thailand**

**Somchai Baimoung**

*Deputy Director General, Thai Meteorological Department*

The severity of natural disasters due to climate change/variability during 15-31 March 2011 in the middle of summer in Thailand has been causing extreme events in the form of cold weather in most areas in the upper part of Thailand, even as it was the summer season in those areas. It has been investigated that in general the minimum temperature dropped immediately more than 10°C within 48 hours from 25.0°C to 15.0°C, approximately, and further decreased continuously within 7 days. Consequently, at the same time on the southeast coast of Thailand it was the dry season. It was investigated that there was very heavy continuous rainfall during 21-31 March which caused widespread flooding in most areas in the lower part of the country.

By analyzing the difference in sea surface temperature during El Nino and La Nina events over the South China Sea, it was found that the moderate La Nina event was prolonged in that

area and caused more humidity, lower air temperature, and persistent easterly winds throughout Thailand. In addition, by analysis of weather pattern behaviors of meteorological parameters over Thailand during that period, it was found that at the surface, the sea surface pressure charts showed the intensified high pressure area from China had been experienced throughout Thailand continuously. In summary from all evidences, we concluded that La Nina and Arctic Oscillation events made the air temperature in upper Thailand very cold and the confluence of northeast and easterly winds at the southeast coast of Thailand became an active low pressure area which was the cause of most of the very heavy rainfall in both coastal sides. This was an extreme event that had never happened before in our climatic record.

Keywords: Climate Change/Variability, Extreme event, La Nina and Arctic Oscillation

## Introduction of MAIRS Megacity Study

**Likun AI**

*MAIRS IPO*

*Institute of Atmospheric Sciences, Chinese Academy of Sciences*

There are four working groups in the Monsoon Asia Integrated Regional Study (MAIRS): dryland study, mountain study, megacity study and regional earth system modeling. MAIRS megacity is focused on the impacts of urbanization in Asia on the local/regional climate. The interactions between regional climate and land cover change in urban areas and aerosol emissions are the main topics for MAIRS urban studies in observation, analysis and modeling.

During the last three years, MAIRS has been trying to develop observation networks in the typical megacities of Asia, and setting up a data collection and sharing system for joint collaboration in the megacity study. MAIRS has also set up a modeling team focused on the simulation of land cover change and aerosol impacts on local/regional climate, social and economic changes, and urbanization in Asian countries.

Keywords: Urbanization, Asian monsoon, Regional study

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## Patterns of pH, Temperature and Salinity in the Straits of Malacca and the South China Sea with Possible Relation to Riverine Run-Offs in the Region

**Anisah Lee Abdullah, Zulfigar Yasin**

*University Sains Malaysia*

Using data collected from the ROSES (Research on the seas and islands) of Malaysia expedition a detailed profile of the water quality was determined for the Straits of Malacca and the lower South China Sea for the inter monsoon period (May to June) of 2004. This revealed a distinct gradient of salinity and temperature between the Straits of Malacca and western and eastern portions of the South China Sea. Salinity, pH, sea surface temperature (SST) and turbidity were lower for the Straits of Malacca. Values for these increased steadily in an east to west gradient in the South China Sea. Sea surface salinity ranged from 30.21 ppt to 34.04 ppt, pH values of 7.99 to 8.32 pH units, SST ranged from 29.4 C to 30.1 C while turbidity values of 0 to 1.0 NTU were recorded. All three parameters were related to the freshwater input into these water bodies. The Straits of Malacca fed by the rivers of western peninsular Malaysia and Sumatra while the

lower South China Sea by the rivers of the eastern peninsular Malaysia and northern Borneo would probably contribute to the significant differences in these values. Recent changes in rainfall patterns resulting in the changing fluxes of salinity, pH and turbidity would result in the changes of the coastal marine climate of these regions. Such changes would affect the ecology of the natural communities such as the coral reefs here as these are sensitive to changes in salinity, pH and turbidity. Since these parameters (except turbidity) affect the aragonite saturation levels in the sea water these would limit the growth of coral reefs and related calcifying organisms such as molluscs in the Straits of Malacca compared to the South China Sea. In addition, these changes are thought to present a negative impact to the large shellfish aquaculture industry here.

Keywords: Water quality, South China Sea, Straits of Malacca

## Impact of Urban Heat Island Effect on the Precipitation over Complex Geographic Environment in Northern Taiwan

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To evaluate the impacts of the urban heat island (UHI) effect on precipitation over the complex geographic environment in northern Taiwan, a next-generation mesoscale model—the Weather Research and Forecasting (WRF) model coupled with the Noah land surface model and Urban canopy model (UCM) (WRF-Noah-UCM model)—was used to study this issue. Based on better land use classification using MODIS satellite (case MODIS), it has significantly improved our simulation results for rainfall accumulation patterns as compared to the original USGS 25-category land use case (case USGS). We have found that the precipitation system developed late but

stronger in the urban case (case MODIS) than in the non-urban case (case USGS). Compared to the observation by radar, simulation results predicted reasonably well; not only was the rainfall system enhanced downwind of the city over the mountainous area, but it also occurred at the upwind plain area in case MODIS. Our simulation results suggested that correct land use classification is crucial for urban heat island modeling. The UHI effect plays an important role in perturbing thermal and dynamic processes; it affects the location of thunderstorms and precipitation over the complex geographic environment in northern Taiwan.

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## FORIN or Far-Out? Exploring Multiple Drivers of Disaster Risks in Africa

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Disasters are increasingly being understood as ‘processes’ and not discreet ‘events’. Moreover, the causes of disasters are driven by complex engineering, socio-economic, socio-cultural, and various geophysical factors. Such interacting driving factors, occurring across a range of temporal and spatial scales, combine in numerous ways to configure disaster risks. The dynamics of such risks and their configurations will be explored using a new approach and methodology, namely Forensic Disaster Investigations (also called FORIN studies).

A forensic task is perhaps similar to solving a picture of a disaster puzzle. Initially, there are dozens or even hundreds of apparently disorganized pieces piled when examined individually, each piece may not provide much information. Methodically, the various pieces are sorted and patiently fitted together in a logical context taking into account all the parameters. Slowly, an overall picture of the disaster emerges. When a significant portion of the disaster puzzle has been solved, it then becomes easier to see where the remaining pieces fit. The Integrated Research on Disaster

Risk programme is proposing new methodologies to examine the root issues surrounding the increase in both human and economic costs.

This paper attempts, as a case study, to investigate the Algiers (Algeria) floods and debris flows of 10 November 2001 which caused the loss of more than 714 human lives and damaged more than 1500 housing units and scores of schools, bridges and public works.

The FORIN TEMPLATE for Forensic Investigations of Disasters is intended to be more than a guide for “case studies” in a narrow scholarly or scientific sense. The objective is to dig more deeply into the causes of disasters in an integrated, comprehensive, transparent, and investigative or forensic style. The intent of the FORIN programme is that the studies will be designed from the outset to be policy relevant and will aim to provide policy options and evidence-based prescriptions and alternatives.

Keywords: Risk reduction, Methodology, Case study, All hazards, Algeria

## Return on Experience for Enhanced Integrated Prevention - Rex-Integrated-Prevention

**Gerd Tetzlaff, Juergen Koengeter, Torsten Schlurmann**

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The European Commission issued a communication entitled "A Community approach on the prevention of natural and man-made disasters" to the European Parliament, Council, European Economic and Social Committee and Committee of the Regions. The reason was the marked increase of disasters between 1990 and 2007 affecting the EU. This negative trend created an understanding that a strategic approach for disaster prevention would be needed at the level of the Commission. Considering the almost comprehensive knowledge of disaster triggers and the carefully designed plans to prevent disasters, the rather frequent occurrence might be regarded as surprising. Even more surprising are these occurrences when publicly announced post-disaster improvements are considered. To improve on the future design of disaster prevention plans, it is essential to learn more about the combination of the causes for failure by studying relevant past disasters.

REX-INTEGRATED PREVENTION contributes to developing knowledge-based disaster prevention policies as it leads to

a better understanding of technical failures, especially failed thresholds and design criteria, and displays the reasons of such failures. The synthesis of the project leads to an international workshop to help determine and disseminate the most important findings. The project tackles the critical issue of whether the agreed and implemented thresholds are sufficient to deal with rare hazard events using data from an extended area in the central parts of Europe. Each of the project's partners will contribute a number of relevant disasters and lessons learned. The lessons learned need to be presented on different time scales and for all parts of the disaster cycle separately. It seems necessary to tackle the problem of disaster prevention optimally and systematically using the experience from past disasters. The basis for really learning from experience is to analyze and understand how learning was structured in real cases.

Keywords: Forensic Analysis, Vulnerability Assessment, Risk Management

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## Critical Cause Analysis of the Delay in Evacuation and Aggravation or Mitigation of Impacts

**Junko Sagara<sup>1</sup>, Naoki Fujiwara<sup>1</sup>, Ken Yoneyama<sup>1</sup>, Toshinori Morita<sup>1</sup>, Kuniyoshi Takeuchi<sup>2</sup>, Shigenobu Tanaka<sup>2</sup>, Katsuhito Miyake<sup>2</sup>, Tadashi Nakasu<sup>2</sup>**

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This is the third part of the ICHARM-CTI forensic study team's interim report on the Great East Japan Earthquake and Tsunami (GEJET), which occurred on 11 March 2011, focusing on the assessment of the effectiveness of past efforts and experiences of local communities in preventing damage and mitigating the impacts of the GEJET.

In this critical cause analysis, we attempted to find answers to key questions. What made people take or not take immediate action for evacuation after the tsunami warning on March 11? What were the major causes for aggravation of impacts in the concatenation of disaster events? What worked well with respect to historical lessons and efforts of local people in

mitigating impacts?

In conducting this study, the ideas expressed in reports published by academic societies, government agencies and business communities within 3 months from the GEJET occurrence were analyzed to identify the answers to the above-mentioned questions. By plotting the relationship between the events and their causes, the root causes for aggregation or prevention of damage and impacts of the GEJET disaster were identified.

Keywords: GEJET, Forensic Investigation, Critical cause analysis

## **The Establishment of Health Vulnerability Assessment Methods in the Context of Climate Change and Its Application on Heat Wave Events in Guangdong Province**

**Qi Zhu**

*Guangdong Centre for Disease Control and Prevention*

**Objective:** To develop a methodology for health vulnerability assessment, and assess the vulnerability of public health to heat waves among 124 counties/districts in Guangdong Province, China.

**Methods:** The assessment of public health vulnerability to heat waves consisted of three dimensions: sensitivity, adaptive capacity and exposure. The indicators for each dimension were proposed after literature review and expert discussion. After the standardization of each indicator, principal component analysis was used to determine weights of indicators in the dimensions of sensitivity and adaptive capacity in order to calculate the social vulnerability index (SVI) which represented the combined effect of sensitivity and adaptive capacity. An analytic hierarchy process was used to determine weights of indicators in the dimension of exposure and calculate the exposure index (EI). An additive model was used to generate the total vulnerability index (VI), and a geographic information system (GIS) was used to map the vulnerability index distribution among 124 districts in Guangdong Province.

**Results:** A total of 13 indicators were proposed to assess vulnerability to heat waves in Guangdong. The weights of all indicators were then determined to calculate the VI. The average score of VI was 0.73 with the highest in Yangshan county of Qingyuan city and the lowest in Yantian district of Shenzhen city. Spatial autocorrelation analysis indicated the geographic distribution of VI was not random but clustered among 124 counties/districts in Guangdong.

**Conclusion:** The health vulnerability of heat waves in 124 districts/counties in Guangdong Province showed gradient change from north to south. Economically undeveloped inlands in northern regions were more vulnerable to heat wave compared with economically developed southern coastal areas. This finding indicates that vulnerable population such as the elderly and patients with chronic diseases in socioeconomically disadvantaged regions are at higher risk in the context of climate change.

**Keywords:** Vulnerability assessment, Heat waves, Guangdong Province

## **Examining the Feasibility of Informal Settlement Flood Early Warning Systems: Focus on the Urban Flood-Risk Experience in Kosovo and Masiphumelele Residents, Cape Town South Africa**

**Francis J. Solomon**  
*University of Stellenbosch*

Much of the City of Cape Town's (CoCT) urban landscape is characterised by informal settlements, a legacy left by the apartheid regime, with many poor and disadvantaged communities living in areas exposed to the recurrent risk of rising floods. Recurrent flood impacts, during the winter rainfall months, and their costs are disproportionately borne, both by those at risk, and the local government that are required to repeatedly respond to them (Van Niekerk, 2005; UNDP, 2004). The topic examines the feasibility of applying people-centred approaches to flood early warning systems (EWS) in informal settlements in the CoCT. It places particular emphasis on the experiences of flood-affected residents living in the Kosovo and Masiphumelele informal settlements.

Specifically the study sought to investigate the urban flood-risk context of both study sites, and the risk governance approach to managing and communicating flood-risk. In addition, factors influencing flood warning processes, and behavioural factors influencing response to flood-risk and flood warnings were examined.

The findings of the study suggest that due to a number of challenges relating to prevailing risk communication processes in the CoCT, people-centred flood EWS for informal settlements may be considered impossible or impractical for informal settlement residents affected by rising floods.

The challenges influencing the success of flood EWS include the CoCT's prevailing risk governance approach and conceptualisation of flood-risk and flood warnings, as well as opportunistic behaviour, revealed by informal respondents, in response to rising floods.

Research findings indicate that informal households value their assets and will make creative adjustments to protect them during a flood event. Therefore a flood EWS centred on these needs may be applicable, if all other challenges are overcome. The results underline a need for greater understanding of the level of flood-risk community members are prepared to pursue, retain or take, and what levels of loss stakeholders are prepared to accept.

## **Spatial Strategies and Practices to Address Hydrometeorological Phenomena in the City of Campeche, Mexico**

**Jimena Cuevas Portilla**  
*CIESAS/ENAH, Mexico*

Hurricanes, storms, rain, and floods are hydrometeorological phenomena that have affected the city of Campeche in Mexico since its foundation in 1547. Its inhabitants are used to living with these phenomena and its consequences. But, how did they learn to do so? The aim of this presentation is to show how the inhabitants and their authorities, all together have developed some spatial and social practices to address these hydrometeorological phenomena and how now they have learned to live with them. In other words, it will be shown how this people have produced its own space to live in harmony.

The city of Campeche is located on the northwestern coast of the so-called Peninsula de Yucatan in Mexico. Because of its geographical conditions, this shore is frequently exposed to hydrometeorological phenomena. Consequently, this city is used to being flooded. Despite this situation, the inhabitants love to live there and used to say that nothing happens here.

They are so accustomed to living with the hydrometeorological phenomena that they do not even realize that they have learned how to live everyday with these frequent floods.

Based on three fundamental sources: 1) Historical documents, 2) Historical newspapers, and 3) Oral testimonials, it will be shown that the city of Campeche has been transformed throughout the years, in order to address these kinds of phenomena. In the different historical documents and newspapers, it was found that in response to the recurrent presence of hydrometeorological phenomena the authorities had to develop some strategies, such as building specific hydraulic works and higher sidewalks, paving streets, etcetera. Also, the oral testimonials of some of the inhabitants have shown that they have developed some personal practices to protect themselves. Both the development of strategies and personal practices will be discussed in this presentation.

## **Asian River Deltas Experiencing Slow-Onset Hazards: Vulnerability, Resilience and Adaptation to Environmental Degradation and Climate Change**

**Claudia Kuenzer<sup>1</sup>, Liu Gaohuan<sup>2</sup>, Fabrice Renaud<sup>3</sup>, Marco Ottinger<sup>1</sup>, Stefan Dech<sup>1</sup>**

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Although river deltas globally contribute only 5% to global land mass, there are about 500 million people living in these areas, where the major rivers meet the ocean. In Asia, it is especially the Deltas of the Yellow River, Yangtze River, Pearl River, Red River, Mekong River, Chao Phraya River, Irrawaddy River, Ciliwung River, Ganges-Brahmaputra and Godavari, which are considered major deltas and are densely settled. Some of the numerous geographic advantages of deltas are their flat topography, fertile soils for crop production, mineral resources in the land or off-shore deltaic sediments, water ways for transport, rich biodiversity within wetland ecosystems, coastal forests and swamps, as well as their recreational value.

At the same time Deltas belong to the most threatened societal development areas when it comes to environmental change and especially climate change – the latter explicitly manifested through sea level rise. These are a creeping threat for delta populations in Asia. The deltas addressed depict strongly changing profiles in vulnerability and resilience, and stakeholders in the areas have to make informed decisions

to improve adaptation options towards environmental degradation and climate change. Such adaptation can be of technological, ecological, educational or political nature, and is – in an ideal case – a healthy mix of these four.

We will depict the typical challenges the major river deltas in Asia are facing, and will also address changes which occurred in the deltas with respect to sudden natural hazards such as cyclones (e.g., Nargis). The main focus, however, will be on the changes in vulnerability, resilience and options for adaptation with respect to slow-onset hazards of climate change and environmental degradation as a consequence of socio-economic transformation. Special case studies on vulnerability and resilience of the Mekong Delta, Vietnam, as well as in the Yellow River Delta, China, will be presented, and adaptation approaches undertaken will be discussed.

Keywords: Slow onset disasters, River deltas, Estuaries, Climate change, Sea level rise, Socio-economic transformation, Vulnerability, Resilience, Adaptation, Stakeholder integration.

## Importance of High Quality Data for Calibration and Verification of Hazard and Risk Models

**Farrokh Nadim**

*Director of International Centre for Geohazards (ICG), Norwegian Geotechnical Institute (NGI), Oslo, Norway*

Natural hazards represent a major threat to human life, constructed facilities, infrastructure and the natural environment in many regions of the world. During the past decade, disasters triggered by natural hazards caused nearly one million fatalities, affecting nearly 2.5 billion people across the globe. Both the material losses and mortality due to natural hazards show an increasing trend, mainly because of the increase in the exposed population. The frequency and/or severity of climate-driven natural hazards also seem to be rising. Some of the reasons for the increase are obvious, others less so. However, many lives could have been saved if more had been known about the risks associated with natural hazards and risk mitigation measures had been implemented. The task of risk analysis professionals is assessing hazard, vulnerability and risk in the context of safety. These are very complex tasks and subject to major uncertainties. Unbiased estimates of hazard and risk, when high quality data are

lacking, are difficult to achieve, even for the most experienced professionals. It is essential that the models for hazard and risk assessment are built on data from past events and verified and calibrated on the basis of high quality inventories. When models are solely based on expert judgment, one "runs the risk" of subconsciously arriving at the answers one wants to achieve. Many of the models in use today, especially those that correlate risk to socio-economic indicators, are built on expert judgment and have not, or cannot, be verified because of lack of relevant high-quality data. Risk mitigation strategies that are based on unverified models may be ineffective or even counter-productive. An important step in improving our understanding of the driving factors for risk is to gather, and make publicly available, high-quality data on losses caused by natural hazards and the socio-economic indicators of the affected community.

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## OISDM: An Open Framework for Disaster Information Systems

**Jan-Ming HO**

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OpenISDM (Open Information System for Disaster Management) is a thematic project of Taiwan Academia Sinica. Its goal is to develop an open framework for systems that provide data and information needed to support decisions and operations during disaster preparedness, response and recovery and research and planning in disaster reduction. An information system based on the framework is open and sustainable. It can: (1) facilitate the access, filtering, fusion, verification, use and presentation of information contributed by crowds, and real-time sensor data, scientific data, historical records and other relevant information from independently developed and maintained information sources owned by government agencies and non-government entities; (2) support common models and views, open standard interfaces and API functions to enable independent development of

applications and provide tools and services to reduce the time and effort needed to develop the applications; (3) weave together hard and soft information and make effective use of available communication resources to offer applications and end users less fragmented and more trustworthy information with higher availability on a timely basis; and (4) grow incrementally and evolutionarily in contents, capabilities and functionalities. The main thrust of the project effort is on the scientific and technological underpinnings of the OpenISDM framework and on the exploitation of diverse data and information made available by the system in research on disaster reduction. The project collaborates closely with Taiwan National Science and Technology Center for Disaster Reduction (NCDR) and the new Academia Sinica Center for Integrated Research on Disaster Risk (IRDR).

## **GEO Grid Disaster Response Task Force Activity for the 2011 Tohoku, Japan Earthquake**

**Koki Iwao**

*National Institute of Advanced Industrial Science and Technology, Japan*

The Global Earth Observation Grid (GEO Grid) under AIST offers satellite imagery of stricken areas, geological maps, and hazard information, including a strong ground motion map based on observation records of seismic networks and geomorphologic conditions in Japan. The information will help those working in emergency response, researching the tsunami and structural damage, and engaged in the restoration and rehabilitation of civilian life and economic activities. Key requirements for the activities

are "Redundancy", "Rapidity", and "Standardization". For Redundancy, the GEO Grid was migrated to external servers and Cloud system; for Rapidity, there is high-speed automatic data processing using high-performance computers; and for Standardization, most of the geographic information is open to the public as Web Map Service (WMS) and KML (KMZ), which are international standards for geographic data. The latter file is also compatible for viewing on Google Earth and other GIS platforms. Ref: <http://disaster-e.geogrid.org/>

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## **Progress and Challenges in Integrating Disaster-Related Data and Information**

**Robert Chen**

*Director, CIESIN, Columbia University; Secretary General, CODATA*

Efforts to improve understanding of the complex interactions between human and environmental systems that can lead to disaster require a variety of data from a range of disciplines in the social, environmental, health, and engineering sciences—each with their own collection methods, terminologies, systems, and data management traditions. Significant progress is being made in accessing and assembling diverse data sources and systems, e.g., through the application of geospatial information technologies and open standards and data models. However, supporting integrated research and decision making across multiple hazards and spatial and temporal scales will require substantial improvements not only in existing data sources and systems, but also in interdisciplinary data collection, management, analysis,

and integration approaches. Key challenges include developing ways of linking diverse data types across disciplinary boundaries, comparing risks with very diverse temporal and spatial characteristics, characterizing potential interdependencies between hazards, exposure, and vulnerability, assessing data quality, observational biases, and uncertainty, and developing meaningful integrated indicators and visualizations of disaster risk and risk management options. Close coordination between integrated research initiatives and data system development and integration activities is vital both for the research enterprise and for practical efforts to reduce disaster risks and deal with complex emergencies in the short and long term.

## The Hyogo Framework for Action

**Abdou Sané**

*Vice-président du Groupe parlementaire Libéral et Démocratique (Majorité parlementaire), Sénégal*

Scientific research must be about lasting responses. This implies the existence or creation of research facilities (laboratories, research centers, training centers, testing for applied research) and the motivation of managers—both of which depend on political decision makers who allocate resources according to their priorities. In return, researchers must also be good teachers and communicators to build interest in the results of their work. They must be reachable and open so that their work can be better understood and accepted (showing the contribution of results in the development process) by the political decision maker.

The difficulties in the relationships between researchers and political decision makers lie in their own ways of thinking: the researcher is working for a sustainable horizon, in the long term, whereas the politician has an immediate vision

often linked to the duration of a political term. So these different approaches partly explain the weakness of research funding. This issue of integrating politicians and researchers on disasters is hard to solve because these are cyclical phenomena that are difficult to control by the scientists themselves. Also note that the politicians are only interested when the consequences dramatically affect humans and they feel that these can jeopardize their re-election.

Right now, these disasters are frequent. A mutual understanding should be established between politicians and researchers on disaster risk reduction to help prevent and mitigate disasters. Overall, political decision makers are at the center of the definition of national strategies for reducing disaster risk, hence the need to work with them like a well-informed and uncomparable partner.

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## Integration of Politicians and Disaster Risk Research

**Byarugaba Alex Bakunda**

*Parliament of Uganda*

In spring over the southern Bay of Bengal (BOB), a vortex commonly develops, followed by the onset of the Asian summer monsoon. It is usually accompanied by disastrous torrential rain, causing serious loss of life and wealth. Better understanding and improved forecasting are required both for scientific development and societal needs.

An analysis of relevant data and a case study reveal that the BOB monsoon onset vortex is formed as a consequence of air-sea interaction over BOB, which is modulated by Tibetan Plateau Forcing and the land-sea thermal contrast over the South Asian area during spring.

Tibetan Plateau Forcing in spring generates a prevailing cold northwesterly over India in the lower troposphere. Strong surface sensible heating is then released, forming a prominent surface cyclone with a strong southwesterly northwestern BOB. This cyclone induces an in situ offshore current and upwelling, resulting in cooler sea surface temperatures (SSTs). This southwesterly, together with the near-equatorial westerly, results in a surface anticyclone with descending air over most

of BOB and a cyclone with ascending air over the south.

In east-central BOB, where surface wind is weak, intense solar radiation and low energy loss result in the development of a unique BOB warm pool in spring, providing favorable conditions for vortex development. Near the surface, water vapor is transferred from northern BOB and other regions to southeastern BOB, where surface sensible heating is relatively high. The atmospheric available potential energy is converted to kinetic energy, thereby resulting in vortex formation. The vortex then intensifies and moves northward, where SST is higher and surface sensible heating is stronger. Meanwhile, the zonal-mean kinetic energy is converted to eddy kinetic energy east of the vortex, and the vortex turns eastward. Eventually, the southwesterly sweeps over eastern BOB and merges with the subtropical westerly, leading to the onset of the Asian summer monsoon.

Keywords: Air-sea interaction, Upwelling, BOB warm pool, Vortex, Monsoon onset

## Politics and DRR – Connecting the Dots

### Saber Hossain Chowdhury

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A major challenge for politicians lies in understanding the context, seeing the bigger picture and thereafter connecting the dots so that potential threats and challenges can be manifested into opportunities.

Prioritization and sequencing of actions and interventions, whether it is in the realm of policy formulation and articulation or implementation at the grass root level is thus critical.

Identifying strategic entry points that then ensure optimal impact in a number of cross cutting sectors and areas is not only an imperative but also ensures the most efficient and smartest utilization and allocation of scarce and limited resources.

Identifying the linkages for instance between Climate Change Adaptation (CCA) and Disaster Risk Reduction (DRR) and thereafter workings towards a total convergence of the two is a clear example.

Whilst all of the above apply generally across the board to

any major policy area, in the instance of DRR and CCA, its applicability is perhaps at its most.

Advancements in science, technology and research challenge existing mindsets and at the same time offer a window into a whole new dimension.

The need to engage, analyze and view past events in a historical perspective through the lens of scientific data and research and the need to use these as essential tools in constructing possible future scenarios are imperative. This is the area where political leadership has to own and drive the process.

Ownership however can only emanate from political will and this in turn can be hugely fortified, enabled and triggered by science and research on the one hand and considerations of welfare and well-being of the people and constituencies politicians represent on the other.

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## Politics and DRR

### Saumura Tioulong

*Elected Member of Parliament, Cambodia*

1. DRR is not just a bunch of techniques to avoid natural hazards from turning into disasters, it is a different approach, a different mindset, similar, in the field of public health, to the concept of immunization in advance, not after an epidemic has developed. Political programs result from mindsets—the philosophy of life. If we are successful in ingraining the mindset of prevention before the hazard materializes itself, we change whole political programs.

2. This different approach has to be translated not only in political programs, but also in budgets at the national, provincial and communal levels. The spirit of DRR has to be translated in resource allocation. Politicians make choices and allocate resources; they are the ultimate decision makers; they adopt budgets.

3. We need to demonstrate to politicians that it is economically less costly to prevent human and material losses than to repair, reconstruct, heal wounds, etc., let alone resuscitate

dead people. An example is schools built in Bangladesh with Switzerland ODA to be flood-resilient that cost on average 6% more than ordinary schools. Research shows that \$1 spent on DRR saves from 10 to 50 dollars in reconstruction (again, the cost of human lives not being counted). Politicians are supposed to make the most out of every cent of tax-payers' money. DRR shows the best cost to quality ratio.

4. Only politicians, through permanent interaction with their constituents and with the help of their party machinery network, can explain to the population the importance of DRR and create the conditions for acceptance of the extra financial cost involved. They create an extra pressure for executive branches to think in terms of DRR and accept the extra cost involved. Politicians are useful aids to disseminate the concept of DRR as well as the concrete tools and measures that the population must use/implement.

## **The Relation between Land Cover and the Urban Heat Island Using Geoinformatics Applications**

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At present, the world population mostly lives in urban areas which are spread throughout the world. The progression and expansion of cities include economic, social and transportation developments. High demand for land in cities contributes to high land value and has led to many useful purposes for land use, for example high building construction. Therefore, the objectives of this study was to examine the correlation of land use, urban expansion, and the urban heat island (UHI) through the application of geoinformation technology. The

measurement of Urban Index and Brightness temperatures were derived from LANDSAT-5 Thematic Mapper (TM) and land surface temperature images from Terra satellites in the MODIS system. Brightness temperature has shown that temperature has been increasing since 2000 to 2007. Land uses, urban expansion and urban index significantly influenced temperatures.

Keywords: Urban heat island, Land cover, Geoinformatics

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## **Probability Distribution of Minimum/Maximum Temperature and Response to Urbanization over China during the Last 50 Years**

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Based on the daily temperature data from 752 Chinese stations, the probability distribution of the minimum/maximum temperature and its response to urbanization were analyzed during 1960-2010. The results show that under global warming, the upward trends of both the minimum and the maximum temperature were all statistically significant over most regions in China except those in Southwest China during the last 50 years. In particular, a significantly abrupt warming in the minimum temperature occurred in the 1980s, and the increasing magnitude of the minimum temperature was higher

than that of the maximum counterpart. After the warming, the probability distribution calculated from both temperature variables has apparently changed. The probability of cooling was reduced significantly but that of warming increased, evidently. The changes of the probability distribution from the minimum/maximum temperature are mainly found in many city stations, especially in those with rapid urbanization.

Keywords: The minimum/maximum temperature, Probability distribution, Increased temperature change, Urbanization, China

## **The Severe Drought in the Yangtze River Basin in the Spring of 2011**

**Jie Wei**

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In the spring of 2011, a severe drought struck the Yangtze River Basin due to the lack of rainfall over a sustained period. The drought is the consequence of persistent anomalous circulation over Eurasia. There was a deep trough sustained over Japan. In the Caspian Sea and Arabian Sea there was a stationary ridge. Due to its persistence, the perturbations from West Asia could hardly reach East Asia. Meanwhile, an eastward displacement of the subtropical high led to the eastward shift of the water vapor channel away from eastern

Asia. Also, the summer monsoon of the South China Sea was weak in May, resulting in a very poor supply of water vapor and very dry weather in the Yangtze River Basin. The formation mechanism of such anomalous atmospheric circulation which lasted three months stably over Eurasia has yet to be further studied.

Keywords: The Yangtze River Basin, Drought, Atmospheric circulation anomalies

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## **An Economic Assessment Method for the Impact of Climate Change**

**Jieming Chou**

*Beijing Normal University*

This paper studies how to assess the grain yield impact of climate change, according to future climate change over a long time period as predicted by a climate system model. The concept of the yield impact of climatic change (YICC) is presented in this paper to assess the impact of global climate change on grain yields. A method is introduced to study the effect of future climatic change on the economy. The researchers determine the economic output of climate change from historical data, and provide a method to quantitatively

predict economic output of climate change by an economic-climatic model (The C-D-C model). A historical reciprocating examination is used to analyze output data for various crops in eight agricultural areas in China and meteorological data from 160 observatories in China from 1980 to 2003. The results show that the methods used are reasonable to a certain extent and good in application.

Keywords: Climate change, Assessment, Method, Economic-climatic model, The impact of climatic change

## Multi-Model Projection of Asian Climate Change

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The new challenge facing policy makers and scientific communities is to devise adaptation and mitigation strategies to reduce the risk induced by climate change on a regional scale. However, absent of the reliable information of magnitude and range of climate changes, the policy making process will possibly turn out to be a debating competition, where people either call for immediate actions or wait for more evidence and information.

Though GCMs are still the principle tools for climate prediction, they are unreliable when applied to generate regional scale climate projections due to their incapability to solve the critical regional topographic features, such as land use, inland water bodies, and soil processes. Facing the challenge of developing highly confident climate change scenarios of Monsoon Asia in the 21st century, a multi-RCMs project was

set up ensembling a group of RCMs nested with GCM to provide high-quality regional climate change projections. Two sets of simulations for both contemporary and future climate are carried out, and the ensemble technique is employed to provide reliable projections of Asian climate change, the variability and extremes, and estimate the uncertainty. The produced scenario is essential to developments cutting across different sectors and systems in the region. The results help stakeholders to identify the main climate risks we face in Asia, and response options can be defined and effective adaptation decisions can be made. This project also provides insights into the change and variability of the monsoon climate in the future.

Keywords: Climate projection, Regional model, Climate change

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## The Global Earthquake Model (GEM) Uniform and Open Standards to Calculate and Communicate Earthquake Risk Worldwide

R. Pinho

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GEM brings together state-of-the-art science and national, regional, and international organisations as well as individuals in a global collaborative effort that aims to have a lasting impact on seismic risk assessment.

Hundreds of organisations and thousands of individual experts and professionals worldwide are working on the development of a cutting-edge, dynamic, openly accessible model for assessing seismic risk worldwide. The model integrates global uniform databases and standardized methods and input models.

Stakeholders will access the model through a web-based OpenGEM platform where they will have access to tools for analysis of seismic risk, for assessing the possible impact on society and economy, and a set of decision-making tools. OpenGEM addresses the needs of a wide group of prospective users and beneficiaries, including those working and deciding on risk resilience and mitigation. It will therefore allow for earthquake risk assessment at the community,

national and international levels and for integration/compatibility with ongoing initiatives on disaster risk reduction. It will have a dedicated interface for users with expert-knowledge that are able to run their own computations, add data to the model and produce their own input-data. Common users will be able to make use of readily-available maps, tables, indicators and tools for analysis and decision-making. Users will be connected to each other, thus being able to share their experiences and analyses and jointly expand the body of knowledge on earthquake risk assessment.

GEM's modus operandi is one of true global collaboration through open communication and discussion, as we believe that a global model can only be built in full cooperation with experts and stakeholders from around the world, and in this way become authoritative because they believe in it and use it. This decentralised working model supports growth of a network of GEM-followers contributing to improved seismic risk assessment, and to making it more accessible for all.

## Risk and Impact Modeling Tools for Weather Related Hazards

**Joanne C. Robbins**

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The availability of high resolution weather forecasts offers a unique opportunity to develop risk and impact modeling tools for weather-related natural hazards to mitigate against high-loss events. The Met Office is currently developing a suite of UK-focused risk and impact models, which can forecast not only the likelihood of severe weather and associated weather related hazards, but also the likelihood of disruption and damage associated with these events. Using combined hazard fields principally forced by weather parameters, in addition to vulnerability and exposure fields, the models quantify the risk of weather related natural hazards affecting the UK out to two days ahead. The addition of vulnerability and exposure information ensures a more comprehensive assessment of how severe weather affects the environment over which it occurs. It also allows a quantified assessment of the impacts such events may cause in terms of disruption or damage to specific regions, communities and infrastructure. This information is currently

being designed to operate as a support tool for decision makers. Having both risk and impact information for multi-hazard events displayed in a single location offers decision-makers a 'one-stop-shop' environment where the number of potential hazards affecting the UK can be seen for each time step of the model run, as well as the risk that any of these weather types may inflict additional hazards and/or impacts on communities and infrastructure. Initial case study tests are being completed for a range of events, while a model to look specifically at vehicle overturning in strong winds along principal UK road networks has been tested over two winter seasons. It is hoped that the model's scalable nature and flexibility to run for multiple hazards and impact scenarios will offer the potential for operational risk and impact modeling to become a useful tool for decision-makers on the ground, during prominent natural hazard events.

Keywords: Risk, Impacts, Modeling, Weather, Hazards

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## Mapping and Understanding Global Disaster Risk and Trends: the GAR Analysis

**Pascal Peduzzi**

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Disasters may be triggered by sudden events, but are the results of cumulative consequences of incremental changes from inappropriate decisions and as consequences of global environmental change. Quantitative methods for highlighting the underlying factors of risk are needed to help make convincing decisions and inform policy makers on how risk is configured.

The risk from natural hazards is an intersection of the hazard, exposure and vulnerability. Each of these risk components are changing. Hazard frequency or intensity might be influenced by climate change or ecosystem decline (e.g., deforestation). This, along with increased exposure due to population growth and change in development, affect the level of vulnerability. Hence risk is a dynamic feature which needs to be re-assessed regularly by governments, insurance providers or development agencies. Most global risk trend analyses are based on international loss databases. These are very useful for calibration, but our results show that improvements in information access make them unsuitable for risk trend

analysis. A new approach is needed.

GIS, remote sensing, databases and statistical analysis were used in order to characterise risk at the global level. The method uses an innovative approach based on individual event modelling, extraction of exposure and contextual parameters to calibrate the weight of the different risk components. It allows the identification of the underlying factors of risk and equations for the mapping of risk distribution. Hazards, exposure and risk were mapped with global coverage at an unprecedented resolution. The risk was aggregated at the country level to generate the Mortality Risk Index, allowing comparison between countries. New techniques were integrated to compute trend analysis, which are totally independent from the international database on reporting losses. The results were provided in the 2009 and 2011 Global Assessment Report on Disaster Risk Reduction (GAR). Data can be viewed and accessed through the Global Risk Data Platform (<http://preview.grid.unep.ch>).

## **CAPRA – Comprehensive Approach to Probabilistic Risk Assessment: International Initiative for Disaster Risk Management Effectiveness**

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Understanding disaster risk due to hazard events, such as earthquakes, creates powerful incentives for countries to develop planning options and tools to reduce potential damages. This has been the reason why CAPRA, the risk evaluation model described in this paper, was developed with the technical and financial support of the World Bank, the Inter-American Development Bank (IDB) and the International Strategy of United Nations for Disaster Reduction (ISDR). CAPRA is a techno-scientific methodology and information platform, composed of tools for the evaluation and communication of risk at various territorial levels. This

model allows the evaluation of probabilistic losses on exposed elements using probabilistic metrics, such as the exceedance probability curve, expected annual loss and probable maximum loss, useful for multi-hazard/risk analyses. The platform is conceptually oriented to facilitate decision making; using CAPRA is possible to design risk transfer instruments, the evaluation of probabilistic cost-benefit ratio, providing an innovative tool for decision makers to analyze the net benefits of the risk mitigation strategies, such as building retrofitting.

Keywords: Seismic risk, Building damage, Insurance, Risk reduction, Loss scenarios.

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## **Judgments of Earthquake Risk before and after the Canterbury Earthquake: Do They Relate to Preparedness?**

**John McClure<sup>1</sup>, Celine Wills<sup>1</sup>, David Johnston<sup>2</sup>, Claudia Recker<sup>1</sup>**

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Previous research has examined the decrease in unrealistic optimism about the likelihood of an earthquake after citizens have experienced an earthquake, but has not compared these patterns in the affected region with other regions. This research compared the effects of an earthquake on risk judgments in the affected region and those outside the region, including a region where there had been as high expectations of an earthquake (Wellington).

Participants in Christchurch, Wellington and Palmerston North judged the likelihood of an earthquake before and after the 2010 Canterbury (Darfield) earthquake, near Christchurch. Palmerston North was chosen as a site to be comparable to Christchurch before the Darfield earthquake, in that many New Zealanders expect an earthquake in Wellington, not Palmerston North. Participants judged earthquake

likelihoods for their own city, for the rest of New Zealand and for Canterbury. Christchurch participants also indicated their preparedness before and after the earthquake. Expectations of an earthquake in Canterbury were low before the Darfield earthquake in all three samples and rose significantly after that earthquake. In contrast, Wellingtonians' perceptions of the likelihood of an earthquake in Wellington were high before the Darfield earthquake and did not rise after that earthquake. Preparedness by Christchurch participants showed only a very weak relation to their risk perceptions. These results clarify how earthquakes affect judgments of earthquake risk for citizens inside and outside the affected area and show that these effects differ for cities where an earthquake is expected. Keywords: Risk judgment, Risk perception, Unrealistic optimism, Preparedness, Earthquakes

## Building and Losing Public Trust in Disaster Risk Management

**Mathew White<sup>1</sup>, J Richard Eiser<sup>2</sup>**

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Most individuals have no way of predicting complex hazards such as earthquakes and severe weather events. They must therefore rely upon (i.e., trust) risk managers to make meaningful forecasts and effective response plans. We present a summary of our recent research into how public trust in such risk managers is built and lost. Results from a series of surveys and experimental studies have identified the following aspects as important: a) Prior attitudes towards the hazard and the managers; b) Prior political beliefs; c) The specificity of risk action plans; c) The accuracy of risk forecasts; d) The

tendency of risk managers to assume that an ambiguous situation is dangerous vs. safe; and e) The willingness of managers to communicate openly with the public. Our central message is that when members of the public have an impoverished understanding of a hazard they focus on trying to assess the motives and capabilities of those responsible for managing it. Risk managers need to understand these processes if they want to get the public “onside” when faced with potential disasters.

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## Data Management in Natural Disaster Mitigation

**Guoqing Li**

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Disasters are emergency events needing quick response, especially fast observation and fast data sharing. Distributed datasets bring big trouble for end users to find, understand, access and process data. International disaster mitigation cooperation programs need a technical platform to bridge such a gap. Good disaster data management includes data collection and sharing, data archiving and mining, and data modeling and simulation. This presentation will discuss three important issues in disaster data management: a global disaster monitoring data exchange platform, an historical data clearinghouse for disaster events, and automatic data tools for disaster information generation. A global disaster monitoring data exchange platform is a cyber framework for monitoring disaster data exchange and management. It can serve automatic data archiving and backup and data accessing control with provider-defined policies. An easy-to-use portal will be developed for end users to find and access data. It can

also support and be connected with national and international disaster reduction activities. Another important part of disaster data management is building an historical data clearinghouse for disaster events. The clearinghouse will provide a technical framework to index distributed disaster data both regionally and globally. Data can be self-registered and managed by any data provider, to share what they want. It has a light central database, metadata harvesting only, no dataset replication and can automatically deal with multidisciplinary data in any format, even unstructured records. And automatic data tools for disaster information generation are especially important for near real-time disaster mitigation. Its objective is to develop intelligent generation algorithms for every kind of disaster information. Its main components includes uniform description and registration of these algorithms, data-driven decision (DDD) computing framework, calibration and validation (accuracy ) and online disaster mapping (thematic map).

## **GEOSS Architecture for the Use of Satellites for Disasters and Risk Assessment**

### **Pakorn Apaphant**

*Working Group on Information Services and Systems (WGISS), Committee on Earth Observation Satellites (CEOS)*

WGISS is one of CEOS' Working Groups. It aims to stimulate, coordinate, and monitor the development of the systems and services which manage and supply the data and information from participating organizations' missions. Thus, WGISS aims to address the needs of data providers by improving their efficiency of operation and maximizing the usefulness and benefit of the EO data, which they gather. WGISS also addresses the needs of data and information users by aiding the development of simpler and wider access to the resources they require.

The WGISS GEOSS Architecture for the use of Satellites for Disasters and Risk project proposal was approved in June 2011. The project leads are soliciting WGISS member participation to collect and evaluate existing GEOSS documents related to the needs of GEOSS users and providers of satellite services for use in response to disasters and risk assessments. WGISS will jointly work

with the CEOS Disasters SBA team to develop the GEOSS enterprise architecture for managing distributed systems and web services for disaster management. The use of satellites, sensors, models, and associated data products to support disaster response and risk assessment will be addressed. An enterprise perspective for managing distributed systems and web services for disaster management will be described. The GEOSS building blocks and how they are composed. The role of information systems and services in support of disaster management and risk assessment will be addressed. Enterprise architecture shall be used to guide implementation of proof-of-concept prototypes. Members will identify potential resources and prototype development to address the needs of disasters management and risk assessment relating to societal benefits, and leverage the capabilities of WGISS participating agencies.

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## **Role of Cyberinfrastructure in Disaster Mitigation, Research and Education**

### **Carol Song**

*Purdue University*

The rapid advancement in the collection of environmental data, geospatial analysis and modeling software in recent years is enabling us to look at new and more effective ways of studying and mitigating natural disasters and their impact on people's lives. The need for large scale, real-time, integrated and coordinated data and analysis activities, often across distant geographical areas, is evident and becoming feasible

with the latest technologies. This presentation will describe the development and challenges of cyberinfrastructure to support disaster data management and sharing, integrated data and modeling. Analysis of needs and examples of tools and platforms from the earthquake engineering and drought research communities will also be discussed.

## Poverty, Vulnerability, and Resilience

**Evans Jaddote**

*Universitat Autònoma de Barcelona, Facultat d'Economia i Empresa*

The dual causality between poverty/vulnerability and natural hazards-related disasters seems to be a well-established fact. Extreme natural events exacerbate poverty and vulnerability, while the latter often determines whether hazardous events (both natural and anthropogenic) will turn into disasters. The exact direction of this dual causality is quite difficult to disentangle. What is irrefutable however is that natural hazards-related disasters lay waste past performances in terms of social and economic development, jeopardizing future development prospects and the advances made toward the Millennium Development Goals (MDGs). As stated in the third research objective of the IRDR Science Plan, reducing risk and curbing losses through knowledge-based actions

will be an imperative for the rise of more resilient communities compared to their pre-disaster conditions. This is particularly crucial for less developed countries (LDCs) if we want to preserve small gains towards development. Such an objective can be best addressed if risk management is mainstreamed into countries' efforts to bring sustainable living standards to their populations, otherwise development efforts will be in vain. The present document proposes an analysis of how to best address the issue of mainstreaming risk management into broad poverty reduction plans to avoid the non-poor vulnerable from slipping into poverty while making the poor more resilient when hazardous events hit.

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## Disaster Risk Insurance in Iran and Building Insurance Risk Index

**Mohsen Ghafory-Ashtiany<sup>1,2,3</sup>, Kiarash Nasseradi<sup>4</sup>**

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*3. Chairman of IASPEI Earthquake Strong Ground Motion, Hazard and Risk Commission*

*4. Assistant professor, Zanjan University, Zanjan, Iran*

Iran, with high exposure to seismic risk, has experienced high property losses in the past decades stemming from the vulnerability of the built environment, rapid population growth and seismically-incompatible urban development. Despite the fact that voluntary earthquake insurance has been offered by insurance companies in Iran since 1992, in practice the government, by providing reconstruction funds to those who have lost their properties, has acted as free insurer to private and public owners. To change this trend and use insurance as an effective risk transfer mechanism, Article 5 of the "Natural Disaster Risk Reduction Strategy of Iran" was approved. It states, "Develop an effective system for financial recovery and compensation through insurance, financial incentives, and supporting funds; as well as promoting and regulating financial incentives for the general public and integrating earthquake risk insurance into the construction process".

As the first step, the Iran Central Insurance Authority has

requested the author to revise the Building Loss Index to be used as a base for earthquake insurance premium calculation. This paper presents the mean annual loss zonation for different building typology in Iran. To do this: 1) The earthquake hazard model of Iran has been modified based on latest information on seismic sources and seismicity to obtain an earthquake hazard curve for 328 cities of Iran; 2) The updated building inventory and its classifications has been obtained; 3) 27 building types have been identified according to the construction material, year of construction and number of stories; 4) The fragility function has been assigned according to the available information; 5) The mean annual loss of each building type has been evaluated for each city provinces. Based on the obtained results, the cities were categorized into five hazard zones and the mean annual loss for each building type in each zone was calculated.

## Modelling the Economic Effects of Disaster Risk in Nepal

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The economic and developmental impacts of disasters in Nepal have been reported to be significant, although there is very little quantitative evidence, and no economic modelling involving disaster risk has been done on Nepal. In collaboration with modellers of hazard, exposure, vulnerability and risk, we develop an approach for modelling the indirect risk of disasters to Nepal in terms of potential macroeconomic impacts. Our analysis discusses aggregate as well sectoral consequences of disaster risks and impacts. This paper discusses (i) the quantification and modeling of economic disaster risk for Nepal; (ii) incorporating disaster risk management into fiscal and development planning; and (iii) assessing the economic consequences of large-scale events for Nepal. This work has been part of a developing a risk model for Nepal that may help to inform decisions and the development of effective risk management strategies. The analysis shows that the economic and fiscal risks posed by natural disasters are large for Nepal, and there is a clear case for specifically considering these impacts in economic and fiscal

planning. Particularly, earthquake risk can lead to large fiscal and economic impacts. When factoring in disaster risk and considering a 10-year planning horizon, budgetary resources may be about 30% lower compared to a case without consideration of disaster risk. As well, when using a social accounting matrix approach to derive intersectoral linkages we find large events, such as of the size of the 1934 earthquake, to lead to substantial (20%) reductions in GDP due to cross-sectional linkages across primarily unaffected sectors such as agriculture. We end with expressing caution when interpreting model results. Those are necessarily associated with considerable uncertainties, which to some extent were captured by us, where possible, using sensitivity analysis. These large uncertainties need to be factored in and before attempting to derive very specific policy recommendations in terms of implementing risk management, options would need more addressing and discussion with key experts and stakeholders.

Keywords: Macroeconomic risks, Distribution, Nepal

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## Disaster Risk Insurance in Iran and Building Insurance Risk Index

Mohsen Ghafory-Ashtiany

President of Iranian Earthquake Engineering Association (IEEA)

The presentation will explore why understanding insurance is a critical dimension for advancing the three research objectives in IRDR's science plan – hazard assessment, decision-making and risk reduction.

Insurance is the business of managing risk. It is also a primary mechanism used by homeowners and businesses in developed countries to manage disaster risk. Insurance is a small part of risk management in developed countries, but a number of international efforts seek to secure an increased role for insurance.

Insurance is the largest industry in the world, with premium revenue in excess of US\$3 trillion a year. It is a mature industry, as it has been operating in a largely similar form for several hundred years. Also it is a highly competitive market, with many companies active competing in most established markets.

The foundation of insurance is risk assessment. Insurance companies are willing to accept the transfer of risk from others if

they can measure the risk of loss and secure an adequate price. Information used by insurance companies to assess the risk of loss includes company loss experience combined with an assessment of public data on perils like earthquakes, flood and severe weather. Companies like Munich Re and Swiss Re share insurance loss data for disasters, and this information supports hazard assessment by a broad range of stakeholders around the world.

Insurance is also an important mechanism to help decision-makers manage disaster risk. Insurance helps to identify risks. It also puts a price on the risk of loss, information that is used by decision-makers to determine the relative importance of each risk within the broad range of risk that they must manage.

Insurers also champion risk reduction at the local, national and international level. They work directly with clients to identify and support loss prevention. Investments in loss prevention are typically rewarded by lower premiums.

## Long- and Short-Range Forecasting of Volcanic Eruptions

**A.Ratdomopurbo, C. Newhall**  
*Earth Observatory of Singapore*

Every volcano has its own characteristics. Some erupt frequently and others sleep for long periods between eruptions. Some produce explosive eruptions and others erupt effusively.

The main task in the assessment of volcanic hazards is to anticipate the type of activity of a volcano in the future. Each volcano tends to have its own pattern of behaviour, in terms of eruption style, magnitude and frequency. By studying the eruption history of a volcano, we can start to forecast its future eruptions. Volcanic hazard maps outline the extent of all possible hazards posed by the volcano.

An eruption is the final step of magma ascent to the Earth's surface. Volcanoes usually provide warning signs (precursory signals) weeks, months or years prior to an eruption. Movement of magma in the "plumbing system" can be monitored by geophysical and geochemical instruments.

Monitoring also tells us when a volcano will erupt and, in some cases, how big that eruption might be. Thus, understanding a volcano's past and having a good monitoring system are keys to successful eruption forecasts.

Eruption forecasts in the order of days and hours are still difficult to achieve, so alert levels are applied during times of crisis. Alert levels warn populations living near the volcano by indicating the state of the volcano, based on indicative unrest. The World Organisation of Volcano Observatories, WOVO, is compiling collective, worldwide volcano monitoring experience into a web-accessible database (WOVOdat) that can be consulted during new crises. Linked with the Smithsonian's database of historical eruptions, WOVOdat will show details of thousands of episodes of unrest, and whether or not each episode led to eruption. All of this effort is part of volcanic hazard management, to prevent loss of life and property from the next eruption.

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## Forecasting and Warning of Tropical Cyclones in China

**Jing Xu**  
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China is one of the most-affected countries in terms of typhoon landfalls and typhoon-induced disasters. Each year there are about 28 tropical cyclones formed over the Northwestern Pacific Ocean and South China Sea, and about 7 tropical cyclones (above tropical storm category) make landfall over China. Typhoons bring disasters such as gales, rainfall and storm tides more than other weather systems, and bring a huge amount of damage to human beings, national treasures and industrial and agricultural production. On the other hand, the rain caused by typhoons can displace or weaken large-scale droughts. Hence, forecasting and warning of typhoons are significant in the China Meteorological Administration (CMA).

The National Meteorological Center (NMC) of CMA is the main release and service center in China's typhoon forecasting and warning operations. It takes charge of monitoring typhoon and releasing warning services in the Northernwest Pacific and South

China Sea, and the global marine security and disaster system (GMDSS) in the XI region covered by the Indian Ocean Satellite. It supplies decision-making information for the government and prevention agencies. It provides public service to the common people and guides the regional coastal bureaus.

Disaster prevention and mitigation, strengthening and expanding services, and improving service efficiency are the main tasks of the National Meteorological Center. Meanwhile, NMC actively carries out exchanges and cooperation with the media and press, and supplies information to the general public about basic typhoon knowledge and the measures of disaster prevention and mitigation in order to improve the public defense capabilities during typhoon disasters. They always rely on modern science and technology to continually improve typhoon forecasting services. The typhoon weather service in the field of disaster prevention and mitigation China has achieved good economic and social benefits.

## **Building an Enhanced Drought Early Warning System: Contributions and Collaborations Toward a Global Drought Early Warning System**

**Mark Svoboda**

*Climatologist, Monitoring Program Area Leader  
National Drought Mitigation Center (NDMC)  
University of Nebraska-Lincoln, School of Natural Resources*

No other hazard lends itself as well to the need for a diligent early warning system than drought. The fact that droughts typically evolve slowly (and can have very large geographic footprints) when compared to other hazards like hurricanes, tornadoes and floods means that a diligent watch system is essential. The U.S. took its first steps in 2006 toward developing a coordinated and integrated drought early warning system (DEWS) through the creation of the National Integrated Drought Information System, or NIDIS. More recently, the National Drought Mitigation Center (<http://drought.unl.edu>) has been collaborating with NIDIS and other international partners (World Meteorological Organization, GEO, the United Nations, etc.) with a goal of developing a virtual and comprehensive global drought early warning system (GDEWS).

The NDMC's mission is to work to reduce societal vulnerability to drought by helping decision makers at all levels to:

implement drought early warning systems, understand and prevent drought impacts and increase long-term resilience to drought through proactive planning. The NDMC is a national center founded in 1995 at the University of Nebraska-Lincoln. The NDMC conducts basic and applied research along with the maintaining of a number of operational drought-related and outreach activities, including the U.S. Drought Monitor (USDM), Drought Impact Reporter (DIR) and the Vegetation Drought Response Index (VegDRI).

This presentation will describe in more detail the various drought resources, tools, research efforts, services and collaborations already being provided by the NDMC and its partners along with a look at what is coming down the road in helping others toward developing drought early warning systems in the U.S. and around the world.

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## **Community Preparedness for Natural Hazards: Cross Cultural and Cultural Perspectives**

**Douglas Paton**

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To reduce the risk of loss and destruction from natural hazards, a prominent risk management strategy is encouraging people to prepare in ways that reduce their risk and increase their capacity to cope with, adapt to, and recover from hazard impacts. Despite extensive efforts to do so, levels of hazard preparedness are often low. This paper proposes that a significant reason for this has been the incorrect assumption that just providing people with information on risk and its management is sufficient to motivate them to prepare. It is argued that preparedness is a function of both people's ability to interpret and make sense of hazards and the implications they have for them and their beliefs about the sources of information that is independent of the information provided. This argument is supported by discussing the testing of a model that describes how interpretive processes at person (outcome expectancy) and community (community participation, collective efficacy) levels and people's relationship with civic risk management agencies (empowerment, trust) interact to explain differences in levels of hazard preparedness. The cross-cultural

validity of the model is demonstrated by comparing data from New Zealand, Indonesia, and Japan. Testing the model across countries and hazards (e.g., earthquake, volcanic hazards) supports its all-hazards and cross-cultural applicability. By demonstrating cross cultural equivalence in hazard preparedness, the ability of the model to provide a basis for collaborative learning and research between countries and provide risk management agencies in different cultures with access to a wider range of risk management options is discussed. Finally, by identifying the significant role people's normal social networks play in motivating hazard preparedness, the paper concludes by discussing how the effectiveness of public hazard education strategies designed to promote community preparedness can be increased by integrating risk management activities with community development strategies.

Keywords: Natural hazards, Resilience, Sustainability, Preparedness, Culture

## Climate Capacity as an Indicator for Adaptation Planning

**Jiahua Pan, Yan Zheng**

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In dealing with climate disasters and risks, focus is often kept on adaptation-related capacities, such as carrying capacity, ecological capacity, and environmental capacity. However, all these capacities are derived from climate capacities, which are determined by one or two climate indicators, such as temperature and rainfall. Derived capacities can be enlarged or shrunk by human activities such as technologies and investments, but climate capacities are independent of human interventions in general, but can be reduced by improper human interventions. Adaptive actions can change derived

capacities but such change must be constrained by the absolute climate capacity. For instance, rainfall determines natural productivity at a given temperature. If derived capacity cannot meet social and economic demand, excessive derivation of capacities can shrink natural climate capacity. Under such a situation, climate risks and disasters are deemed to be more frequent and more severe. The result would be concerns over climate security like climate refugees and migration. A conclusion is drawn that climate capacity must be taken as a key indicator for climate adaptation planning.

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## The Role of Multidisciplinary Research and Collaboration for Improving the Resilience of Communities to Natural Hazards

**David Johnston<sup>1</sup>, Graham Leonard<sup>1</sup>, Emm<sup>1</sup> Hudson-Doyle<sup>1</sup>, Julia Becker<sup>1</sup>, Douglas Paton<sup>2</sup>, Kevin Ronan<sup>3</sup>, Bruce Houghton<sup>4</sup>, Chris Gregg<sup>5</sup>, Shane Cronin<sup>6</sup>, Tom Wilson<sup>7</sup>, Carol Stewart<sup>1</sup>, Jan Lindsay<sup>8</sup>, Gill Jolly<sup>9</sup>, Sally Grant<sup>1</sup>, Victoria Sword-Daniels<sup>10</sup>**

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*10. Civil Environmental and Geomatic Engineering, University College London, United Kingdom*

Over the last few decades it has been recognized that integrated multi-disciplinary research is needed to provide an understanding of the social, economic and cultural factors that influence the development of strong communities, resilient to the impacts of natural hazards and able to respond effectively when events occur. The benefits of a multi-disciplinary approach include: (1) improvements in governance structures and processes, such as policy and legislative frameworks, planning (including land use), governance institutions and leadership; (2) identification of the characteristics that make people, communities, organizations, and other social structures resilient, and the impediments that prevent it; (3) improvement in emergency management and disaster relief procedures and processes; (4) more efficient and effective recovery after an event; and (5) improved uptake and value of hazard related research investment. Other less direct benefits

include: (6) the capture of emerging trends (e.g., how an aging population effects community resilience and what this means for research and policy); (7) a better understanding of the relationship between economics, resilience and recovery; (8) an assessment of the impact of hazards on society (including social, economic, environmental, cultural impacts); (9) a better understanding of vulnerability and how society perceives its own vulnerability; (10) strengthening the evidence-base at the research/policy interface; and (11) a better understanding of the linkages between the stakeholders, frameworks and institutions. In this paper we discuss the importance of multi-disciplinary research to enhance community education programs and emergency response, and highlight examples of programs that are utilizing this approach to address these issues at national and international levels.

## **Integrating Knowledge and Actions in Decision-Making for Disaster Risk Reduction: A Road Map**

**JC Gaillard<sup>1</sup>, Jessica Mercer<sup>2</sup>**

*1. School of Environment, The University of Auckland, New Zealand*

*2. Oxfam Australia*

A large amount of studies have been produced on disaster related issues over the last century yet there continue to be gaps in decision-making for disaster risk reduction (DRR). This presentation discusses the battlefield of knowledge and action for DRR, outlining a road map for a more integrative process consisting of bottom-up and top-down actions, local and scientific knowledge, and a vast array of stakeholders (Fig. 1). It emphasises key issues in addressing the need for an

integrated process. These refer to challenges for integrating knowledge, the predominance of technocratic institutional frameworks, and the lack of tools enabling dialogue between diverse stakeholders. The presentation leads to three suggestions for bridging the gap, including the need for consensual tools, practical frameworks for integrating different forms of knowledge, and alternative national policies for integrating knowledge and action into decision making.

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## **Integrated Approach to Landslide Risk Management**

**Raymond K.S. Chan**

*Geotechnical Engineering Office, Civil Engineering and Development Department, Hong Kong SAR Government*

Landslides pose a significant threat to many communities in different parts of the world. To effectively manage landslide risk, a multi-prong approach should be adopted. It would comprise a suite of measures ranging from land use planning, engineering works, community engagement, to provision of early warning and emergency services. These would require knowledge and skills in natural science, earth science, engineering science and social science. As the majority of landslides are triggered by severe rainfall, input from meteorologists in weather forecasts and rainfall monitoring would allow early warning of landslide hazards. The assessment of severe rainfall scenarios associated with climate change would permit formulation of an effective landslide emergency preparedness plan. How to evaluate landslide susceptibility from rainfall requires specialist input

from earth scientists. The process would involve geological, geomorphological and hydrogeological assessment. This is essential for landslide hazard assessment and land use planning. Engineering knowledge is inevitable in the implementation of retrofit and mitigation works programmes, vetting of the engineering design of new works and setting of geotechnical standards. For the soft part of landslide risk management such as public education, evacuation of people at risk and provision of temporary shelter, good social science skills would greatly facilitate the work. This paper will discuss an integrated approach to landslide risk management and illustrate the approach with examples from Hong Kong's experience.

Keywords: Landslide risk management

## Natural Hazard Risk Assessment in the Australasian Region: Informing Disaster Risk Reduction and Building Community Resilience

**John Schneider, Jane Sexton**  
*Geoscience Australia*

Effective disaster risk reduction is founded on knowledge of the underlying risk. While methods and tools for assessing risk from specific hazards or to individual assets are generally well developed, our ability to holistically assess risk to a community across a range of hazards and elements at risk remains limited. Developing a holistic view of risk requires interdisciplinary collaboration amongst a wide range of hazard scientists, engineers and social scientists, as well as engagement of a range of stakeholders. This paper explores these challenges and explores some of the common and contrasting issues sampled from a range of applications addressing earthquake, tsunami, volcano, severe wind, flood, and sea-level rise from projects in Australia, Indonesia and the Philippines.

Key issues range from the availability of appropriate risk

assessment tools and data, to the ability of communities to implement appropriate risk reduction measures. Quantifying risk requires information on the hazard, the exposure and the vulnerability. Often the knowledge of the hazard is reasonably well constrained, but exposure information (e.g., people and their assets) and measures of vulnerability (i.e., susceptibility to injury or damage) are inconsistent or unavailable. In order to fill these gaps, Geoscience Australia has developed computational models and tools which are open and freely available. As the knowledge gaps become smaller, the need is growing to go beyond the quantification of risk to the provision of tools to aid in selecting the most appropriate risk reduction strategies (e.g., evacuation plans, building retrofits, insurance, or land use) to build community resilience.

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## Cost-Benefit Probabilistic Ratio of Seismic Retrofitting

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To reduce seismic risk it is necessary to carry out structural reinforcements that can imply significant costs. A methodology for evaluating the probability distribution (PDF) of the cost-benefit ratio (B/C) is developed—a ground-breaking tool to analyze the net benefits of risk mitigation measures, such as earthquake retrofitting and seismic code enforcement. An analytical solution for the PDF of the net present value of losses (NPV(i)) is presented, verified using Monte Carlo. The

model and the derived tools are described based on three groups of public buildings in Bogota (education, health and administration). The analysis obtained the PDF for the NPV(i) for both the non-retrofitted and the retrofitted structures, allowing the determination of the probability that B/C is positive.

Keywords: Cost-benefit, Seismic reinforced, Risk mitigation, Vulnerability reduction

## Design and Implementation of Seismic Risk Insurance to Cover Low-income Homeowners by Cross-Subsidies

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This paper discusses how a catastrophe risk model based on metrics such as the Probabilistic Maximum Loss and the Average Annual Loss has been used to estimate, building by building, the probabilistic losses of different portfolios of exposed elements. It also explains how a risk transfer instrument to cover the private housing in Manizales, Colombia, was designed, promoting the insurance culture and covering the low-income homeowners through a cross-subsidy strategy. This instrument is a voluntary collective insurance promoted by the city administration and the

insurance industry, using the mechanism of the property-tax payment. The program provides financial protection not only to the estate-tax payers but also to the low-income homeowners that cannot pay the tax due to their income limitations. This collective insurance helps the government to access key resources for low-income householder recovery and improve disaster risk management at the local level.

Keywords: Seismic risk, Insurance instruments, Catastrophe risk model, Probable maximum loss, Expected annual loss, Risk premium

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## The Need for Data – Natural Disasters and the Challenges of Loss Data Collection and Management

Angelika Wirtz

Head of Munich Re NatCatSERVICE

Year after year, tens of thousands of people are killed in natural catastrophes, and many millions lose all their possessions. Since 1980, more than 2 million people have been killed throughout the world in natural disasters. With two-thirds of the fatalities, Asia is the worst-hit continent in this respect. Regarding the frequency of natural loss events, NatCatSERVICE, Munich Re's global loss database, confirms that the number of natural catastrophes has been increasing continuously since the 1980s. The annual average number of events in the last ten years has reached 780.

Loss data relating to current and historical natural catastrophes can be used for a whole variety of analyses and purposes, and are needed by numerous scientific institutes, researchers, government agencies, UN and EU organisations and NGOs, as well as the insurance and financial sectors. To ensure that detailed, high-quality analyses can be performed, the data must be collected and managed with high expertise

and professionalism. The methods employed for acquisition of the data and for assessing the damage must be consistent over the entire period and transparent for the party using the data. It is important that global and national database operators must follow internationally recognised standards.

Disaster loss data are necessary to improve integrated disaster risk management. In this respect the IRDR Working Group on Disaster Loss Data has identified the following projects: identification what data and quality are needed to improve integrated disaster risk management; bring together loss data stakeholders and utilize synergies; have recognized standards, minimize uncertainties; education of users regarding data interpretation and data biases; ensure increased downscaling of loss data to sub-national geographies for policy makers; and a definition of "losses" and creation of a methodology for assessing it.

## Global Loss Databases, Methodologies, Uncertainties

### Regina Below

*Centre For Research on the Epidemiology of Disasters - CRED*

There are currently 3 global disaster losses databases in the world, of which one was created in 1988 and is managed by the Centre for Research on the Epidemiology of Disasters (CRED) at the catholic University of Louvain in Brussels. The EM-DAT database contains core data on the occurrence and impact of over 18,000 disasters in the world from 1900 to present. It has become one of the unique global reference datasets, mainly due to its methodological consistency and comparability over time and space. One of the major current challenges in the field of disaster data is to overcome the limitations induced by the lack of clear standardized collection methodologies and definitions, which leads to inconsistencies, data gaps and poor interoperability of different disaster data compilation initiatives. This leads to confusion in the evaluation of a disaster situation and poses severe obstacles for prevention and preparedness planning. Furthermore, ambiguities exist regarding the intent behind the reporting

of the data, start and end dates and changing national boundaries and the loose definition of people affected. Information is not specifically gathered for statistical purposes and so, inevitably, even where compiling organizations apply strict definitions and parameters, the original suppliers of the information may not. Information systems have improved vastly over the last 30 years and statistical data is now more easily available. However, the lack of systematic and standardized data collection from disasters in the past is now revealing itself as a major weakness for any long term planning. Despite efforts to verify and review data, the quality of disaster databases can only be as good as the reporting system that feeds them. CRED has militated for years for the creation of internationally recognized standards and definitions and has lead over the last years several such standardization initiatives with institutions such as MunichRe and UNDP.

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## National and Local Databases: Implementation in Decision Making Processes

### Carlos Villacis

*Coordinator, Global Risk Identification Programme (GRIP)*

Only by understanding the past is it possible to prepare for the future. Every country has a long history of disasters from which they can learn about their most disaster-prone areas, their vulnerabilities, their recovery capacities, the cumulative impact of those disasters on the development processes and gains. Most importantly, people can learn about the causes of the disaster and then take the necessary actions and measures to reduce their vulnerability to future events.

There are many institutions, organizations, governments, and sectors already collecting information on disaster losses. Unfortunately, most of these efforts have been isolated endeavors that are not necessarily performed in a systematic way. There is a clear need to homogenize methodologies, standardize concepts and guide applications of disaster loss information. UNDP, through the Global Risk Identification Programme, GRIP, is assisting countries in their efforts to learn

from the past by supporting the establishment of National Disaster Observatories that utilize standardized methodologies and implement strict quality control mechanisms that ensure the reliability of the compiled information.

GRIP is also promoting and supporting the development of standards for disaster data collection that improve compatibility and integration capabilities of valuable disaster information that is being currently generated. Working in collaboration with key institutions and experts, representing both the generators of information and its end users, GRIP is trying to develop better ways and tools to learn from the past, and extract valuable lessons and apply them in sound decision making. It always should be kept in mind that compiled information is valuable only when it effectively contributes to the final goal of reducing the negative impact of natural hazards on communities and on their development.

## Usage of National Disaster Loss Data in the Global Assessment Report

**Julio Serje**

*United Nations International Strategy for Disaster Reduction UNISDR*

GAR 2011 uses comprehensive National Disaster Loss databases to present evidence about the behavior of risk in developing and developed countries today, and showcases specific applications that demonstrate the usefulness of loss data in assessing risk and in decision making within Governments.

'Extensive' and 'intensive' risks are relative terms, but the first term could be associated with frequently occurring, low and medium intensity disasters that are spatially spread, while 'intensive' disasters are those infrequent, high intensity and very spatially-concentrated disasters.

The past 20 years have seen an exponential increase in the number of local areas reporting losses such as the number of houses damaged, the number of hectares of crops affected, roads destroyed, and the damage to health and educational facilities associated with extensive disasters.

Increasing extensive risk is closely related to the challenges low- and middle-income countries face in addressing

underlying risk drivers and reducing vulnerability. GAR 11 shows how the contribution to economic damage of extensive risk disasters is substantial, reaching or surpassing the mark of 50% of the total losses in several sectors.

Conducting a comprehensive risk assessment and systematically accounting for disaster losses do not guarantee that governments will invest more. They can, however, encourage governments to take ownership over their stock of risk and identify strategic trade-offs when making policy decisions for or against investing in DRM.

Although economic costs and benefits are never the only criteria for investment, making these trade-offs transparent offers two significant advantages for governments. They would then be able to assess the liabilities implicit in the full spectrum of risk in their country, important for fiscal and fiduciary planning, and make more informed decisions concerning the most cost-effective portfolio of risk management and financing strategies.

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## Climate Change and Migration - Evidence and Policy in Northern China

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The relationship between climate change, environmental degradation, and migration has been explored in recent decades. In China, climate and migration have long been observed, but climate change has not been considered as a direct, driving factor of migration, even in ecologically sensitivity areas. In many cases, migrants displaced for climatic or environmental reasons are improperly called ecological migrants, which should refer to those who have been forced to move away from their original settlements for the sake of ecological conservation. Emigrants displaced by ecological conservation should be compensated for their losses. On the contrary, climate-induced migration could be forced by a long term event (sea level rise, drought) or a surprise or extreme event (flooding, typhoon, wild fire), and the migration might be short term, long term, seasonal or circular in different context and cases. Those migrants would not be compensated by government, but supported by disaster relief

and/or resettlement projects.

Take Ningxia as a typical example. Since the 1980s, its mountainous southern region has suffered so much from drought and poverty that the government has subsidized more than 600 thousand rural residents to move out to the middle and northern areas where they can get access to the Yellow River for irrigation and drinking. The key driving factor has been attributed to increasing conflicts among the population for natural resources, such as land area and water, which shadows the impacts of climate change on those migrants. With field work and social investigations, we found clear evidence that increasing drought and extreme weather events worsen the livelihood in the southern area. The research also gave some suggestions to improve the existing migration, social, and other policies.

Keywords: Climate change, Migration, Vulnerability, Drought, Policy

## Applications of Precis for Assessing Extreme Climate Events

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Based on recent climate change research, one of the many dangers of global warming is the predicted propensity for rising temperatures to produce more frequent, more severe and more lasting weather extremes almost everywhere on earth. Many extremes and their associated impacts are now changing. For example, in recent decades most regions in China have been experiencing more unusually hot days; heavy snowfall has also become more frequent and intense;

droughts are becoming more severe in some regions. This talk focuses on extreme climate events and how the occurrence of these events is expected to change over China in the decades to come. The study starts with an analysis of how extreme climate indices have changed over the past few decades and then discusses the results from a downscaling effort based on the PRECIS Regional Climate Model and provides downscaled, future climate projections for key climate indices.

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## How Do Climate-Related Disasters Exacerbate Poverty?

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Climate-related disasters have intensified because of more and more frequent occurrences of extreme weather/climate events related to global warming. Poverty is likely to be exacerbated in the more environmentally vulnerable areas, where the fragile ecosystem and social infrastructure would be easily damaged due to intensified climate-related disasters.

Take China for example, where impoverished areas are closely linked with environmental vulnerability. It is shown that the distribution of poverty and ecological fragility are geographically coherent. Among the inhabitants living in the ecologically fragile zones, 74% reside in poverty-stricken counties, accounting for 81% of the whole population in poverty.

Three high-poverty counties in three typical regions were selected for case studies:

- 1) Yongjing County, Gansu Province, northwestern China. Since the mid-1980s, the frequency of droughts has significantly increased with warming and decreased precipitation.
- 2) Mabian Yi Autonomous County, Sichuan Province,

southwestern China, which has suffered from intensified geological hazards with more frequently occurring storms since 2000. The direct economic loss has reached ~24 million RMB per year.

3) Yangshan County, Guangdong Province, southern China. Temperature increases and variability of precipitation due to climate change led to alternating appearances of droughts and floods as well as freezing rains and snowstorms.

Though China's government has made great efforts to alleviate poverty, to some extent the process of poverty reduction is hampered by climate-related disasters. In some cases, poverty returned due to these frequent climate-related disasters. It seems that poverty reduction efforts will become much harder in the future with inevitable climate change, so integrated assessments on future climate-related disaster risk are necessary to support proper actions for incorporating climate change adaptation with poverty reduction to ensure the elimination of poverty in China.

Keywords: Climate change, Disaster risk, Ecological vulnerability, Poverty reduction

## Science in the Context of Advice: Volcanic Risk Assessments on Montserrat

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Providing advice during volcanic eruptions can put a great deal of social and political pressure on scientists, which is compounded by the inherent challenges of predicting or forecasting volcanic activity. A survey of volcanologists in 2008-2009 revealed that many are unsure of their responsibility in providing advice about evacuations, and interviews further confirmed that the dependence on science for political decisions can be very high, which renders scientists vulnerable to criticism if evacuations are not well managed, or are perceived as unnecessary. The underlying assumptions of models may be questioned by non-experts, but the models may represent the only information available about the volcanic system. This raises a range of questions about the use of scientific methods in decision-making.

The Soufriere Hills Volcano on Montserrat in the West Indies started to erupt in 1995, and episodic activity has continued since then. The capital city, Plymouth - which was the centre

of island life - was completely destroyed. Two-thirds of the population left the island, and two-thirds of the land remain inaccessible due to volcanic hazard. The scientific response to the eruption has been impressive, resulting in an increased understanding of andesitic volcanism, and the development of risk assessment tools for use in a volcanic crisis. This paper will use examples from Montserrat to discuss the implications of the social context of science for its processes and particularly its framing; while the importance of social sciences in managing eruptions has been noted repeatedly, its integration with scientific method is currently very limited. Pathways will be suggested for better communication between social and physical scientists, particularly in the context of international networks for disaster reduction.

Keywords: Volcanic risk, Disaster reduction, International networks, Social sciences, Modelling

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## The Case of Istanbul: Are Decision Makers Actually Making Their Decisions Based on the Findings of the Scientific Community?

Funda Atun

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The 1999 Kocaeli Earthquake is the fault line between the past and future of disaster risk perception in Turkey. The damage of the 1999 Kocaeli earthquake was quite high, because of the accumulation of mistakes before the event. After its occurrence these mistakes were clarified and argued by scientists, the public, media and governmental bodies. Four years after the Kocaeli Earthquake “the Istanbul Earthquake Master Plan” was issued in July 2003 by collaboration of four universities. Six years after the acceptance of the “Istanbul Earthquake Master Plan”, the “Istanbul City Master Plan”, which especially indicates the new development areas, was issued in March 2009. In this research, these two plans are compared to understand whether the decisions given

by scientific communities are taken into consideration by decision makers in municipalities and the government. The questions raised are “Can perception changes be seen in the implementation of projects?” and “Are decision makers actually making their decisions based on the findings of the scientific community?” By aiming to answer these questions, the two master plans “Istanbul Earthquake Master Plan” and “Istanbul City Master Plan” are analysed in terms of the given development decisions and transportation improvements to find proper answers to research questions.

Keywords: Earthquake master plan, Disaster risk management, Implementation

## **Spatial and Sectoral Impact Analysis on Farm and Rural Non-Farm Organisations Following the 4 September 2010 Darfield Earthquake, New Zealand**

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Rural organisations were impacted by the Mw 7.1 Darfield earthquake in a variably distributed, sector-specific manner. This research presents the findings of perishable impact data collected from farm and rural non-farm organisations proximal to the surface expression of the Greendale fault. Two months following the earthquake, organisations were sampled along five 25 km-long transects running perpendicular to the fault trace. Spatial and sectoral differences were observed and compared to the level of impact reported by participating organisations. The results from this research catalogue the physical damages to affected organisations, sectoral-level vulnerabilities to earthquake-related impacts, reasons for business interruption, and the factors that helped organisations mitigate the effects of the earthquake. The majority of sampled organisations identified the disruption of electricity to be the most disruptive element of the earthquake. While most organisations saw no changes to their revenue,

the majority of organisations that saw revenue decreases were rural non-farm organisations. Rural non-farm organisations also reported closure lengths of 5 days on average. Affected organisations found that critical services being restored quickly or not interrupted was the second most helpful factor in mitigating the effects of the earthquake, following well designed and well-built buildings. Farm organisations found the largest challenges to be lifeline disruption and structural repairs. Alternatively, rural non-farm organisations were more challenged by staff concerns, maintaining cash flow, decreases in revenue and fewer customers. The 4 September earthquake impacted farm and rural non-farm organisations in different areas of business, and identified unique sectoral vulnerabilities for both groups.

Keywords: Earthquake, Darfield, Canterbury, Organisation, Sectoral

## **Drought and Disaster in Central America: Perceptive and Scientific Misinterpretations and the Search for Root Causes in Ongoing Territorial Processes**

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Central America has faced severe drought in recent decades. The magnitude of the crisis associated with drought is expressed in rural malnutrition, which has led to a downgrading of the state of public health, including at times, death from starvation; significant economic losses in the agriculture sector; and noticeable and recurrent disruptions of the flows and dynamics in urban and rural areas with regard to such things as energy, food, water and sanitation. A more paused reflection and explanation of drought which goes beyond a consideration of hydric deficits and impacts suggests that the drought crisis in Central America is far more complex and idiosyncratic.

The paper will attempt to demonstrate that the crises linked to drought are the result of determined territorial processes that have been little studied and many times misunderstood and that are very closely related to failed “development” initiatives. A conceptual and empirical debunking, using risk reduction

theory and statistical information on climate is proposed. Concepts and theory relating to the notion of drought and the way that it has been portrayed in the media and by technical agencies are provided. The paper leaves an “impact” focus on drought aside and focuses on the real significance of physical phenomenon as such and the social root causes of the disaster that it is many times associated with.

Structural development factors will be addressed and related to the broader context of the economic, social and political changes since the beginning of the 1990s. The major concern of the paper is to discuss crucial topics that must be addressed by the disaster risk reduction and development communities, cutting across the physical-social science divide. The paper will also propose a series of recommendations that seeks to close two major gaps: between the disaster risk reduction and development agendas; and between science and policy.

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## **Using Modis Ndvi Time Series to Identify Landslides in Vegetated Regions**

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The 2008 Wenchuan Earthquake caused massive landslides in mountainous regions with heavy casualties and property losses. Most of these landslides caused by the Wenchuan Earthquake occurred in vegetation-covered mountainous regions. Disturbances on vegetation can be detected using NDVI time series by identifying abnormal, sudden drops in NDVI values. In this paper, Pingwu County, an area in northern Sichuan Province heavily affected by landslides during the earthquake, is selected as a case study to investigate the efficiency of this method. Using MODIS MOD13Q1 NDVI

products from 2007 and 2008, landslides occurring in different periods were recognized in this study. To examine the accuracy of this method, ETM images with spatial resolution of 30 m taken shortly before and after the main shock were used to verify landslides identified by NDVI time series. Results indicate that landslides recognized from NDVI time series can have a good temporal profile distinguishing landslides induced by the main shock, aftershocks and heavy rainfall events.

Keywords: Landslide identification, NDVI time series, Temporal profile

## Extreme Seismic Hazards and Disasters: From Basic Science to Preventive Disaster Management

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Extreme seismic events (e.g., 1755 Lisbon, 1906 San Francisco, 1960 Chile, 2004 Aceh-Sumatra, 2008 Wenchuan, and 2011 Great East Japan earthquakes) are a manifestation of complex behavior of the lithosphere structured as a hierarchical system of blocks of different sizes. We will discuss how extreme seismic events can be studied using various scientific approaches including those developed in seismology and geodesy, and how the extreme events can be modeled. Although the lithosphere behaves as a large non-linear system, some integral empirical regularities emerge, indicating possibilities for earthquake prediction. Large earthquakes are

surprising, and society, as a matter of fact, is poorly prepared to deal with them. Protecting human life and property against earthquake disasters requires an uninterrupted chain of research and civil protection tasks: from understanding of physics of earthquakes, their analysis and monitoring, through interpretation, modeling, seismic hazard assessment, and earthquake prediction, to delivery of scientific forecasts to local authorities, public awareness, preparedness, and preventive disaster management.

Keywords: Extreme events, Disasters, Society

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## Barriers in the Science-Policy-Practice Interface Toward a Knowledge-Action-System in Global Environmental Change Research

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The paradigm of transdisciplinarity has evolved in environmental research due to a revised positioning of science in society. It labels a variety of approaches in which scientists, the public, and decision makers in policy and practice collaborate to generate not only scientifically reliable but also context-sensitive, socially robust and actionable knowledge. However, collaborative knowledge production in global environmental change research faces various challenges that affect the scientific credibility, political saliency, and practical relevance of the research results. The talk identifies some of the barriers in the science-policy interface and outlines factors

– social, structural, institutional – that inhibit the collaborative production of applied knowledge. Combining understanding from multiple sources and providing mechanisms for linking solutions proposed by research with articulated needs and problems of policy makers and practitioners would reduce the discrepancies in activities of different actors and result in more timely and context-appropriate solutions. It is argued that research efforts are more likely to be effective when they manage boundaries between knowledge and action in ways that simultaneously enhance the saliency, credibility, and legitimacy of the information they produce.

## Urban Risks and Disaster Planning: A Different Perspective

**R. Samuel Wittingham**

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For the first time in history, half of the world's population lives in urban areas. By 2030, at least 61 percent of the global population will live in cities. Over 2 billion of these people will be living in slums. The expansion of cities to accommodate such rapid population growth requires appropriate land-use planning, updated regulation of building standards, and improved disaster risk management.

Urban disaster risks from extreme natural hazards are compounded by both technological hazards and everyday urban risks. These everyday risks include, but are not limited to, populations switching en masse from living off wages to living off capital, and, an increased number of children being raised by a single parent or grandparent. Human activities such as these engender a process of "risk accumulation" that amplifies the disaster risks specific to urban areas.

Traditionally, urban risk identification and assessment looked at the structures and infrastructure of a community. However, the 2009 Global Assessment Report on Disaster Risk Reduction

lists unplanned urbanization, poor urban governance, and accelerated migration from rural areas or smaller cities as three main underlying factors accelerating urban disaster risk. Research supports moving the traditional disaster strategies for urban centers from a 'disaster response' mode to a 'risk reduction' mode. Unfortunately, this is not currently happening. Both public and private urban disaster risk research clearly identifies elements such as the lack of common approaches between agencies, geospatial data, land use, lifelines, and services to quantify vulnerability as issues that need to be addressed.

The challenge is to raise the issues of urban disaster risk to a new level of significance for local governments by integrating the substantial amount of public and private urban disaster risk research. The present investigation explores the disconnections between urban disaster risk research and the actual application and implementation of research findings.

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## Empirical Relationships between Development and Disaster

**Christopher M Lavell**

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In this paper we discuss models we are building and testing in order to establish a causal relationship between empirical human development and disaster risk indicators. To accomplish this, we propose modelling, on the one hand, historical disaster data from the largest global, regional, and national databases, and on the other hand, historical development related indicators from the many disparate sources that track this information using statistical, econometric and finance tools designed to infer causal relationships between latent variables. By establishing such a relationship between development and disaster risk we can then provide a context within which to analyse underlying risk drivers and vulnerability reduction measures to better inform decision makers at all levels.

Three modelling methodologies, as well as hybrids of these, are being considered: Structural Equation Models (SEM), Bayesian Networks (BN) and Systems Dynamics Models (SDM). All three require large datasets to reduce sources of

error and bias as well as a conceptual model mapped into the latent variables and relationships between these variables that the models will then analyse with the data. To take advantage of possible synergies, we propose the creation of a generic meta-database of disaster data, underlying risk drivers and demographic data that all of the different empirical/causal models can use. There are several key benefits to this approach: the framework for testing these models can be reused in the future by different or more refined models; by using time series data, the models can be validated by predicting risk for a period during which empirical data are available for validation; the models should produce similar results with differences that are explainable due to idiosyncrasies endemic to each of the particular methodologies, and if not, then we can explore the reasons that particular models failed, such as flaws in the original conceptual models.

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