World Conference on Disaster Reduction
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# KOBE REPORT draft
# Report of Session 4.8, Thematic Cluster 4

# Vulnerability of modern societies towards natural disasters – the impact on critical infrastructures

## 1. Summary of the session's presentations and discussions

The value of focusing efforts to enhance the resilience of infrastructure against extreme events (natural disasters, technological disasters, and acts of terrorism) has been long recognized, and has certainly risen in recent years following an increase in the threat from terrorism. Recent events such as the catastrophic earthquake and tsunami in the Indian Ocean reveal the extent to which societies are vulnerable to extreme events. They also reveal the need for a comprehensive approach to loss-reduction that encompasses mitigation preparedness, response, and recovery. To address the challenges associated with reducing the impacts of disasters and other extreme events, a substantial increase in research is needed. The development of innovative and integrated solutions to the problem of worldwide disaster vulnerability will benefit from the input from experts from a large number of disciplines, including the physical sciences, various engineering disciplines, and the social sciences. Indeed, knowledge and practice can only advance through collaborative efforts that bridge disciplinary boundaries and encourage multi- and interdisciplinary problem-focused research. Civil protection investigations and earthquake engineering research, integrated with knowledge from the social, economic, and policy sciences, have provided theoretical and practical approaches focusing on such areas as: (i) Risk and vulnerability assessment, including the development of risk and vulnerability assessment methodologies, to prioritize the allocation of limited resources; (ii) System analysis and design, to investigate the behavior of systems during and following extreme events and to foster capacity-design principles for fail-safe outcomes; (iii) Improved materials, to enhance the ability of infrastructure components and systems to withstand hazards; (iv) Sensing technologies, for structural health monitoring, with possible applications for detection, surveillance and prevention; (v) Post-event assessment, including the use of remote sensing technologies (e.g., satellite imagery, radar) to rapidly identify areas most seriously impacted by a disaster and the type of damage suffered and to aid in prioritizing response and relief activities; (vi) Post-event on-site screening methodologies, to assess the safety of structures after an event using simple tools based on expert knowledge; (vii) Advanced technologies for repair and restoration following an event, or retrofitting prior to an event; (viii) Evaluation test-beds, to test and validate new technologies proposed to achieve the above objectives; and (ix) Decision support tools for disaster mitigation, response, and recovery that are both validated on the basis of empirical data and acceptable and useful to end-users. Progress in all these areas requires close collaboration among researchers and practitioners.

The objectives of this thematic session were to (1) discuss the concepts of vulnerability and resilience and their application to the field of disaster loss reduction; (2) review research on resilience-enhancing strategies for mitigation, response, and recovery; (3) review the opportunities afforded by existing advancements and developments made in the fields of civil protection and earthquake engineering in each of the above categories; and (4) provide an overview of modifications possible to some of these tools to help address the broader extreme event and multi-hazard problems. Discussions center on selected critical infrastructure systems and interdependencies among them and on research demonstrating the applicability of advanced decision support tools for disaster response and recovery.

***Lesson Learned (within the theme of the session)***

Integrated multidisciplinary research, modeling, and simulation are needed on order to provide both key actors and populations at risk with improved estimates of the likely physical, social, and economic impacts of extreme events, in order to enhance their ability to make better-informed decisions for disaster loss reduction.

As engineering moves increasingly toward embracing the concept of performance-based design, it is also becoming increasingly apparent that societal participation in the development of acceptable performance standards is needed. Performance objectives must be based on a broad consensus of what different societies and different stakeholder groups consider desirable.

***Examples of Good Practices***

Development of advanced technologies for the seismic design of critical infrastructure, validated through rigorous research, have been integrated into nationally-used recommended design specifications. These specifications were published and widely distributed gratis by the Federal Emergency Management Agency (FEMA) throughout the U. S. and abroad, building on the results of research in an expedient and constructive way. As a result, there has been a rapid growth of new construction integrating these advanced technologies (dampers, base isolation systems, etc.) in many seismic regions worldwide, thus accelerating the objective of enhancing the seismic resistance of many communities.

With respect to the vulnerability of the critical infrastructure and interdependencies among infrastructural elements, sensitization of public authorities and private stakeholders is being accomplished through regular national-level meetings in Germany.

**2. Primary issues**

Key elements resulting from the discussions to consider for effective implementation of disaster risk reduction, from the perspective of this session, are:

- Although the robustness and damage-resistance of a lifeline system (such as power distribution network, water/gas distribution systems, and highway infrastructure) is important, the rapidity dimension of resilience (i.e., rapid response and reduced time to recovery) is key for lifelines.
- National Critical Infrastructure protection programs (combining governance, education and technology efforts) are necessary to reduce vulnerability.
- Research is important to develop the models and technologies to deliver a global integrated resilience framework that defines and quantifies both infrastructural and social vulnerability and resilience for critical infrastructure.
- Performance-based design for critical infrastructure is feasible provided a suite of credible data and tools (e.g. fragility functions) can be developed for all critical system components and system analysis. This will be a powerful tool for mitigation decision-support, pre-event planning and emergency response.
- Rapid response and restoration are dependent upon monitoring and assessment tools that can provide real-time and near-real time information.

**3. a) Suggested targets and indicators to measure accomplishments**

An example of resiliency target would be the ability to demonstrate that there is a 95% chance that 80% of hospitals can operate at 90% of their capacity within 5 days within a given urban region following an earthquake (or other disaster). However, it is important to emphasize that targets and indicators are the product of deliberations among stakeholders regarding acceptable levels of infrastructure performance, loss, and disruption. Thus, based on the best available science, stakeholders must define for themselves what constitute desirable targets. The development of plans and timelines to achieve these targets is then to be articulated by these communities, with due consideration of the resources needed to achieve these targets (e.g. code compliance strategies, retrofit programs, appropriate land use measures, funding formulas, etc).

**3.b) Existing indicators with reference**

There exist many different kinds of indicators to measure the vulnerability and resilience of infrastructural and social systems. .However, much remains to be done in this area, particularly in the development of consensus-based measures of these concepts. The following document defines such an approach for conceptualizing and measuring resilience for infrastructure systems:

Bruneau, M., Chang, S., Eguchi, R., Lee, G., O'Rourke, T., Reinhorn, A., Shinozuka, M., Tierney, K., Wallace, W., von Winterfelt, D., (2003). "A Framework to Quantitatively Assess and Enhance the Seismic Resilience of Communities", EERI Spectra Journal, Vol.19, No.4, pp.733-752.

**4. Partnerships**

Partnerships are needed among government and international agencies, universities` and research centers, to develop an integrated effort to achieve the quantified objectives stated above. Code development and enforcement bodies, private sector, and key stakeholders both provide input to the process, and serve as the implementation agents.

**5. Name, affiliation and contacts of presenters and titles of presentations**

Angela Queste, Head of Division, Centre for Critical Infrastructure Protection, Federal Office for Civil Protection and Disaster Response, Germany
*Vulnerability of modern societies towards natural disasters - the impact on critical infrastructures*

Dr. Masanobu Shinozuka, Distinguished Professor, and Chair, Civil and Environmental Engineering, University of California, Irvine, USA
*Enhancing the resilience of power grids against extreme events*

Dr. Michel Bruneau (Session Chair), Director, Multidisciplinary Center for Earthquake Engineering Research, and Professor, Department of Civil, Structural and Environmental Engineering
*Enhancing the resilience of acute care facilities against extreme events*

Dr. Kathleen Tierney (Session Rapporteur), Director of Natural Hazards Research and Applications Information Center, and Professor, Department of Sociology, University of Colorado at Boulder, USA
*Response and recovery in the perspective of enhancing the resilience of communities against extreme events*

Michel Bruneau also presented on behalf of Dr. Ian Buckle, Director, Center for Civil Engineering Earthquake Research, and Professor of Civil Engineering, University of Nevada, Reno.
*Enhancing the resilience of highway networks against extreme events*

**Name, affiliation and contact of person filling in the form**

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